

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.

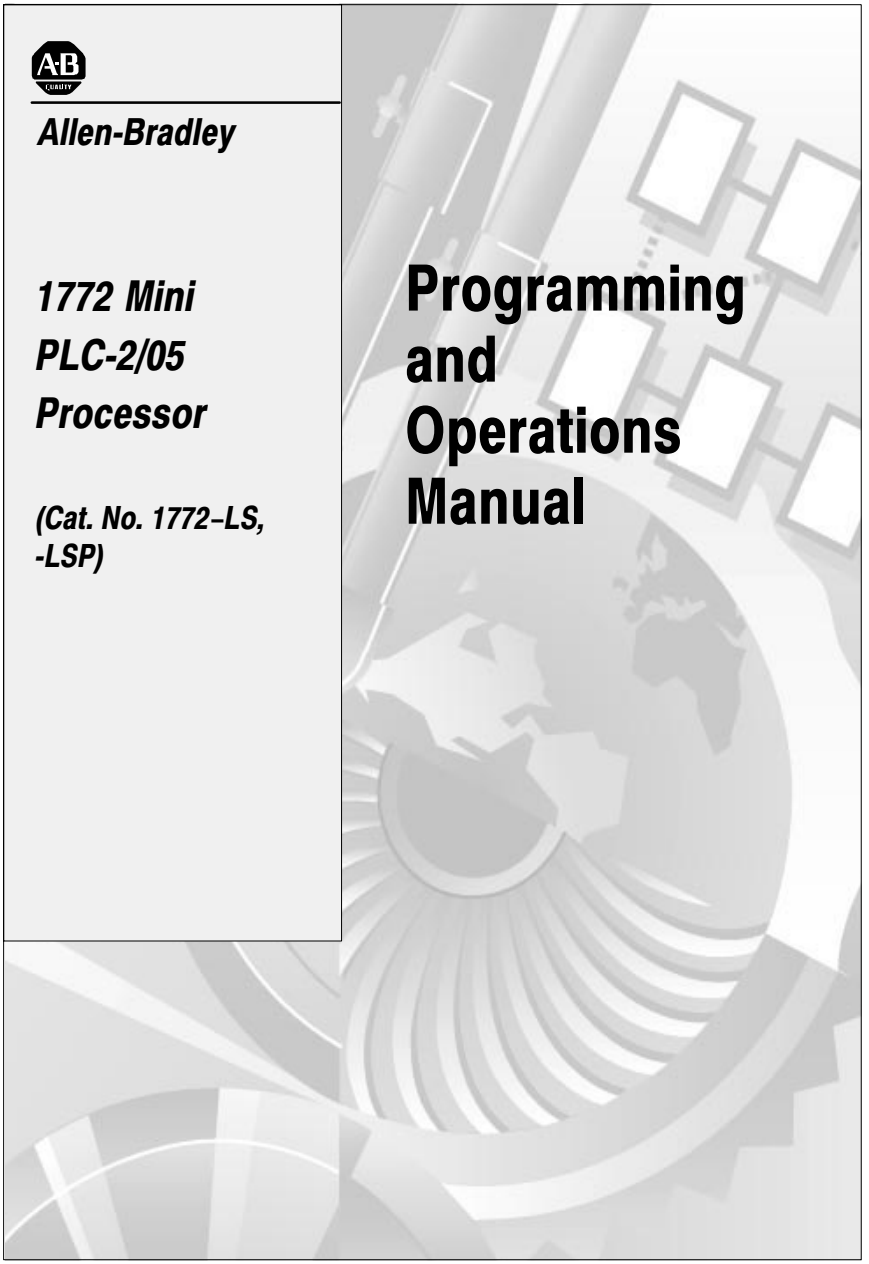
Custom engineering
so your equipment works exactly as you specify.

- 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.

Visit our website - *Click HERE*



Allen-Bradley

1772 Mini PLC-2/05 Processor

(Cat. No. 1772–LS, -LSP)

Programming and Operations Manual

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

Important User Information

Because of the variety of uses for this product and because of the differences between solid state products and electromechanical products, those responsible for applying and using this product must satisfy themselves as to the acceptability of each application and use of this product. For more information, refer to publication SGI-1.1 (Safety Guidelines For The Application, Installation and Maintenance of Solid State Control).

The illustrations, charts, and layout examples shown in this manual are intended solely to illustrate the text of this manual. Because of the many variables and requirements associated with any particular installation, Allen-Bradley Company cannot assume responsibility or liability for actual use based upon the illustrative uses and applications.

No patent liability is assumed by Allen-Bradley Company with respect to use of information, circuits, equipment or software described in this text.

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

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



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

Attention helps you:

- Identify a hazard
- Avoid the hazard
- recognize the consequences

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

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

Summary of Changes

Summary of Changes

This release of the publication contains updated information:

For this updated information:	See:
revised conventions	chapter 1
clarification to switch settings for 1772-LSP	chapter 3
description of keys on keytop overlay (1770-KCB)	chapter 3
corrections to the discussion about automatic restart	chapter 18
corrections to the discussion about program control	chapter 18
addition of ZCL to glossary	appendix B
new format	all chapters and appendices

To help you find new information in this publication, we have included change bars as shows to the left of this paragraph.

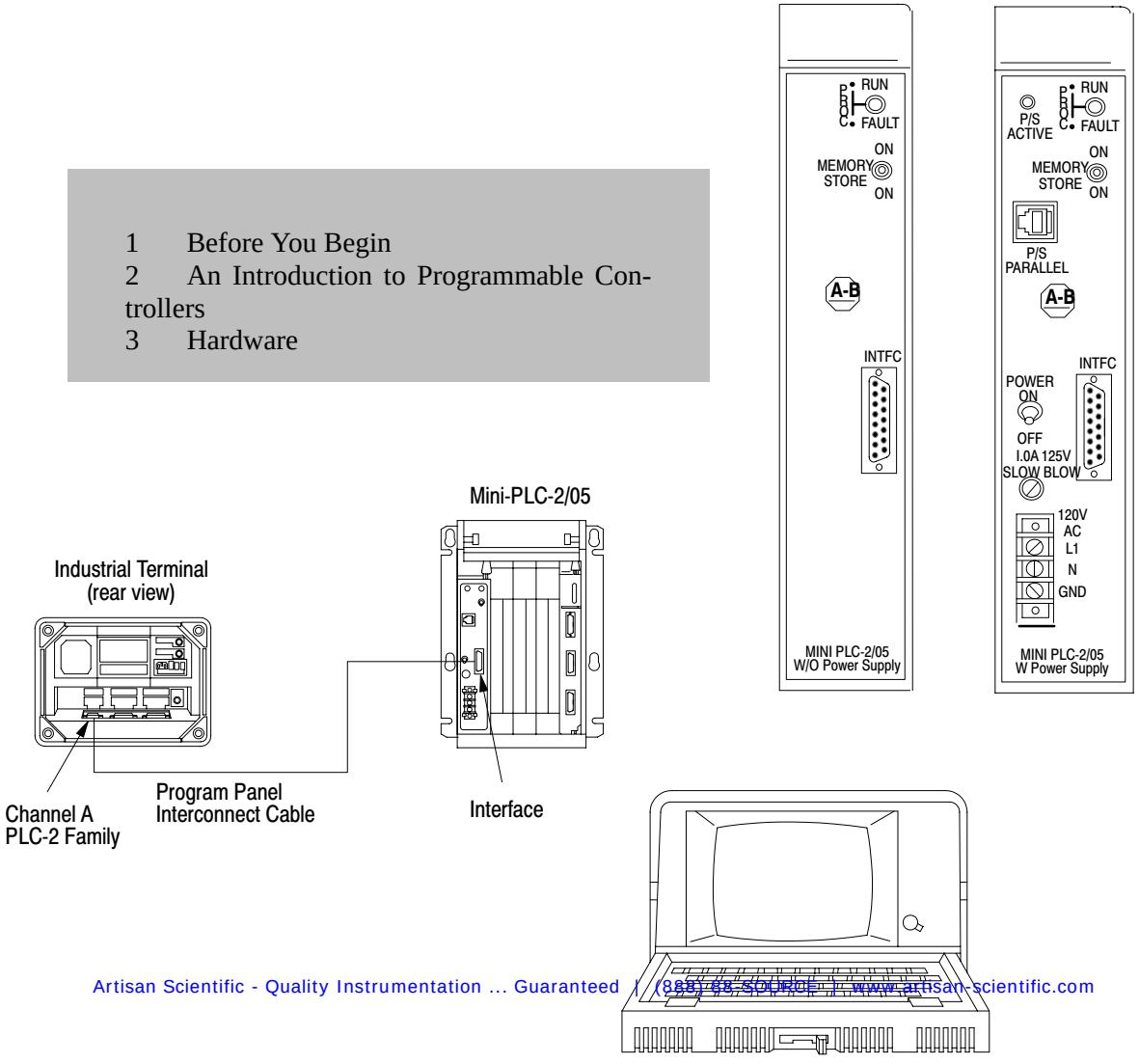
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Part

A

Hardware Overview

1 Before You Begin
2 An Introduction to Programmable Controllers
3 Hardware



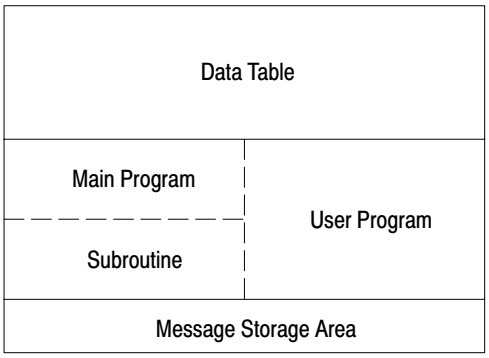
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

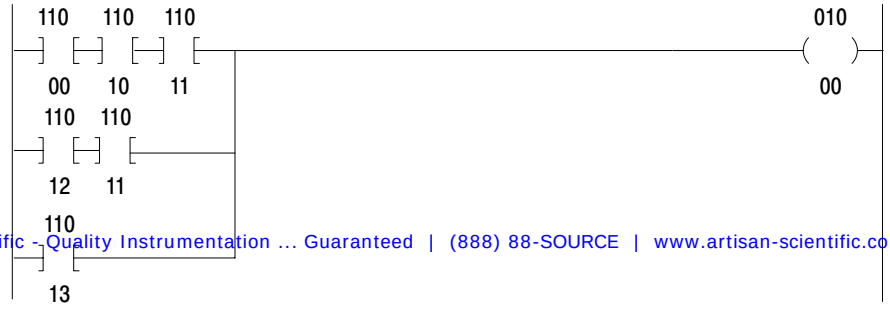
Part

B

Memory / Instruction Set

4 Memory Organization
5 Scan Theory
6 Relay-type Instructions
7 Program Control Instructions
8 Timers and Counters
9 Data Manipulation Instructions
10 Math Instructions
11 Data Transfer File Instructions
12 Sequencers
13 Jump Instructions and Subroutines
14 Block Transfer
15 Selectable Timed Interrupt





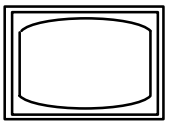
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Part

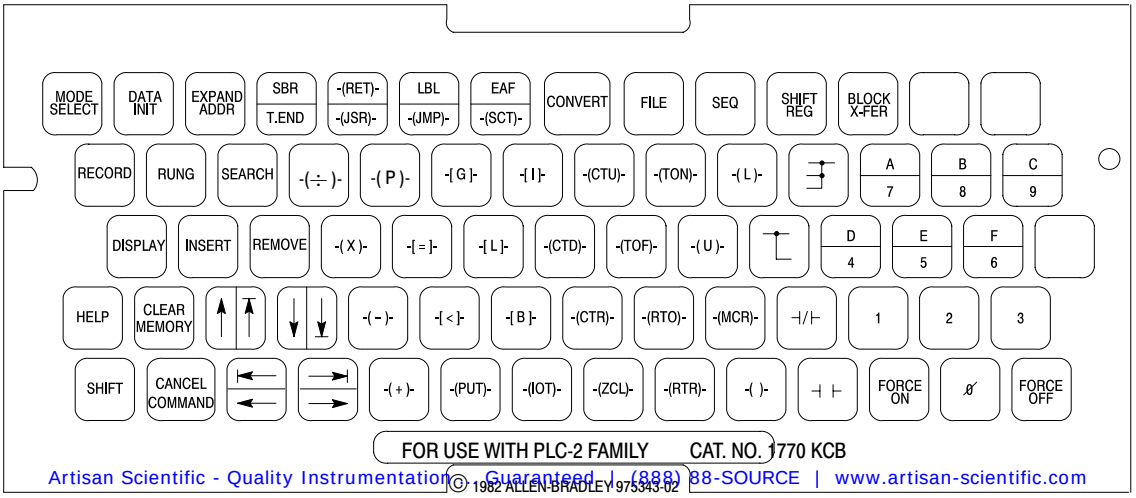
C

Program Editing





16 Program Editing



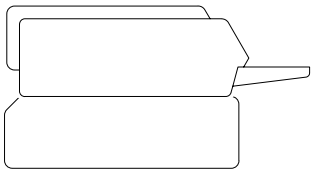
Artisan Scientific - Quality Instrumentation, Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Part

D

Report Generation / Application Programming Techniques

17 Report Generation
18 Programming Techniques



MS.0

198 MESSAGES SELECTED

MESSAGE CONTROL WORDS (ENTER 5 DIGIT WORD ADDRESS)

ADDRESS 00200 – 00227

MESSAGE CONTROL WORDS	MESSAGE NUMBERS	MESSAGE CONTROL WORDS	MESSAGE NUMBERS	MESSAGE CONTROL WORDS	MESSAGE NUMBERS
027	1–6				
00200	010–017	00210	1010–1017	00220	2010–2017
00201	110–117	00211	1110–1117	00210	2110–2117
00202	210–217	00212	1210–1217		
00203	310–317	00213	1310–1317		
00204	410–417	00214	1410–1417		
00205	510–517	00215	1510–1517		
00206	610–617	00216	1610–1617		
00207	710–717	00217	1710–1717		

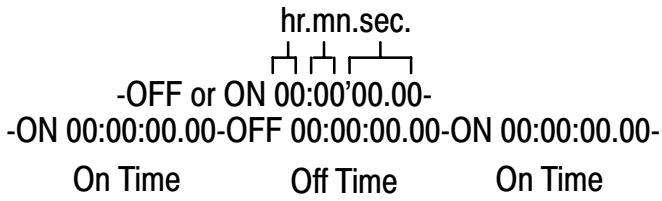
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Part

E

Program Troubleshooting

19 Program Troubleshooting



WORD ADDRESS: 0030

BIT NO.: 17 16 15 14 13 12 11 10 07 06 05 04 03 02 01 00

STATUS : 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

FORCE :

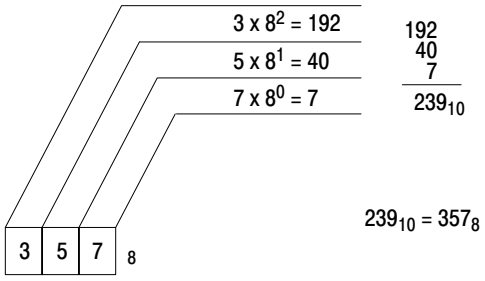
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Part

F

Appendices

A Number Systems
B Glossary
C Quick Reference
Index



Key Sequences:

[SEARCH]
[Instruction key]
(Address)

[SEARCH]
[5][3]
[Address]
[↑]or[↓]

[SEARCH]
[5][3]
[←] or [→]
[1] or [0]

This appendix contains defines terms and abbreviations that because of their complexity or recent introduction are not widely understood. These terms are:

AC Input Module
An I/O module that converts various AC signals originating at user devices to the appropriate logic level signal for use within the processor.

AC Output Module
An I/O module that converts the logic level signal of the processor to a usable output signal to control a user AC device.

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

Table of Contents

Summary of Changes i

Before You Begin 1-1

An Introduction to Programmable Controllers 2-1

Hardware 3-1

Memory Organization 4-1

Scan Theory 5-1

Relay-type Instructions 6-1

Program Control Instructions 7-1

Timers and Counters 8-1

Data Manipulation Instructions 9-1

Math Instructions 10-1

Three-Digit Math 10-1
Expanded Math 10-4
Chapter Summary 10-21

Data Transfer File Instructions 11-1

Types of File Instructions 11-1

Sequencers 12-1

Comparison with File Instructions 12-1
Chapter Summary 12-22

Jump Instructions and Subroutines 13-1

Label Instruction 13-3
Subroutine Area Instruction 13-4
Chapter Summary 13-7

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

Block Transfer 14-1

Selectable Timed Interrupt 15-1

Program Editing 16-1

Rules for Editing Instructions 16-1

Report Generation 17-1

Programming Techniques 18-1

Program Troubleshooting 19-1

Number Systems A-1

Glossary B-1

Quick Reference C-1

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

Chapter 1

Before You Begin

Important: Read this chapter before you use the Mini-PLC-2/05 Processor (cat. no. 1772-LS,-LSP). It tells you how to use this manual.

Purpose

The Mini-PLC-2/05 processor is functionally similar to the Mini-PLC-2/15 processor. The Mini-PLC-2/05 processor has some additional features:

- selectable timed interrupt
- memory protect switch
- fast I/O scan
- user selectable PROM/RAM backup
- 3K memory
- expanded mathematics

However, this processor does not have a mode select switch.

To the Reader

This manual is divided into six parts (Table 1.A).

Table 1.A
Parts of the Mini-PLC-2/05 Processor Programming and Operations Manual

Part	Title	What's Covered
A	Hardware Overview	basic theory concerning the hardware features available when using this processor
B	Memory/Instruction Set	describes the memory and informs you about the techniques you can use when programming this processor
C	Program Editing	how to edit your program once it has been entered into the memory
D	Report Generation/Application Program Techniques	how to do report generation and use special program techniques
E	Program Troubleshooting	acts as a guide so you can minimize production down time
F	Appendices	contains tables and reference information useful when programming your processor

This manual is procedure oriented. It tells you how to program and operate your Mini-PLC 2/05 Processor. If you need to learn more about the Mini-PLC-2/05 Processor, contact your local Allen-Bradley representative or distributor.

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

Vocabulary

To make this manual easier to read and understand, we refer to the:

We Refer to the:	As the:
Mini-PLC-2/05 Processor	processor
Electrically Erasable Programmable Read Only Memory	EEPROM
Execute Auxiliary Function	EAF
Complementary Metal Oxide Semi-conductor Random Access Memory	CMOS RAM
Industrial Terminal (cat. no. 1770-T3)	1770-T3 terminal

A glossary at the back of this manual clarifies technical terms.

Conventions

A word equals 16 bits; a byte equals 8 bits (1/2 a word).

Words in [ ] denote the key name or symbol. Words in < > denote information that you must provide - for example, an address value.

Word values are displayed in:

- decimal (0-9) for timers, counters, and mathematics

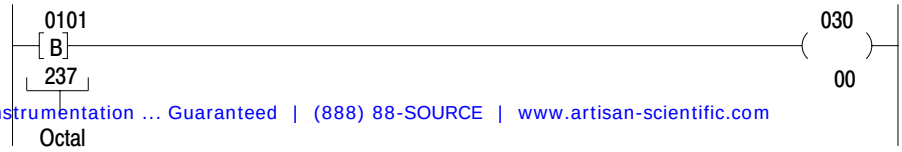


- hexadecimal values (0-9, A-F) for gets and puts



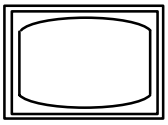
Important: Numbers 0-9 are displayed the same in decimal and hexadecimal.

- octal for byte values



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

Keystroke directions are divided into two columns:

-  tells you what key or keys to press
-  tells you the processor's action.

Related Publications

The publication index, publication SD 499, lists all available publications to further inform you about products related to the Mini-PLC-2/05 processor. Consult your local Allen-Bradley distributor or sales engineer for information regarding this publication or any needed information.

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

Chapter 2

An Introduction to Programmable Controllers

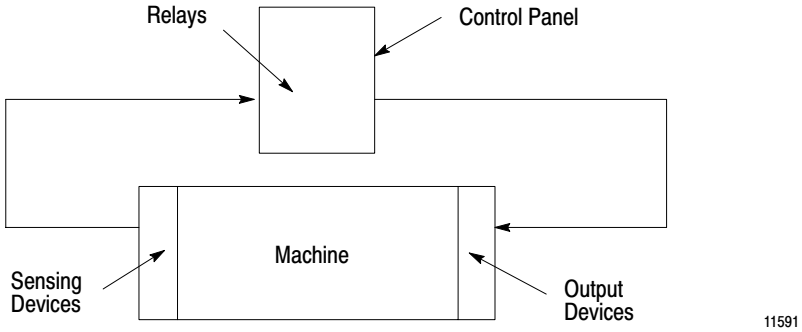
Chapter Objectives

In this chapter, you review general fundamentals common to our programmable controllers. This chapter:

- describes what a programmable controller does
- describe the four major sections of a programmable controller
- describes how the four major sections of a programmable controller interact
- gives an example of a simple program

Traditional Controls

You are probably familiar with the traditional methods of machine control.



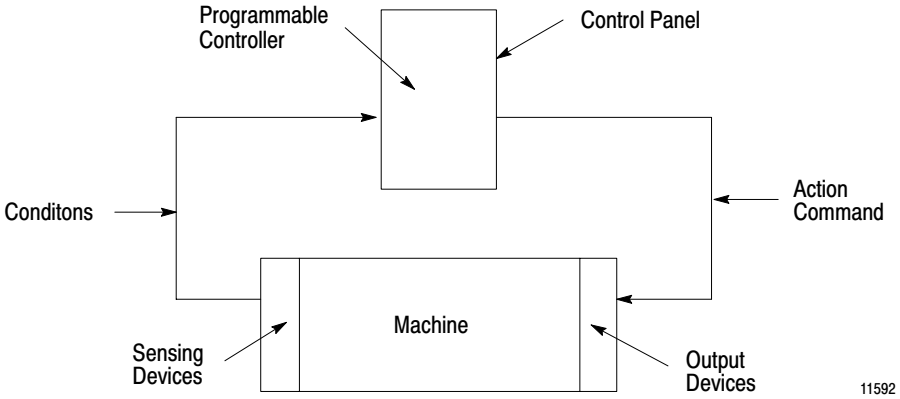
Sensing devices located on the machine detect changes in the machine's condition. For instance, a part arriving at a work station contacts and closes a limit switch, the sensing device. As a result, an electrical circuit is completed and a signal is sent to the control panel.

At the control panel, the electrical signal enters a bank of relays or other devices, such as solid state modules. Circuits within the control panel open or close causing additional electrical signals to be sent to output devices at the machine. For example, a relay energized by the limit switch closed by the arriving part may complete another circuit energizing the output device, a clamp, which secures the part at the work station.

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

Programmable Controls

Programmable controllers can perform many of the functions of traditional controls. Sensing devices report to the processors. The output devices at the machine operate the same as they would with traditional controls.



The field wiring between the machine and the control panel provides electrical paths from the sensing devices to the control panel, and from the control panel to the output devices.

However, inside the control panel you'll find a programmable controller rather than relays or discrete solid state devices. Instead of wiring those devices and relays together to produce a desired response, you simply tell your programmable controller by means of a program how you want it to respond to the same conditions.

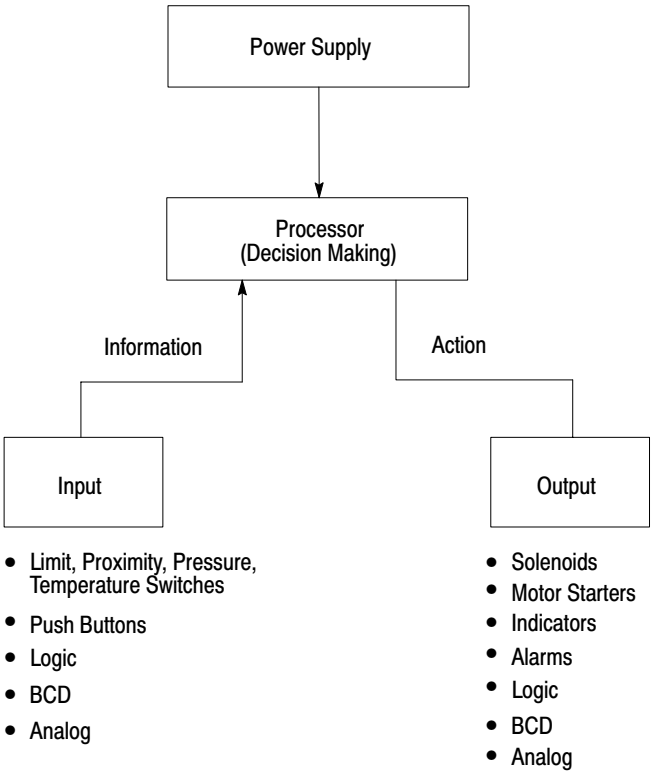
Programming is telling your programmable controller what you want it to do. A program is nothing more than a set of instructions you give the programmable controller telling it how to react to different conditions within the machine.

The Four Major Sections

Let's take a closer look at a typical programmable controller. It usually consists of four major sections:

- processor
- input
- output
- power supply

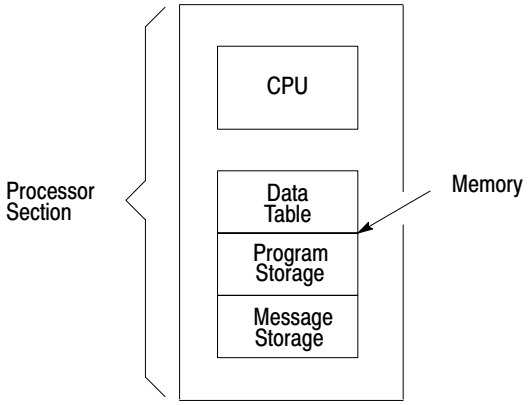
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com



Processor

The first section of a programmable controller is the processor. The processor might be called the “brains” of the programmable controller. It is divided into halves:

- central processing unit
- memory



Central Processing Unit

The central processor unit (CPU) makes decisions about what the processor does.

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

Memory

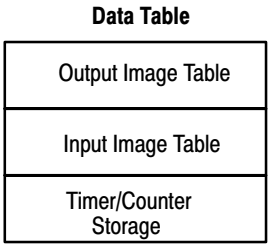
Memory serves three functions:

- stores information in the data table that the CPU may need
- stores sets of instructions called a program
- stores messages

Data Table

The area of memory where data is controlled and used, is called the data table. The data table is divided into several smaller sections according to the type of information to be remembered. These smaller sections are called:

- output image table
- input image table
- timer/counter storage



At this time, we will only discuss the input and output image tables and program storage.

I/O Image Tables

The input image table reflects the status of the input terminals. The output image table reflects the status of bits controlled by the program.

Each image table is divided into a number of smaller units called bits. A bit is the smallest unit of memory. A bit is a tiny electronic circuit that the processor can turn on or off. Bits in the image table are associated with a particular I/O terminal in the input or output section.

When the processor detects a voltage at an input terminal, it records that information by turning the corresponding bit on. Likewise, when the processor detects no voltage at an input terminal, it records that information by turning the corresponding bit off. If, while executing your program, the CPU decides that a particular output terminal should be turned on or off, it records that decision by turning the corresponding bit on or off. In other words, each bit in the I/O image tables corresponds to the on or off status of an I/O terminal.

When people who work with personal computers talk about turning a bit on, they use the term “set.” For example - “The processor sets the bit” means “turns it on.” On the other hand, we use the term “reset” when we talk about turning the bit off - for example, “The processor reset the bit.”

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

Picture memory as a page that has been divided into many blocks. Each block represents one bit. Since each bit is either on or off, we could show the state of each bit by writing “on” or “off” in each block. However, there is an easier way. We can agree that the numeral one (1) means on and that the numeral zero (0) means off. We can show the status of each bit by writing 1 or 0 into the appropriate block. For example, you might hear expressions like, “The CPU responded by writing a one into the bit when the limit switch closed.” Of course, the processor didn’t really write a one into memory: it simply set the bit by turning it on.

When the I/O device is:	The bit status is said to be:
on	on 1 set
off	off 0 reset

If you heard the expression, “The processor wrote a zero into that bit location.” What actually happened? If you said the processor merely reset the bit by turning it off, you’re right.

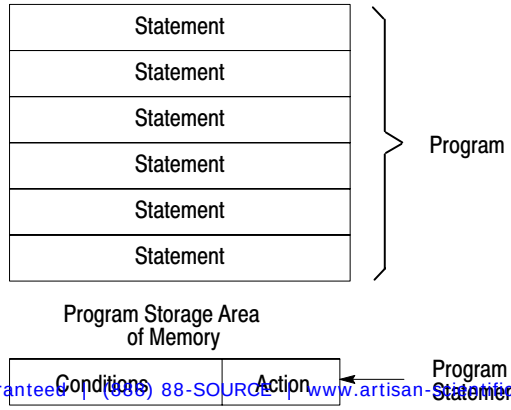
Program Storage

The other major area of memory, program storage, takes up the largest portion of memory. You’ll recall that this is where your instructions to the programmable controller are stored. You’ll also recall that this set of instructions is called a program.

Program Language

A program is made up of set of statements. Each statement does two things:

- It describes an action to be taken. For instance, it might say, “Energize motor starter number one.”
- It describes the conditions that must exist in order for the action to take place.



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

For example, you may want this action to take place: ”Whenever a certain limit switch closes.” So your condition could be: “If limit switch number two is closed,...” The action would be: “energize motor starter number one.” The entire statement is then: “If limit switch number two is closed, then energize motor starter number one.” Therefore, when limit switch number two at the machine closes, the programmable controller energizes the motor starter. If limit switch number two does not close, the programmable controller does not energize the motor starter. Thus, when limit switch number two opens, the programmable controller de-energizes the motor starter because that action is implied in the statement.

A program is made up of a number of similar statements. Typically, there is one statement for each output device on the machine. Each statement lists the conditions that must be met and then, states the action to be taken.

Instructions
Each condition is represented by a specific instruction; therefore, each action is represented by a specific instruction. These instructions tell the processor to do something with the information stored in the data table.

Some instructions tell the processor to read what’s written in the image table. When the processor is instructed to read from an image table, it examines a specific bit to see if a certain I/O device is on or off.

Other instructions tell the processor to write information into the image table. When the processor is instructed to write into the output image table, it writes a one or a zero into a specific bit. The corresponding output device will turn on or off as a result.

Input

The second section is the input, which serves four very important functions:

- termination
- indication
- conditioning
- isolation

Termination
The input provides terminals for the field wiring coming from the sensing devices on the machine.

Indication
The input of most modules also provides a visual indication of the state of each input terminal with indicators. The indicator is on when there is a voltage applied to it terminal. It is off when there is no voltage applied to its terminal. Since the indicator reveals the status of its terminal, it’s usually called an input status indicator.

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

You should also notice another important characteristic of input indicators. They are only associated with terminals used for wiring sensing devices to the input section. The terminal that's used to provide a ground for the sensing circuits has no indicator.

Conditioning
Another function of the input is signal conditioning. The electrical power used at the machine is usually not compatible with the signal power used within the programmable controller. Therefore, the input section receives the electrical signal from the machine and converts it to a voltage compatible with the programmable controller's circuitry.

Isolation
The input isolates the machine circuitry from the programmable controller's circuitry. Isolation helps protect the programmable controller's circuitry from unwanted and dangerous voltage levels that may occur occasionally at the machine or in the plant's wiring system.

Output

The third section is the output, which serves functions similar to those of the input image table:

- termination
- indication
- conditioning
- isolation

Termination
The output provides terminals for the field wiring going to the output devices on the machine.

Indication
The output of most modules provides a visual indication of the selected state of each output device with indicators.

The output status indicator is on when the output device is energized. A common term applied to either input status indicators or output status indicators is I/O status indicators. I/O stands for either input or output.

In addition, the output section of modules with fuses has blown fuse indicators. When one of the fuses in the group opens, the blown fuse indicator lights.

Conditioning
The output conditions the programmable controller's signals for the machine. That is, it converts the low-level dc voltages of the programmable controller to the type of electrical power used by the output devices at the machine.

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

Isolation

The output isolates the more sensitive electronic circuitry of the programmable controller from unwanted and dangerous voltages that occasionally occur at the machine or the plant's wiring system. Some situations require additional external protection.

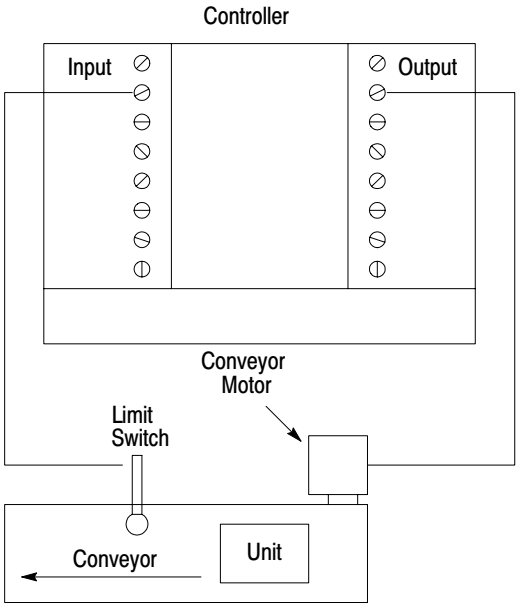
Power Supply

The fourth section is the power supply. It provides a low level dc voltage source for the electronic circuitry of the processor. It converts the higher level line voltages to low level logic voltages required by the processor's electronic circuitry.

Control Sequence

Let's look at a simple example to see the sequence of events that take place in controlling a machine with a programmable controller (Figure 2.1). Suppose you are making a part. The motor driven conveyor carries a unit to the work area. The limit switch detects wen the part arrives at the work area. When that happens, we want the conveyor to stop so you can work on the part.

Figure 2.1
A Simplified Example of a Machine with a Programmable Controller



Notice how the limit switch and motor are wired to the programmable controller. The limit switch, wired to terminal 02, is normally-closed. The arriving part will open the switch. Therefore, the program statement controlling the conveyor motor must read: "If there is voltage at input terminal 02 (limit switch), then energize output terminal 02 (conveyer motor)." The conveyor motor is wired to output terminal 02.

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

Important: Figure 2.1 is for demonstration purposes only. We do not show the associated wiring, a motor starter, or an emergency stop button.

Since the limit switch is wired normally-closed, the conveyor motor will run until the arriving part opens the switch. At that time, the condition for energizing the motor is not longer met. Therefore, the motor is de-energized.

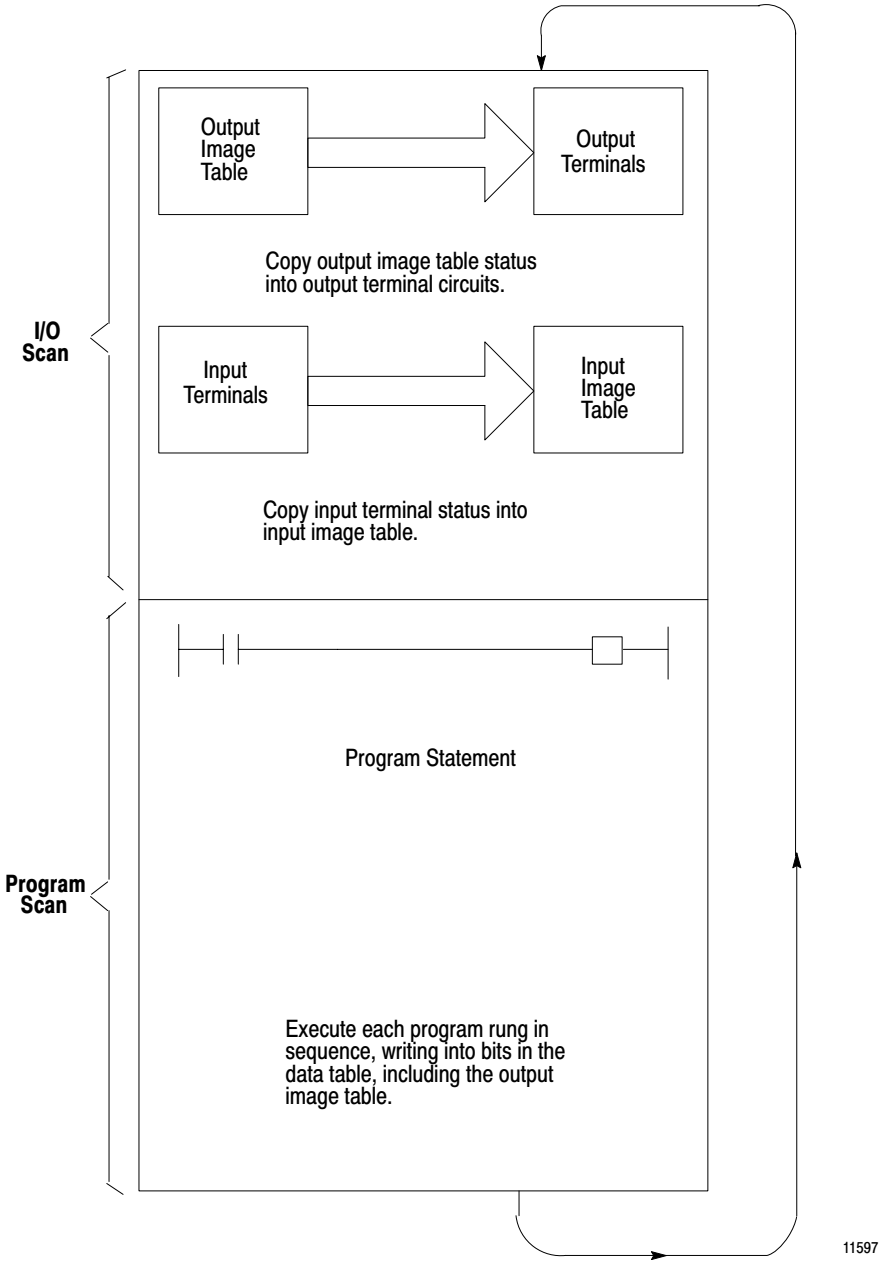
When the condition is met, we say it is true. When the condition is not met, we say it is false. There may be more than one condition which must be met before an action is executed. When all the conditions are met, the action is executed and we say the statement is true. When one or more of the conditions are false, the action is not executed and we say the statement is false.

Scan Sequence

On power up, the processor begins the scan sequence (Figure 2.2) with the I/O scan. During the I/O scan, data from input modules is transferred to the input image table. Data from output image table is transferred to the output modules.

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

Figure 2.2
Scan Sequence



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

Next, the processor scans the program. It does this statement by statement. Each statement is scanned in this way:

1. For each condition, the processor checks, or "reads," the image table to see if the condition has been met.
2. If the set of conditions has been met, the CPU writes a one into the bit location in the output image table corresponding to the output terminal to be energized. On the other hand, if the set of conditions has not been met, the processor writes a zero into the bit location, indicating that the output terminal should not be energized.

Here is a simple explanation of the program. If input 02 is on, then turn on output 02. If input 02 is off, then turn off output 02. The program could be written this way:

If (condition)	**Then** (action)
Input bit 02 is on	Turn output bit 02 on

In this example, the processor reads a 1 at input bit location 02 and knows that the condition has been met. The processor then carries out the action instruction by writing a 1 into output bit location 02.

If there were more statements in the program, the processor would continue in this same manner scanning each statement and executing each instruction until it reached the end of the program. Statement by statement, the processor would write a 0 or a 1 into an output bit as directed by the program. Then, the processor would read specific image table bits to see if the proper set of conditions were met. After reading and executing all program statements, the processor scans the output image table and energizes or de-energizes output terminals. The processor then goes to the input modules to update the input image table.

Now the entire process is repeated. In fact, it's repeated over and over again, many times a minute. Each time, the processor sets or resets output bits. Next, the processor senses the status of the input terminals. Finally, the processor scans the program and orders each output terminal on or off according to the state of its corresponding bit in the output image table.

When forcing is attempted, the processor's I/O scan slows down to do the forcing (see chapter 19). When forcing is terminated, the processor automatically switches back to the faster I/O scan mode.

When this example begins, the processor is energizing output terminal 02 because output bit 02 is on.

When the part is conveyed to the work station, it turns the limit switch off. When the limit switch is off, there is no voltage at input terminal 02. The processor scans the input image table, senses no voltage, and responds by writing a zero into bit 02 in the input image table.

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

The processor scans the program. Our program states that if (conditions) input bit 02 is on, turn on output 02. If input bit 02 is off then output bit 02 is off. Since the alter condition is not true, the processor turns off output bit 02.

When the processor next scans the output image table, it sees the zero in output bit 02 and responds by de-energizing output terminal 02. The action causes the conveyor to stop.

Chapter Summary

We reviewed fundamentals common to A-B processors. The next chapter summarizes hardware features of the Mini-PLC-2/05 processors.

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

Chapter 3

Hardware

Chapter Objectives

This chapter is a summary of the Mini-PLC-2/05 Processor Assembly and Installation Manual, publication 1772-6.6.6. In this chapter, you will read about:

- major features
- general features
- hardware features
- optional features

Major Features

A complete processor system consists of the following major components:

- Mini-PLC-2/05 processor
- I/O chassis
- power supply
- I/O modules (up to 16 modules)
- industrial terminal (cat. no. 1770-T3)

General Features

The processor has the following features:

- 3K CMOS RAM memory
- 488 timers
- up to 2944 word capacity data table (23 blocks)
- ladder diagram and functional block instruction set
- four function arithmetic capabilities
- remote mode selection
- on-line programming
- block transfer capability
- 70 message storage (with the 1770-T3 terminal only)
- 198 message storage with the PLC-2 Family Report Generation Module (catalog number 1770-RG)
- data highway compatibility
- selectable timed interrupts
- expanded math capability

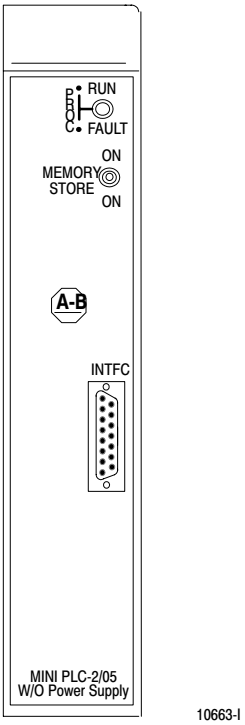
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Hardware Features

Mini-PLC-2/05 Processor (cat. no. 1772-LS)

The Mini-PLC-2/05 Processor (cat. no. 1772-LS) comes equipped with the following hardware features (Figure 3.1):

Figure 3.1
Mini-PLC-2/05 Processor (cat. no. 1772-LS)



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

Processor Status Indicator

PROC RUN/FAULT: This red/green LED keeps you informed of the processor's operating conditions.

Table 3.A
Status Indication

Status Indicator	If the color is	Then the Indication represents
PROC RUN/FAULT	Green	The processor module is in the run mode and will begin operation.
	Blinking Green	The EEPROM memory module (if present) is being programmed.
	Red	There is a fault. Recycle power to reset the processor module.
	Off	Either program mode of operation, run time error, memory error or a program error.
P/S ACTIVE	Green	AC and DC is all right.
	Off	There has been a power supply fault, overcurrent condition, improper input voltage or the module has been turned off.

MEMORY STORE (Switch)

Purpose: Enables you to backup or copy the program into the optional EEPROM Memory Module.

Hardware: An optional EEPROM Memory Module (cat. no. 1772-MJ) can be installed in the module.

INTFC (Interface socket)

Purpose: The 15 pin socket, labeled INTFC, provides communication between the processor and the programming terminal (1770-T3 or 1784-T50), the 1770-RG report generation module, the 1770-T11 hand held terminal, the 1772-KG interface module or 1771-KA communications interface module.

Processor Module and:	Through:	Catalog Number:
Industrial Terminal (cat. no. 1770-T3)	PLC-2 Program Panel Interconnect Cable	1772-TC
Industrial Terminal (cat. no. 1784-T50)	PLC-2 Program Panel Interconnect Cable	1772-TC or 1784-CP2
Data Highway Communication Modules	Data Highway/Processor Cables	1771-CN, -CO, or -CR
PLC-2 Family Report Generation Module (cat. no. 1770-RG)	PLC-2 Program Panel Interconnect Cable	1772-TC (with external ground wire only)

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

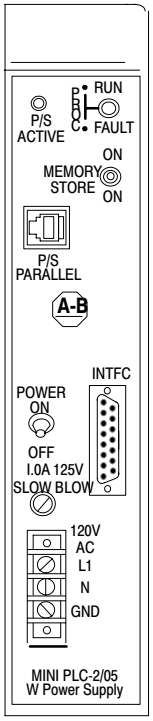
The 1784-T50 also requires PLC-2 6200 programming software (cat. nos. 6201-PLC2, 6203-PLC2, 6211-PLC2, or 6213-PLC2).

Function: Provides interface to the above devices.

Mini-PLC-2/05 Processor (cat. no. 1772-LSP)

The Mini-PLC-2/05 Processor (cat. no. 1772-LSP) contains all the hardware features of the LS processor and in addition contains the following (Figure 3.2):

Figure 3.2
Mini-PLC-2/05 Processor with Power Supply (cat. no. 1772-LSP)



10717-I

Processor Status Indicator

P/S ACTIVE: This green LED keeps you informed of the power supply section's operating conditions (table 3.A).

P/S PARALLEL (socket)

Purpose: Enables paralleling connections between these two sockets on two power supply modules.

POWER (switch)

Purpose: This is on/off toggle switch lets you provide power to your processor.

If the switch is:	Then you are:
On	Supplying power to your processor module.
Off	Not supplying power to your processor module.

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

Fuse

Purpose: Guards against overcurrent conditions on the input line.

Sizes: 1.0 amp fuse for 120V AC operations

Terminal Strip

Purpose: To provide wire connections for the processor.

Hardware: Terminals L1, N and GND label the AC input connections.

Switch Assembly on the I/O Chassis

Purpose: Determines processor response to memory protect and power-up sequence.

Location: Left side of the I/O chassis backplane.

Settings:

If	Then
Switch 8 is on	Memory protection is on. Memory above 20_{08} cannot be changed by the programmer.
Switch 8 is off	Memory protection is disabled. memory can be changed by the programmer. Memory can be changed when the processor module is in the program mode.
Switch 6 is off	Contents of the EEPROM is always transferred to the CMOS RAM at power-up.
Switch 6 is on and Switch 7 is off	Memory transfer does not occur and the module gives a fault indication.
Switch 6 is on and Switch 7 is on	If the CMOS RAM passes its checksum on power-up, the contents of the EEPROM transfer to the CMOS RAM.
The settings for Switch 1– Switch 5 do not matter.	

Important: Series A/Revision A of the 1770-T3 industrial terminal is not compatible with memory protect feature.



ATTENTION: Use a ball point pen to set each switch. Do not use a lead pencil because the tip can break off and jam the switch.

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

Battery Backup

Purpose: Provides battery backup power for the processor's memory.

Hardware: Size AA, 3.6V Lithium Battery, 1.785 amp hr, 0 to 70ºC

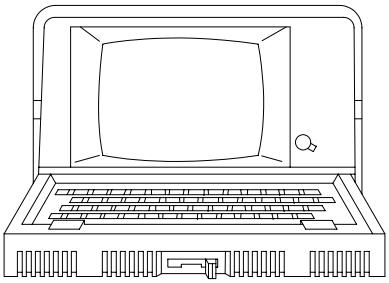
Function: In order for you to retain processor memory after loss of power, the processor contains an AA size lithium battery. A removeable holder located at the rear of the processor module houses your battery. This battery supports stored memory for up to two years. We recommend documenting the start-up date of your processor. Put the date on the label at the side of the processor.

Optional Features

Industrial Terminal

Purpose: You need the Industrial Terminal System (cat. no. 1770-T3) or an Industrial Terminal (cat. no. 1784-T50) with 6200 programming software (6201-, 6203-, 6211-, 6213-PLC2) to program the processor and access the processor modes of operation (Figure 3.3).

Figure 3.3
Industrial Terminal System



10697-I

Function: With your industrial terminal you can:

- enter
- edit
- test
- troubleshoot

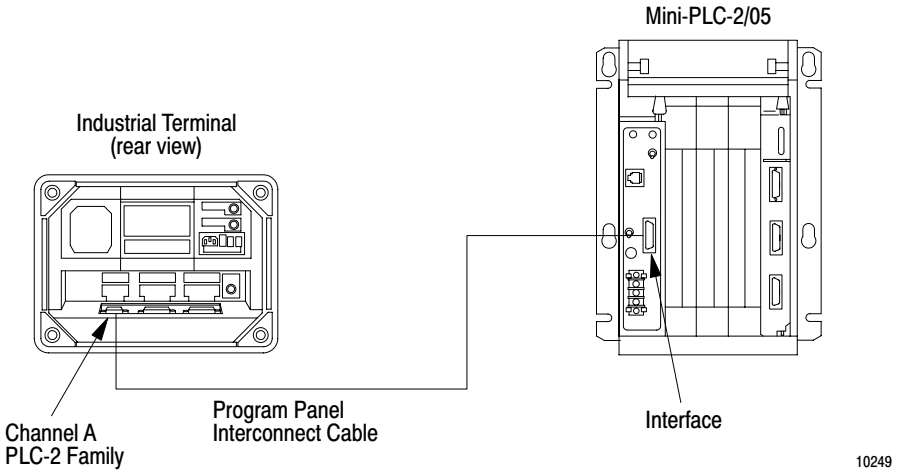
your program.

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

Installation

Before you start to program your processor make sure all of your peripheral equipment is installed properly. Follow these basic instructions to install the industrial terminal to the processor. Refer to Figure 3.4 when following these instructions.

Figure 3.4
Industrial Terminal Installation



1. Plug the ac power cord of the industrial terminal to the incoming ac power source.

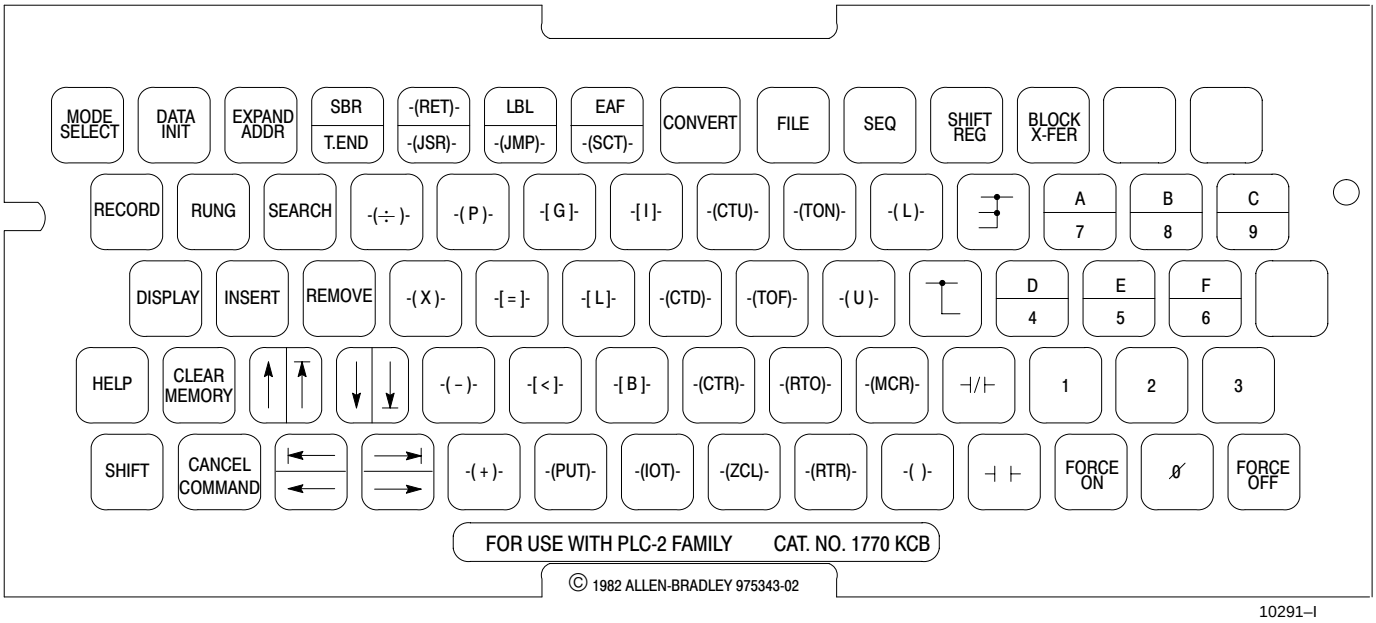
2. Connect one end of the PLC-2 Program Panel Interconnect Cable (cat. no. 1772-TC) to CHANNEL A at the rear of the industrial terminal.

3. Connect the other end of the cable to the socket labeled INTFC at the front of the processor.

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

4. Place the PLC-2 Family Keytop Overlay (cat. no. 1770-KCB) (Figure 3.5) onto the keyboard.

Figure 3.5
PLC-2 Family Keytop Overlay



10291–I

Table 3.B
Definitions of Keys

This key:	Does this:	This key:	Does this:	This key:	Does this:
top row of keys					
MODE SELECT	select terminal mode	DATA INIT	enter data into a file	EXPAND ADDR	enter expanded address
SBR / T.END	SHIFT – enter sub-routine enter temporary	-(RET)- / -(JSR)-	SHIFT – enter return enter jump to sub-	LBL / -(JMP)-	SHIFT – enter label enter jump to jump
EAF / -(SCT)-	SHIFT – enter EAF, expanded not with applicable to Mini-PLC-2/05	CONVERT	not applicable to Mini-PLC-2/05	FILE	enter file instruction
SEQ	enter sequencer	SHIFT REG	not applicable to Mini-PLC-2/05	BLOCK X-FER	enter block transfer

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

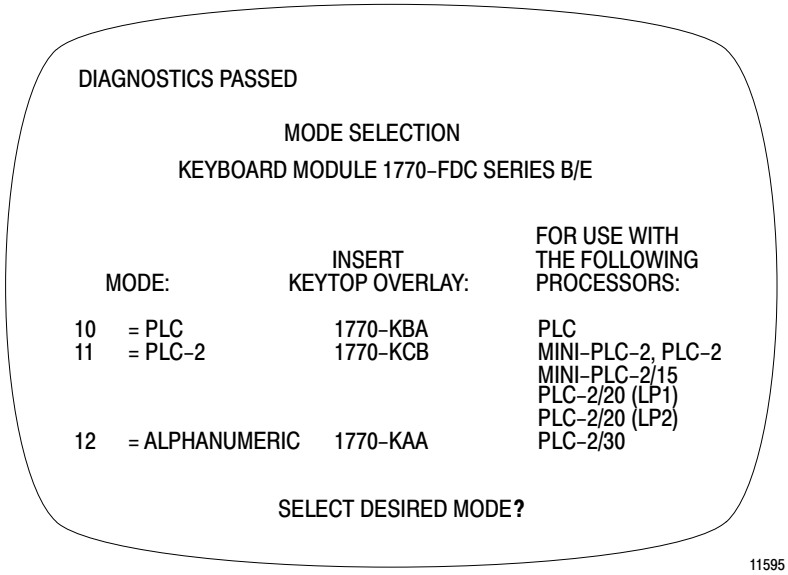
second row of keys					
RECORD	enter new data	RUNG	specify rung	SEARCH	specify search
-(÷)-	enter 3-digit divide	-[G]-	enter get	-[I]-	enter immediate input
-(CTU)-	enter up counter	-(TON)-	enter timer on-delay	-(L)-	enter output latch
⊣	enter branch end	A / 7	SHIFT – enter A enter 7	B / 8	SHIFT – enter B enter 8
C / 9	SHIFT – enter C enter 9				
third row of keys					
DISPLAY	display specified data	INSERT	insert the next specified item	REMOVE	remove the next specified item
-(X)-	enter 3-digit multiply	-[=]-	enter equal	-[L]-	enter limit test
-(CTD)-	enter down counter	-(TOF)-	enter timer off-delay	-(U)-	enter output unlatch
⊢	enter branch start	D / 4	SHIFT – enter D enter 4	E / 5	SHIFT – enter E enter 5
F / 6	SHIFT – enter F enter 6				
fourth row of keys					
HELP	display help directory	CLEAR MEMORY	clear processor memory	↑	SHIFT – move cursor up move cursor up
↓	SHIFT – move cursor down move cursor down	-(-)-	enter 3-digit subtract	-[<]-	enter less than
-[B]-	enter get byte	-(CTR)-	enter counter reset	-(RTO)-	enter retentive timer on-delay
-(MCR)-	enter master control reset	⊣/⊢	enter examine off	1	enter a 1
2	enter a 2	3	enter a 3		

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

fifth row of keys					
SHIFT	access function on top half of keys that support two functions	CANCEL COMMAND	end current function without saving	←	SHIFT – move cursor left move cursor left
→	SHIFT – move cursor right move cursor right	-(+)-	enter 3-digit add	-(PUT)-	enter put
-(IOT)-	enter immediate output	-(ZCL)-	enter zone control last state	-(RTR)-	enter retentive timer reset
-( )-	enter output energize	⊣ ⊢	enter examine on	FORCE ON	specify force off
0	enter a 0	FORCE OFF	specify force off		

5. Turn the power switch on the front of the industrial terminal to the ON position.

6. After a short while the following display will appear.



Select your desired processor mode by pressing 11 on the 1770-T3 terminal.

7. After initialization has been completed, select the processor mode of operation using the keystrokes below.

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

Run/Program	[SEARCH] 590
Remote test	[SEARCH] 591
Remote Program	[SEARCH] 592



ATTENTION: Use only Allen-Bradley authorized programming devices to program Allen-Bradley programmable controllers. Using unauthorized programming devices may result in unexpected operation, possibly causing equipment damage and/or injury to personnel.

Important: When power is re-applied following a power failure and if switch 6 is on, the processor returns to the last programmed mode of operation.

If you are not familiar with each mode of operation, here is the way we define each term:

Run/Program - This is the normal mode of operation where the program controls your outputs. you can edit your program and make on-lien data changes when you are in this operational mode.

Remote Test - The program is executed, the inputs are scanned, the outputs are disabled. The selectable timed interrupts are executed.

Remote Program - The processor stops scanning and executing its stored program and waits for commands from the programmer. If you have an optional EEPROM memory module, you must be in the remote program mode when duplicating RAM memory contents to the EEPROM memory module. Refer to Memory Module Product Data (publication 1771-936) for operational details on memory transfer.

Industrial Terminal Keyboard

Function: The detachable keyboard houses PROM memory, a sealed touchpad, and a keytop overlay.

There are three keytop overlays:

PLC-2 Family - for use with any PLC-2 family processor.

PLC - for use with any PLC family processor.

Alphanumeric - for alphanumeric characters and graphic characters generation.

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

Key Symbols - There are no numbered keys greater than 9. To display numbers which are greater than 9 press the individual keys. For example:

To display:	1011
Press individually:	1011

Some keys have two symbols occupying one key (Figure 3.5). To display the top section of each key use your shift key before the desired symbol. For example:

Press 7:	To display 7
Press[SHIFT] A:	To display A

Data Monitor Functions - You can display on a CRT and print directly to a data terminal - binary, hexadecimal, and ASCII data monitor functions by performing the keystrokes in table 16.B.

Paralleling Cable

Purpose: using the 1772-CT parallel cable, you can parallel with 1772-P3, 1771-P4 power supply for start up.

EEPROM Memory Module

Purpose: Provides you with a 3K non-volatile backup.

Hardware: EEPROM Memory Module (cat. 1772-MJ)

Function: After you've entered the application program into the processor module's CMOS RAM memory, the program can be copied into the EEPROM.

Chapter Summary

So far, we've briefly described the hardware associated with your Mini-PLC-2/05 processors. The next chapter explains memory and how the processor stores and manipulates data. Read the next chapter carefully. It is a fundamental concept that you must master before continuing.

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

Chapter 4

Memory Organization

Chapter Objectives

In this chapter, you will read about:

- hardware and its relationship to your program
- memory and its components

This chapter provides detailed concepts of the memory's organization and its structure. Understanding these concepts aids you in programming your processor.

Introduction

Before we explain memory organization and its structure, read the following definitions:

Bit - the smallest unit of information that memory is capable of retaining

Byte - a group of 8 consecutive bits ($00\text{-}07_{08}$ or $10\text{-}17_{08}$)

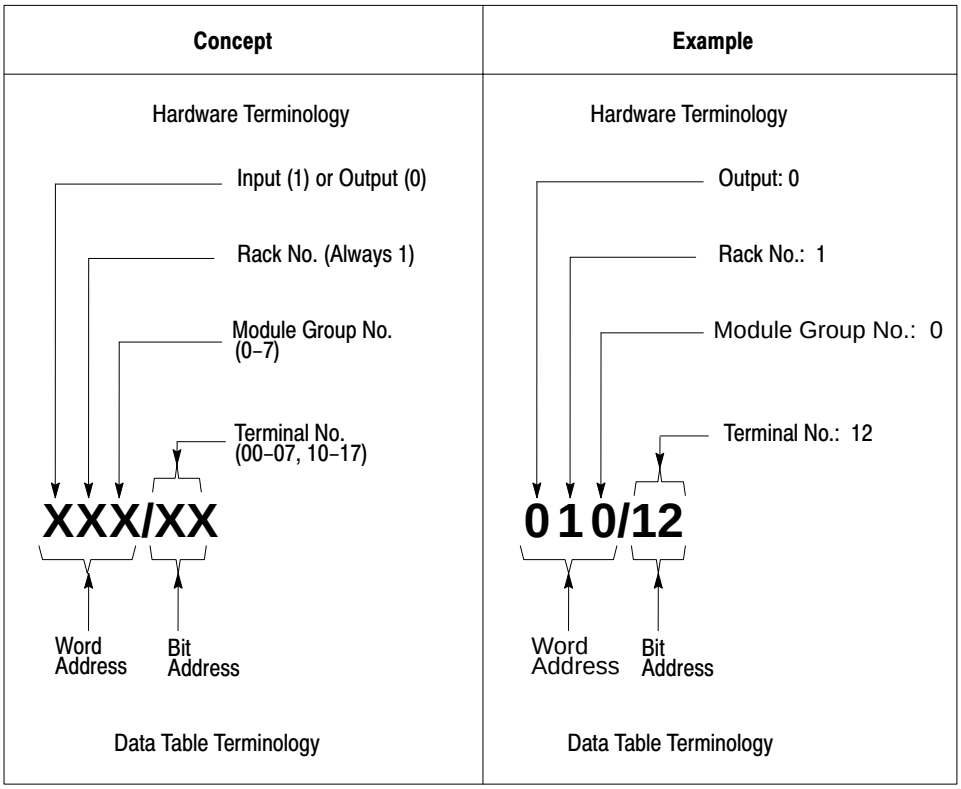
Word - a group of 16 consecutive bits ($00\text{-}17_{08}$)

Hardware and Your Program

Figure 4.1 and the following chart represents how the hardware of your processor relates to the input and output image tables. Understanding the two figures help you understand programming.

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

Figure 4.1
Word Address Equals Memory Bits



10248

Hardware	vs	Your Program
I/O terminal		bit
module group		word
module slot		byte
one rack		eight words
if the terminal has voltage (on state)		a specific bit is on, which is a 1 in memory
if the terminal has no voltage (off state)		a specific bit is off, which is a 0 in memory

To calculate the input and output image tables' areas and how these values compare with the hardware of your processor.

Remember: 1 rack = 8 words
You can only have one rack in this system.

Therefore: 8 words/rack x 16 bits - 128 I/O

Conclusion: The combined amount of usable bits in the input image table and/or the output image table is 128 I/O.

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

Memory Areas

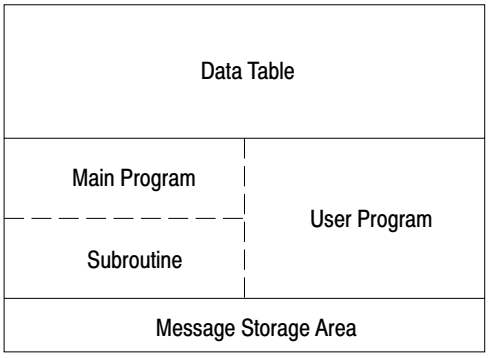
Memory is divided into three major sections: data table, user program and a message storage area. The areas store input status, output status, your program instructions and messages.

We describe these areas in detail so you can gain programming flexibility using your processor.

Data Table

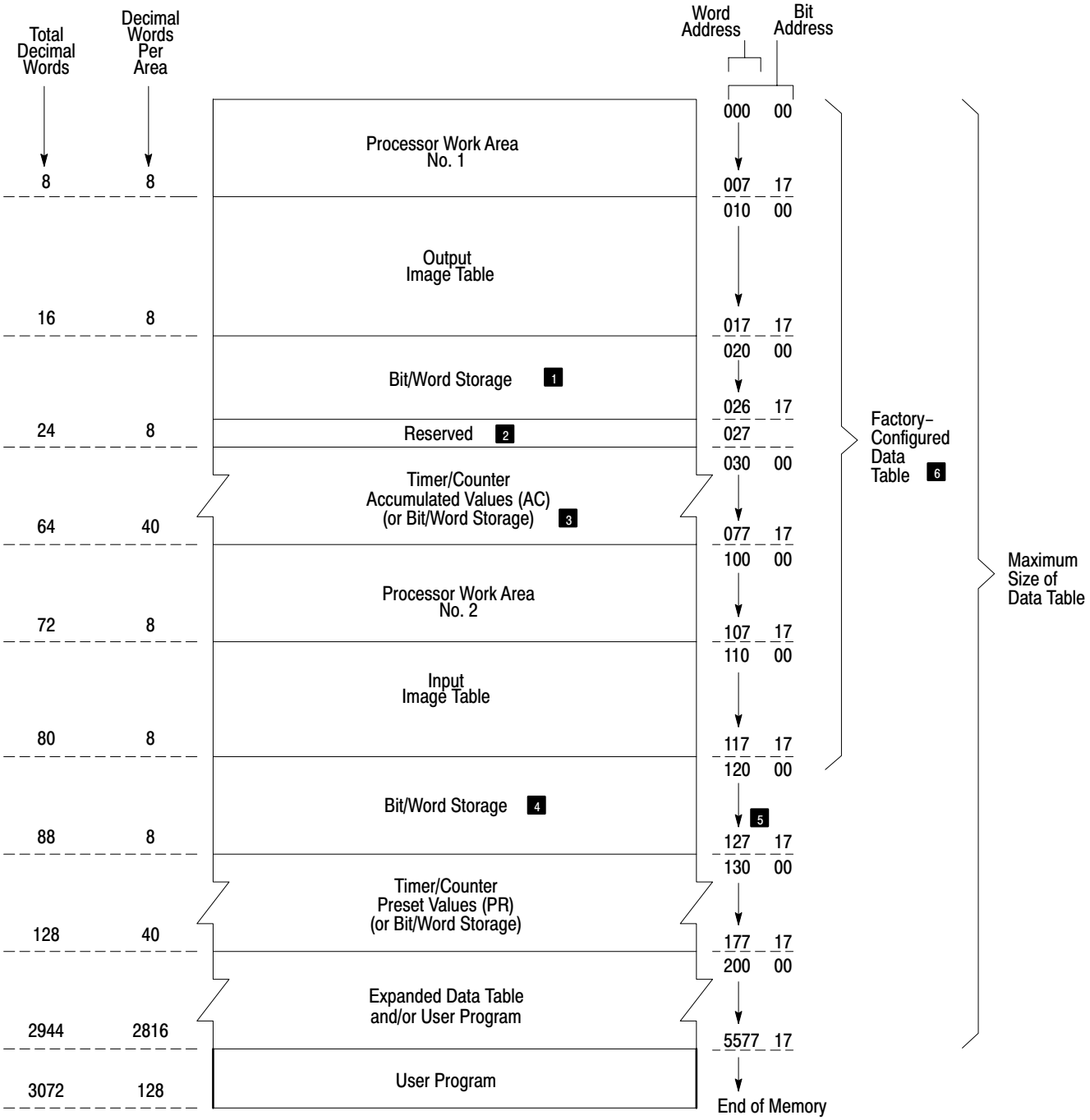
The first part of memory is the data table (Figure 4.2). The processors are factory configured for 128 words. Figure 4.3 shows memory structure with a factory configured data table. The specific concepts throughout this publication refer to a factory configured data table.

Figure 4.2
Memory Structure



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

Figure 4.3
Data Table Organization, Factory Configured



1 May not be used for accumulated values.
2 Not available for bit/word storage. Bits in this word are used by the processor.
3 Unused timer/counter memory words can reduce data table size and increase user program area.
4 May not be used for preset values.
5 Do not use word 127 for block transfer data storage.
6 Can be decreased to 48 words.

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

10148-I

The data table area is a major part of memory. It is divided into six sections which includes the input and output image tables. (These two areas were described in chapter 2). The processor controls and utilizes words stored in the data table. The input devices coupled with the control logic from your program determines the status of the output devices. Input devices are limit switches, pushbutton switches, pressure switches, etc. Output devices are solenoids, motor starters, alarms, etc. Transfer of input data from input devices and the transfer of output data to output devices occur during I/O scan. If the status of the output instruction changes in the program then the on or off status of the output devices update during the I/O scan to reflect the change.

To use the data table, you must understand the following:

- The processor initially reserves the first 128 words in the memory for the data table.
- You can decrease the data table size to 48 words in two word increments.
- You can increase the data table size to 256 words in two word increments. Then you can increase the data table size in blocks of 128 words.
- When the data table is set to 256 words, you can program up to 104 timer/counter instructions.
- You can change the data size from 48 words to 2,944 words using the 1770-T3 terminal.

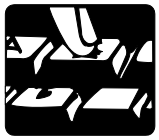
Data Table Expansion
Using the 1770-T3 industrial terminal, you can adjust the data table size to be anywhere from 48 words to 2944 words. Expanding the data table provides additional timers/counters and space for files (see chapter 8 for timers/counters and chapter 10 for file information), but it also proportionally reduces the program storage and memory areas.

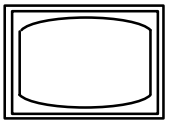
Expansion is in increments of two words until a table of 256 is reached and then in increments of 128 words.

Important: When using the data table expansion capability, allow sufficient room for both data table and user program.

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

To expand your data table do this:





SEARCH

The word SEARCH appears in the lower left hand corner of the screen.

50

DATA TABLE CONFIGURATION

NUMBER OF 128-WORD D.T. BLOCKS	01
NUMBER OF INPUT/OUTPUT RACKS	2
NUMBER OF T/C (if applicable)	40
DATA TABLE SIZE	128

The following chart helps you adjust the data table size for your processor:

Enter	Data Table Size
01	128
02	256
03	384
04	512
05	640
06	768
07	896
08	1024
09	1152
10	1280
11	1408
12	1536
13	1664
14	1792
15	1920
16	2048
17	2176
18	2304
19	2432
20	2560
21	2688
22	2816
23	2944

After you adjust the data table, press [CANCEL COMMAND].

Important: Other industrial terminal commands are summarized in appendix C.

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

Data Table Areas

The following areas make up the data table. They are:

- processor work area no. 1
- output image table
- bit/word storage (020-027)
- timer/counter accumulated values and internal storage
- processor work area no. 2
- input image table
- bit/word storage (120-127)
- timer/counter preset values and internal storage

Chapter 1 describes the input and output image tables. The following sections describe the remaining areas.

Processor Work Areas

Purpose: The processor uses these 16 words for its internal control functions.

Description: There are two processor work areas. They are located at addresses 000-007 and 100-107. You cannot access these data table words. Their word addresses are not available for addressing.

Important: The term address is defined in chapter 6. Remember, all addresses are in octal values.

Accumulated Values and Internal Storage

Purpose: Stores accumulated values of timer or counter instructions. This area also stores data by words and/or bits from your program instructions (addresses 030-077).

Description: Each timer or counter instruction uses two words of data table. one word is stored in the accumulated value area, the other is the preset value area. When the accumulated value equals the preset value (AC=PR), a status bit is set and can be examined to turn on or off an output device.

Preset Values and Internal Storage

Purpose: Stores preset values (PR) of timer or counter instructions. This area also stores data by words and/or bits from your program (addresses 130-177).

Description: The preset value is the number of timed intervals or events to be counted. The preset value is 100 octal words above the accumulated word. Therefore, a timer/counter having an address of 030 automatically has its preset value stored at address 130.

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

User Program

The second major part of memory is the user program (Figure 4.2). It is divided into two areas:

- main ladder diagram program
- subroutine area

The user program area begins at the end of the data table.

Main Program
Purpose: The program is a group of ladder diagram and functional block instruction used to control an application.

Description: A program is a list of instructions that guides the processor. These instructions can examine or change the status of bits in the memory of the processor. The status of these bits determines the operation of output devices.

The program specifies the things you want done in your application and the conditions that must be met before those things are done. For example, if you want a solenoid energized when a limit switch is closed, you would specify:

Condition: If limit switch is closed
Action: Energize solenoid

Programming logic differs from relay logic in an important way. Programming logic is only concerned with whether or not conditions have been met. These conditions may be open or closed input or output devices. We must have a continuous or unbroken path of true logic conditions for an action to be taken. The number of conditions is not important. There can be none, one, or many conditions preceding an output action.

When the path of conditions is continuous, we say that the rung is true. When the path of conditions is not continuous, we say the rung is false.

Subroutine Area
Purpose: Used to jump to a defined ladder diagram area. This allows you to perform ladder diagram subroutines.

Description: The subroutine area is between the main program and the message store areas. This area acts as the end of program statement for the main program. It allows storage of small programs that are to be accessed periodically. Subroutine areas are not scanned unless you program the processor to jump to this area.

A maximum of eight subroutines can be programmed in the subroutine area. Each subroutine begins with a label instruction and (when you want to exit to your main program) ends with a return instruction.

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

Message Storage Area

The third major part of memory is the message storage area (Figure 4.2). You can print out messages in hard copy form. You can store up to 70 messages using the 1770-T3 industrial terminal, or 198 messages using the 1770- T3 terminal with the 1770-RG module.

Message storage follows the end statement of your program and is limited by the number of unused words remaining in memory. Each word stores two message characters. A character is any alpha or numerical figure (this includes blank spaces).

Messages are written to display current data table information such as the number of parts rejected in a production run for a particular time period. you can write your program to display messages when a pushbutton switch is activated.

Address 027 controls messages 1-6. You designate control words which control your messages in groups of 8. Your control word must be arranged in consecutive order.

Report generation (see chapter 17) is a function of your message control words. Reserve bit addresses 02710 thru 02717 for this automatic report generation function to determine status of this function. These bit addresses should not be used for any other functions if you want to achieve maximum flexibility within your program.

Chapter Summary

We described detailed concepts of memory organization and its structure. The next chapter explains how the processor scans the program.

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

Chapter 5

Scan Theory

Chapter Objectives

In this chapter you will read about:

- scan function
- scan time

Scan Function

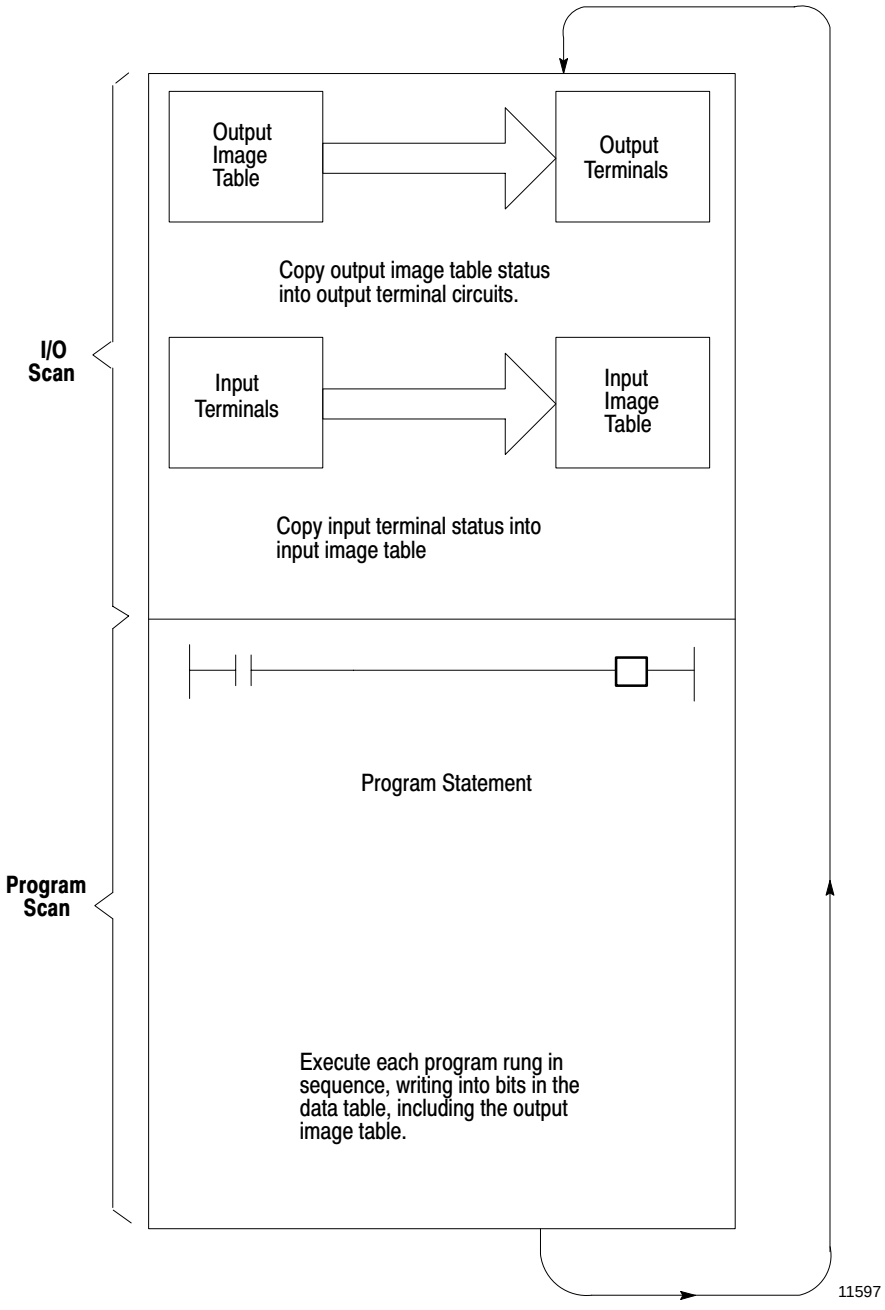
The processor controls the status of output devices or instructions in accordance with program logic. Every instruction in your program requires execution time. These times vary greatly depending upon the instruction, the amount of data to be operated on, and whether the instruction is true or false.

As a review from chapter 1, there are two types of scans (Figure 5.1):

- I/O scan (775µs without forcing: 1 ms with forcing)
- Program scan (15ms/K of user memory)

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

Figure 5.1
Scan Sequence



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

On power-up, the processor begins the scan sequence with the I/O scan. Data from output image table is written to the output modules. Data from the input modules is read into the input image table.

Next, the processor scans the program statement by statement:

1. For each condition, the processor checks, or "reads," the image table to see if the condition has been met.
2. If the set of conditions has been met, the processor writes a one into the bit location in the output image table corresponding to the output terminal to be energized. On the other hand, if the set of conditions has not been met, the processor writes a zero into that bit location, indicating that the output terminal should not be energized.

Important: When your processor is in the remote test mode, all outputs are held off. When your processor is in the run/program mode, all outputs are controlled by the user program.

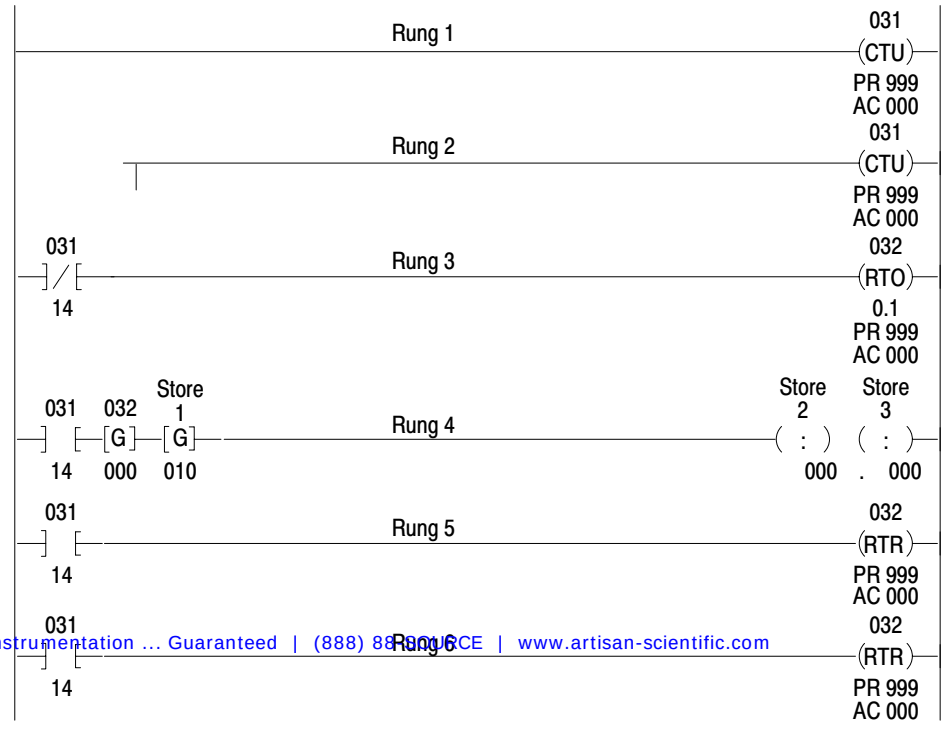
Average Scan Time

Average scan time is the average amount of time it takes the processor to monitor and update input and outputs, and to execute instructions in the program. The scan is performed serially; first the I/O image table is updated, (other parts of the data table are not scanned), then the user program is scanned.

There are two ways to measure average scan time:

- Append the rungs in Figure 5.2 to your program.

Figure 5.2
Average Scan Time



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

- Add the execution values for each instruction by using Table 5.A. The sum of these values added to the I/O scan time is the average scan time.

Table 5.A
Approximate Execution Time Per Scan (in average microseconds)

Instruction Name	Symbol	Instruction True	Instruction False
Examine on, Examine off	-| |-,-| / |-	14	11
Output energize	-( )-	16	16
Output latch	-(L)-	17	13
Output unlatch	-(U)-	17	13
Get	-[G]-	28	-
Put	-(PUT)-	26	14
Equal	-(=)-	23	11
Less than	-(<)-	25	13
Get byte	-|B|-	16	-
Limit test	-|L|-	24	11
Counter reset	-(CTR)-	20	14
Retentive timer reset	-(RTR)-	20	14
Timer on-delay	-(TON)-	75	47
Retentive timer on-delay	-(RTO)-	78	48
Timer off-delay	-(TOF)-	82	60
Up counter	-(CTU)-	70	55
Down counter	-(CTD)-	75	60
3 Digit Math			
Add	-(+)-	48	15
Subtract	-(-)-	80	19
Multiply	-(x)-(x)-	615	60
Divide	-(÷)-(÷)-	875	60
Add to any of the above when its address is 4008 or greater		27	27
Expanded Math			
Add	EAF 01	400-500	40
Subtract	EAF 02	400-500	40
Multiply	EAF 03	800-2250	40
Divide	EAF 04	500-3250	40
Square root	EAF 05	1850	40
BCD to binary	EAF 13	500	40
Binary to BCD	EAF 14	500	40
Master control reset	-(MCR)-	16	16
Zone control last state [1]	-(ZCL)-	22(no skip)	20+(13 per word skipped)
Branch start		16	16
Branch end		18	18
End, temporary end	T.END	27	27
Subroutine area	SBR	27	27
Immediate input update	-[I]-	45 (with forcing on 55)	-
Immediate output update	-(IOT)-	70(with forcing on 80)	17

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

Instruction Name	Symbol	Instruction True	Instruction False
Label	LBL	34	-
Return	-(RET)-	30	15
Jump to subroutine	-(JSR)-	100	15
Jump	-(JMP)-	55	15
Block transfer read	BLOCK X-FER 1	80	75
Block transfer write	BLOCK X-FER 0	80	75
Sequencer load	SEQ 2	390(80/extra word)	105
Sequencer input	SEQ 1	420(90/extra word)	55
Sequencer output	SEQ 0	470(90/extra word)	110
File-to-word move	FILE 12	250	45
Word-to-file move	FILE 11	250	45
File-to-file move	FILE 10440 (+10/word transferred)	200	

[1] When a rung that contains a ZCL instruction is false, the execution time of each instruction between the start fence and end fence is 17 microseconds per word.

Here is an explanation of the rungs in Figure 5.2:

Rung 1 - The count increments its accumulated value each time this rung is true.

Rung 2 - This rung enables the counter to increment on the next scan. If we did not have this rung, the counter would always be true and it would not increment. Remember: Counters increment only on false to true transitions.

Rung 3 - The timer times in tenths of seconds when we are counting. This value is displayed on the industrial terminal screen.

Rung 4 - The average scan time is displayed beneath store 2 and store 3 in milliseconds.

Important: Refer to three digit math in chapter 10.

Rung 5 - The counter overflow bit is re-setting the timer.

Rung 6 - The counter overflow bit is resetting the counter.

Chapter Summary

We described scan sequence and a method to measure average scan time. The next chapter explains some of the instructions you use in a program.

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

Chapter 6

Relay-type Instructions

Chapter Objectives

This chapter describes:

- relay-type instructions
- how to define conditions before an action takes place

Programming Logic

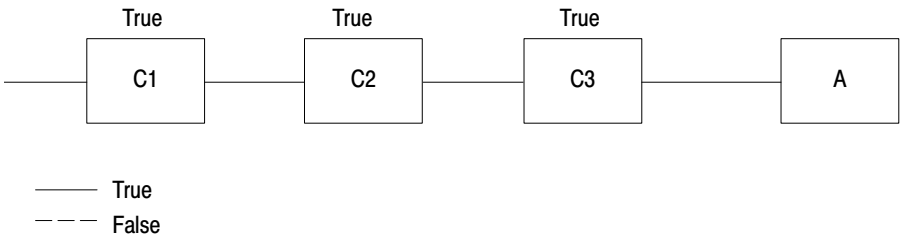
A program is a list of instructions that the processor executes. These instructions can examine or change the status of bits in the data table of the processor. The status of these bits can determine the operation of other instructions.

The program you specifies the order of things you want done in your application and the conditions that must be met before those things are done. For example, if you want a solenoid energized when a limit switch is closed, you specify:

Condition: if limit switch is closed
Action: energize solenoid

Programming logic differs from relay logic in an important way. Programming logic is only concerned with whether or not conditions have been met. These conditions may be open or closed input or output devices. We must have a continuous or unbroken path or true logic conditions for an action to be taken. The number of conditions is not important. There can be none, one, or many conditions preceding an output action.

Perhaps an example might make this clearer:



Here, a **series** of conditions (C2, C2, C3) must be true before action A is performed.

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

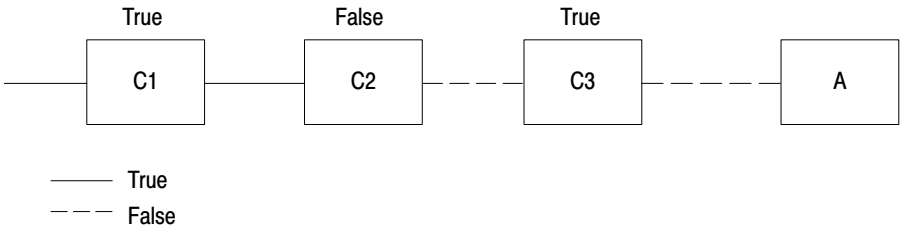
C1 = Input switch 1. When the switch is on, this condition is true. This switch turns on a conveyer belt.

C2 = Input sensor 1. When the sensor is off, this condition is true. This sensor detects if the temperature in the factory is below 40°C.

C3 = Input sensor 2. When the sensor is on, this condition is true. This sensor detects the presence of a part of the conveyer belt.

A = The part will be drilled. = The path of conditions is continuous, that is, all conditions are true.

When C1, C2, and C3 are true, then a continuous path is made to a particular action. In this case, the continuous path causes the part to be drilled. When the path of conditions is continuous, we say that the rung is true. When the path of conditions is not continuous, we say the rung is false.



Here the path of conditions is not continuous because condition 2 is false. Therefore, the action A is not performed. We say the rung is false.

Set vs. Reset

As a review, if the device goes on, then we say the corresponding bit in data table is set to a 1. If the device goes off, we say the corresponding bit in data table is reset to a 0. (From this point on, set means the on-condition or 1. Reset means the off-condition or 0.)

If the device is:	Then a bit in memory is
on	set
off	reset

Addresses

The processor scans the status of inputs and controls output devices. It does not go to the input or output terminals to see if outputs are on or off. Rather, it checks the status of the input and output devices by scanning corresponding bits in the input and output image area of the data table. The processor uses addresses to refer to words and bits in the data table.

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

Each input and output bit has a five-digit address. Reading from left to right:

- the first number denotes the type of I/O module:
  - 0 output
  - 1 input
- the second number denotes an I/O chassis and it always is a 1.
- the third number denotes a module group. This number will range from 0-7.
- the fourth and fifth numbers denote a terminal designation:
  - 00-07 left slot of the module group
  - 10-17 right slot of the module group

Important: Remember a Mini-PLC-2/05 processor can use only one rack.

Important: For addressing purposes, I/O modules in a given I/O rack are organized into “module groups.” A module group is a pair of adjacent I/O modules. Thus, the module group number of an individual I/O module depends only on the I/O slot the module occupies. It is important to note that the first module group in any I/O chassis is always module group 0.

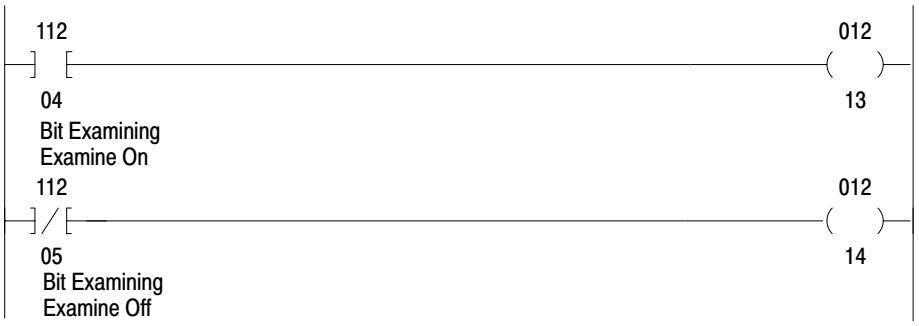
Programming Instructions

You can use seven programming instructions to write a program. These instructions are divided into three categories: bit examining, bit controlling, and branch instructions.

Bit Examining

Examine On and Examine Off

Purpose: The Examine On -] [- and Examine Off -]/[- instructions tell the processor to examine a bit at a specified data table location



Determines the bit condition. The bit condition becomes:

True - Examine On detects a bit in the data table that is set.
True - Examine Off detects a bit in the data table that is reset.
False - Examine On detects a bit in the data table that is reset.
False - Examine Off detects a bit in the data table that is set.

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

Keystrokes: Enter an Examine On or Examine Off instruction by performing the following steps.

1. Press either -] [- or -]/[- as required.
2. Enter <address>.

Removing the Examine On or Examine Off Instruction
You remove an Examine On or a Examine Off instruction by performing the following steps.

1. Position the cursor over the Examine On or Examine Off instruction you want to remove.
2. Press [REMOVE] -] [- or -]/[-.

Editing a Partially Completed or a Completed Rung
You edit an Examine On or Examine Off by performing the following steps.

If you are editing a completed rung, proceed to step 1. If you are editing a partially completed rung, enter the next instruction and proceed to step 1.

1. Position the cursor over the Examine On or Examine Off instruction you want to edit.
2. Press either -] [- or -]/[- or any other appropriate instruction type key.
3. Enter <address>.

Bit Controlling

Output Energize
Purpose: This Output Energize instruction tells the processor to set or reset a specified data table bit.



Controls a specific bit based on the rung condition. When its rung conditions are:

True - Output Energize sets a specified bit.
False - Output Energize resets a specified bit.

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

Keystrokes: You enter an Output Energize instruction by performing the following steps.

1. Press -( )-.
2. Enter <address>.

Removing an Output Energize Instruction
The only way you remove an Output Energize instructions is to remove the entire rung. See chapter 16.

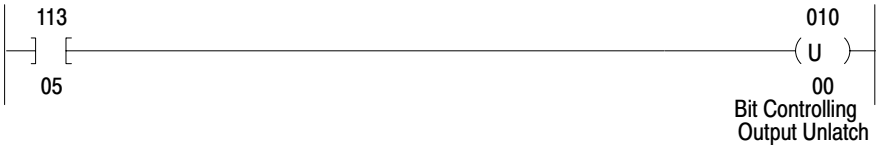
Editing in a Completed Rung
You edit the Output Energize instruction by performing the following steps. However, you cannot remove an output instruction.

1. Position the cursor over the Output Energize instruction you want to change.
2. Press -( )- or any other appropriate output instruction type key.
3. Enter <address>.

Output Latch/Unlatch
Purpose: The Output Latch -(L)- instruction tells the processor to latch and set a specified data table bit. It is usually paired with an unlatch instruction.



The Output Unlatch -(U)- instruction tells the processor to unlatch and reset a specific data table bit. It is usually paired with a latch instruction.



Important: The conditions for the Output Unlatch instruction must be different than the conditions that precede the Output Latch instruction.

These are retentive instructions. Retentive means that when the rung condition goes false, the latched bit remains set and the unlatched bit remains reset until changed by the program.

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

These instructions control a specific bit based on the rung condition. When its rung conditions are:

True - Output Latch sets a specified bit.
True - Output Unlatch resets a specified bit.
False - No action is taken.

Keystrokes: You enter an Output Latch or Unlatch instruction by performing the following steps.

1. Press either -(L)- or -(U)- as required.
2. Enter <address>.

Important: You can initially condition the latch or unlatch instruction to on or off by pressing 1 or 0, respectively.

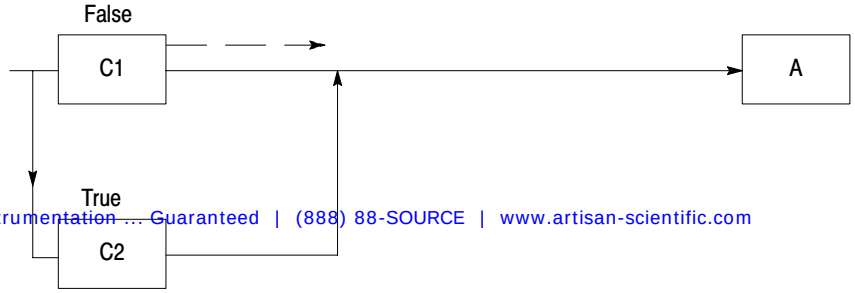
Editing in a Completed Rung
You edit an Output Latch or Unlatch instruction by performing the following steps.

1. Position the cursor over the Output Latch or Unlatch instruction you want to change.
2. Press either -(L)- or -(U)- or any other output instruction type as required.
3. Enter <address>.

Important: If power is lost, all latch bits remain in their last state. When power is restored, all outputs connected to latch bits are energized immediately.

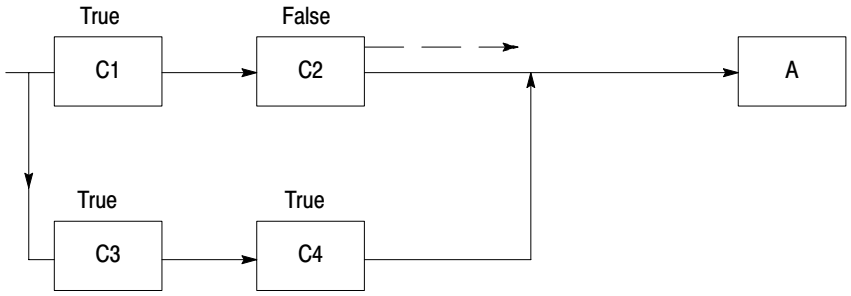
Branching Instructions

Use branching instructions when you want several parallel sets of conditions to make an output action possible. A program with branching says, “If this set of conditions is true, or if that set of conditions is true, perform the following action.” Branching allows two or more paths to reach the same output destination.



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

Here two conditions are parallel. As long as one of the conditions (C1 or C2) is true, a continuous path to the action exists. Therefore, the action is performed.



Here are two sets of parallel conditions. If either set of conditions are true, the action is performed.



This illustration shows a program rung with branching, as it would appear by the 1770-T3 terminal display. You create a branch by using two different branch instructions. These are the branch start and branch end instructions.

Branch Start/End
Purpose: A Branch Start instruction begins each parallel logic branch of a rung. It allows more than one combination of input conditions to energize an output device.

A Branch End instruction completes a set of parallel branches.

Keystrokes: You enter a Branch Start or Branch End instruction by performing the following steps

1. Press either [ ] or [ ].

Important: You must begin each rung of parallel conditions with a Branch Start instruction.

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

Removing a Branch Start or Branch End Instruction

You remove either a Branch Start or Branch End instruction or change an instruction type by performing the following steps.

1. Position the cursor over either the Branch Start or Branch End instruction.

2. Press [REMOVE] [ ] or [ ].

Inserting a Branch Instruction in a Completed Rung

You insert either a Branch Start or Branch End instruction or change an instruction type by performing the following steps.

1. Position the cursor over the instruction immediately preceding the position you want to insert a Branch Start instruction.

2. Press [INSERT] [ ].

Important: Once you press the Branch Start instruction, the statement BRANCH END OMITTED appears in the lower lefthand corner of the screen. It stays there until you enter a Branch End instruction.

3. Insert the conditioning instructions for this rung.

4. You must begin each set of parallel conditions or rung with a Branch Start instruction.

Complete the set of parallel conditions by:

5. Press [INSERT] [ ].

Important: Once you press the Branch End instruction, the statement BRANCH END OMITTED disappears.

Nesting

The following rung shows a nested branch.



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

Creating nested branches is not possible because the branch end instruction completes a branch group. But the above rung shows a single branch group with two branch end instruction. Above, the examine on instruction with the address 11012 is actually a branch group within a branch group.

The following rung achieves the same result and avoids nested branching:



Chapter Summary

We showed you how enter and edit bit examining, bit controlling, and branching instructions. The next chapter shows you how to use program control instructions to update I/O ahead of their usual scan time.

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

Chapter 7

Program Control Instructions

Chapter Objectives

This chapter describes these program control instructions:

- output override
- immediate I/O update

Introduction

Some applications need programming techniques designed to override a group of non-retentive outputs or update I/O ahead of the usual I/O scan time. The program control instructions satisfy this need.

The output override, or zone type instructions, operate similarly to a hardwired master control relay in that they affect a group of outputs in the user program. But these instructions are **not** a substitute for a hardwired master control relay, which provides emergency I/O power shutdown.

The following table illustrates specific instructions for these categories:

Output Override	Immediate Update I/O
Master Control Reset	Immediate Input Update
Zone Control Last State	Immediate Output Update

Output Override Instructions

Master Control Reset and Zone Control Last State

Purpose: A Master Control Reset (MCR) establishes a zone in the user program in which all non-retentive outputs are turned off simultaneously.

Important: Retentive instructions (-(U)-, -(L)-, -(RTO)-) should not be placed within an MCR zone, because the MCR zone maintains retentive instructions in the last active state when the start fence goes false.

A Zone Control Last State (ZCL) instruction allows control of one or a group of outputs in more than one manner in the same program. It establishes a zone in the user program which controls the same outputs, through separate rungs, at different times.

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

To override a group of output devices, you must use two MCR (Figure 7.1) or ZCL (Figure 7.2) instructions: one each to begin the zone and one each to end the zone. The start fence is always programmed with a set of input conditions. The end fence must be programmed unconditionally.

Figure 7.1
Master Control Reset

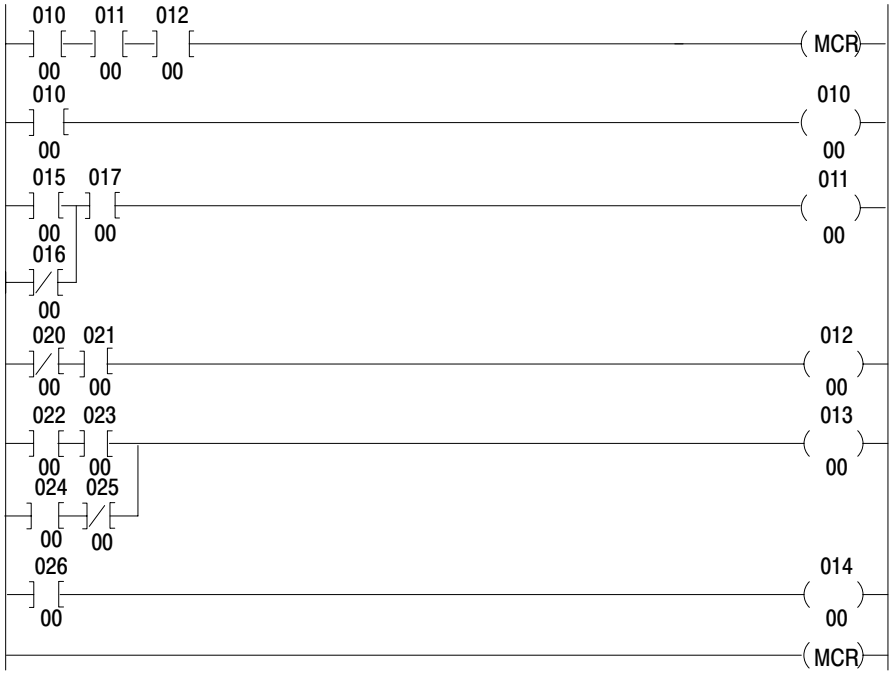
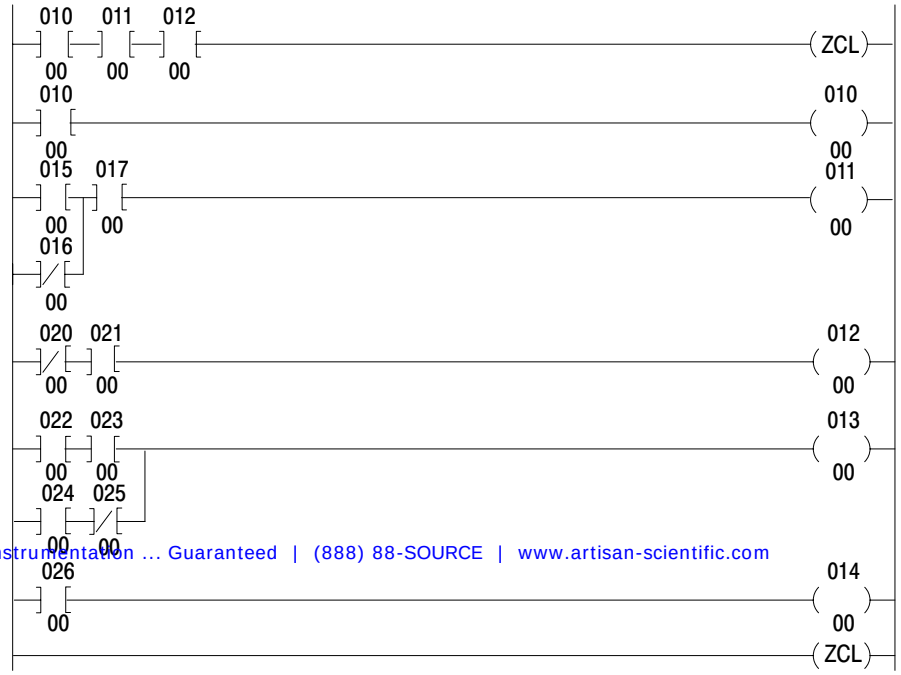


Figure 7.2
Zone Control Reset



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

If the start fence becomes:

True - Each rung condition controls their output instruction.
False - All output instructions within the zone are left in their last state. The same outputs may now be controlled by another zone program. Only one zone may control a set outputs at one time.

Keystrokes: You enter an MCR or ZCL instruction by performing the following steps.

1. Press either -(MCR)- or -(ZCL)-.

Editing in a Completed Rung
You edit these instructions by performing the following steps:

1. Position the cursor over the MCR or ZCL instruction you want to change.

2. Press either -(MCR)- or -(ZCL)- or any other appropriate instruction type key.

3. Enter any parameters that may be required by a new instruction.

Immediate I/O Update Instructions

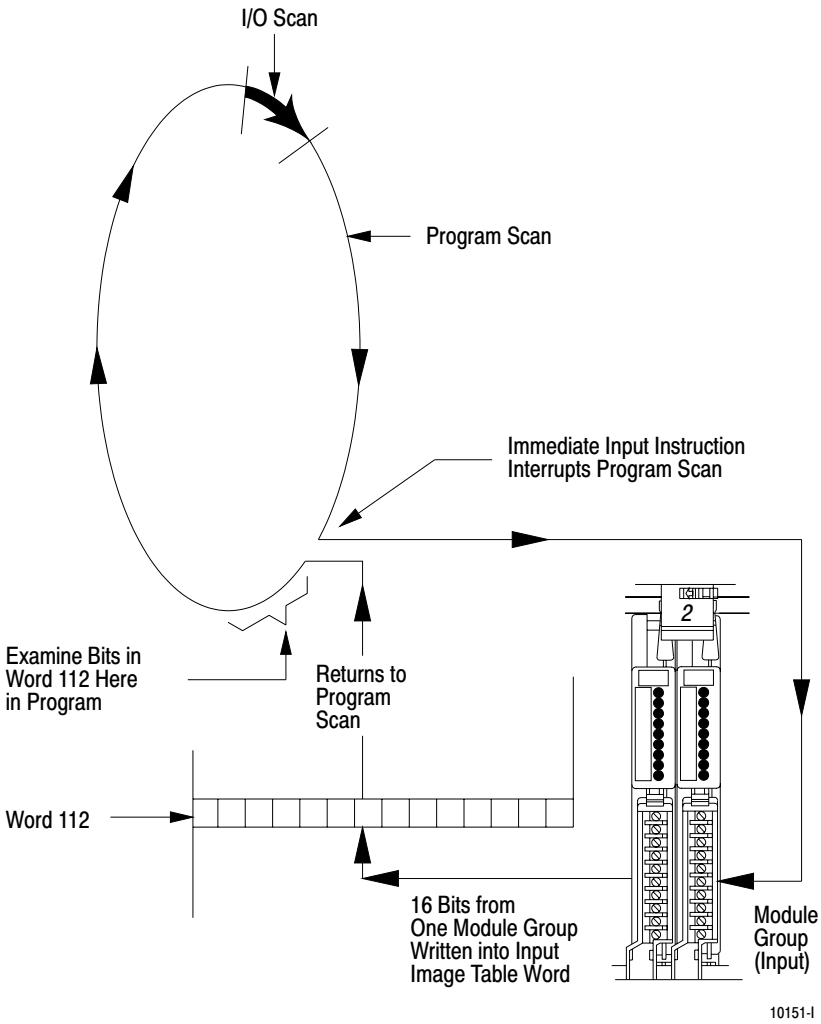
Immediate I/O update instructions interrupt the program scan to update I/O data before the normal I/O update sequence. Use these instructions where I/O modules interface with I/O devices that operate in a shorter time period than the processor scan.

Immediate Input/Immediate Output Update

Purpose: An Immediate Input Update instruction interrupts the program scan to update input image table with data from the corresponding module group. The image table is updated before the normal I/O scan and executed each program scan (Figure 7.3). This instruction is always considered logic true and execution takes place whether or not other rung conditions allow logic continuity.

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

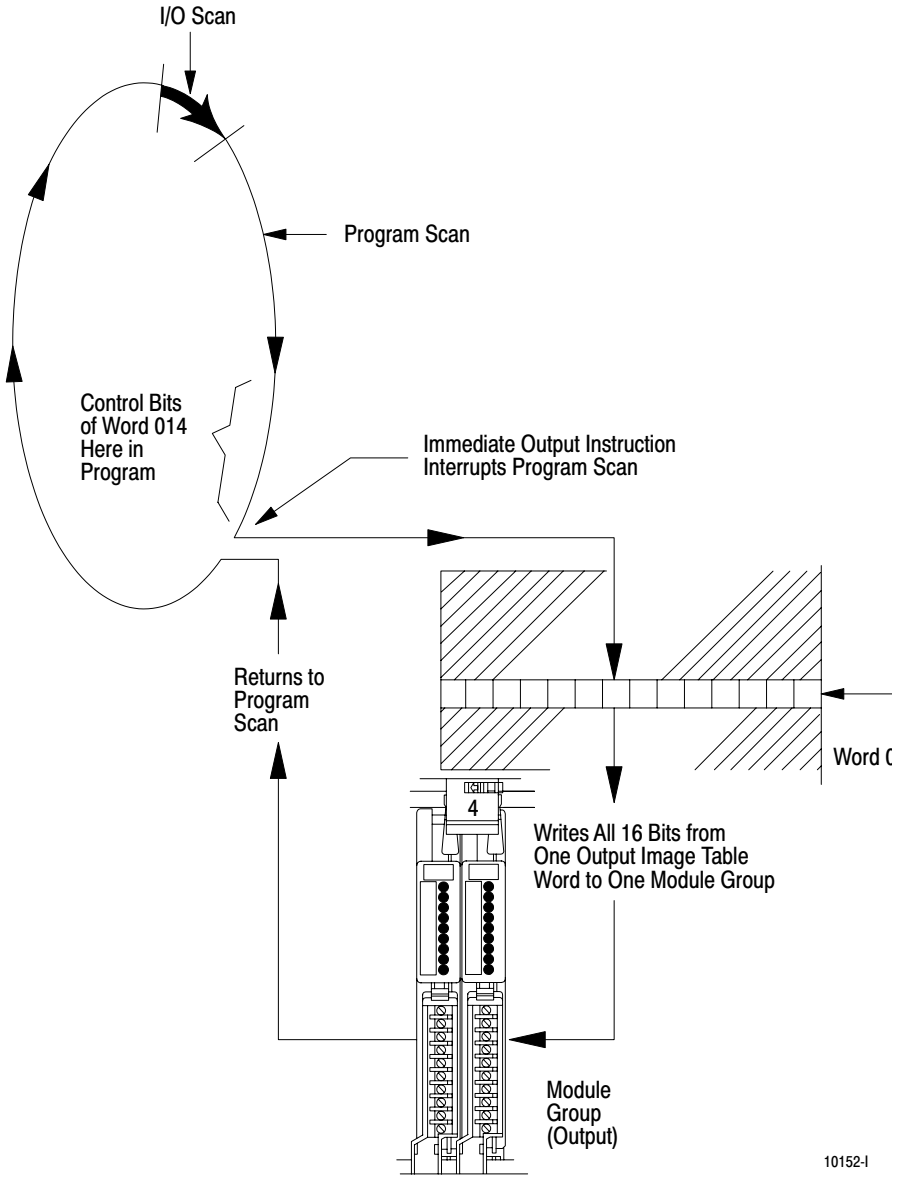
Figure 7.3
Immediate Input Instruction



An Immediate Output Update instruction interrupts the program scan to update the module group with data from corresponding output image table word address (Figure 7.4). The image table is updated before the normal I/O scan and executed each program scan when the rung is true. It can be programmed unconditionally. This instruction immediately transfers output data from the selected 16-bit word in the output image table without waiting for the normal I/O scan.

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

Figure 7.4
Immediate Output Instruction



Important: These instructions significantly impact program scan time. Use them only when absolutely necessary.

Keystrokes: You enter an Immediate Input or Immediate Output Update instruction by performing the following steps.

1. Press either -[I]- or -[IOT]-.

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

2. Enter <address>.

Removing an Immediate Output Update Instruction
The only way to remove an Immediate Output Update instruction is to remove the entire rung. See chapter 11.

Removing an Immediate Input Update Instruction
You remove an Immediate Input Update instruction by performing the following steps.

1. Position the cursor over the Immediate Input Update instruction you want to remove.

2. Press [REMOVE]-[I]-.

Editing a Partially Completed Rung or a Completed Rung
You edit an Immediate Input or Immediate Output Update instruction by performing the following steps.

If you are editing a completed rung, proceed to step 1. If you are editing a partially completed rung, enter the next instruction and proceed to step 1.

1. Position the cursor over the Immediate Input or Immediate Output Update instruction you want to change.

2. Press -(I)-, -[IOT]-, or any other appropriate instruction type key.

3. Enter <address>.

Chapter Summary

We have shown you how to override a group of non-retentive outputs to update I/O ahead of their usual scan time. The next chapter shows you how to keep track of timed intervals or counted events according to the logic of your ladder diagram.

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

Chapter 8

Timers and Counters

Chapter Objectives

This chapter describes two instructions that keep track of timed intervals or counted events:

- timers
- counters

Introduction

Timer and counter instructions are output instructions internal to the processor. They provide many of the capabilities available with timing relays and solid state timing/counting devices. Usually conditioned by examine instructions, timers and counters keep track of timed intervals or counted events according to the logic continuity of the rung. You can program up to 488 internal timers. The last valid timer address is 1677.

Each timer or counter instruction has two 3-digit values. Each value requires one word of data table memory. These 3-digit values are:

Accumulated Value (AC)

Storage: Begins at word address 030.

Function: Timers - number of elapsed timed intervals
Counters - number of counted events
Both - upper 4 bits of accumulated word (14-17) are the status bits.

Preset Value (PR)

Storage: Always at address 100 words greater than its corresponding AC value.

Function: Denotes the number of timed intervals or events to be counted. When the accumulated value equals the preset value, AC = PR, a status bit is set and can be examined to turn an output device on or off.

Timer Instructions

A timer counts the elapsed time-base intervals and stores this count in the accumulated value word. All timers must be placed within the first eight data table blocks. Timer instructions have three time bases: 1.0 second, 0.1 second, or 0.01 second.

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

Two bits in the accumulated value word are status bits:

- Bit 15 is the timed bit. It is either set or reset when the timer has timed out. The setting or resetting depends on the type of timer instruction used.
- Bit 17 is the enable bit. It is set when rung conditions are true and is reset when rung conditions are false.

There are four types of timer instructions available with the controller:

- timer on-delay
- timer off-delay
- retentive timer on-delay
- retentive timer reset

We will look at these timers in detail.

Timer On/Timer Off Delay

Purpose: The Timer On and Timer Off Delay instructions can be used to turn a device on or off once an interval is timed out.

Timer On Delay
The Timer On Delay instruction is programmed as an output instruction.



When the timer on delay rung condition becomes:

True

- Timer cycle begins.
- Timer increments its AC value.
- Bit 15 is set when AC=PR and the timer stops timing.
- Bit 17 is set.

False

- Accumulated value resets to 000.
- Bits 15 and 17 are reset.

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

Timer Off Delay

The Timer Off Delay instruction is programmed as an output instruction.



When the timer off delay rung condition becomes:

True

- Bit 15 is set.
- Bit 17 is set.
- Accumulated value resets to 000.

False

- Timer cycle begins.
- Timer increments its AC value.
- Bit 15 resets when the AC=PR and the timer stops timing.
- Bit 17 is reset.

Keystrokes: You enter a Timer On or a Timer Off Delay instruction by performing the following steps.

1. Press either -(TON)- or -(TOF)-.
2. Enter <address>.
3. Enter <time base>.
4. Enter <preset value>.

Editing in a Completed Rung

You edit the Timer On or Timer Off Delay instruction by performing the following steps.

1. Position the cursor over the Timer On or Timer Off Delay instruction you want to change.
2. Press -(TON)-, -(TOF)-, or any other appropriate instruction type.
3. Enter <address>.
4. Enter <time base>.
5. Enter <preset value>.

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

Retentive Timer On/Reset

Retentive Timer On

Purpose: The Retentive Timer On accumulates the amount of time that the preconditions of its rung are true. It controls one or more outputs (by means of other rungs) after the total accumulated time is equal to the preset time. Whenever the rung is false, the accumulated time is retained. If the outputs have been energized, they remain on. The accumulated time and energized outputs are retained if power is removed from the processor. A separate rung, containing a retentive timer reset instruction must be programmed in order to reset the accumulated time to zero and turn off the outputs.



When the rung condition becomes:

True

- Timer begins counting time-base intervals.
- Bit 15 is set when AC=PR and the timer stops timing.
- Bit 17 is set.

False

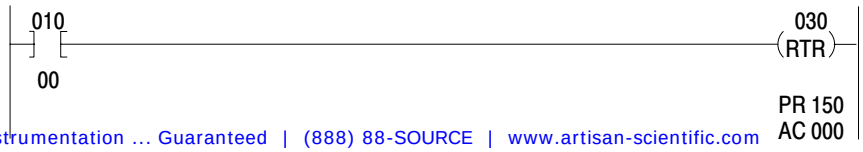
- Accumulated value is retained.
- Bit 15 - no action is taken.
- Bit 17 is reset.

Important: The RTO instruction retains its AC value when the:

- Rung condition turns false.
- Processor changes to remote/program mode.
- Power outage occurs and memory backup is maintained.

Retentive Timer Reset

Purpose: The Retentive Timer Reset instruction resets the accumulated value and timed bit of the retentive timer to zero. This instruction is given the same word address as its corresponding RTO instruction. When the rung conditions go true, the RTR instruction resets the ac value and resets the status bits to zero.



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

When the rung condition becomes:

True

- RTR instruction resets the accumulated value of the RTO instruction.
- Bits 15 and 17 are reset.

False

- No action is taken.

Keystrokes: You enter a Retentive Timer On or a Retentive Timer Reset instruction by performing the following steps.

1. Press -(RTO)- or -(RTR)-.
2. Enter <address>.

Perform the following step for a Retentive Timer instruction only.

3. Enter <time base>.
4. Enter <preset value>.

Editing in a Completed Rung
You edit a Retentive Timer On or a Retentive Timer Reset instruction by performing the following steps.

1. Position the cursor over the Retentive Timer or Retentive Timer Reset you are going to change.
2. Press -(RTO)-, -(RTR)-, or any other appropriate instruction type key.
3. Enter <address>.

Important: Do not perform steps 4 and 5 for a Retentive Timer Reset instruction.

4. Enter <time base> if appropriate.
5. Enter <preset value>.

Counter Instructions

A counter counts the number of events that occur and stores this count in its accumulated value word. Counters can be located anywhere in the data table. The last valid counter address is 5477 (in a fully expanded data table). An event is defined as a false-to-true transition. Counter instructions have no time base.

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

The upper four bits in the accumulated value (AC) word are status bits:

Bit 14 - Overflow/underflow bit. It is set when the AC value of the CTU instruction exceeds 999 or when the AC value of the CTD instruction falls below 000.

Bit 15 - Count complete bit. it is set when the AC value $\geq$ PR value.

Bit 16 - Enable bit for CTD instruction. It is set when the rung condition is true.

Bit 17 - Enable bit for CTU instruction. It is set when the rung condition is true.

There are three types of counter instructions available with the controller:

- up counter
- down counter
- counter reset

Up Counter

Purpose: An Up Counter instruction increments its accumulated value for each false-to-true transition of the rung condition.



When the rung condition becomes:

True

- Accumulated value increments by 1.
- Bit 14 is set if the AC > 999.
- Bit 15 is set when AC $\geq$ PR. Incrementing the accumulated value continues after the preset value is reached.
- Bit 17 is set and stays set until the rung goes false.

False

- Accumulated value is retained.
- Bit 14 - no action is taken.
- Bit 15 - no action is taken.
- Bit 17 is reset.

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

The Up Counter instruction retains its AC value when:

- You change the mode to the remote program.
- The rung condition turns false.
- A power outage occurs and memory backup is maintained.

Important: Bit 14 of the accumulated value word is set when the accumulated value either overflows or underflows. when a down counter preset is 000, the underflow bit 14 will not be set when the count goes below 0.

Down Counter

Purpose: The Down Counter instruction subtracts one from its accumulated value for each false to true transition of its rung conditions. A count is only added on a false to true transition, so rung conditions must go from true to false and back to true before the next count is registered.



When the rung condition becomes:

True

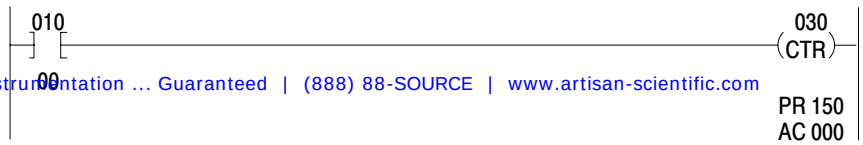
- Accumulated value decrements by 1.
- Bit 14 is set when AC < 000.
- Bit 15 is reset when AC < PR; counting continues.
- Bit 16 is set and stays set until the rung goes false.

False

- Accumulated value is retained.
- Bit 14 - no action is taken.
- Bit 15 - no action is taken.
- Bit 16 is reset.

Counter Reset

Purpose: The Counter Reset instruction resets the up counter down counter instructions accumulated value and status bits to 0.



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

When the rung condition becomes:

True

- Accumulated value of the specified counter is reset to 000.
- Status bits (14,15,16,17) are reset.

False

- No action is taken.

Keystrokes: You enter an Up Counter, Down Counter or Counter Reset instruction by performing the following steps.

1. Press -(CTU)-, -(CTD)-, or -(CTR)-.
2. Enter <address>.

Important: Do not perform steps 3 and 4 for a Counter Reset instruction.

3. Enter <preset value>.
4. Enter <accumulated value>.

Editing in a Completed Rung

You edit an Up Counter, a Down Counter, or a Counter Reset instruction by performing the following steps.

1. Position the cursor over the Up Counter, Down Counter or Counter Reset you want to change.
2. Press either -(CTU)-, -(CTD)-, -(CTR)-, or any other appropriate instruction type.
3. Enter <address>.
4. Enter <preset value> if appropriate.

Important: Do not perform steps 4 and 5 for a Counter Reset instruction.

5. Enter <accumulated value>.

Chapter Summary

We showed you how to use timer and counter instructions to keep track of timed intervals and counted events. The next chapter shows you how to transfer and compare data.

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

Chapter 9

Data Manipulation Instructions

Chapter Objectives

In this chapter, you will read about two types of instructions used to transfer and compare data and how to use these instructions to perform operations of data that is stored in the data table. These types of instructions are:

- transfer instructions
- compare instructions

Transfer Instructions

There are two data transfer instructions. They are:

- get
- put

Get

Purpose: A Get instruction accesses all 16 bits of one word location in the data table. It does not determine rung or require logic continuity. A Get also provides a time base for a selectable timed interrupt. In an STI, the Get instruction is the first instruction in the subroutine area. See chapter 15 for more information.



ATTENTION: Use the subroutine area carefully because unintended subroutine execution can cause unexpected machine operation.

Programmed in the condition area of the ladder diagram rung. It can be located at the beginning of a rung or with one or more conditions preceding it. It is always true and intensified.

Get always accesses the word to which it is addressed. It displays a three hexadecimal value of lower 12 bits (bits 0-13) of the specified word.

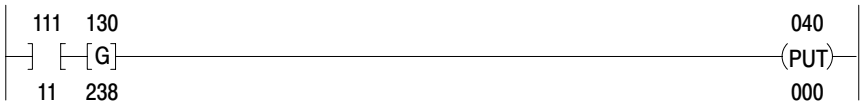


Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Put

Purpose: A Put instruction receives all 16 bits of data from the immediately preceding Get instruction and stores the data at the specified data table word location. Use with a Get instruction to form a data transfer rung.

Programmed in the output side of the ladder diagram rung. This instruction can have the same address as other instructions in the program. It must be immediately preceded by a Get or a Get-Byte instruction.



When rung conditions become:

True

- A Get instruction transfers data to the Put instruction.
- The lower 12 bits are displayed in hexadecimal beneath the Put instruction.
- Bits 14-17 are transferred but not displayed.

False

- Because he Put instruction is retentive, any change in Get instruction data does not change Put instruction data.

Keystrokes: You enter a Get or Put instruction by performing the following steps.

1. Press -[G]- or -(PUT)-.
2. Enter <address>.

Important: Do not perform step 3 for a Put instruction.

3. Enter <data> if appropriate.

Removing a Get Instruction

You remove a Get instruction by performing the following steps.

1. Position the cursor over the Get instruction you are going to remove.
2. Press [REMOVE] -[G]-.

Removing a Put Instruction

The only way to remove a Put instruction is to remove the whole rung. See chapter 16.

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

Editing a Get Instruction in a Partially Completed Rung

1. Enter the next instruction.
2. Position the cursor over the Get instruction you want to change.
3. Press -[G]- or any other appropriate instruction type key.
4. Enter <address>.
5. Enter <data> if appropriate.

Editing a Get or Put Instruction in a Completed Rung

1. Position the cursor over the Get or Put instruction you want to change.
2. Press -[G]-, -(PUT)-, or any other appropriate instruction type key.
3. Enter <address>.

Important: Do not perform step 4 for a Put instruction.

4. Enter <data> if appropriate.

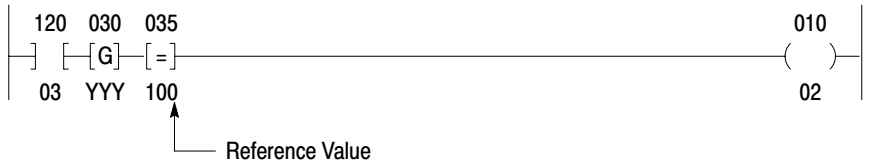
Compare Instructions

There are three compare instructions:

- equal to
- less than
- limit test

Equal To

Purpose: An equal to comparison is made with the Get and Equ instructions. The get value is the changing variable and is compared to the reference value of the Equ instruction for an equal to condition. When the get value equals the equ value, the comparison is true and logic continuity is established. It determines the rung condition. Compares only the lower 12 bits to the immediately preceding get instruction.



When YYY = 100, GET/EQU comparison is true and 010/02 is energized.

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

If the rung condition becomes:

True - If there is equality.
False - If there is no equality.

Keystrokes: You enter an Equal To instruction by performing the following steps.

1. Press -[=]-.
2. Enter <address>.
3. Enter <reference value> if appropriate.

Removing an Equal To Instruction
You remove an Equal To instruction by performing the following steps.

1. Position the cursor over the Equal To instruction you are going to remove.
2. Press [REMOVE] -[=]-.

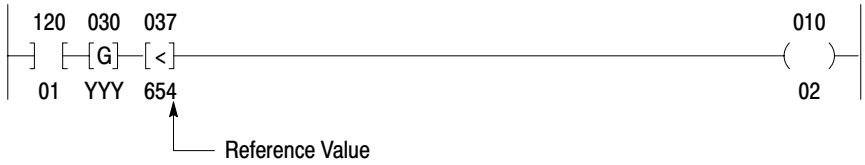
Editing a Completed Rung
You edit an Equal To instruction by performing the following steps.

1. Position the cursor over the Equal To instruction you are going to edit.
2. Press -[=]- or any other appropriate instruction type key.
3. Enter <address>.
4. Enter <reference value> if appropriate.

Less Than

Purpose: The Less Than instruction compares the data in your specified address with the data stored at another address in memory. It determines the rung condition. Compares only the lower 12 bits to the immediately preceding Get instruction.

Programmed after the Get instruction in the condition side of the ladder diagram rung.



When YYY < 654, GET/LES comparison is true and 010/02 is energized.

The rung condition becomes:

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

True - If the get value is less than the reference value stored in the Less Than instruction.
False - If the get value is equal to or greater than the less than value.

Keystrokes: You enter a Less Than instruction during initial programming by performing the following steps.

1. Press -[<]-.
2. Enter <address>.
3. Enter <reference value>.

Removing the Less Than Instruction
You remove a Less Than instruction by performing the following steps.

1. Position the cursor over the Les Than instruction you want to remove.
2. Press [REMOVE] -[<]-.

Editing a Completed Rung
You edit a Less Than instruction by performing the following steps

1. Position the cursor over the Less Than instruction you are going to edit.
2. Press -[<]- or any other appropriate data comparison instruction.
3. Enter <address>.
4. Enter (reference value).

Limit Test

Purpose: The limit test checks to see if a byte value is between two reference byte values in the limit test instruction.

- Programmed with a Get Byte instruction located in the condition area of the ladder diagram.
- Do not place compare instructions between the Get Byte and Limit Test instruction.
- The Get Byte and Limit Test instructions work only with octal values.

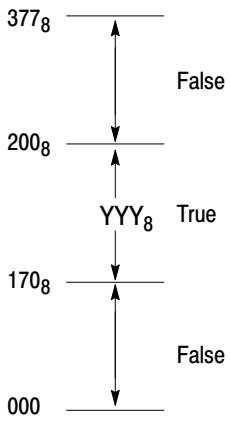
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

There are two cases for comparison:

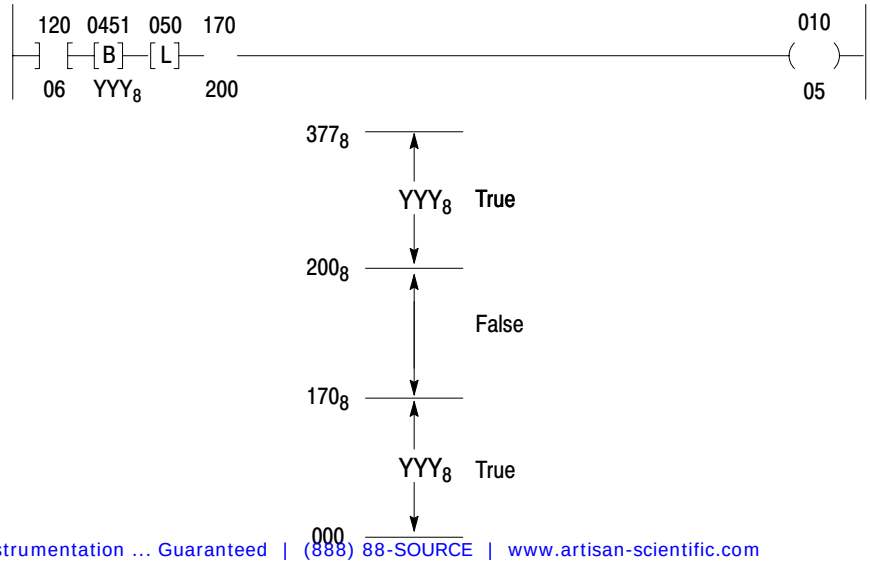
Case 1. Lower Limit ≤≤YYY ≤≤Upper Limit



If YYY is equal to or greater than 170 and equal to or less than 200, the comparison is true and logic continuity is established. If YYY is less than 170 or greater than 200, the comparison is false and logic continuity is not established.



Case 2. Lower Limit ≥ YYY ≥ Upper Limit



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

If YYY is equal to or less than 200 and equal to or greater than 170, the comparison is false and logic continuity is not established. If YYY_8 is greater than 200 or less than 170, the comparison is true and logic continuity is established.

Keystrokes: You enter a Limit Test instruction by performing the following steps.

1. Press -[L]-.
2. Enter <address>.
3. Enter <upper limit>.
4. Enter <lower limit>.

Editing a Completed Rung
You edit the Limit Test comparison by performing the following steps.

1. Press -[L]-.
2. Enter <address>.
3. Enter <upper limit>.
4. Enter <lower limit>.

Operations Involving Transfer and Comparison Instructions

You can perform five operations involving transfer and comparison instructions.

- equal to or less than
- greater than
- equal to or greater than
- get byte
- get byte/put

Equal To or Less Than

Purpose: The equal to/les than comparison is made using the Get, Les, Equ and branching instructions. The get value is the changing value. The Les and Equ instructions are assigned a reference value. When the get value is either less than or equal to the value at Les and Equ instructions, the comparison is true and logic continuity is established.

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



When YYY $\leq$ 237, GET/LES-EQU comparison is true and 010/03 is energized.

Important: Only one Get instruction is required for a parallel comparison. The Les and Equ instructions are programmed in parallel branches.

Keystrokes: You enter an equal to or less than comparison by following the following steps.

1. Press -[G]-.

2. Enter <address>.

3. Enter <reference value>.

4. Press [ ]

5. Press -[<]-.

6. Enter <address>.

7. Enter <reference value>.

8. Press [ ].

9. Press -[=]-.

10. Enter the same address as that entered for the Less Than instruction.

11. Enter <reference value>.

12. Press [ ]

13. Press -( )-.

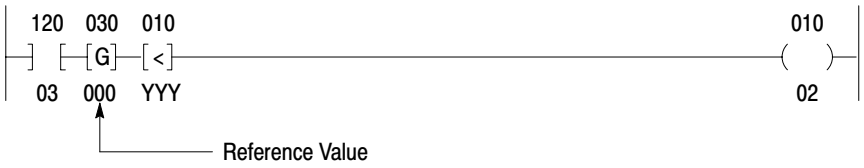
14. Enter <address>.

Editing the Operation
See the editing for the Get, Les, Equ and Branching instructions.

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

Greater Than

Purpose: A greater than comparison is also made with the Get/Les pair of instructions. This time the Get instruction BCD value is the reference and the Les instruction BCD value is the changing value. The Les value is compared with to the Get value for a greater than condition. When the Les value is greater than the Get value, the comparison is true and logic continuity is established.



When YYY > 100, GET/LES comparison is true and 010/02 is energized.

Keystrokes: You enter a greater than comparison by performing the following steps.

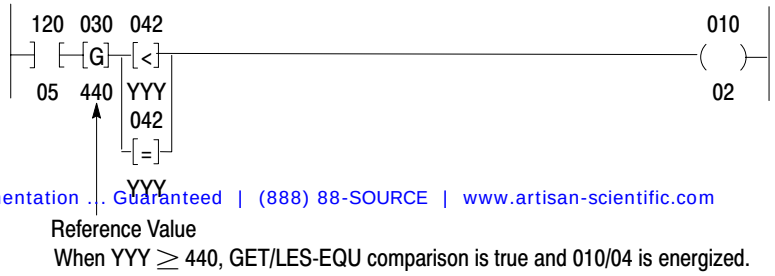
1. Press -[G]-.
2. Enter <address>.
3. Enter <reference value>.
4. Press -[<]-.
5. Enter <address>.
6. Enter <reference value>.

Editing the Operation

See the editing for the Get and Less instructions

Equal To or Greater Than

Purpose: This comparison is made using the Get, Les, Equ and branching instructions. The Get value is assigned a reference value. The Les and Equ values are changing and are compared to the Get value. When the Les and Equ values are greater than or equal to the Get value, the comparison is true and logic continuity is established.



When YYY ≥ 440, GET/LES-EQU comparison is true and 010/04 is energized.

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

Keystrokes: You enter an Equal To or Greater Than comparison by performing the following steps.

1. Press -[G]-.
2. Enter <address>.
3. Enter <reference value>.
4. Press [ ].
5. Press -[=]-.
6. Enter <address>.
7. Enter <reference value>.
8. Press [ ].
9. Press -[<]-.
10. Enter <address>.
11. Enter <reference value>.
12. Press [ ].
13. Press -( )-.
14. Enter <address>.

Editing the Operation
See the editing Get, Les, Equ and branching instructions.

Get Byte

Purpose: The Get Byte instruction accesses 1 byte (instead of word) from one address in the data table.

- The Get Byte instruction can be programmed with a limit test instruction located in the condition area of the ladder diagram rung.
- Use with a Put instruction to transfer either the upper or lower byte to the upper or lower byte of the Put instruction address.
- Do not place compare instructions between the Get Byte and Limit Test instructions.

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

Keystrokes: You enter a Get Byte instruction by performing the following steps.

1. Press -[B]-.
2. Enter <address>.
3. Enter <byte designation>.

Editing the Operation
You edit the Get Byte comparison by performing the following steps.

1. Position the cursor over -[B]-.
2. Press -[B]-.
3. Enter <address>.
4. Enter <by designation>.

Get Byte/Put

Purpose: The Get Byte instruction can be programmed either at the beginning of the rung or with one or more condition instructions preceding it. Condition instructions, however, should not be programmed after a Get Byte instruction. When one or more condition instructions precede the Get Byte instruction, they determine whether the rung is true or false.

The Get Byte instruction addresses either the upper or lower byte of a data table word. A 1 is entered after the word address for an upper byte; a 0 is entered for the lower byte.

There are two ways to perform a Get Byte/Put instruction.

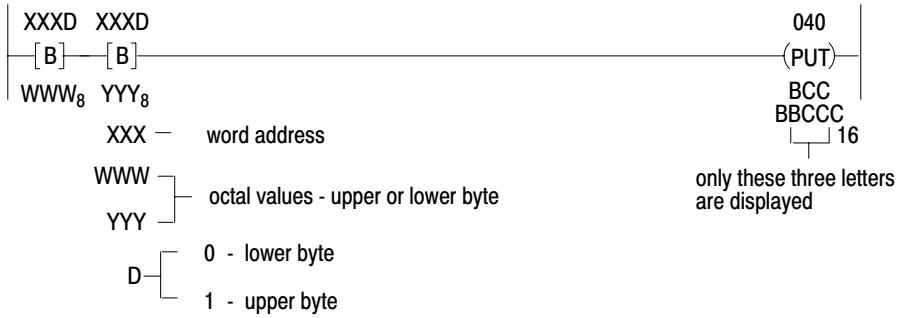
Case 1. One Get Byte



The Get Byte instruction is programmed in the condition area of the ladder rung. It tells the processor to make a duplicate of all 8 bits in the addressed byte. When the rung containing the Get Byte/Put instructions goes true, the data is transferred to both the upper and lower byte of the word address of the Put instruction.

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

Case 2. Two Get Bytes



Two Get Byte instructions are programmed in the condition area of the ladder rung. It tells the processor to make a duplicate of all 8 bits in each addressed byte. When the rung containing the Get Byte/Put instructions goes true, the data from the first get byte is transferred into the upper byte of the addressed Put instruction. Also, the data from the second get byte is transferred into the lower byte of the addressed Put instruction.

Keystrokes: You enter a Get Byte/Put instruction by performing the following steps.

1. Press -[B]-.

2. Enter <address>.

3. Enter <byte designation>.

Important: Repeat steps 1, 2 and 3 when using two Get Byte instructions.

4. Press -(PUT)-.

5. Enter <address>.

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

Editing the Operation
You edit a Get Byte/Put instruction by performing the following steps.

6. Position the cursor over -[B]-.

7. Press -[B]-.

8. Enter <address>.

9. Enter <byte designation>.

Important: Repeat steps 2, 3 and 4 when using two Get Byte instructions.

10. Press -(PUT)-.

11. Enter <address>.

Chapter Summary

We showed you how to transfer and compare data. Also, we showed you how to use these instructions to perform comparison operations. The next chapter shows you how to perform operations involving three digit and expanded math.

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

Chapter 10

Math Instructions

Chapter Objectives

This chapter describes two different types of math operations:

- three digit math
- expanded math

Table 10.A lists definitions of some mathematical terms.

Table 10.A
Common Arithmetic Terms

Terms	A	B	C
Operands	Operand A	Operand B	
Addition	Augend	+ Addend	Sum
Subtraction	Minuend	- Subtrahend	Difference
Multiplication	Multiplicand	Multiplier	Product
Division	Dividend	Divisor	Quotient
Square Root	Root		Square Root

Three-Digit Math

Your processor can perform four operations using three-digit math:

- addition
- subtraction
- multiplication
- division

These operations are not signed functions.

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

Addition, Subtraction, Multiplication and Division

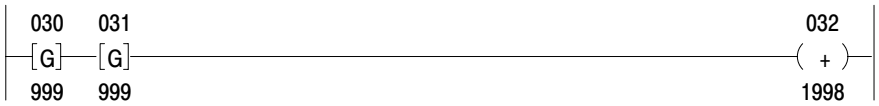
Addition

Reports the sum of two values from the two Get instructions immediately preceding the addition instruction. Programmed in the output position of the ladder diagram rung. The sum is stored in the add instruction word address.



When the sum exceeds 999, the overflow bit (bit 14) in the add instruction word is set. When the processor is operating in the run, program, or remote test mode, the overflow condition appears on the industrial terminal screen as a “1” preceding the sum.

Important: If an overflow value (four digits) is used for subsequent comparisons or other arithmetic operations, inaccurate results could occur.



Subtraction

Reports the difference between two get values immediately preceding the subtraction instruction. The second get word value is subtracted from the first get word value. Programmed in the output position of the ladder diagram rung. The difference is stored in the subtract instruction word address.



When the difference is a negative number, the underflow bit (bit 16) in the subtract instruction word is set. When your processor is in the run, program, or remote test mode, the negative sign appears on the industrial terminal screen preceding the difference.



Important: Use only positive values. If you use a negative BCD value for subsequent operation, inaccurate results could occur.

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

Multiplication
Reports the product of two values stored in the Get instruction words immediately preceding the multiply instruction. Programmed in the output position of the ladder diagram. The product is stored in two multiplication instruction words. The first word contains the most significant digit and the second word contains the least significant digit. If the product is less than six digits, leading zeros appear in the product.



Important: Use consecutive word addresses for the two addresses of the multiply instruction.

Division
Reports the quotient of two values stored in the two Get instructions immediately preceding division instruction. Programmed in the output position of the ladder diagram rung. The quotient is stored in two divide instruction words. The first word contains the most significant word and the second word contains the least significant digit.



Important: Use consecutive word addresses for the two addresses of the divide instruction. Quotient is expressed as a decimal, accurate to 3 decimal places. Any remaining data is rounded. Division by zero (including 0 : 0) gives the result of 999.999. This result differs from the PLC-2/20 and PLC -2/30 controllers where 0.0 = 1.000.



Keystrokes: You enter a three-digit math operation by performing the following keystrokes.

1. Start the rung. Press -[G]-.
2. Enter <address>.
3. Enter <data> if appropriate.

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

4. Press -[G]-.
5. Enter <address>.

6. Enter <data> if appropriate.

7. Close the rung by pressing the appropriate math instruction key (Table 10.B).

Table 10.B
Three Digit Math Functions

Addition	-(+)-
Subtraction	-(-)-
Multiplication	-(x)-
Division	-(÷)-

8. Enter <address(es)>.

Editing a Completed Rung
You edit a three digit math operation to change an address or the instruction type by performing the following steps.

1. See chapter 9 and follow the editing procedure for a Get instruction.

2. Position the cursor over the math function.

3. Press the appropriate instruction type key.

4. Enter <address(es)>.

Expanded Math

The processor can perform four math operations involving two operands:

Addition A + B = C
Subtraction A - B = C
Multiplication A x B = C
Division A ÷ B = C

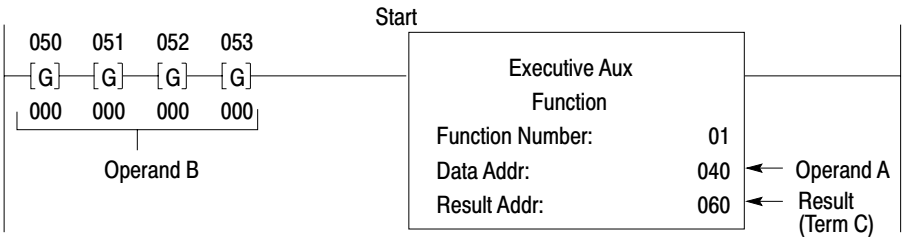
The processor can perform three additional operations that involve only one operand, the equations are:

Square Root $\sqrt{A} = C$
Conversion
(BCD to Binary) E (BCD) = F (Binary)
Conversion
(Binary to BCD) F (Binary) = E (BCD)

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

You solve these equations with expanded math operations using the EAF function of your processor. Figure 10.1 shows operand and result locations in a ladder diagram rung.

Figure 10.1
Primary Ladder Diagram for EAF Addition



Data Address

The data address (operand A) is the starting address of four consecutive data table words that contain the:

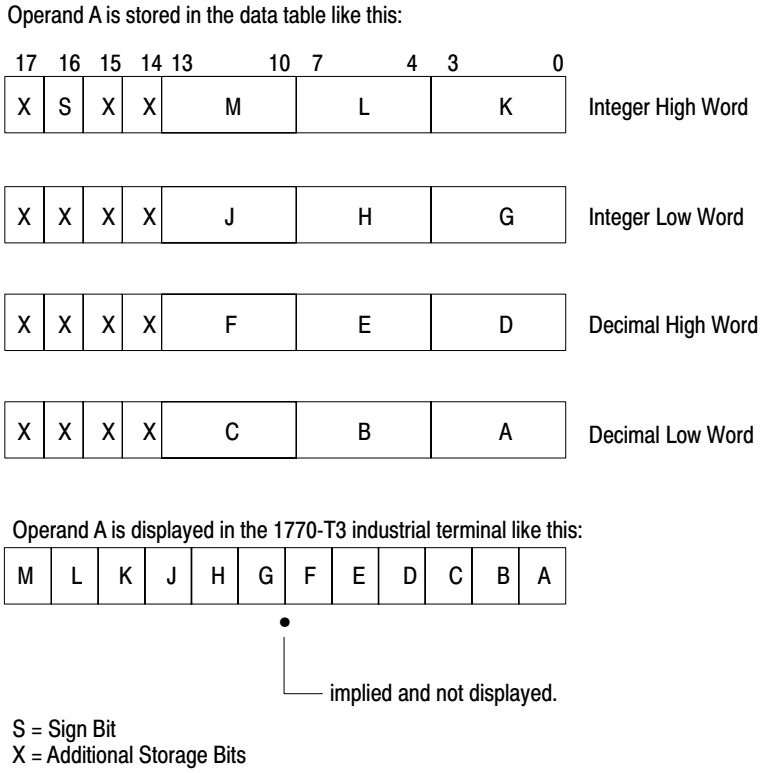
- augend
- minuend
- multiplicand
- dividend
- root
- conversion word

The data table can also contain a default value when performing square roots and conversions. The default value directs the processor to get its data from the rung.

The operand has a format like that shown in Figure 10.2. Enter the instructions for operand A from the keyboard of the 1770-T3 industrial terminal or through ladder diagram instructions. Once you select the data address(s), the EAF automatically reserves the next three addresses (four total) for the remaining words.

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

Figure 10.2
Data Address Format



Important: Valid data addresses include the I/O image table and the data table (except word 027). Specifically, valid addresses are from 010 to 026, from 030 to 077, and from 110 to the end of the data table. Data addresses and result addresses must not reside in the input image table.

The most significant four bits of the integer high word of the data address (Figure 10.2) are reserved for status bits.

- bit 17 - not used
- bit 16 - sign (+/-)
- bit 15 - not used
- bit 14 - not used

There is an implied decimal point between the integer low word and the decimal high word. The decimal point is implied but not displayed (Figure 10.2).

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

Conditioning Instructions

The conditioning instructions (operand B) may require up to four data table words (Figure 10.2). We use Get instructions to enter data for operand B that can contain an:

- addend
- subtrahend
- multiplier
- divisor
- root
- conversion word

Operand B has the format xxx xxx.xxx xxx. Enter it from the keyboard of the 1770-T3 industrial terminal or through ladder diagram instructions. The number you enter has a fixed decimal point. To include the range of numbers between 999 999.999 999 to 000 000.000 000 requires 12 bits from each of the four data words.

To enter the number MLK takes only one get or one data table word.

```
—[G]—                                   XXX MLK . XXX XXX
+\ - MLK
```

To enter the number MLK JHG takes two gets or two data words.

```
—[G]—[G]—                               MLK JHG . XXX XXX
+\ - MLK JHG
```

To enter the number MLK JHG.FED takes three gets or three data table words.

```
—[G]—[G]—[G]—                           MLK JHG . FED XXX
+\ - MLK JHG  FED
```

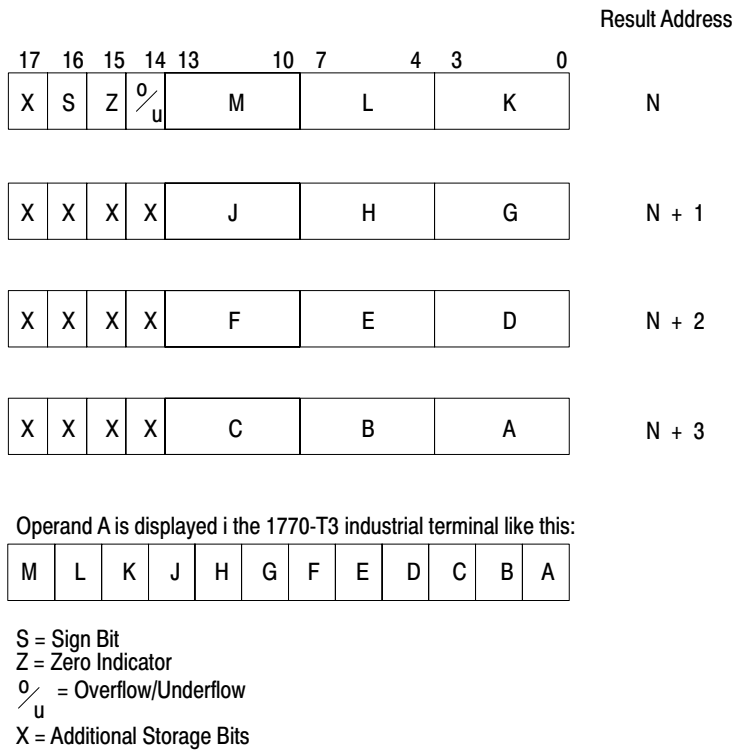
To enter the number MLK JHG.FED CBA takes four gets or data table words.

```
—[G]—[G]—[G]—[G]—                       MLK JHG . FED CBA
+\ - MLK JHG  FED  CBA
```

Access an expanded math function by pressing [SHIFT][EAF] or [SHIFT][SCT]. The EAF instruction is an output instruction and must be preceded by the gets of operand B. This operand may be preconditioned but nothing can be programmed between the gets and the EAF instruction. Should you program five gets, the last four gets are the only ones to be processed. The four gets need not have consecutive addresses. They can have any address except 000-007 and 100-107 in the processor work area.

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

Figure 10.3
Result Address Format



Result Address

The result address (term C) is the starting address of four consecutive data table words that contain the:

- sum
- difference
- product
- quotient
- root
- converted word

The result word has the format shown in Figure 10.3. The format is similar to the data address except that there are three status bits.

Once you select the result address, the EAF instruction automatically reserves the next three addresses for the remaining words of the result (Figure 10.3). Be careful not to select data and result addresses so close together that the addresses of the operands following the data address overlap the result address.

- bit 17 - not used
- bit 16 - sign bit: 0 = positive (+), 1 = negative (-)
- bit 15 - zero indicator: 0 = non-zero; 1 = zero result

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

- bit 14 - overflow/underflow/illegal bit; significance depends on the arithmetic operation being performed at the time

  overflow (addition) - set indicates result exceeds displayable result

  overflow (subtraction) - set indicates result exceeds displayable result

  overflow or underflow (multiplication) - set indicates result exceeds displayable result

  illegal (division) - set indicates division by zero or result exceeds result word range

In this section, unused status bits are shown blank for the following reasons:

- Whether the content of an unused status bit in an input word is 0 or 1 is irrelevant as such bits are ignored in EAF instruction execution.
- The EAF instruction reset unused status bits in result words. For simplicity the bits are left blank.

The processor can “chain” the results of the last executed EAF instruction with the current EAF instruction. You can use the last result as either the augend, minuend, multiplicand or dividend. Or, you can also use the last result as either the addend, subtrahend, multiplier or divisor.

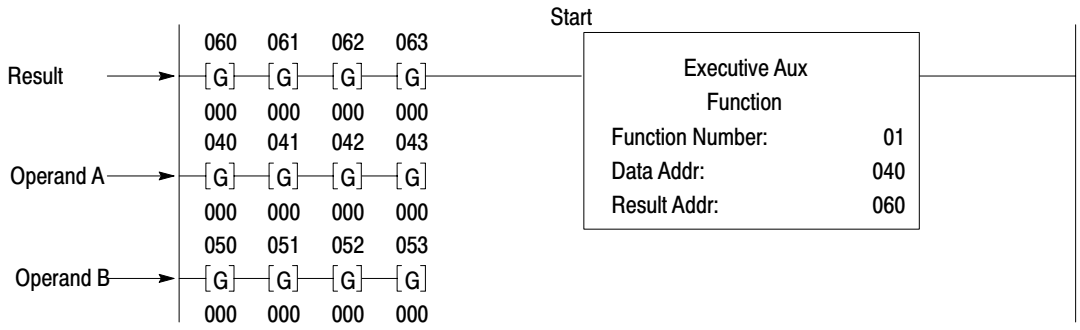
Branch Instructions

The least amount of instructions required to make the processor execute an EAF instruction is shown in Figure 10.1. The instructions composing the three terms A, B, and C are probably in different locations of your ladder diagram. Chances are that you would never see them. You can monitor the values in these instructions using the ladder diagram shown in Figure 10.4. The ladder diagram serves two purposes. It contains both the least amount of instructions required to execute an EAF instruction and display branches. Therefore, you have a choice of using either one of two ladder diagrams to execute an EAF instruction. These two ladder diagrams are named:

- primary
- optional

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

Figure 10.4
Optional Ladder Diagram for EAF Addition



In the optional ladder diagram (Figure 10.4), the first branch contains the result (term C). The second branch contains the data address or operand A (term A). The third branch contains operand B (term B).

Function Numbers

To program a specific operation, enter the appropriate function number (Table 10.C). This entry identifies a specific EAF math operation.

Table 10.C
EAF Function Numbers

Function Number	Mathematical Operation
01	Add
02	Subtract
03	Multiply
04	Divide
05	Square Root
13	BCD to Binary
14	Binary to BCD

Error Handling

Two types of run-time errors can occur when you use EAF instructions. They are illegal opcode and illegal address errors. An illegal opcode occurs if you enter a function number other than 1, 2, 3, 4, 5, 13, or 14. An illegal address error occurs if the operand pointed to by the data address or if the result pointed by the result address is located in the processor's work areas or in the program areas.

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

Expanded Math Operations

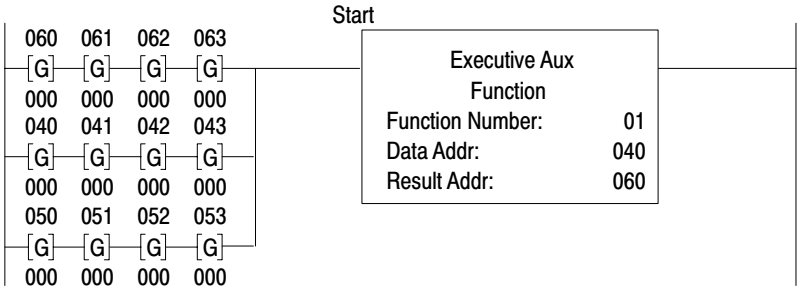
Your processor executes the following expanded math operations and maintains the proper sign of the result:

- addition
- subtraction
- multiplication
- division
- BCD to binary conversion
- Binary to BCD conversion
- square root (not a signed function)

Addition, Subtraction, Multiplication, and Division

Addition

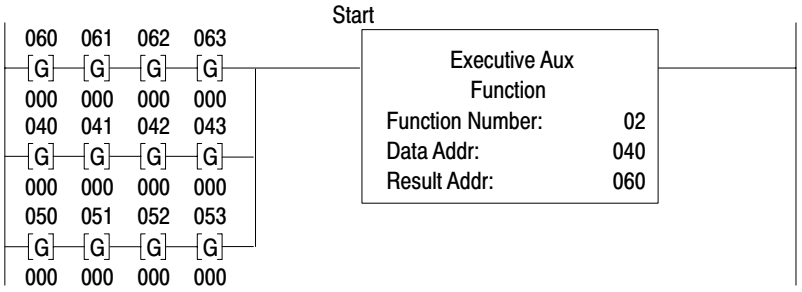
Reports the sum (result address) of the augend (operand A, the data address) and the addend (operand B, the conditioning gets). The addition function uses up to 12 digits for each operand. When the sum exceeds 999 999.999 999, the overflow bit (bit 14) in the result address word is set.



Important: If an overflow value is used for subsequent comparisons or other arithmetic operations, inaccurate results could occur.

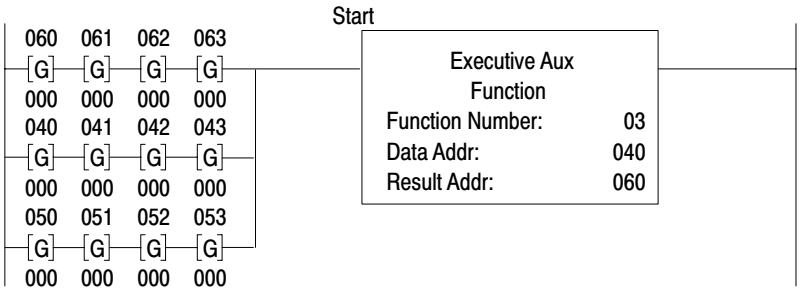
Subtraction

Reports the difference (result address) between two operands, a minuend (data address) and subtrahend (conditioning gets). The operands can use up to 12 digits.

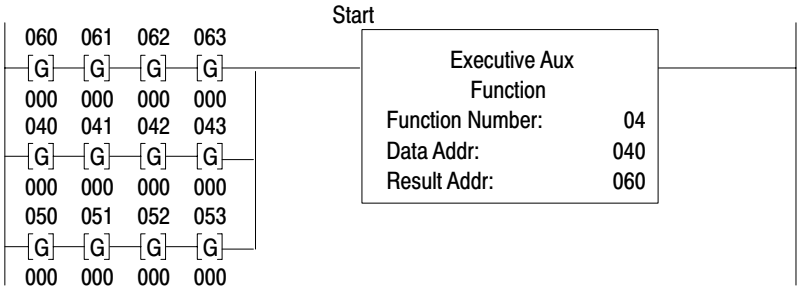


Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Multiplication
Reports the product (result address) of a multiplicand (data address) and a multiplier (conditioning gets). Operands can only be six digits.



Division
Reports the quotient (result address) of a dividend (data address) and a divisor (conditioning instructions).



Important: The quotient has at least six decimal digits. Any remaining data is rounded. Division of a number by zero (including 0 : 0) gives the result of 999.999 and the illegal bit is set.

Primary Ladder Diagram
Keystrokes: You enter the instructions for a primary ladder diagram to execute an addition, subtraction, multiplication, or division operation by performing the following steps.

1. Open the rung. Press -[G]-.
2. Enter <address>.
3. Enter <data> if appropriate.
4. Press -[G]-.
5. Enter <address>.
6. Enter <data> if appropriate.
7. Press -[G]-.
8. Enter <address>.

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

9. Enter <data> if appropriate.

10. Press -[G]-.

11. Enter <address>.

12. Enter <data> if appropriate.

13. Close the rung. Press [SHIFT][EAF].

14. Enter the appropriate function number

15. Enter <data address>.

16. Enter <result address>.

Optional Ladder Diagram
Keystrokes: You enter the instructions for an alternate ladder diagram to monitor an addition, subtraction, multiplication, or division operation by performing the following groups of steps.

The first group of steps you perform enters the branch for term C.

1. Open the rung. Press the branch start key [ ].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

5. Press -[G]-.

6. Enter <address>.

7. Enter <data> if appropriate.

8. Press -[G]-.

9. Enter <address>.

10. Enter <data> if appropriate.

11. Press -[G]-.

12. Enter <address>.

13. Enter <data> if appropriate.

The second group of steps you perform enters the branch for term A.

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

1. Press the branch start key [┌].
2. Press -[G]-.
3. Enter <address>.
4. Enter <data> if appropriate.
5. Press -[G]-.
6. Enter <address>.
7. Enter <data> if appropriate.
8. Press -[G]-.
9. Enter <address>.
10. Enter <data> if appropriate.
11. Press -[G]-.
12. Enter <address>.
13. Enter <data> if appropriate.

The third group of steps you perform enters the branch for term B.

1. Press the branch start key [┌].
2. Press -[G]-.
3. Enter <address>.
4. Enter <data> if appropriate.
5. Press -[G]-.
6. Enter <address>.
7. Enter <data> if appropriate.
8. Press -[G]-.
9. Enter <address>.
10. Enter <data> if appropriate.
11. Press -[G]-.
12. Enter <address>.

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

13. Enter <data> if appropriate.

14. Close the branches. Press the branch end key [ ].

15. Complete the rung. Press [SHIFT][EAF].

16. Enter the appropriate function number (Table 10.C).

17. Enter <data address>.

18. Enter <result address>.

Editing a Completed Rung

Operands A, B and Result: Follow the editing procedures for a Get instruction.

EAF Instruction: You can edit an EAF instruction to change an address or the function by performing the following steps.

1. Press [SHIFT][EAF].

2. Enter the appropriate function number (Table 10.C).

3. Enter <data address>.

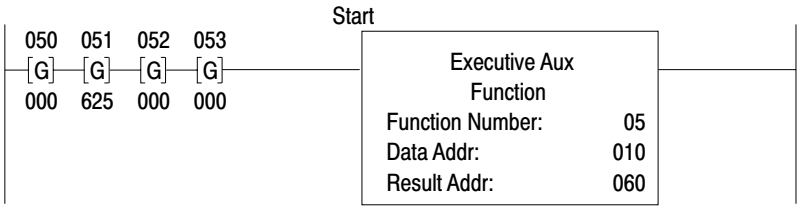
4. Enter <result address>.

Square Root

You must decide whether or not to enter a data address. If you choose to enter a data address, the processor seeks its data at that address in the data table. If you choose not to enter a data address and use the default number (010), the processor seeks its data from the instructions in the rung.

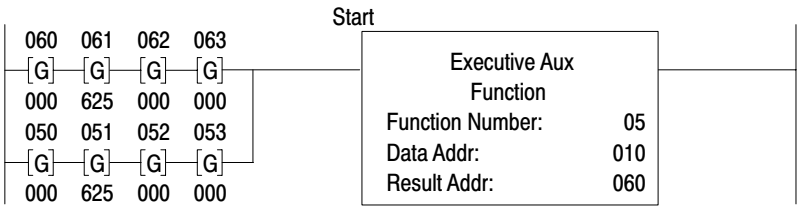
The primary ladder diagram that enables the processor to execute an EAF square root instruction is shown in Figure 10.5. You can monitor the values of an expanded math square root operation using the optional ladder diagram shown in Figure 10.6.

Figure 10.5
Primary Ladder Diagram for EAF Square Root



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

Figure 10.6
Optional Ladder Diagram for EAF Square Root



Only the six most significant digits are taken for a square root. The result is displayed in the result address words.

Primary Ladder Diagram
Keystrokes: You enter the instructions for the primary ladder diagram to execute a square root operation by performing the following steps.

1. Press -[G]-.

2. Enter <address>.

3. Enter <data> if appropriate.

4. Press -[G]-.

5. Enter <address>.

6. Enter <data> if appropriate.

7. Press -[G]-.

8. Enter <address>.

9. Enter <data> if appropriate.

10. Press -[G]-.

11. Enter <address>.

12. Enter <data> if appropriate.

13. Close the rung. Press [SHIFT][EAF].

14. Enter 05 (function number).

15. Enter 010 (data address).

16. Enter <result address>.

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

Optional Ladder Diagram
Keystrokes: You enter the instructions for an optional ladder diagram to

execute and monitor an square root operation by performing the following steps.

The first group of steps you perform enters the branch for the result.

1. Open the rung. Press the branch start key [⊤].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

5. Press -[G]-.

6. Enter <address>.

7. Enter <data> if appropriate.

8. Press -[G]-.

9. Enter <address>.

10. Enter <data> if appropriate.

11. Press -[G]-.

12. Enter <address>.

13. Enter <data> if appropriate.

The second group of steps you perform enters the branch for the number taken for a root.

1. Press the branch start key [⊤].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

5. Press -[G]-.

6. Enter <address>.

7. Enter <data> if appropriate.

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

8. Press -[G]-.

9. Enter <address>.

10. Enter <data> if appropriate.

11. Press -[G]-.

12. Enter <address>.

13. Enter <data> if appropriate.

14. Close the branches. Press the branch end key [ ].

15. Close the rung. Press [SHIFT][EAF].

16. Enter 05 (function number).

17. Enter 010 (data address).

18. Enter <result address>.

Editing a Completed Rung
Operand and Result: Follow the editing procedures for a Get instruction.

EAF Instruction: You can edit a square root operation to change an address by performing the following steps.

1. Press [SHIFT][EAF].

2. Enter 05 (function number).

3. Enter 010 (data address).

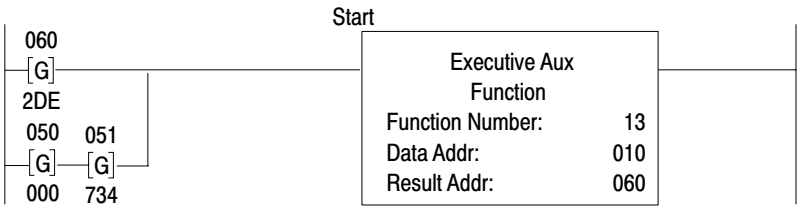
4. Enter <result address>.

BCD to Binary
You must decide whether or not to enter a data address. If you choose to enter a data address, the processor seeks the conversion number at that address in the data table. If you choose not to enter a data address and use the default number (010), the processor seeks its conversion number from the instructions in the rung.

The ladder diagram that enables the processor to perform a BCD to Binary conversion is shown in Figure 10.7. The default number is used as the data address.

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

Figure 10.7
Optional ladder diagram for BCD to Binary Conversion



If the operand is greater than (+) 32 767, the result 7FFFh is displayed. If the operand is more negative than (-) 32 767, the result 8001 is displayed at the result address. All negative values are stored as 2's complement.

Keystrokes: You enter instructions to perform a BCD to Binary EAF conversion by performing the following steps.

The first group of steps you perform enters the branch for the result (term F).

1. Open the rung. Press the branch start key [ ].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

The second group of steps you perform enters the branch for the conversion number (term E).

1. Press the branch start key [ ].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

5. Press -[G]-.

6. Enter <address>.

7. Enter <data> if appropriate.

8. Close the branches. press the branch end key [ ].

9. Close the rung. Press [SHIFT][EAF].

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

10. Enter 13 (function number).

11. Enter 010 (default number).

12. Enter <result address>.

Editing a Completed Rung
Operand and Result: Follow the editing procedures for a Get instruction.

EAF Instruction: You can edit a conversion operation to change an address by performing the following steps.

1. Press [SHIFT][EAF].

2. Enter 13 (function number).

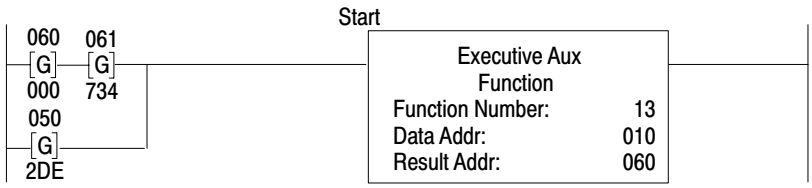
3. Enter 010 (data address).

4. Enter <result address>.

Binary to BCD Conversion
You must decide whether or not to enter a data address. If you choose to enter a data address, the processor seeks the binary number to be converted at that address in the data table. If you choose not to enter a data address and use the default number (010), the processor seeks its binary number to be converted at that address in the data table.

The ladder diagram that enables the processor to execute a Binary to BCD conversion is shown in Figure 10.8.

Figure 10.8
Optional Ladder Diagram for Binary to BCD Conversion



Keystrokes: You enter the instructions for a Binary to BCD conversion by performing the following steps.

The first group of steps you perform enters the branch for the result (term E).

1. Open the rung. Press the branch start key [ ].

2. Press -[G]-

3. Enter <address>.

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

4. Enter <data> if appropriate.

5. Press -[G]-.

6. Enter <address>.

7. Enter <data> if appropriate.

The second group of steps you perform enters the branch for the number to be converted (term F).

1. Open the rung. Press the branch start key [ ].

2. Press -[G]-.

3. Enter <address>.

4. Enter <data> if appropriate.

5. Close the branches. press the branch end key [ ].

6. Close the rung. Press [SHIFT][EAF].

7. Enter 14 (function number).

8. Enter 010 (data address).

9. Enter <result address>.

Editing a Completed Rung
Operand and Result: Follow the editing procedures for a Get instruction.

EAF Instruction: You edit an EAF instruction to change an address by performing the following steps.

1. Press [SHIFT][EAF].

2. Enter 14 (function number).

3. Enter 010 (data address).

4. Enter <result address>.

Chapter Summary

We showed you how to program different types of math functions. The next chapter tells how to transfer data files.

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

Chapter 11

Data Transfer File Instructions

Chapter Objectives

This chapter describes the data transfer file instructions:

- file to file move
- word to file move
- file to word move

A file is a group of consecutive data table words used to store information. A file can be between 1 and 999 words in length. The address of word 1 defines the address of the file. When displayed, the words of a file are designated consecutively by positions 001-999 according to the length of the file.

The word address defines:

- the location in the data table to which or from which the data will be moved.
- this word address can be manipulated by ladder diagram logic

Types of File Instructions

There are two types of file instructions:

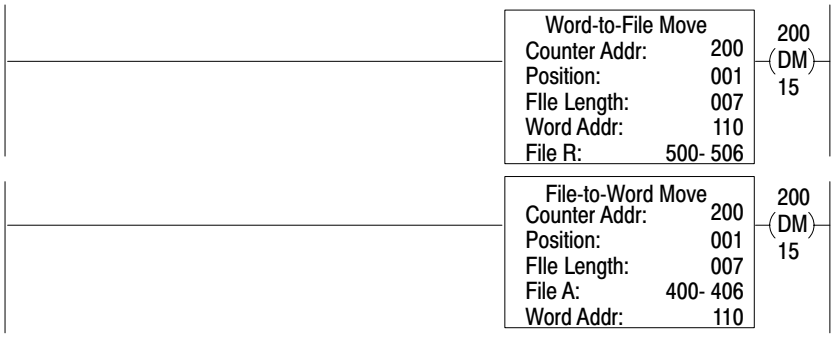
- those with an externally indexed counter (word-to-file move and file-to-word move)
- those with an internally indexed counter (file-to-file move)

Figure 11.1 shows the difference in format between these two types of file instructions.

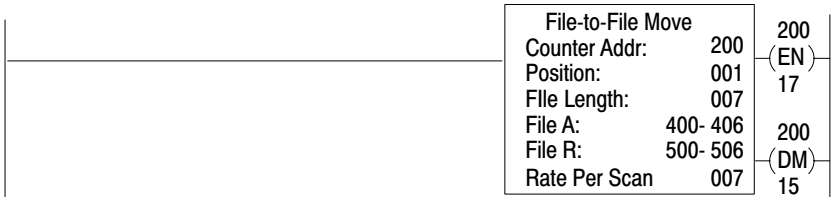
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Figure 11.1
Types of Counter Indexing

externally indexed file instructions



internally indexed file instructions



Externally Indexed

An externally indexed counter must be controlled by other rungs of your program. The counter address is used to identify the file instruction. The counter address holds the accumulated value. The accumulated value of the counter points to the file's position value. The position value is the accumulated value and it represents the specific word location within the file. The preset value of the counter represents the length of the file.

Another characteristic of the externally indexed file instruction is that it only has a done bit. This is bit 15. The done bit is automatically entered from the counter address. It is set when the operation is complete and remains set as long as the rung condition is true.

Internally Indexed

Internally indexed means that the counter is internally incremented by the instruction itself. No outside control is required. You assign an address to the counter.

In Figure 11.1 notice that a value for rate per scan is needed. The rate per scan defines the number of words which are operated upon during one scan. For example, suppose you have a file that contains twelve words. If you assign the value of 004 for the rate per scan that means that the instruction executes four words per scan at a time. Therefore, the entire operation is completed in three consecutive scans.

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

An internally indexed file instruction has a done bit and an enable bit. The done bit is bit 15 and the enable bit is bit 17. These bits are automatically entered from the counter address. The enable bit is set when the rung logic goes from a false to true transition; the done bit is set when the file instruction is completed.

Modes of Operation

There are three modes of operation based on the rate per scan. They are:

- complete
- distributed complete
- incremental

The following three sections describe each mode of operation.

Complete Mode

In the complete mode, the rate per scan is equal to the file length value and the entire file is operated upon in one scan. For example, if there are 12 words in your file and your rate per scan value is 12 then all 12 words are operated upon during one scan.

For each false-to-true transition of the rung condition, the instruction is enabled, the accumulated value of the file counter is internally indexed from the first to the last word of the file. As the accumulated value points to each word, the operation defined by the file instruction is performed. After the instruction has operated on the last word, the done bit (bit 15) is. When the rung condition goes false, both the done and enable bits are reset and the counter resets to position 001. If the rung was enabled for only one scan, the done bit would come on during that scan and remain set for one additional scan.

Distributed Complete Mode

In the distributed complete mode, the rate per scan is less than the file length value and the entire file is operated over several program scans. For example, if there are twelve words in your file and your rate per scan value is three, then three words are operated upon during each scan. Therefore, it takes four consecutive scans to execute the entire file instruction operation.

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

For each true rung condition, the instruction is enabled. The number of words equal to the rate per scan is operated upon during one scan. The process is repeated over a number of consecutive scans until the entire file has been operated upon. Once the file instruction is enabled it remains enabled for the number of scans necessary to complete the operation. The rung could become repeatedly false and true during this time without interrupting the operation of the instruction.

At the time of completion, if the rung is true, the enable bit (bit 17) and the done bit (bit 15) are both set. If the rung is false, the enable bit is reset after the last group of words is operated upon. At the same time, the done bit is set and stays set for one scan. During the next scan the done bit is reset, and the counter is reset to position 001.

Incremental Mode

In the incremental mode, the rate per scan is equal to 0. This means that upon each false-to-true transition one word is operated upon per scan, then the counter increments to the next position. When the rung is true the enable bit (bit 17) is set. After the last word in the file has been operated upon, the done bit (bit 15) is set. When the rung goes false, the done and enable bits are reset (after the last word has been operated upon), and the counter is reset to position 001. If the rung remains true for more than one scan, the operation does not repeat. The operation only occurs in the scan in which the false-to-true transition occurs.

To change from one mode to another, use Table 11.A to determine the values.

Table 11.A
Changing Modes

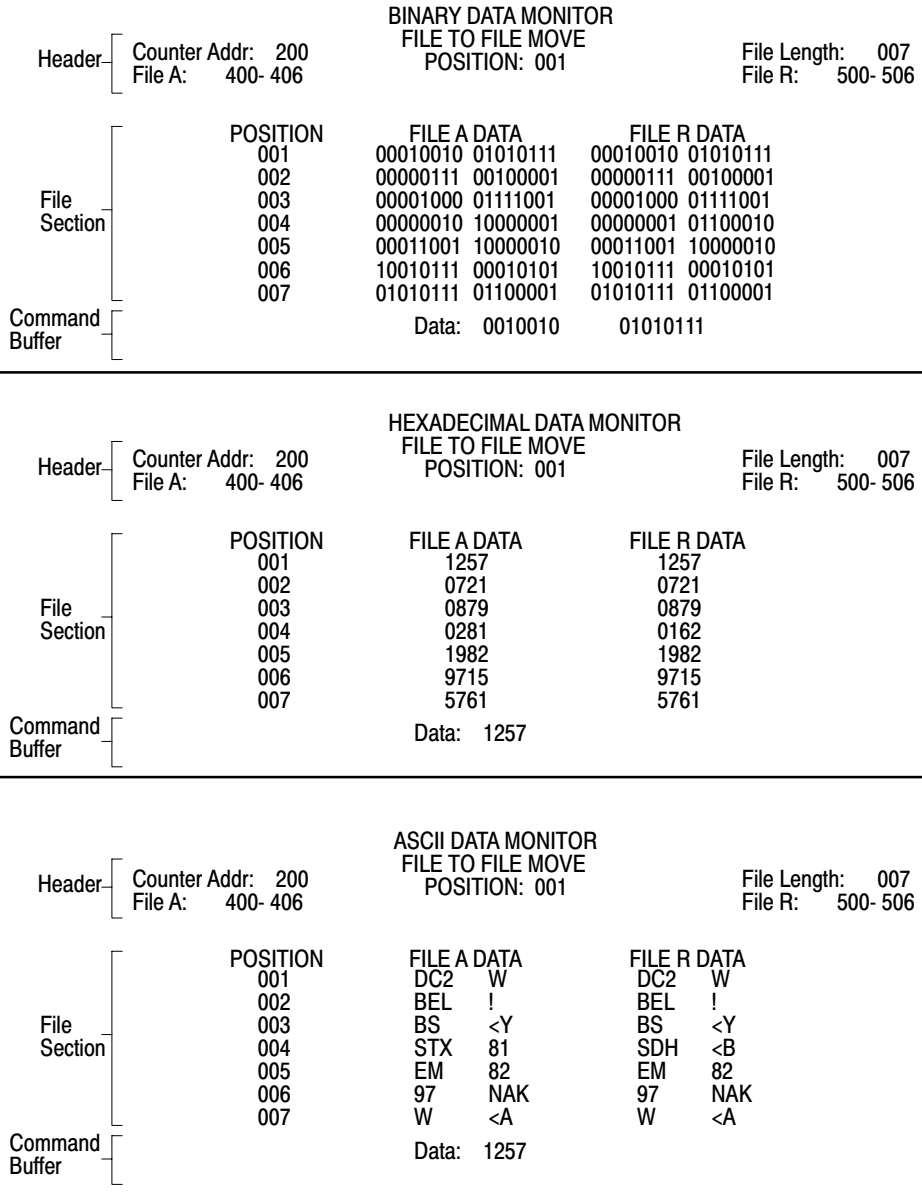
To change	Enter the Rate per Scan Value
Complete to Distributed Complete	001 thru 006
Distributed Complete to Incremental	000
Distributed Complete to Complete	007
Incremental to Complete	007

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

Data Monitor Display

Once you establish your file data, you'll want to edit, load, or monitor your file data. To do these functions the processor has a data monitor mode. This mode lets you access your file in three ways; either by displaying binary, hexadecimal, or ASCII values (Figure 11.2)

Figure 11.2
Data Monitor Display



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

The binary data monitor display lets you manipulate one word at a time by displaying each bit using binary digits. The hexadecimal monitor display lets you manipulate 4 digits which represents word values. The ASCII monitor display converts 4 digits to the ASCII code. The industrial terminal can automatically convert data from one number system to the other when the alternate display is selected. You can print this display directly from the CRT to a data terminal by following these steps:

Table 11.B
Monitor Functions

Function	Key Sequence	Mode	Description
Display	[DISPLAY][0]	Any	Displays binary data monitor.
Print	[DISPLAY][0] [RECORD]	Any	Prints first 20 lines of binary data monitor.
Display	[DISPLAY][1]	Any	Displays hexadecimal data monitor.
Print	[DISPLAY][1] [RECORD]	Any	Prints first 20 lines of hexadecimal data monitor.
Display	[DISPLAY][2]	Any	Displays ASCII data monitor.
Print	[DISPLAY][2] [RECORD]	Any	Prints first 20 lines of ASCII data monitor.

Three sections divide the data monitor display. They are identified as (Figure 11.2):

- Header: located at the top of the screen and contains information pertaining to its corresponding file instruction. For example: counter, file, word addresses, and file length.
- File Section: located in the center of the screen and displays the data stored in a file. The column labeled POSITION refers to each word's position in the file. FILE A DATA represents the original file, and FILE R DATA represents the new file.
- Command Buffer: located at the bottom center of the screen and is used to enter or change file data. It is always displayed in the program mode.

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

Use the following illustration as you read about each file instruction.

Key Sequence	1770–T3 Display	Instruction Notes
FILE 10	File-To-File Move Counter Addr: 030 Position: 001 File Length: 001 File A: 110–110 File R: 110–110 Rate Per Scan: 001 030 EN 17 030 DN 15	Output instruction. Modes: Complete, distributed, and incremental. Counter is internally incremented by the instruction. Requires 5 words of user program.
FILE 11	Word-To-File Move Counter Addr: 030 Position: 001 File Length: 001 Word Address: 010 File R: 110–110 030 DN 15	Output instruction. Counter must be externally indexed by user program. Data is transferred every scan that rung is true. Requires 4 words of user program.
FILE 12	File-To-Word Move Counter Addr: 030 Position: 001 File Length: 001 File A: 110–110 Word Address: 010 030 DN 15	Same as word–to–file.

IMPORTANT: Numbers shown are default values. Numbers in shaded areas must be replaced by user-entered values. The number of 0 default address digits initially displayed (3 or 4) will depend on the size of the data table.

Here is an explanation of each value:

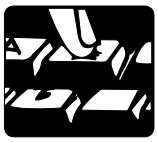
This Value:	Stores the:
Counter Address	Address of the instruction's file position in the accumulated value area of the data table
Position	Current word being operated upon (accumulated value of the counter)
File Length	Number of words in the file (preset value of the counter)
File A	Starting address of the source file
File R	Starting address of the destination file
Word Address	Address of the source word or destination word outside of the file
Rate Per Scan	Number of data words moved per scan

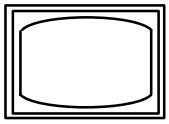
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Before You Begin

Put the processor in the program mode.

You may have to expand your data table to provide additional space for files. To do this:





[SEARCH] There is no change in the screen display.

50

DATA TABLE CONFIGURATION

NUMBER OF 128-WORD D.T. BLOCKS	01
NUMBER OF INPUT/OUTPUT RACKS	2
NUMBER OF T/C (If applicable)	40
DATA TABLE SIZE	128

The following chart will help you adjust the data table size of your processor.

Enter	Data Table Size
01	128
02	256
03	384
04	512
05	640
06	768
07	896
08	1024
09	1152
10	1280
11	1408
12	1536
13	1664
14	1792
15	1920
16	2048
17	2176
18	2304
19	2432
20	2560
21	2688
22	2816
23	2944

After you adjust the data table, press [CANCEL COMMAND] and continue.

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

Important: Other industrial terminal commands are summarized in appendix C.

File to File Move

Purpose: Duplicates and transfers the source file to the destination file address you identified. The source file remains intact.

Programmed as an output instruction; requires five words of the user program area. The counter is incremented internally by the instruction.

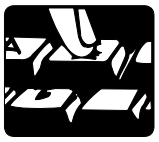
ATTENTION: The counter address for the file-to-file move instruction should be reserved for that instruction. Do not manipulate the counter accumulated or preset word. Changes to these values could result in unpredictable machine operation or a run-time error. Damage to equipment and/or injury to personnel could occur.

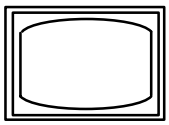
When the rung becomes:

True - The data is transferred from the source file to your designated file at the specified rate per scan.

False - no action is taken.

Keystrokes: You enter a file to file move by performing the following steps.

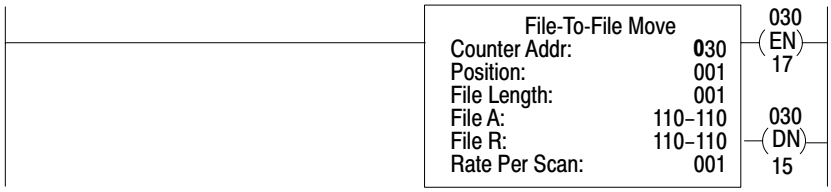




[FILE]

The screen does not change.

10

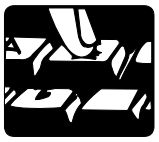


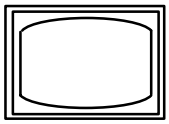
Parameters: Notice that the cursor is now on the first digit of the counter address. Also, the display shows all default values.

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

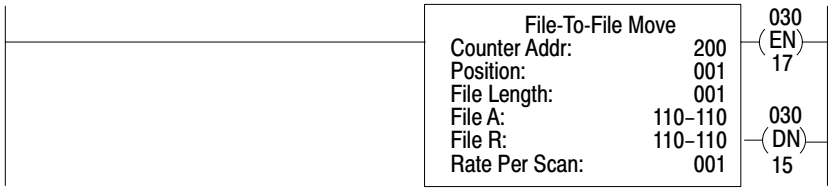
Insert the following values. The cursor moves automatically through the file instruction. The values are:

COUNTER ADDR - 200
POSITION - 001
FILE LENGTH - 007
FILE A - 400
FILE R - 500
RATE PER SCAN - 007

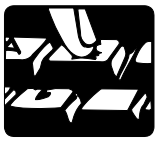


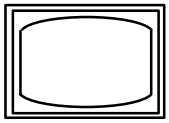


200

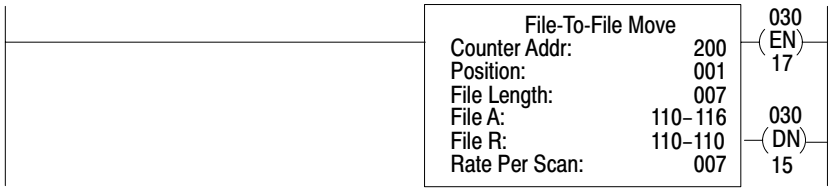


Now the cursor is on the first digit of the file length.

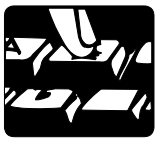


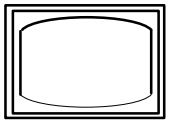


007

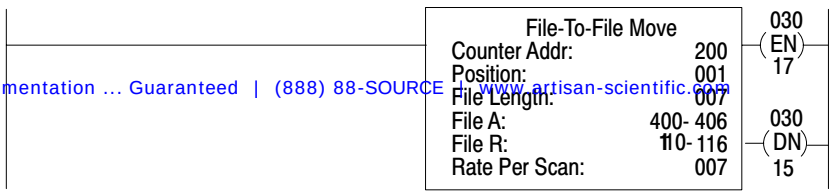


The cursor moved to the first digit of file A.



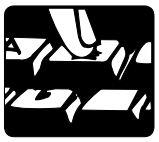


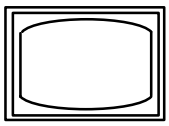
400



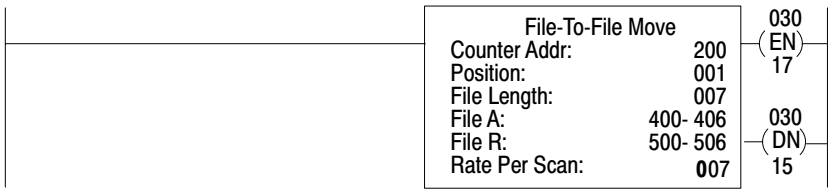
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

The cursor moved to the first digit of file R.

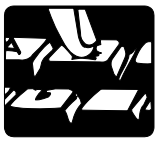


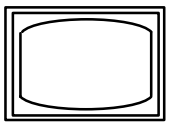


500

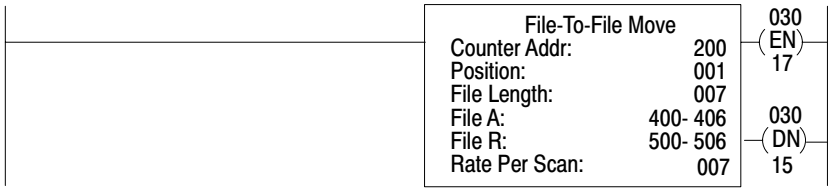


Finally, the cursor is on the first digit of the rate per scan.

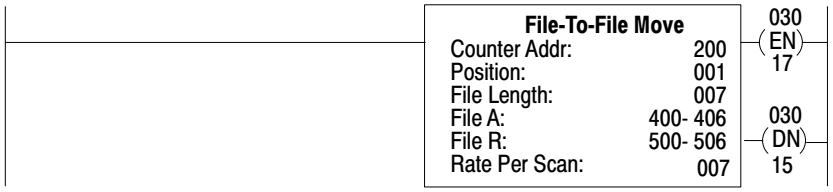




007



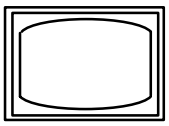
You can now proceed to add data to your file. Position your cursor on the words file to file move. Use the arrow keys to move your cursor.



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

This example uses the hexadecimal data monitor display.





[DISPLAY]

1

The screen does not change

```
                    HEXADECIMAL DATA MONITOR
                      FILE TO FILE MOVE
Counter Addr:   200       POSITION:  001          File Length:     007
File A:      400- 406                             File R:      500- 506

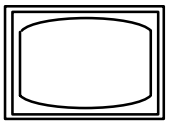
      POSITION      FILE A DATA      FILE R DATA
         001            0000             0000
         002            0000             0000
         003            0000             0000
         004            0000             0000
         005            0000             0000
         006            0000             0000
         007            0000             0000

                    Data:  0000
```

Important: :If you want to enter binary information, press [DISPLAY][0]. If you want to enter ASCII information, press [DISPLAY] 2.

Now, enter data in position 001 to file A.





1257

```
                    HEXADECIMAL DATA MONITOR
                      FILE TO FILE MOVE
Counter Addr:   200       POSITION:  001          File Length:     007
File A:      400- 406                             File R:      500- 506

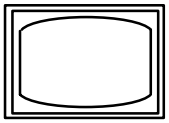
      POSITION      FILE A DATA      FILE R DATA
         001          0000               0000
         002          0000               0000
         003          0000               0000
         004          0000               0000
         005          0000               0000
         006          0000               0000
         007          0000               0000

                    Data:  1257
```

Important: If you make a mistake, you can correct it by moving the cursor left or right to the incorrect number and then pressing the correct number key.

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





1257

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

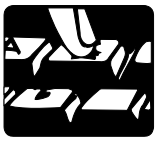
Counter Addr: 200 POSITION: 001 File Length: 007
File A: 400- 406 File R: 500- 506

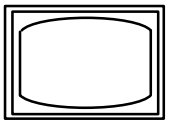
POSITION	FILE A DATA	FILE R DATA
001	**1257**	0000
002	0000	0000
003	0000	0000
004	0000	0000
005	0000	0000
006	0000	0000
007	0000	0000

Data: **1257**

This information (1257) now appears in position 001 of file A. The command buffer at the bottom of the screen now displays 1257.

Cursor down one line and add data to position 002.





0721

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 001 File Length: 007
File A: 400- 406 File R: 500- 506

POSITION	FILE A DATA	FILE R DATA
001	**0000**	0000
002	0000	0000
003	0000	0000
004	0000	0000
005	0000	0000
006	0000	0000
007	0000	0000

Data: **0721**

[INSERT]

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 001 File Length: 007
File A: 400- 406 File R: 500- 506

POSITION	FILE A DATA	FILE R DATA
001	1257	0000
002	**0721**	0000
003	0000	0000
004	0000	0000
005	0000	0000
006	0000	0000
007	0000	0000

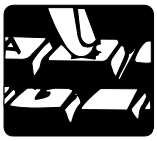
Data: **0721**

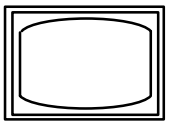
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisanscientific.com

Load each position of file A with the following data:

POSITION 003 0879
POSITION 004 0162
POSITION 005 1982
POSITION 006 9715
POSITION 007 5761

Important: You do not have to enter data in each position. You can skip position numbers.





[CANCEL COMMAND]	The file to file move rung is displayed.
[SEARCH]	The screen does not change.
590	Puts the processor in the run/program mode.
[DISPLAY]	The screen does not change.
1	

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 007 File Length: 007
File A: 400- 406 File R: 500- 506

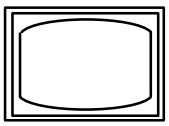
POSITION	FILE A DATA	FILE R DATA
001	1257	**1257**
002	0721	**0721**
003	0879	**0879**
004	0162	**0162**
005	1982	**1982**
006	9715	**9715**
007	5761	**5761**

Notice that the data in file A transferred to file R.

Do not clear your processor memory. The next example edits this rung.

Editing in a Completed Rung
In this section, you will edit your file's data in the hexadecimal data monitor display.

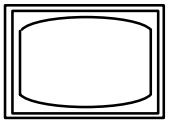




Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

[SEARCH]	The screen does not change.
592	Puts the processor in the remote program mode.





[DISPLAY]

The screen does not change.

1

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 007 File Length: 007
File A: 400- 406 File R: 500- 506

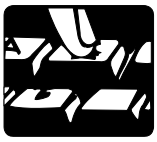
POSITION	FILE A DATA	FILE R DATA
001	1257	1257
002	0721	0721
003	0879	0879
004	0162	0162
005	1982	1982
006	9715	9715
007	5761	5761

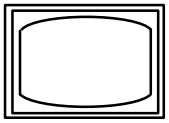
DATA: 1257

Notice the command buffer at the bottom of the screen. It is labeled DATA:1257. This is also the same number in FILE A at POSITION 001.

Cursor down to POSITION 004.

Change the data in the command buffer from 0162 to 0281.





0281

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 007 File Length: 007
File A: 400- 406 File R: 500- 506

POSITION	FILE A DATA	FILE R DATA
001	1257	1257
002	0721	0721
003	0879	0879
004	**0162**	0162
005	1982	1982
006	9715	9715
007	5761	5761

Data: **0281**

[INSERT]

HEXADECIMAL DATA MONITOR
FILE TO FILE MOVE

Counter Addr: 200 POSITION: 007 File Length: 007
File A: 400- 406 File R: 500- 506

POSITION	FILE A DATA	FILE R DATA
001	1257	1257
002	0721	0721
003	0879	0879
004	**0281**	0162
005	1982	1982
006	9715	9715
007	5761	5761

Data: 0281

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

Notice that file R's POSITION has not changed.

Now practice by changing POSITION 006 of file A to 7777.

Important: If you want to change the data in FILE R, you follow the same procedure. To move your cursor to file R press the [SHIFT}, [⇉].

Word to File Move

Purpose: Duplicates and transfers the data of a word from the data table to a specified word within a file.

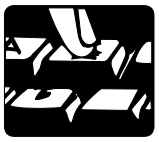
Programmed as an output instruction; requires four words of the user program area. Your program must externally index the counter.

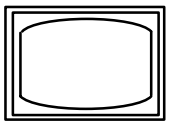
When the rung goes:

True - Data from a designated word address in the data table is transferred to the selected position in the source file.

False - No action is taken.

Keystrokes: You enter a word to file move by performing the following steps.

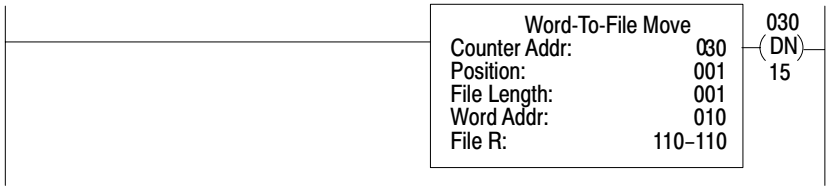




[FILE]

The screen does not change.

11



Parameters: The procedure for entering the parameters for a word to file move is the same as the procedure for a file to file move.

File to Word Move

Purpose: Duplicates and transfers the data of a word within your source file to a specified word elsewhere in the data table.

Programmed as an output instruction; requires four words of the user program area. Your program must externally index the counter.

Artisan Scientific - Quality Instruments and Services for Your Laboratory (USA) | Buy, Sell, Trade, Lease, Rent, Calibrate, Repair

When the rung becomes:

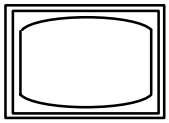
True - The data of a word is transferred from your file to your designated word address.

False - No action is taken.

ATTENTION: The counter address for the word-to-file move and file-to-word move instructions should be used only for the intended instruction and the corresponding instructions which manipulate the accumulated value. Do not inadvertently manipulate the preset or accumulated word. Changes to these values could result in unpredictable machine operation or a run time error. Damage to equipment and/or injury to personnel could occur.

Keystrokes: You enter a file to word move by performing the following steps.

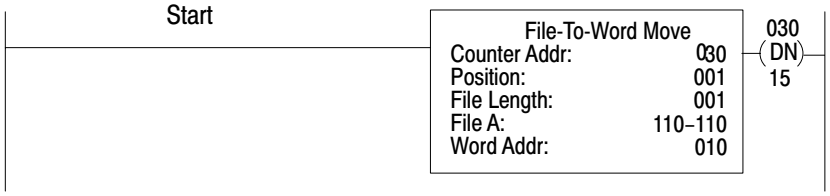




[FILE]

The screen does not change.

12



Parameters: The procedure for entering parameters for a file to word move is the same as the procedure for a file to file move.

Chapter Summary

In this chapter, we have showed you three data transfer file instructions. Also, we showed you how to use the data monitor display. The next chapter shows you three types of sequencer instructions.

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

Chapter 12

Sequencers

Chapter Objectives

This describes the three types of sequence instructions:

- sequencer input
- sequencer output
- sequencer load

These instructions either transfer information from the data table to output word addresses, compare I/O word information with information stored in tables, or transfer I/O word information into the data table.

Comparison with File Instructions

Sequencer instructions can transfer information from the data table to output word addresses for the control of sequential machine operation (sequencer output); compare I/O word information stored in tables so that machine operation conditions can be examined for control and diagnostic purposes (sequencer input); and transfer I/O word information into the sequencer file (sequencer load).

File instructions operate on files that are one word or 16 bits wide. In contrast, sequencer instructions operate on files that are up to four words or 64 bits wide. A sequencer file can be represented graphically by a sequencer table. The length or number of steps (rows) in a sequencer table can be up to 999. The width of a sequencer table can be up to four words (columns) as shown in Figure 12.1.

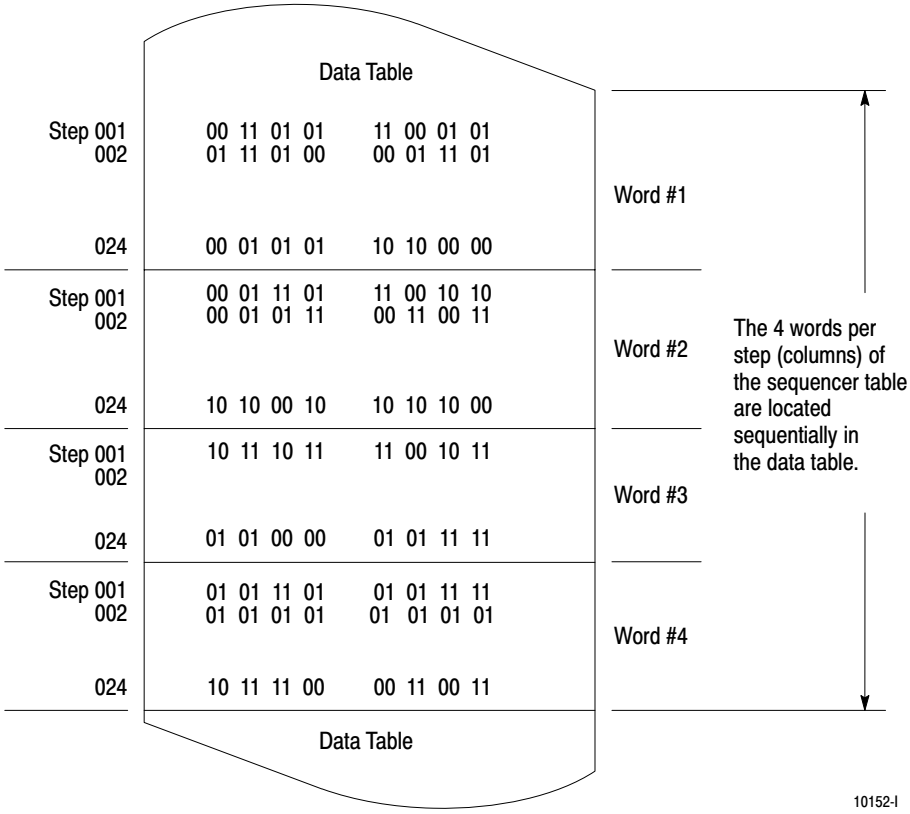
Figure 12.1
Sequencer Table

Step	Word 1	Word 2	Word 3	Word 4
001	00110101 11000101	00011101 11001010	10111011 11001011	01011101 01011111
002	01110100 00011101	00010111 00110011	”	01010101 01010101
003	”	”	”	”
”	”	”	”	”
”	”	”	”	”
”	”	”	”	”
”	”	”	”	”
”	”	”	”	”
”	”	”	”	”
024	00010101 10100000	10100010 10101000	01010000 01011111	10111100 00110011

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

Important: The data table is one word wide by many long. A sequencer table appears in the data table as one continuous file. The length of the file in the data table equals the product of the number of steps and the length as shown in Figure 12.2. As an example, a 24 step x 4 word wide sequencer table occupies 96 consecutive words in the data table.

Figure 12.2
Sequencer Table Format in the Data Table



Internally indexed file instructions perform the operation and then increment to the next step. In contrast, internally indexed sequencer instructions increment to the next step and then the operation is performed.

Mask

A special programming technique called a “mask” is used with the sequencer instructions. A mask is a means of controlling what bits are controlled/compared by the sequencer instruction. By masking bits, you ensure that the sequencer instruction does not affect them. The masked bits may then be used for other program purposes.

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

A 0 in a mask bit location prevents the instruction from controlling or comparing the data in the corresponding bit location. A 1 in a mask bit location allows the corresponding bit to be controlled or compared. When all the output/input bits are controlled or compared by the instruction, use a mask of all 1's.

Other instructions can change a mask in the user program. If a changing mask is required for different steps in the sequencer operation use a get/put or a file move.

ATTENTION: When choosing a mask word address, be sure that the next 1, 2, or 3 consecutive word addresses are not already assigned. Other data written into a mask could cause unpredictable machine operation. This could cause damage to your equipment and/or injury to your personnel.

Programming Limitations

Sequencer instructions can be powerful tools when programming your operations. Two steps in the same instruction can not be operated simultaneously.

ATTENTION: When programming a sequencer input with a sequencer output instruction, the counter address for both instructions must be the same. Failure to use the same counter address for both sequencers, can result in input and output steps becoming unsynchronized which may result in unwanted machine motion and/or injury to personnel.

Sequencer Instructions

Use Figure 12.3 while you read about each sequencer instruction.

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

Figure 12.3
Sequencer Instructions

Key Sequence	1770–T3 Display	Instruction Notes
SEQ 0	Sequencer Output Counter Addr: 030 Current Step: 001 Seq Length: 001 Words Per Step: 1 File: 110–110 Mask: 010–010 Output Words 1: 010 2: 3: 4: 030 (EN) 17 030 (DN) 15	Output instruction. Increments, then transfers data. Same data transferred each scan that the rung is true. Counter is indexed by the instruction. Unused output bits can be masked. Requires 5–9 words of your program.
SEQ 1	Sequencer Input Counter Addr: 030 Current Step: 000 Seq Length: 001 Words Per Step: 1 File: 110–110 Mask: 010–010 Input Words 1: 010 2: 3: 4:	Input instruction. Compares input data with current steps for equality. Counter must be externally indexed by your program. Requires 5–8 words of your program.
SEQ 2	Sequencer Load Counter Addr: 030 Current Step: 001 Seq Length: 001 Words Per Step: 1 File: 110–110 Output Words 1: 010 2: 3: 4: 030 (EN) 17 030 (DN) 15	Outupt instruction Increments, then loads data. Counter is indexed by the instruction. Does not mask. Requires 4–7 words of your program.

NOTE: Numbers shown are default values. Numbers in shaded areas must be replaced by your entered values. The number of default address digits initially displayed (3 or 4) will depend on the size of the data table.

Here is an explanation of each value:

This Value:	Stores the:
Counter Address	Address of the instruction in the accumulated value area of the data table
Position	Position in the sequencer table (accumulated value of counter)
Seq Length	Number of steps (preset value of the counter)
Words per Step	Width of the sequencer table
File	Starting address of the source file
Mask	Starting address of the mask file
Word Address	Address of the source word or destination word outside of the file
Output Words	Words controlled by the instruction
Load Words	Words fetched by the instruction
Input Words	Words monitored by the instruction

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

Sequencer Input

Purpose: Compares input data to stored data for equality.

Programmed as an input instruction. The counter is externally controlled by the ladder diagram logic in your program. This instruction requires 5-8 words of the program. May be programmed with a sequencer output instruction. You can compare up to 64 bits. You can mask the unused input bits.

If the rung becomes:

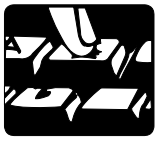
True - The instruction increments to the next step and compares the input word to current step for equality.

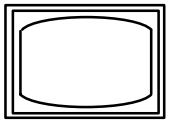
False - No action is taken.



ATTENTION: The counter address of the sequencer input instruction should be used only for the intended instruction and the corresponding instructions which manipulate the preset or accumulated value. Do not inadvertently manipulate the preset or accumulated word. Changes to these values could result in unpredictable machine operation or a run-time error. Damage to equipment and/or injury to personnel could occur.

Keystrokes: Start by expanding your data table if required. Expand it to a size large enough to store your program. See appendix C for data table size values.

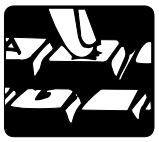


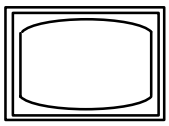


[SEARCH]	The screen does not change.
50	The DATA TABLE CONFIGURATION appears. The cursor is on the first digit of NUMBER OF 128 WORD D.T. BLOCKS.

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

To be able to use the sequencer input, output, and load examples:



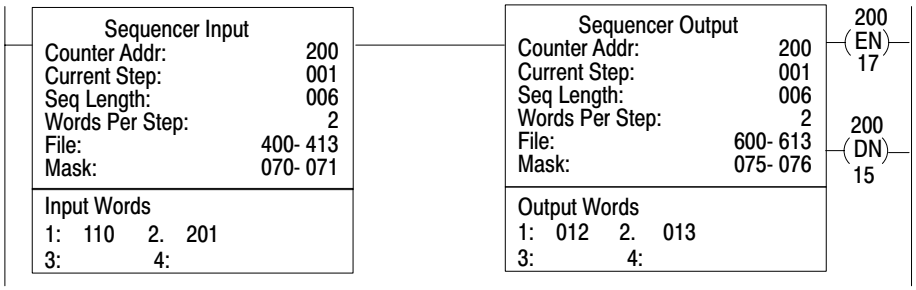


04

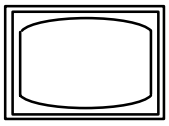
The cursor moves the digit 4 and DATA TABLE SIZE changed to 512.

This gives you a 512 word data table.

After you adjust the data table press [CANCEL COMMAND]. You are now ready to insert this program.

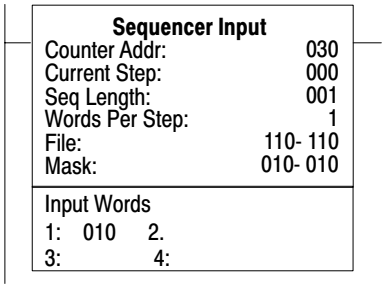






1

The word SEQUENCER appears in the lower left hand corner of the screen.



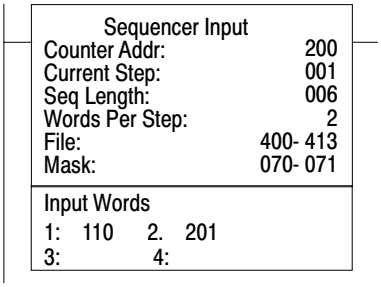
Notice that the words SEQUENCER INPUT are flashing, the cursor is on the first digit of counter address, and the default values are shown.

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

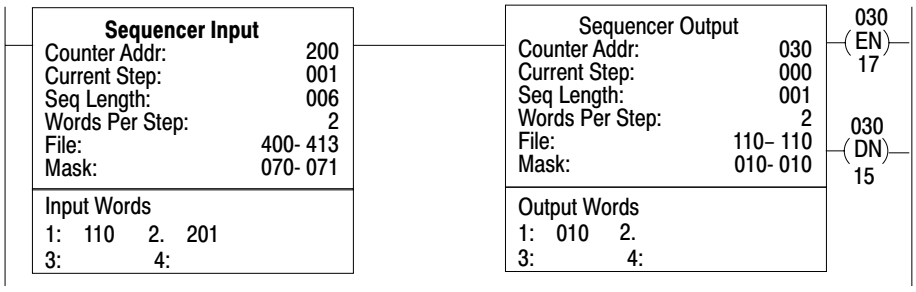
Insert the following values. The cursor moves automatically throughout the sequencer instruction. The values are:

COUNTER ADDR:	200
CURRENT STEP:	001
SEQ LENGTH: 006	
WORDS PER STEP:	2
FILE:	400
MASK:	070
INPUT WORDS:	
1:110 2: 201	

The completed instruction should look like this:



For this example, enter data using the binary data monitor mode. Get your data from the worksheet (Figure 12.4). A filled in block means that a 1 should be inserted in the corresponding bit position.



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

Figure 12.4
Completed Sequencer Input Worksheet

ALLEN-BRADLEY
Programmable Controller
Data Table MAP (128-word)

PAGE 1 OF 2

PROJECT NAME Bottle Filling Applications PROCESSOR Mini-PLC-2/05

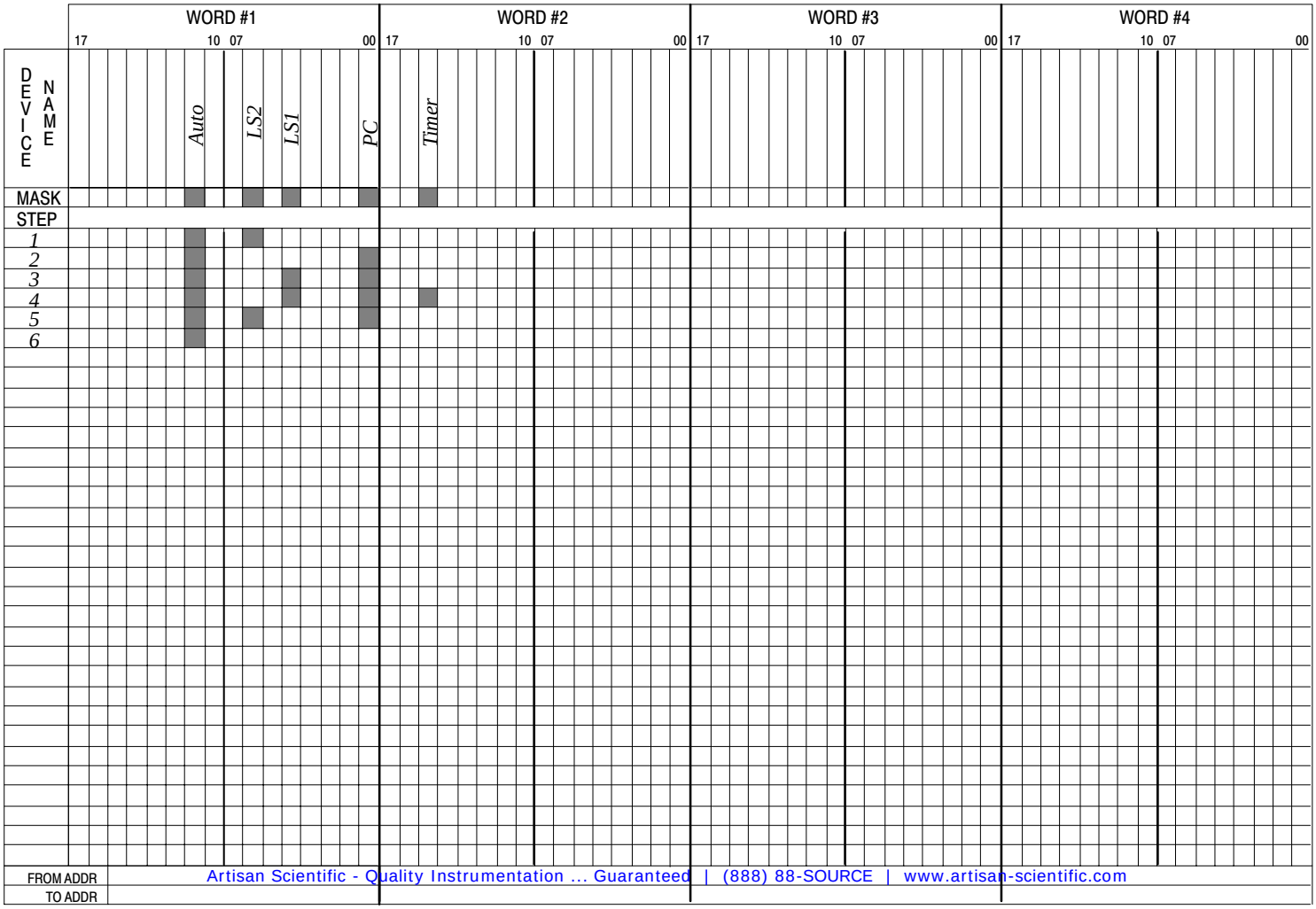
DESIGNER Engineer DATA TABLE ADDR _____ TO _____

SEQUENCER Input

COUNTER ADDR: 200 FILE 400 TO 413 SEQ LENGTH: 006

WORD ADDR: 110 Timer 200

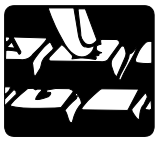
MASK ADDR: 070 071

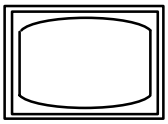


Note: A filled-in box means that each device is actuated

10145-I

Position the cursor on the words SEQUENCER INPUT. Use the arrow keys to move the cursor.





[DISPLAY]

0

The display appears in the lower left hand corner of the screen.

```
                        BINARY DATA MONITOR
                          SEQUENCER INPUT
COUNTER ADDR:  200          STEP:  001          SEQUENCER LENGTH:  006
                          FILE:  400- 413
              INPUT ADDR:  110                  201
              DATA:  00000000 00000000  00000000 00000000

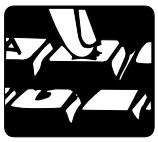
              MASK ADDR:  070                  701
              DATA:  00000000 00000000  00000000 00000000

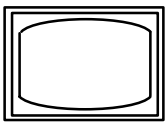
              STEP      WORD 1           WORD 2
              001   00000000 00000000  00000000 00000000
              002   00000000 00000000  00000000 00000000
              003   00000000 00000000  00000000 00000000
              004   00000000 00000000  00000000 00000000
              005   00000000 00000000  00000000 00000000
              006   00000000 00000000  00000000 00000000

                        DATA: 00000000  00000000
```

The cursor is located on the first digit of DATA in the Command Buffer. The digits in step 1 for word 1 are intensified.

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





00000010 00000000

```
                                BINARY DATA MONITOR
                                SEQUENCER INPUT
COUNTER ADDR:  200              STEP:  001              SEQUENCER LENGTH:  006
                                FILE:  400- 413
                    INPUT ADDR:  110                    201
                    DATA:  00000000 00000000   00000000 00000000

                    MASK ADDR:  070                     701
                    DATA:  00000000 00000000   00000000 00000000

                    STEP        WORD 1          WORD 2
                    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
                                DATA: 00000010  00000000
```

[INSERT]

```
                                BINARY DATA MONITOR
                                SEQUENCER INPUT
COUNTER ADDR:  200              STEP:  001              SEQUENCER LENGTH:  006
                                FILE:  400- 413
                    INPUT ADDR:  110                    201
                    DATA:  00000000 00000000   00000000 00000000

                    MASK ADDR:  070                     701
                    DATA:  00000000 00000000   00000000 00000000

                    STEP        WORD 1          WORD 2
                    001    00000010 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
                                DATA: 00000010  00000000
```

Data is inserted into Step 001 of Word 1.

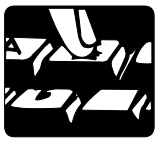
Cursor down one line. The cursor is on the first digit of DATA in the command buffer. The digits in step 2 for word 1 are intensified.

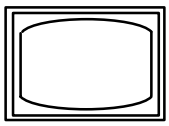
```
                                BINARY DATA MONITOR
                                SEQUENCER INPUT
COUNTER ADDR:  200              STEP:  001              SEQUENCER LENGTH:  006
                                FILE:  400- 413
                    INPUT ADDR:  110                    201
                    DATA:  00000000 00000000   00000000 00000000

                    MASK ADDR:  070                     701
                    DATA:  00000000 00000000   00000000 00000000

                    STEP        WORD 1          WORD 2
                    001    00000010 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
                                DATA: 00000000  000000
```

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





00000010 00000000

```
                    BINARY DATA MONITOR
                     SEQUENCER INPUT
COUNTER ADDR:  200      STEP:  001      SEQUENCER LENGTH:  006
                      FILE:  400- 413
          INPUT ADDR:  110                  201
          DATA:  00000000 00000000   00000000 00000000
          MASK ADDR:  070                  701
          DATA:  00000000 00000000   00000000 00000000
          STEP      WORD 1           WORD 2
          001  00000010 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
                    DATA: 00000010 00000001
```

[INSERT]

```
                    BINARY DATA MONITOR
                     SEQUENCER INPUT
COUNTER ADDR:  200      STEP:  001      SEQUENCER LENGTH:  006
                      FILE:  400- 413
          INPUT ADDR:  110                  201
          DATA:  00000000 00000000   00000000 00000000
          MASK ADDR:  070                  701
          DATA:  00000000 00000000   00000000 00000000
          STEP      WORD 1           WORD 2
          001  00000010 00000000  00000000 00000000
          002  00000010 00000001  00000000 00000000
          003  00000000 00000000  00000000 00000000
          004  00000000 00000000  00000000 00000000
          005  00000000 00000000  00000000 00000000
          006  00000000 00000000  00000000 00000000
                    DATA: 00000010 00000001
```

Cursor down one line. The cursor is on the first digit of DATA in the command buffer. The digits in step 3 for word 1 are intensified.

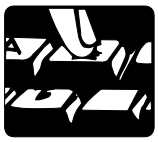
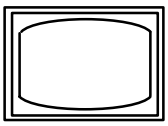
Continue adding your data.

```
003:    00000010  00010001
004:    00000010  00010001
005:    00000010  01000001
006:    00000010  00000000
```

To add data to WORD 2 press [SHIFT][→|] and cursor up [↑] or down [↓] as desired.

Do not press [CANCEL COMMAND]. The next example uses this data to add a mask.

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

[DISPLAY]

000

The screen does not change.

```
                        BINARY DATA MONITOR
                          SEQUENCER INPUT
COUNTER ADDR:  200            STEP:  001            SEQUENCER LENGTH:  006
                            FILE:  400- 413

                  INPUT ADDR:  110                  201
                  DATA: 00000000 00000000 00000000 00000000

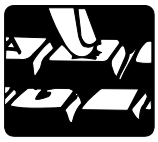
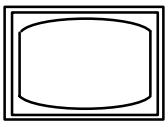
                  MASK ADDR:  070                  701
                  DATA:  00000000 00000000  00000000 00000000

                  STEP       WORD 1           WORD 2
                  001   00000010 00000000  00000000 00000000
                  002   00000010 00000001  00000000 00000000
                  003   00000010 00010001  00000000 00000000
                  004   00000010 00010001  00000000 00000000
                  005   00000010 01000001  00000000 00000000
                  006   00000010 00000000  00000000 00000000

                        DATA:  00000000 00000000
```

The cursor is on the first digit of DATA in the command buffer. INPUT ADDR 110, DATA is intensified. You can enter additional data.

Cursor down one line. MASK ADDR 070, DATA is intensified.

11111111 00000000

[INSERT]

The screen does not change.

```
                        BINARY DATA MONITOR
                          SEQUENCER INPUT
COUNTER ADDR:  200            STEP:  001            SEQUENCER LENGTH:  006
                            FILE:  400- 413

                  INPUT ADDR:  110                  201
                  DATA:  00000000 00000000  00000000 00000000

                  MASK ADDR:  070                  701
                  DATA: 11111111 00000000  00000000 00000000

                  STEP       WORD 1           WORD 2
                  001   00000010 00000000  00000000 00000000
                  002   00000010 00000001  00000000 00000000
                  003   00000010 00010001  00000000 00000000
                  004   00000010 00010001  00000000 00000000
                  005   00000010 01000001  00000000 00000000
                  006   00000010 00000000  00000000 00000000

                        DATA: 11111111 00000000
```

[CANCEL COMMAND] To display your rung.

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

Sequencer Output

Purpose: Transfers the values of the current sequencer step to a specified output word.

Programmed as an output instruction. The counter is externally controlled by the ladder diagram logic in your program. The instruction requires 5-8 words of your program. May be programmed with a sequencer input instruction. You can transfer up to 64 bits. You can mask the unused output bits.

True - The counter increments to the next step and transfers the data.

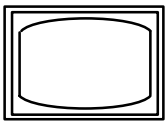
False - No action is taken.



ATTENTION: The counter address for the sequencer output instruction should be reserved for that instruction. Do not preset values. inadvertent changes to the values could result in hazardous machine operation or a RUN TIME ERROR. Damage to equipment and/or personal injury could result.

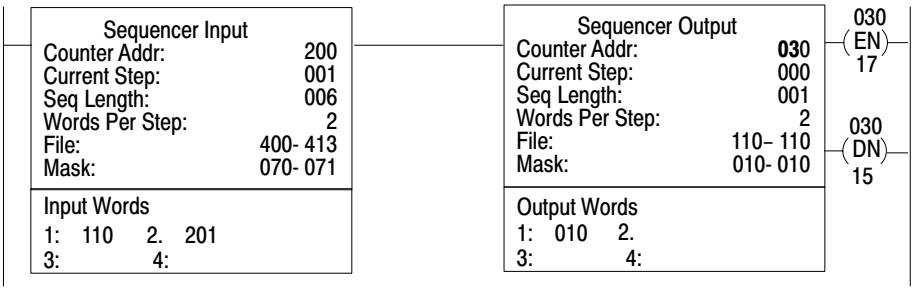
Keystrokes: You enter the sequencer output instruction by performing the following steps.





[SEQ] The word SEQUENCER appears in the lower left hand corner of the screen.

0



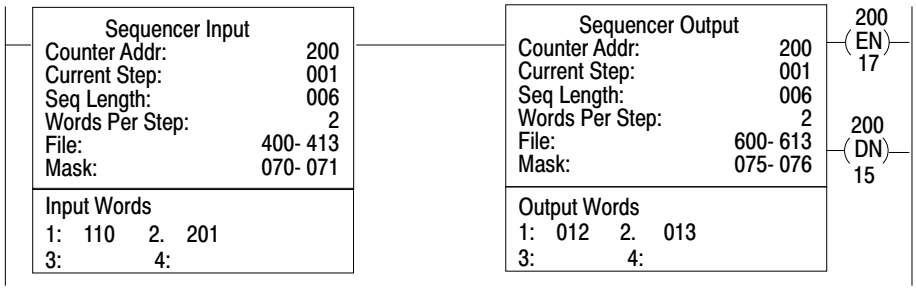
Notice that the words SEQUENCER OUTPUT are flashing, the cursor is on the first digit of the counter address, and the default values are shown.

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

Insert the following values. The cursor moves automatically throughout the instruction. The values are:

COUNTER ADDR:	200
CURRENT STEP:	001
SEQ LENGTH:	006
WORDS PER STEP:	1
FILE:	600
MASK:	075
OUTPUT WORDS:	
1:012 2: 013	

The sequencer output instruction should look like this:



For this example, enter data using the binary data monitor mode. Get your data from the worksheet (Figure 12.5). A filled block means that a 1 should be inserted in the corresponding bit location.

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

Figure 12.5
Completed Sequencer Output Worksheet

ALLEN-BRADLEY
Programmable Controller
Data Table MAP (128-word)

PAGE 2 OF 2

PROJECT NAME Bottle Filling Applications PROCESSOR Mini-PLC-2/05

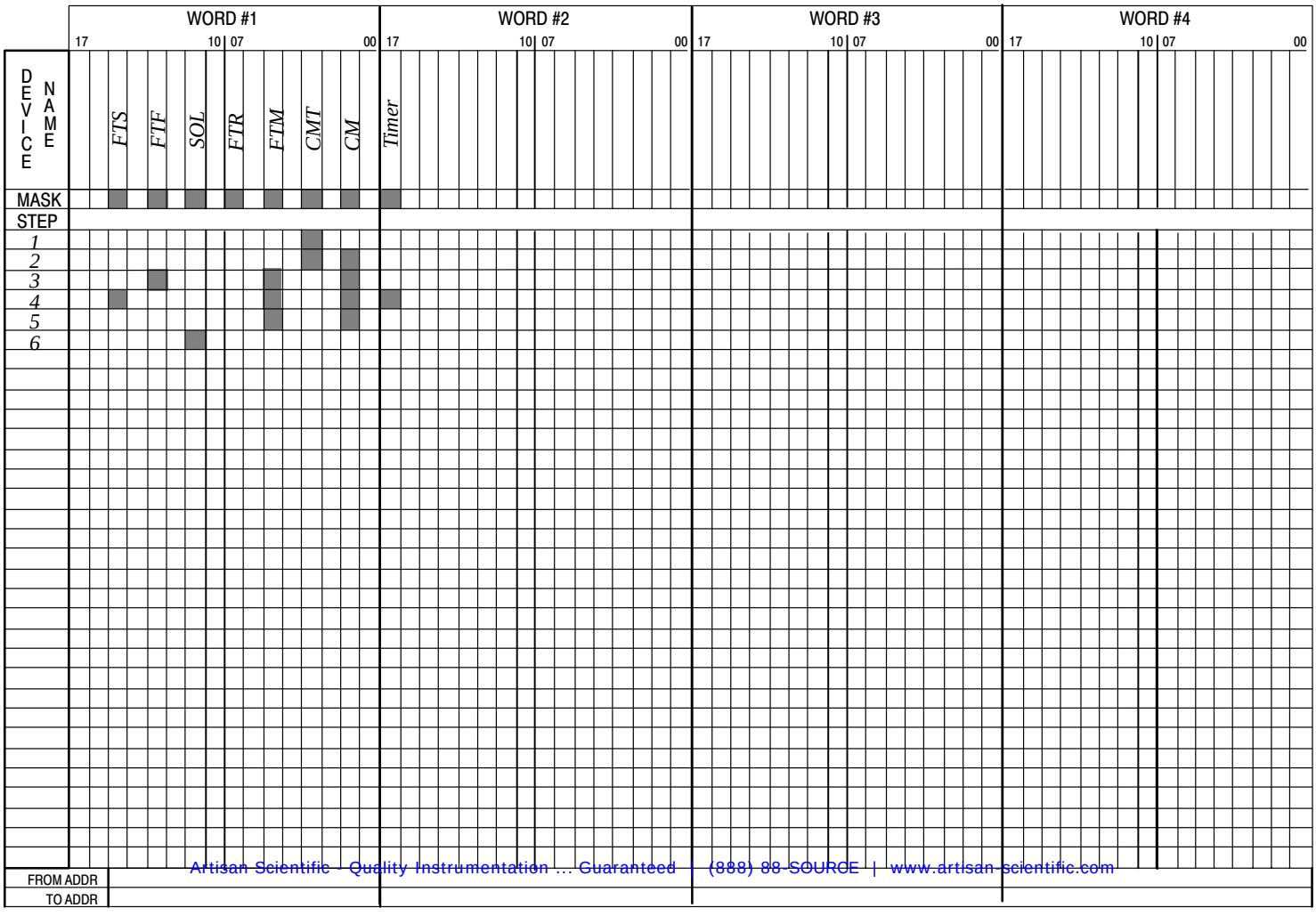
DESIGNER Engineer DATA TABLE ADDR _____ TO _____

SEQUENCER OUTPUT

COUNTER ADDR: 200 FILE 600 TO 613 SEQ LENGTH: 006

WORD ADDR: 012 013

MASK ADDR: 075 076



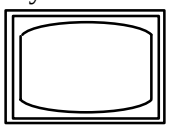
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Note: A filled-in box means that each device is actuated

10148-I

Position the cursor on the words SEQUENCER OUTPUT. Use the arrow keys to move the cursor.





[DISPLAY]

0

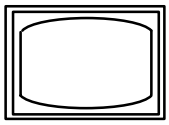
The word display appears in the lower left hand corner of the screen.

```
                    BINARY DATA MONITOR
                    SEQUENCER INPUT
COUNTER ADDR:  200        STEP:  001        SEQUENCER LENGTH:  006
                    FILE:  600- 613
          OUTPUT ADDR:  012              013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075              076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          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
               DATA: 00000000  00000000
```





00000010 00000000

```
                    BINARY DATA MONITOR
                    SEQUENCER INPUT
                         STEP:  001
COUNTER ADDR:  200                    SEQUENCER LENGTH:  006
                    FILE:  600- 613
          OUTPUT ADDR:  012              013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075              076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          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
               DATA: 00000000  00001010
```

[INSERT]

```
                    BINARY DATA MONITOR
                    SEQUENCER INPUT
COUNTER ADDR:  200        STEP:  001        SEQUENCER LENGTH:  006
                    FILE:  600- 613
          OUTPUT ADDR:  012              013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075              076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          001  00000000 00001010  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
               DATA: 00000000  00001010
```

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

The cursor is on the first digit of DATA in the command buffer. The digits in step 1 for word 1 are intensified.

Data is inserted into Step 1 of Word 1.

Cursor down one line. The cursor is on the first digit of DATA in the command buffer. The digits in step 2 for word 1 are intensified.

```
                    BINARY DATA MONITOR
                     SEQUENCER INPUT
COUNTER ADDR:  200        STEP:  001        SEQUENCER LENGTH:  006
                      FILE: 600- 613

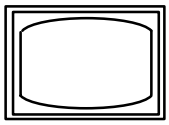
          OUTPUT ADDR:  012          013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075            076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          001  0000000000001010  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

                DATA:  00000000  000000
```





00000010 00001010

```
                    BINARY DATA MONITOR
                     SEQUENCER INPUT
                          STEP:  001
COUNTER ADDR:  200                          SEQUENCER LENGTH:  006
                      FILE: 600- 613
          OUTPUT ADDR:  012          013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075            076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          001  00000000 00001010  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

                DATA:  00000000  00001010
```

[INSERT]

```
                    BINARY DATA MONITOR
                     SEQUENCER INPUT
COUNTER ADDR:  200        STEP:  001        SEQUENCER LENGTH:  006
                      FILE: 600- 613
          OUTPUT ADDR:  012          013
          DATA:  00000000 00000000  00000000 00000000

          MASK ADDR:  075            076
          DATA:  00000000 00000000  00000000 00000000

          STEP      WORD 1           WORD 2
          001  00000000 00001010  00000000 00000000
          002  00000000 00001010  00000000 00000000
          003  00000000 00000000  00000000 00000000
          004  00000000 00000000  00000000 00000000
          005  00000000 00000000  00000000 00000000
          006  00000000 00000000  00000000 00000000

                DATA:  00000000  00001010
```

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

Cursor down one line. The cursor is on the first digit of DATA in the command buffer. the digits in step 3 for word 1 are intensified.

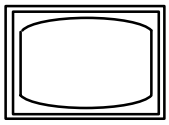
Continue adding data:

003:	00000010 00010001
004:	00000010 00010001
005:	00000010 01000001
006:	00000010 00000000

To add data to WORD 2 press [SHIFT][→] and cursor up [↑] or down [↓] as desired.

Do not press [CANCEL COMMAND]. The next example uses this data to enter a mask.





[DISPLAY]

000

The screen does not change.

```
                        BINARY DATA MONITOR
                          SEQUENCER INPUT
COUNTER ADDR:  200          STEP:  001          SEQUENCER LENGTH:  006
                          FILE:  600- 613

                OUTPUT ADDR:  012              013
                DATA:  00000000 00000000   00000000 00000000

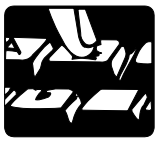
                MASK ADDR:  075                076
                DATA:  00000000  00000000  00000000  00000000

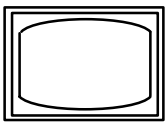
                STEP      WORD 1           WORD 2
                001   00000000 00000000  00000000 00000000
                002   00000000 00000000  00000000 00000000
                003   00000000 00000000  00000000 00000000
                004   00000000 00000000  00000000 00000000
                005   00000000 00000000  00000000 00000000
                006   00000000 00000000  00000000 00000000
                          DATA: 00000000  00000000
```

The cursor is on the first digit of DATA in the command buffer. OUTPUT ADDR 012, DATA is intensified. You can add additional data.

Cursor down one line. MASK ADDR 075, DATA is intensified.

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





00101010 10101010

[INSERT]

The screen does not change.

```
                    BINARY DATA MONITOR
                      SEQUENCER INPUT
COUNTER ADDR:  200        STEP:  001        SEQUENCER LENGTH:  006
                        FILE:  600- 613
                 OUTPUT ADDR:  012              013
                 DATA:00000000 00000000  00000000 00000000

                 MASK ADDR:  075                076
                 DATA: 00101010 10101010  00000000 00000000

                 STEP      WORD 1          WORD 2
                 001  00000000 00001010  00000000 00000000
                 002  00000000 00001010  00000000 00000000
                 003  00000010 00010001  00000000 00000000
                 004  00000010 00010001  00000000 00000000
                 005  00000010 01000001  00000000 00000000
                 006  00000010 00000000  00000000 00000000
                        DATA:  00101010 10101010
```

[CANCEL COMMAND]

To display your rung.

Sequencer Load

Purpose: Places data into sequencer file that your established in the data table for this instruction.

Programmed as an output instruction. You can not mask any unused bits. The counter is internally controlled by the ladder diagram logic in your program. This instruction requires 4-7 words of the user program area.

A false-to-true rung transition enables the instruction.

When the rung becomes:

True - The instruction increments to the next step and loads the data.

False - No action is taken.

Use this instruction for:

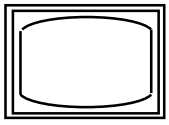
- Machine diagnostics - If the actual sequence of an operation becomes mismatched with the desired sequence of operation as contained in the sequencer input instruction, a fault signal can be enabled by the user program.
- Teach sequential operation - The I/O conditions representing the desired operation can be loaded into the sequencer input tables as the machine is manually stepped through the control cycle.

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

ATTENTION: The counter address of the sequencer load instruction should be reserved for that instruction. Do not manipulate the counter accumulated or preset word. Changes to these values could result in unpredictable machine operation or a run-time error. Damage to equipment and/or injury to personnel could occur.

Keystrokes: You enter the sequencer output instruction by performing the following steps.

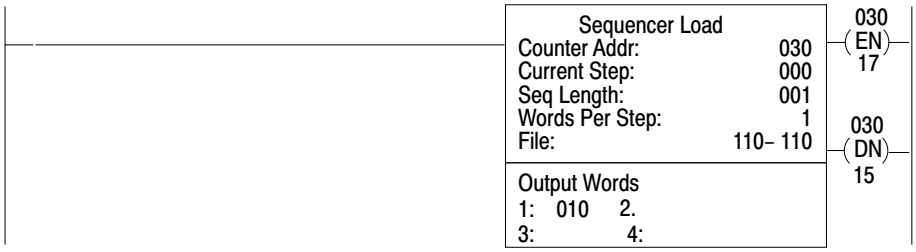




[SEQ]

The screen does not change.

2



Insert the following values. The cursor moves automatically through the The values are:

COUNTER ADDRESS - 056
CURRENT STEP - 008
SEQUENCE LENGTH - 012
WORDS PER STEP - 4
FILE - 510
LOAD WORDS
1: 110
2: 113
3: 012
4: 314

For this example, enter data using the binary data monitor mode. Get your data from the worksheet (Figure 12.6). A filled block means a 1 will be entered in that position.

Load the data from Figure 12.6 exactly as you did in for the sequencer input and output instructions.

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

Figure 12.6
Completed Sequencer Load Worksheet

ALLEN-BRADLEY
Programmable Controller
Data Table MAP (128-word)

PAGE _____ OF _____

PROJECT NAME Bottle Filling Applications PROCESSOR Mini-PLC-2/05

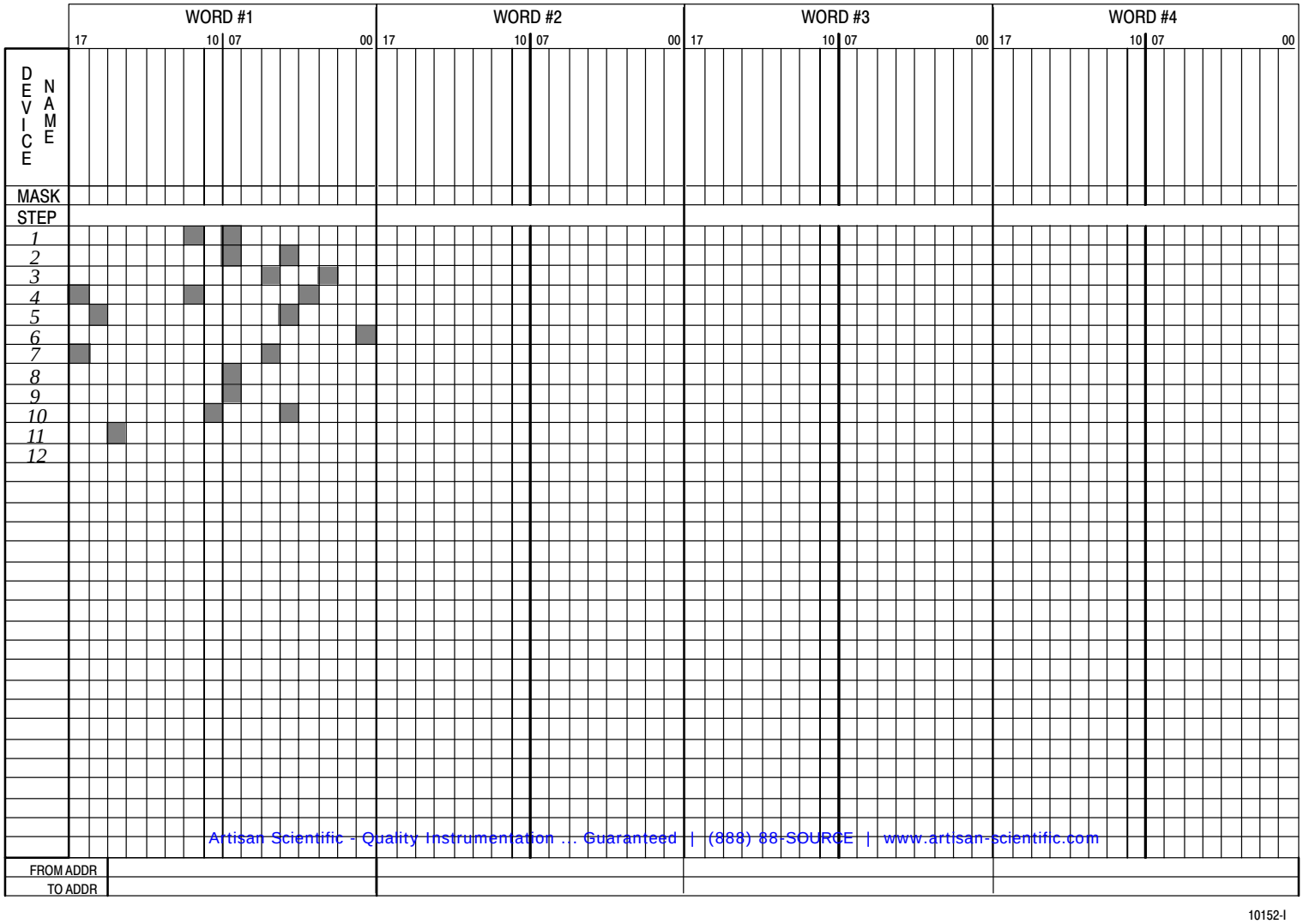
DESIGNER Engineer DATA TABLE ADDR _____ TO _____

SEQUENCER Load

COUNTER ADDR: 030 FILE 600 TO _____ SEQ LENGTH: 012

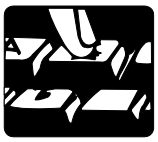
WORD ADDR: 110

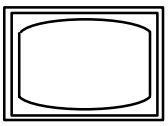
MASK ADDR:



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

10152-I





[CANCEL COMMAND] To display your rung.

The instruction should look like this.

BINARY DATA MONITOR
SEQUENCER INPUT

COUNTER ADDR: 056 STEP: 008 SEQUENCER LENGTH: 012

FILE: 510- 567

LOAD ADDR:	110	113	012	314
DATA:	00000000 00000000	00000000 00000000	00000000 00000000	00000000 00000000

STEP	WORD 1	WORD 2	WORD 3	WORD 4
001	00000010 10000000	00000000 00000000	00000000 00000000	00000000 00000000
002	00000000 10001000	00000000 00000000	00000000 00000000	00000000 00000000
003	00000000 00100100	00000000 00000000	00000000 00000000	00000000 00000000
004	10000010 00001000	00000000 00000000	00000000 00000000	00000000 00000000
005	01000000 00001000	00000000 00000000	00000000 00000000	00000000 00000000
006	00000000 00000001	00000000 00000000	00000000 00000000	00000000 00000000
007	10000000 00100000	00000000 00000000	00000000 00000000	00000000 00000000
008	00000000 10000000	00000000 00000000	00000000 00000000	00000000 00000000
009	00000000 10000001	00000000 00000000	00000000 00000000	00000000 00000000
010	00000001 00010000	00000000 00000000	00000000 00000000	00000000 00000000
011	00100000 00000000	00000000 00000000	00000000 00000000	00000000 00000000
012	00000000 00000000	00000000 00000000	00000000 00000000	00000000 00000000

Chapter Summary

We showed you three types of sequencer instructions and how to use the data monitor display to enter data. The next chapter shows you how to reduce scan time by selectively jumping over portions of the program.

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

Chapter 13

Jump Instructions and Subroutines

Chapter Objectives

This chapter describes the instructions you can use to selectively jump over portions of a program. The instructions are:

- jump
- jump to subroutine
- label
- return

This chapter describes how jump instructions and subroutine programming direct the path of the program scan through the main program and the subroutine area.

Jump/Jump to Subroutine/Return Instructions

Purpose: A Jump instruction is an output instruction. It has an identification number from 00-07. When its rung is true, it instructs the processor to jump forward in the main program to the Label instruction having the same identification number. The main program executes from that point.



Jump

You can reduce scan time by selectively jumping over a portion of the program. Do not program in an area where the jump instruction crosses the boundary between the main program and subroutine area, or vice-versa.



ATTENTION: Allowances should be made for conditions which could be created by the use of the Jump instruction. Jumped program rungs are not scanned by the processor. Input conditions are not examined and outputs that are controlled by these rungs remain in their last state. Timers and counters cease to function. Critical rungs should be re-programmed outside the jumped section in the program zone.

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

Jump to Subroutine

Purpose: The Jump to Subroutine instruction is an output instruction. It has an octal identification number from 00-07. When its rung is true, it instructs the processor to jump from the main program to the label instruction having the same number in the subroutine area. Subroutine execution begins at that point.

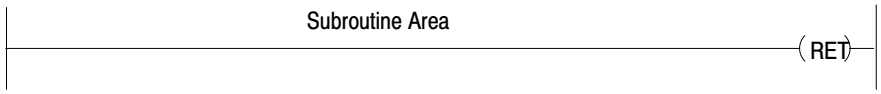
This instruction always causes the processor to cross the boundary from the main program to the subroutine area.



Return

Purpose: The Return instruction is an output instruction. It is used only in the subroutine area to terminate a subroutine or selectable timed interrupt and return the processor to the main program or, in the case of nested subroutines, return program execution to the preceding subroutine. It returns program execution to the instruction immediately following the Jump to Subroutine instruction that initiated the subroutine. Program execution continues from that point.

It is programmed as an output instruction without an identification number in the subroutine area. It is usually programmed unconditional. Every subroutine must have a return instruction.



Keystrokes: You enter a Jump, Jump to Subroutine, or Return instruction by performing the following steps.

1. Press -(JMP)-, -(SR)-, or [SHIFT] -(RET)-.

Important: Do not perform step 2 for a Return instruction.

2. Enter <octal identification number>.

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

Editing the Instruction
You can edit a Jump, Jump to Subroutine or Return instruction to change an instruction type or its address by performing the following steps.

1. Position the cursor over the Jump, Jump to Subroutine or Return instruction you are going to edit.

2. Press -(JMP)-, -(JSR)-, or [SHIFT]-(RET)- or any other appropriate instruction type key.

Important: Do not perform step 3 for a Return instruction.

3. Enter <octal identification number>.

Label Instruction

Purpose: The Label instruction is the target for both the Jump and Jump to Subroutine instructions. Label instructions are assigned octal identification numbers from 00-07. The label identification number must be the same as that of the Jump and/or Jump to Subroutine instruction with which it is used. A Label instruction can be defined only once, meaning that a label with a given identification number can only appear in one location. However, a Label instruction can be the target of jumps from more than one location.

The Label instruction is always logically true. Programmed as the first condition instruction in the rung. If conditions precede a Label instruction, they will be ignored by the processor during a jump operation. Do not program with a program control instruction.



Important: There are 8 labels available. Each label can only be defined once (using an octal identifier), but can be the target of multiple Jump or Jump to Subroutine instructions. Octal identifiers are labeled from 00-07.

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

ATTENTION: Do not place a Label instruction in a ZCL or MCR zone. When jumping over a start fence, the processor executes the program from the label to the end fence as if the start fence had been true, i.e. outputs controlled by the rungs. The start fence may have been false intending that all outputs within the zone be controlled by the output override instruction, i.e. off for MCR or last state for ZCL instructions. Unpredictable machine operation could occur with possible damage to equipment and/or injury to personnel.

Keystrokes: You enter a Label instruction by performing the following steps.

1. Press [SHIFT][LBL].
2. Enter the <octal identification number>.

Removing the Label Instruction

You can remove a Label instruction. You can edit it by performing the following steps.

1. Position the cursor over the Label instruction you want to remove.
2. Press [REMOVE][SHIFT][LBL].

Editing a Partially Completed or a Completed Rung

If you are editing a completed rung, proceed to step 1. If you are editing a partially completed rung, enter the next instruction and proceed to step 1.

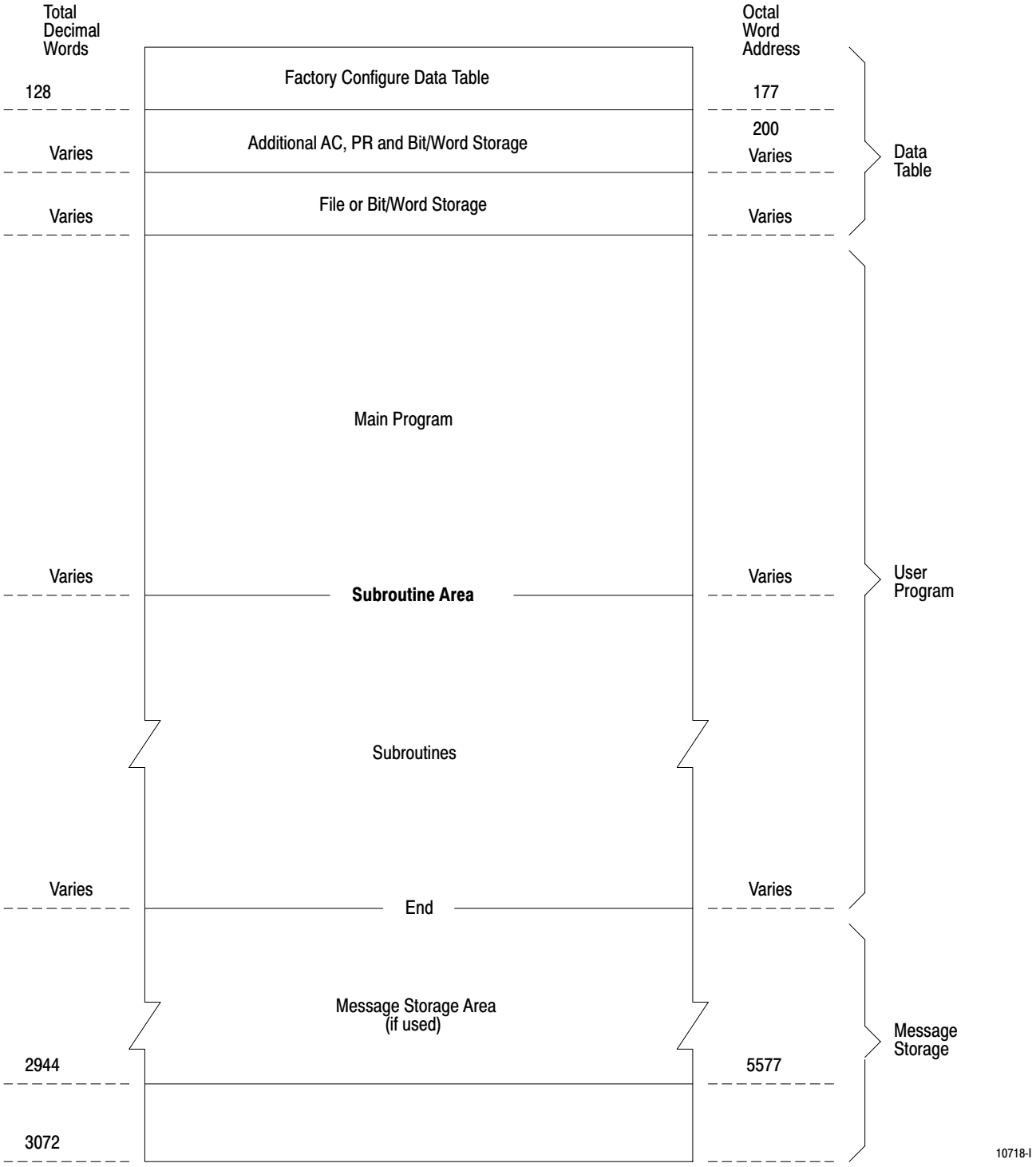
1. Position the cursor over the Label instruction you are going to edit.
2. Press [SHIFT][LBL] or any other appropriate instruction type key.
3. Enter <octal identification number>.

Subroutine Area Instruction

Purpose: The subroutine area is located in the memory between the main program and the message store areas (Figure 13.1). This area acts as the end of program statement for the main program. It allows storage of small programs that are to be accessed periodically. Subroutines are not scanned unless you program the processor to jump into this area.

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

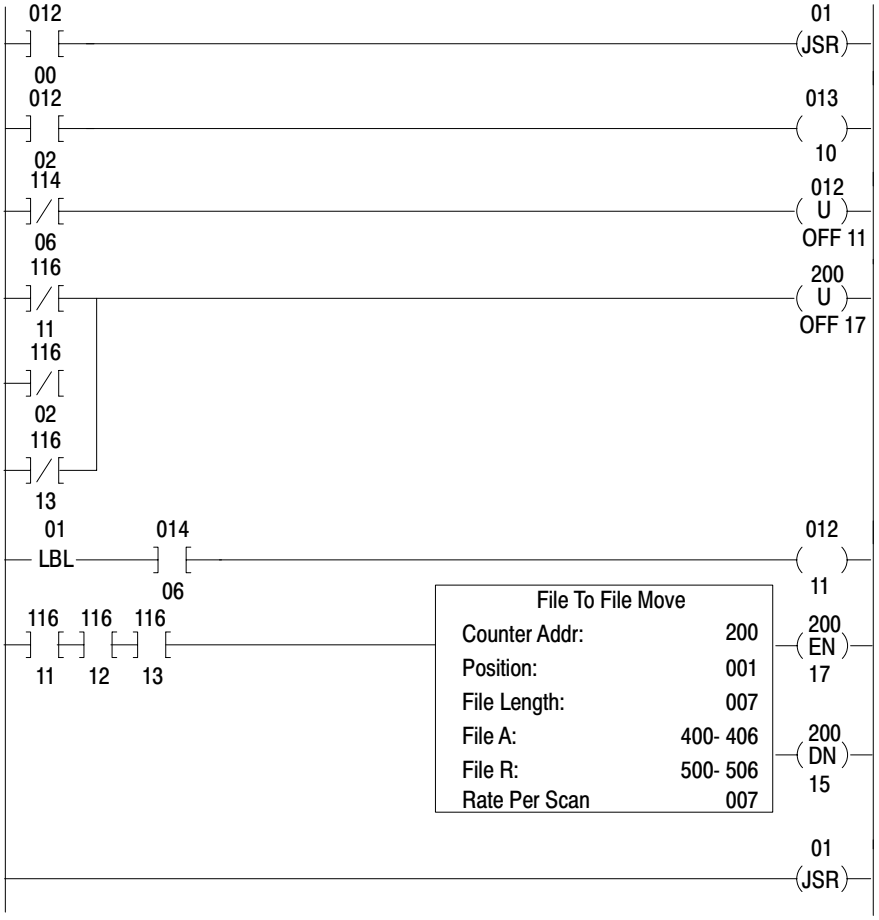
Figure 13.1
Subroutine Area



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

You can program a maximum of eight subroutines in the subroutine area. Each subroutine begins with a label instruction and (when you want to exit to your main program) ends with a return instruction. The subroutine area serves as the end of the main program and defines the beginning of the subroutine program (Figure 13.2).

Figure 13.2
Subroutine Programming Example



Here general programming facts for the subroutine instruction:

- Uses one word in the data table
- Processor does not scan the instruction until you program a Jump to Subroutine instruction.
- Up to eight subroutines can be programmed if you do not program any jump instructions.
- You cannot nest subroutine programs by inserting a Jump to Subroutine instruction in the Subroutine area.
- It is possible to jump from one subroutine to another using a Jump instruction.

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

Keystrokes: You establish a subroutine area by performing the following steps.

1. Cursor down to the end of the main program.
2. Press [SHIFT][SBR].

Important: The boundary marker SUBROUTINE AREA appears. A subroutine area instruction can only be programmed as the last instruction in the main program. It cannot be inserted between rungs. It requires one memory word, can be programmed only once, and cannot be removed except by clearing the entire subroutine area or the entire memory.

Chapter Summary

We showed you how to reduce scan time by selectively jumping over portions of the program. The next chapter shows you how to transfer a block of data in a single scan.

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

Chapter 14

Block Transfer

Chapter Objectives

This chapter describes three types of block transfer:

- read
- write
- bidirectional

Block transfer is a combination of an instruction and support rungs used to transfer up to 64 16-bit words of data in one scan from I/O modules to/from the data table. This transfer method is used by intelligent I/O modules such as the analog, PID, servo positioning, stepper positioning, ASCII, thermocouple, or encoder/counter modules.

Block transfer can be performed as a read, write, or bidirectional operation, depending on the I/O module you are using. An input module uses the read operation, an output module uses the write operations. During a read operation, data is read into the data table from the module. During a write operation, data is written to the output module from the data table.

Basic Operation

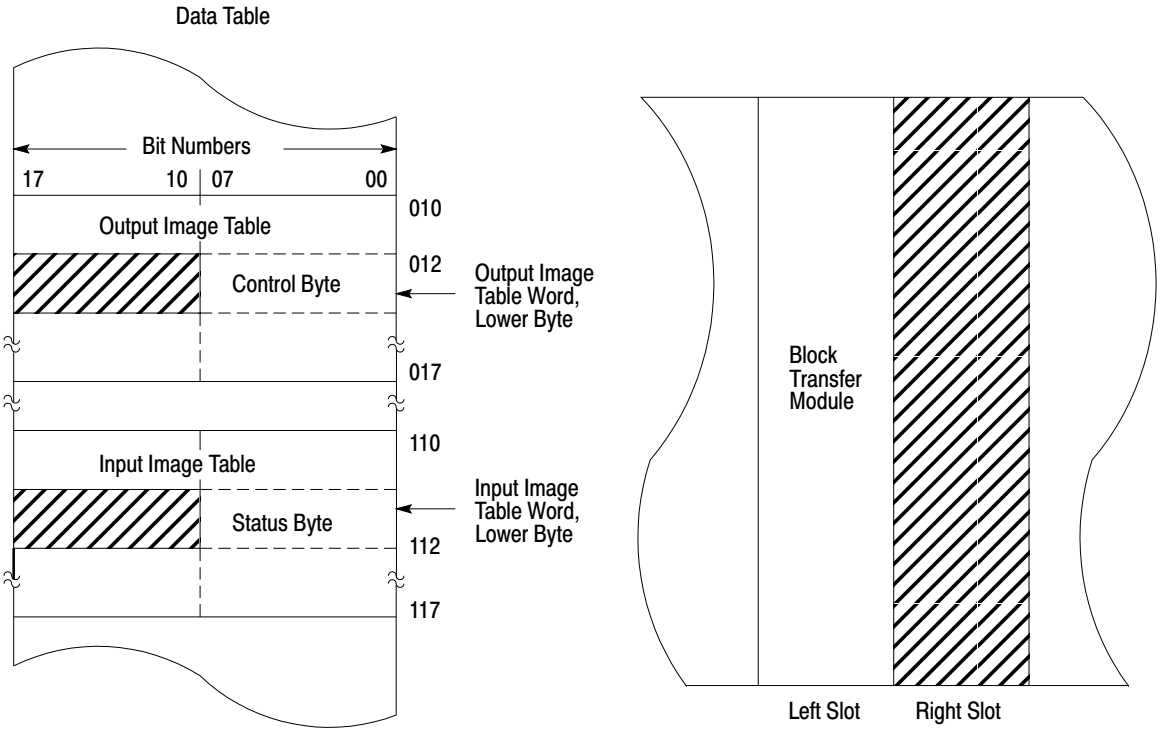
The processor uses two I/O image table bytes to communicate with block transfer modules. The byte corresponding to the module's address in the output image table (control byte) contains the read or write bit for initiating the transfer of data. The byte corresponding to the module's address in the input image table (status byte) is used to signal the completion of the transfer.

Important: Do not use word 127 for data storage.

Whether the upper or lower byte of the I/O image table word is used depends on the position of the module in the module group. When in the lower slot, the lower byte is used and vice versa (Figure 14.1).

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

Figure 14.1
Image Table Byte Relationship vs Module Position



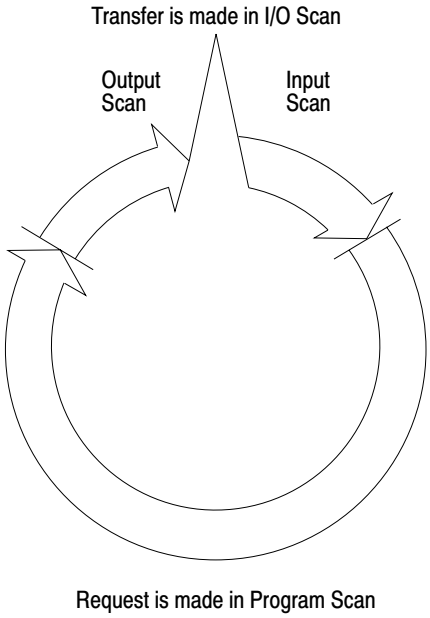
The lower byte of the I/O image table words is used when the module is in the left slot and the upper byte when the module is in the right slot.

10222

The block transfer read or write operation (Figure 14.2) is initiated in the program scan and completed in the I/O scan as follows:

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

Figure 14.2
Block Transfer Diagram



- Program scan - When the rung goes true, the instruction is enabled. The number of words to be transferred and the read or write bit that controls the direction of transfer are set by a bit pattern in the output image table byte.

- I/O scan - The processor requests a transfer by sending the output image table byte data to the block transfer module during the scan of the output image table. The module signals that it is ready to transfer. The processor then interrupts the I/O scan and scans the timer/counter accumulated area of the data table, looking for the address of the module that is ready to transfer. The module address is stored in BCD at a word address in the same manner as an accumulated value of a timer is stored. The module address was entered by the programmer when entering the block instruction parameters. The word address at which the module address is stored is called the data address of the instruction.

Once the module address is found, the processor locates the address of the file to which (or from which) the data is transferred. The file address is stored in BCD at an address 100 above the address containing the module address. This is done in the same manner that the processor locates the preset value of a timer in a word address 100 above the accumulated value address. The analogy between block transfer and timer/counter data and addresses is shown in Table 14.A.

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

Table 14.A
Timer/Counter Transfer Analogy

Address of Accumulated Value	Data Address of Instruction
Accumulated Value in BCD	Module Address in BCD (R,G,S)
Address of Preset Value	10_{08} Above Data Address
Preset Value in BCD	File Address in BCD

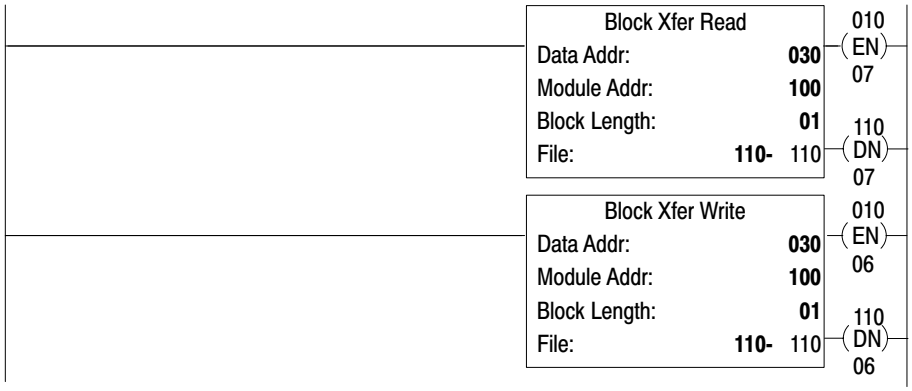
After locating the file address in the timer/counter area of the data table, the processor then duplicates and transfers the file data consecutively one word at a time until complete, starting at the selected file address.

At the completion of the transfer, a done bit for the read or write operation is set in the input image table byte as a signal that a valid transfer has completed.

Block Transfer Format

The format of a block transfer read and a block transfer write instruction with default values is shown in Figure 14.3.

Figure 14.3
Block Transfer Format



Note: Numbers shown are default values. Numbers in shaded areas must be replaced by user-entered values. The number of default address digits initially displayed (3 or 4) will depend on the size of the data table.

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

Here is an explanation of each value:

This Value:	Stores the:
Data Address	First possible address in the timer/counter accumulated value area of the data table
Module Address	RGS for R = rack, G = module, S = slot number
Block Length	Number of words to be transferred (enter 00 for default value or for 64 words)
File	Address of the first word of the file
Enable bit -(EN)-	Automatically entered from the module address Set on when the rung containing the instruction is true
Done bit -(DN)-	Automatically entered from the module address Remains on for 1 program scan following successful transfer

Data Address

The data address stores the module address of the block transfer module. The data address must be assigned the first available address in the timer/counter accumulated area of the data table. This depends on the number of I/O racks being used (Table 14.B). When more than one block transfer module is used, consecutive data addresses must be assigned ahead of address for timer and counter instructions.

Table 14.B
The First Available Address in Timer/Counter Area of Data Table

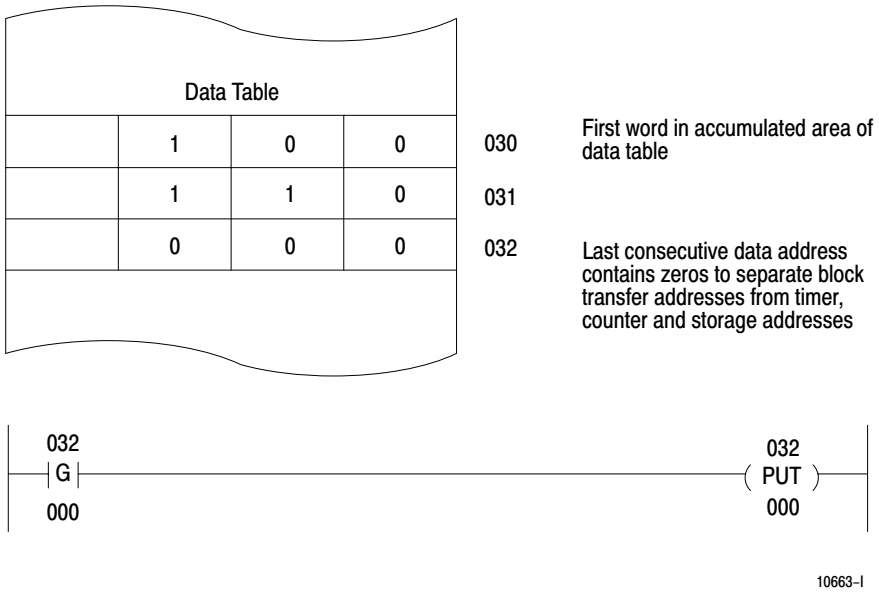
# I/O Racks	First Available Address in Timer/ Counter Area
1	020
2	030
3	040
4	050
5	060
6	070
7	200

The last consecutive word in the accumulated area following the words reserved for block transfer data addresses should be loaded with zeroes. When the processor sees this boundary word, it does not search further for block transfer data. In addition, the processor is prevented from finding other BCD values that could, by chance, be in the same configuration as the rack, group and slot numbers found in block transfer data addresses.

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

The boundary word data bits can be set to zero manually using bit manipulation. Use [SEARCH] 53 and insert zeros. A Get/Put transfer can be programmed assigning Get and Put instructions to the address immediately following the last block transfer data address (Figure 14.4). The value of the Get instruction is set to 000 when programmed.

Figure 14.4
Defining the Data Address Area



Module Address

The module address is stored in BCD by r = rack, g = module group and s = slot number. When a block transfer is performed, the processor searches the timer/counter accumulated area of the data table for a match of the module address.

Block Length

The block length is the number of words that the module will transfer. It depends on the type of module and the number of channels connected to it. The number of words requested by the instruction must be a valid number for the module: i.e. from 1 up to the maximum of 64. The maximum number is dependent on the type of module that is performing block transfer. The block length can also be set at the default value of the module, useful when programming bidirectional block transfers. For some modules, the default value allows the module to decide the number of words to be transferred. See the documentation for the module for for additional information.

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

The block length heading of the instruction accepts any value from 00-63, whether or not the value is valid for a particular module. Enter 00 for the default value and/or a block length of 64.

The block length is stored in binary in the byte corresponding to the module's address in the output image table.

Equal Block Lengths
When the block lengths are set equal or when the default block length is specified by the programmer, the following considerations are applicable:

- Read and write instructions could and should be enabled in the same scan (separate but equal input conditions).
- Module decides which operation will be performed first when both instructions are enabled in the same scan.
- Alternate operation will be performed in a subsequent scan.
- Transferred data should not be operated upon until the done bit is set.

Unequal Block Lengths
Consult the user's manual for the block transfer module of interest for programming guidelines when setting the block lengths to unequal values.



ATTENTION: When the block lengths of bidirectional block transfer instructions are set to unequal values, the rung containing the alternate instruction must not be enabled until the done bit of the first transfer is set. If they are enabled in the same scan, the number of words transferred may not be the number intended, invalid data could be operated upon in subsequent scans, or analog output devices could be controlled by invalid data. Unexpected and/or hazardous machine operation could occur. Damage to equipment and/or personal injury could result.

File Address

The file address is the first word of the file to which (or from which) the transfer is made. The file address is stored 100 words above the data address of the instruction. When the file address is entered into the instruction block, the industrial terminal computes and displays the ending address based on the block length.

When reserving an area for a block transfer file, select an appropriate address to ensure that block transfer data does not write over assigned timer/counter accumulated and preset values. The file address cannot exceed address 5777_{08}.

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

Enable/Done Bit

The read and write bits are the enable bits for block transfer modules. Either one (or both for a bidirectional transfer) is set on in the program scan when the rung containing the block transfer instruction is true.

The done bit is set on in the I/O scan that the words are transferred, provided that the transfer was initiated and successfully completed. The done bit remains on for only one scan.

A block transfer is requested in each program scan that the read and/or write bit remains on. The read and/or write bits are turned off when the rung containing the instruction goes false.

Run-Time Errors

Misuse and/or inadvertent changes of instruction data can cause run-time errors when:

- The module address is given a non-existent I/O rack number.
- A read transfer overruns the file into a processor work area or into user program by an inadvertent change of the block length code.

Block Transfer Read

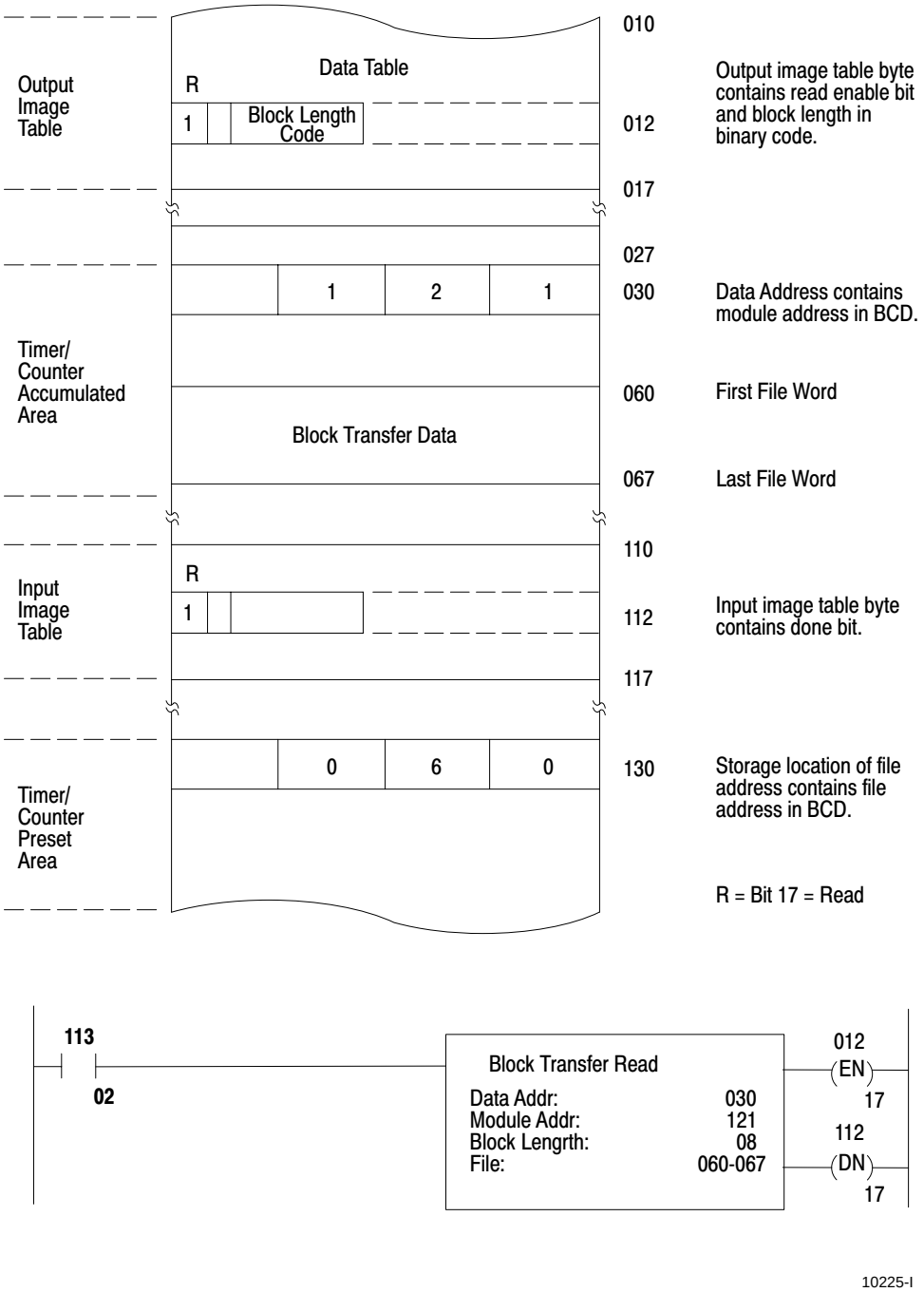
Purpose: Block transfer reads data from an I/O module into the processor's input image table in one I/O scan.

- Programmed as an output instruction.
- Block length depends on the type of module you are using.
- Request for transfer is made in the program scan.
- I/O scan is interrupted for the transfer.
- Done bit remains on for one scan after a valid transfer.
- Instruction requires two words of the data table.

Figure 14.5 shows an example rung containing a block transfer read instruction and the data table areas used by the instruction.

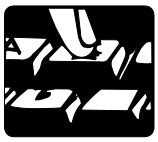
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

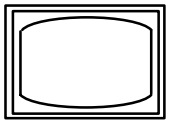
Figure 14.5
Data Table Locations for Bi-directional Block Transfer



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

Keystrokes: In this example, you enter a block transfer read instruction.

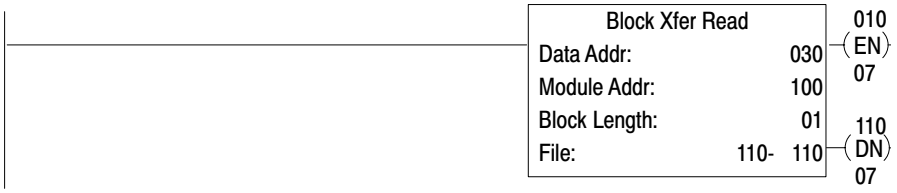




[BLOCK XFER]

1

The screen does not change



Note that the words BLOCK TRANSFER READ are flashing.

Insert the following values. The cursor moves automatically through the instruction. The values are:

- DATA ADDRESS 040
- MODULE ADDRESS 130
- BLOCK LENGTH 05
- FILE 070-074

The instruction should look like this:



Block Transfer Write

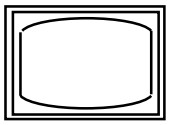
Purpose: A block transfer writes data from the processor's output image table to an I/O module in one scan.

- Programmed as an output instruction.
- Block length depends on the type of module you are using.
- Request for transfer is made in the program scan.
- I/O scan is interrupted for the transfer.
- Done bit remains on for one scan after a valid transfer.
- Request requires two words of the data table.

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

Keystrokes: In this example, you enter a block transfer write instruction.





[BLOCK XFER]

0

The screen does not change



Note that the words BLOCK TRANSFER WRITE are flashing.

Insert the following values. The cursor moves automatically through the instruction. The values are:

- DATA ADDRESS 041
- MODULE ADDRESS 130
- BLOCK LENGTH 05
- FILE 060-064

The instruction should look like this:



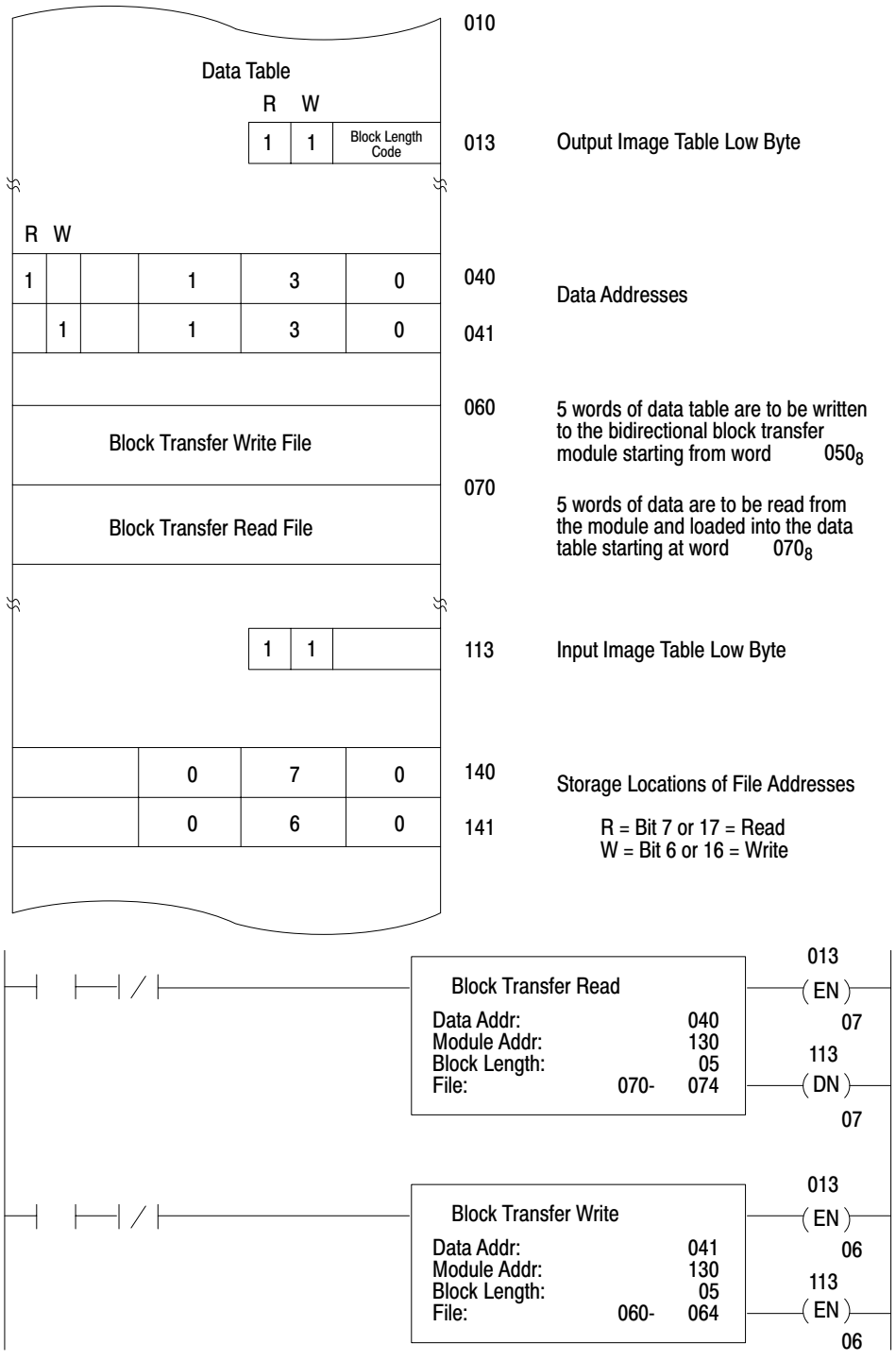
Bidirectional Block Transfer

Purpose: Bidirectional block transfer is the sequential performance of both operations. The order of operation is generally determined by the module.

Two rungs of user program are required, one containing the block transfer read instruction, the other containing the block transfer write instruction. When both instructions are given the same module address, the pair are considered as bidirectional block transfer instructions. Figure 14.6 shows an example rung containing a bidirectional block transfer instruction and the data table areas used by the instruction.

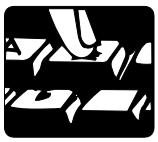
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

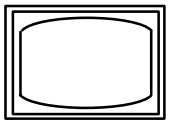
Figure 14.6
Data Table Locations for Bidirectional Block Transfer



Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com 10229-I

Keystrokes: In this example, you enter a bidirectional block transfer instruction. First, enter the block transfer read instruction.

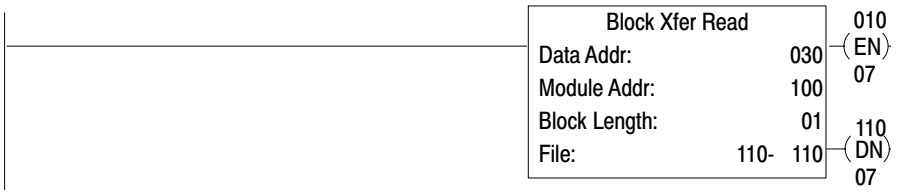




[BLOCK XFER]

1

The screen does not change

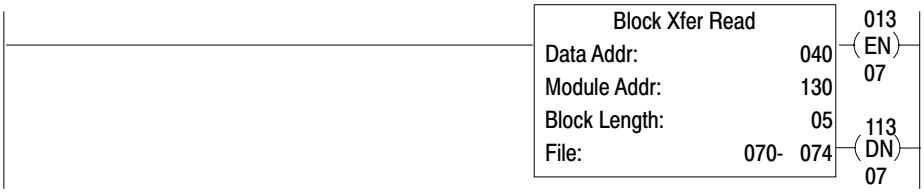


Note that the words BLOCK TRANSFER READ are flashing.

Insert the following values. The cursor moves automatically through the block transfer read instruction. The values are:

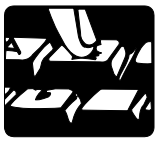
- DATA ADDRESS 040
- MODULE ADDRESS 130
- BLOCK LENGTH 05
- FILE 070-074

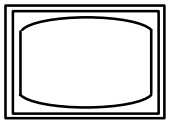
The instruction should look like this:



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

Keystrokes: Now enter the block transfer write instruction.





[BLOCK XFER]

0

The screen does not change

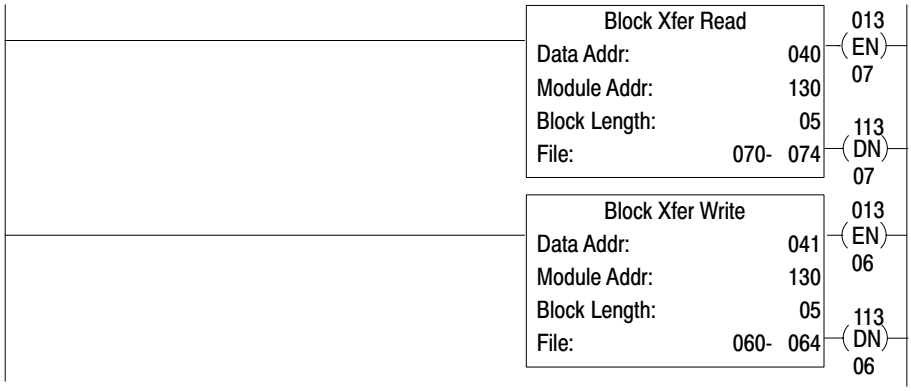


Note that the words BLOCK TRANSFER WRITE are flashing.

Insert the following values. The cursor moves automatically through the block transfer write instruction. The values are:

- DATA ADDRESS 041
- MODULE ADDRESS 130
- BLOCK LENGTH 05
- FILE 060-064

The completed bidirectional instruction should look like this:



Multiple Reads of Different Block Lengths from One Module

Under certain conditions, it may be desirable to transfer part of a file rather than the entire file. For example, a processor could be programmed to read the first two or three channels of an analog input module periodically but read all channels less frequently. To do this, use two or more block transfer read instructions: one for each desired transfer length starting at the same first word. The read instructions would have the same module address, data address and file address but different block lengths. The size of the file would equal the largest transfer.

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

When two or more block transfer instructions have a common module address, program carefully to compensate for the following possible situations:

First - During any program scan, data in the output image table byte can be changed by each successive block transfer instruction having a common module address. The enable bit can be turned on or off according to the true or false condition of the rungs containing these instructions. The on or off status of the last rung governs whether the transfer occurs.

Second - The block length can be changed according to the block lengths of the enabled instructions. The block length of the last enabled block transfer instruction having a common module address governs the number of words transferred.



ATTENTION: When programming multiple writes (or reads) to the same module, it is possible that a desired transfer does not take place or the number of words transferred is not the number intended. Invalid data can be sent to a device (or can be operated upon in subsequent scans) resulting in unpredictable and/or hazardous machine operation.

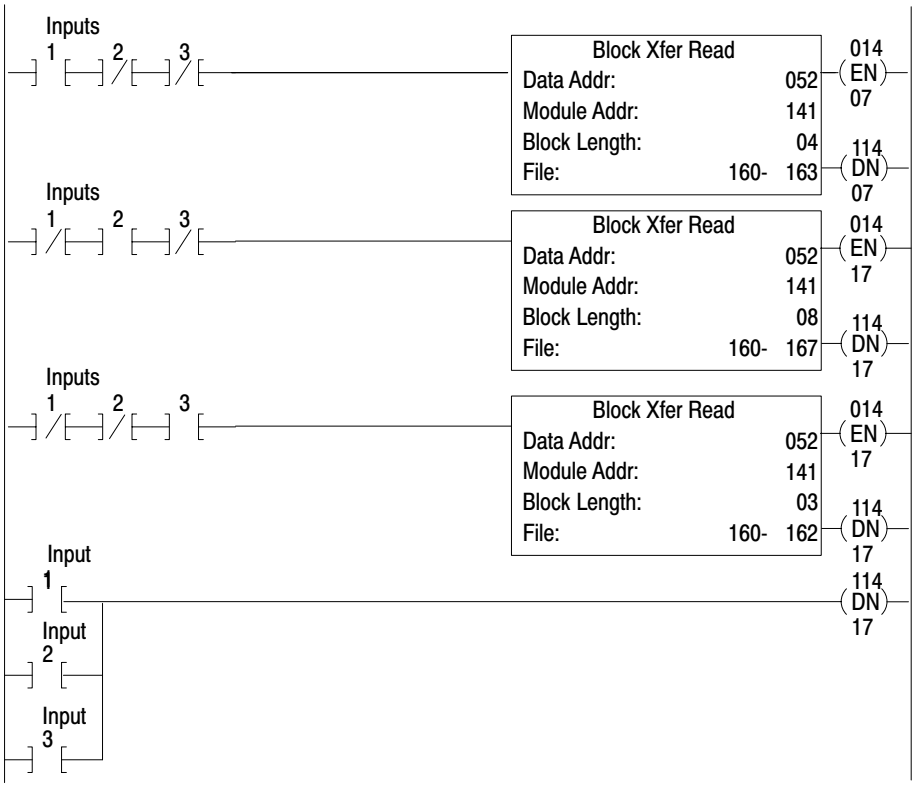
See the module user's manual for any information unique to that module.

The example in Figure 14.7 shows how multiple reads of different block lengths from one module can be programmed. When any one of the input switches is closed, the rung is enabled and the lock length is established. The last rung enables the block transfer instruction regardless of the previous changes in status of the enable bit. The Examine Off instructions prevent more than one of the block transfer instructions from being energized in the same scan.

Important: The same discussion applies when programming multiple writes of different block lengths to one module.

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

Figure 14.7
Programming Multiple Reads from One Module



Buffering Data

You should buffer block transfer data to allow the data to be validated before it is used. Data that is read from the block transfer module and transferred to data table locations must be buffered. Data that is written to the module need not be buffered because block transfer modules perform this function internally.

Transferred data is buffered to ensure that both the transfer and the data are valid. As an example, readings from an open-circuited temperature sensor (invalid data) could have a valid transfer from an analog input module to the data table. The processor examines data-valid and/or diagnostic bits contained in the transferred data to determine whether or not the data is valid. the block transfer done bit is set if the transfer is valid.

The data-valid and/or diagnostic bits differ for each block transfer module. Some modules set one or both for the entire file of words transferred, while others set a data-valid diagnostic bit in each word. See the documentation for the block transfer module to determine the correct usage of the diagnostic and/or data valid bit(s).

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

One technique of buffering data is to store the transferred data in a temporary buffer file. If the data in the buffer is valid, it is immediately transferred to another file in the data table where it can be used. If invalid, it is not transferred but written over in the next transfer.

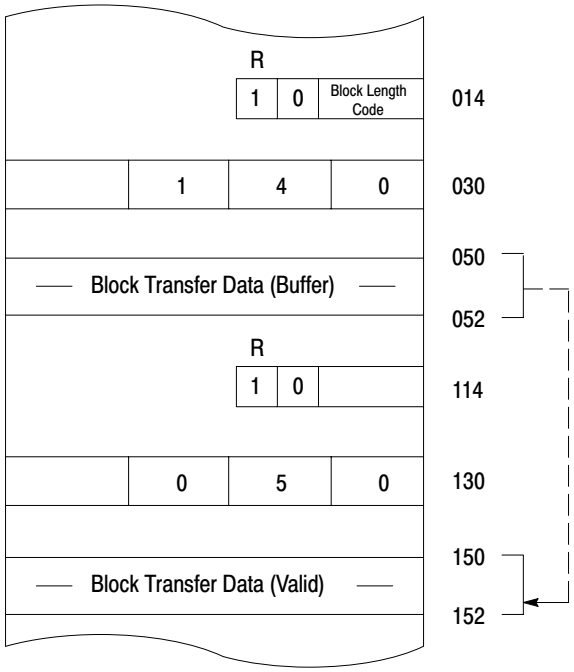
Another technique uses only one file. The technique prevents invalid data from being operated upon by preconditioning the rungs that would transfer data out of a file one word at a time. Diagnostic and/or data-valid bits are examined in these rungs.

Data can be moved from the buffer word-by-word using get/put transfers, or the entire file can be moved at once using a File-to-File Move instruction. The choice depends on the kinds of diagnostic and/or data-valid bits and the objectives of the user program. Generally, when one diagnostic bit is contained in each word, a get/put transfer is used. When one is set for the entire file, a File-to-File Move instruction is used. In either case, the diagnostic bits are examined as conditions for enabling the file move or word transfer.

The example in Figure 14.8 shows the memory map and ladder diagram rungs for buffering 3 words of data that are read from the block transfer module. The data is read and buffered in the following sequence:

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

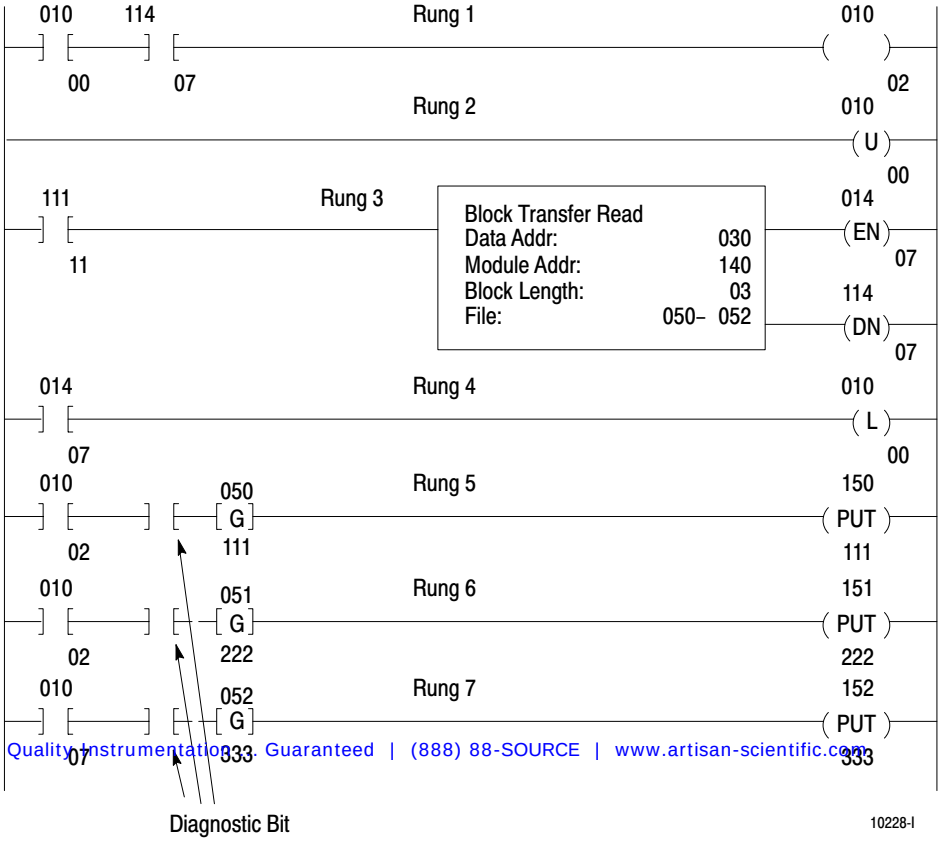
Figure 14.8
Buffering Data



Data in the buffer file 050–052 will be moved to 150–152 when:

A. Done Bit 114/07 is set (Valid transfer)

B. Diagnostic Bit is TRUE for each word to be moved in rungs 5–7 (valid data)



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

1. When rung 3 goes true, bit 014/07 (the block transfer enable bit) is turned on and block transfer is requested. This latches on storage bit 010/00 in rung 4.

2. Block transfer is enabled during the program scan. The transfer is performed during an interruption of the next I/O scan. Data from the module is loaded into words 050-052. When block transfer is complete, done bit 114/07 is set in the input image table byte. This indicates block transfer was successfully performed. The processor then continues with the I/O scan and program scan.

3. During the program scan, rung 1 is true because bit 010/00 is still latched on. Bit 114/07 (the block transfer done bit) is on because block transfer was performed. This turns bit 010/02 on. In rung 2, bit 10/00 is then unlatched.

4. In rung 5, bit 010/02 is still on and a diagnostic bit is examined to ensure the data read from the module is valid. Assuming the data is valid, the diagnostic bit is on and the data is transferred from word 050 to 150. In rungs 6 and 7, the data in words 051 and 052 is transferred to words 151 and 152 if the diagnostic bit is on.

Chapter Summary

In this chapter, we showed you how to transfer a block of data in one scan. The next chapter shows you how to perform subroutines at timed intervals.

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

Chapter 15

Selectable Timed Interrupt

Chapter Objectives

This chapter describes a method to execute subroutines at timed intervals. This method is called selectable timed interrupt.

Introduction

Selectable timed interrupt is a special subroutine that can be programmed into the subroutine area and designated as a Selectable Timed Interrupt (STI). This subroutine can then be executed at timed intervals.

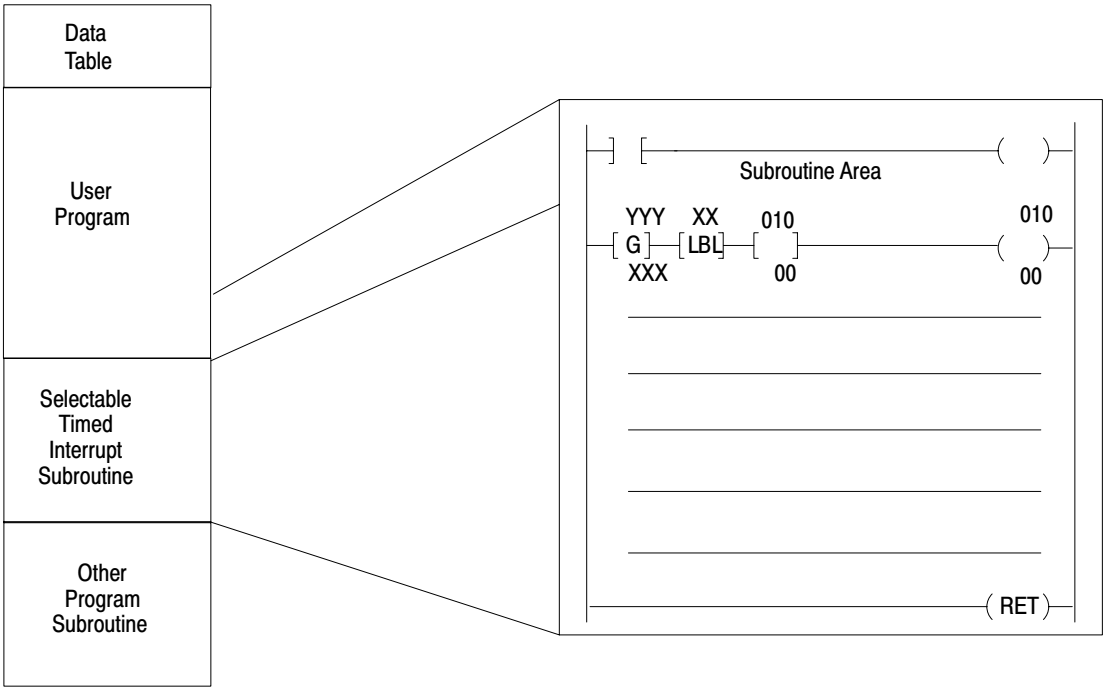
General programming facts are:

- First instruction is the first rung of the subroutine area must be a Get instruction. This identifies it as an STI.
- Get instruction must be used solely for the purpose of designating the time period of the STI.
- STI subroutine execution time should not exceed approximately 2/3 STI interval.

Keystrokes: To program a selectable timed interrupt subroutine, a Get instruction must be the first instruction in the first rung after the use program subroutine area statement (Figure 15.1). This designates that an STI follows. Then, you can program your subroutine. The transition time from main program to STI and return is 100µs.

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

Figure 15.1
Memory Organization



The Get instruction serves as a time base (xxx) for the STI. The Get instruction can have any data table address (yyy) except a processor work area. It must be used solely to designate the time base of the STI. The available time bases are: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 20, and 50 milliseconds. Your program, through the use of a Get/Put instruction (see chapter 9) can change the time base of the selectable timed interrupt. The subroutine must end with an unconditional return instruction.

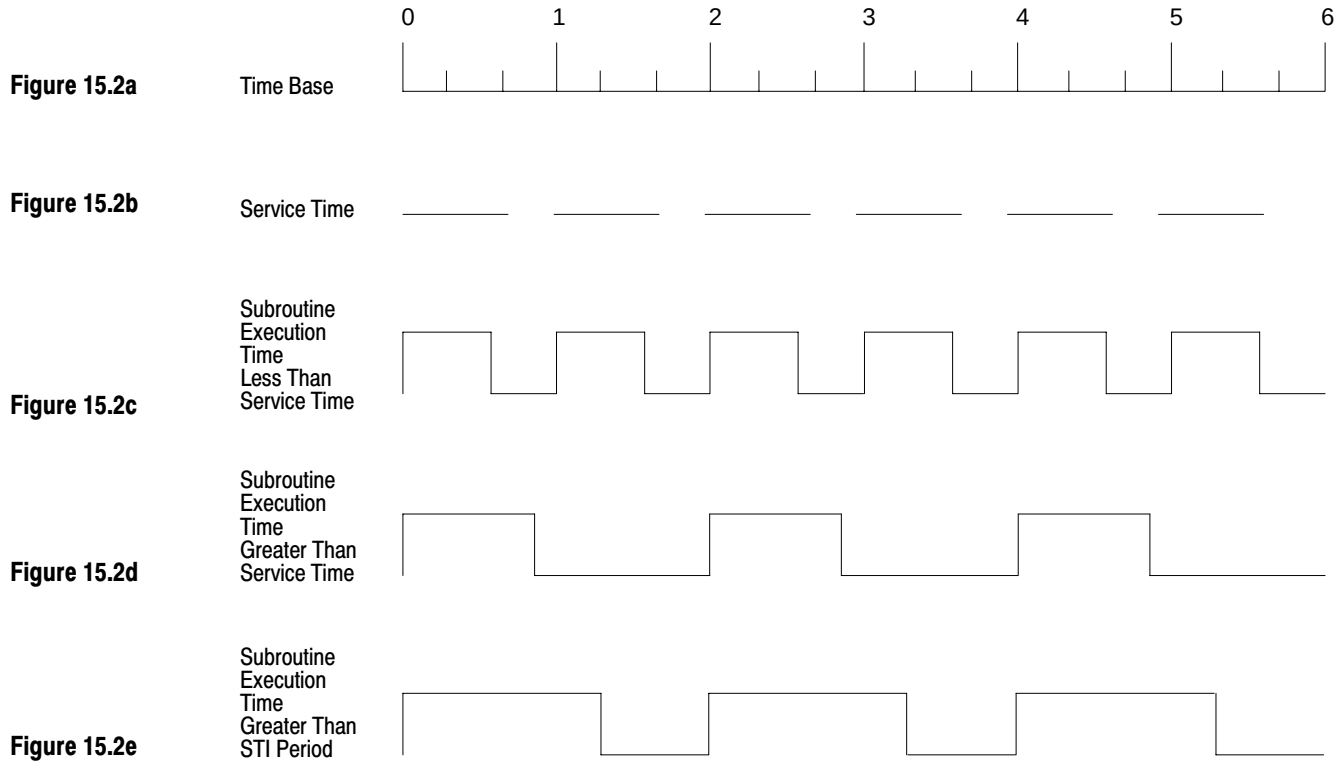
The Label instruction is optional and is only used when the main program wants to call the subroutine based on other conditions rather than selected time periods. If the subroutine timed interrupt is used as a direct subroutine with a Label instruction, you can have seven subroutines plus the STI. If the subroutine is not used as a direct subroutine, you can have eight subroutines plus the STI.

Operational Overview

Service time (Figure 15.2b) is factory set at approximately 2/3 of the timed interrupt period. Subroutine execution time plus program transition time (Figure 15.2c) should not exceed the maximum allowable service time (Figure 15.2b). When the program transition time plus subroutine execution time does not exceed service time, there is sufficient time for the processor to scan the subroutine.

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

Figure 15.2
Time Relationship of Subroutine Execution Time versus Service Time



Selectable timed interrupts are executed at every time period once they are enabled, including the I/O scan. During the program, the program is interrupted while the STI subroutine is executed. The program returns to the point of interrupt and continues execution just as if nothing has happened. However, during an I/O scan, a block transfer may be requested by a module. In this case, the STI is not executed until the block transfer is completed. In addition, the STI is disabled during an insert/remove or a mode of operation change.

Should the subroutine execution time plus program transition time exceed service time (Figure 15.2d), the selectable timed interrupt is no longer accurate. Two things happen:

- The STI too long bit (02702) is set on. This bit is available for your use and can be used to initiate annunciators or other status indicators. The bit functions similar to a latch instruction and must be reset with an Unlatch instruction.
- The processor completely executes the subroutine. It waits one complete STI period before executing the subroutine again (Figure 15.2d and 15.2e).

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

Chapter Summary

In this chapter, we showed you how to execute subroutines at timed intervals. The next chapter shows you how to edit instructions in your program.

Chapter 16

Program Editing

Chapter Objectives

This chapter describes how to edit instructions in your program:

- rules for editing instructions
- editing relay-type instructions
- editing other instructions

Rules for Editing Instructions

This section outlines the rules for editing instructions:

- editing
- searching
- clearing memory

Editing

Changes to an existing program can be made through a variety of editing functions (Table 16.A). Instructions and rungs can be added or deleted; addresses, data, and bits can be changed.

Table 16.A
Editing Functions [1]

Function	Key Sequence	Mode	Description
Inserting a condition instruction	[INSERT] (Instruction) (address) or [INSERT][←] (Instruction) (Address)	Program	Position the cursor on the instruction that will precede the instruction to be inserted. Then press key sequence. [2] Position the cursor on the instruction that will precede the instruction to be inserted. Then press key sequence. [2]
Removing a condition instruction	[REMOVE] (instruction)	Program	Position the cursor on the instruction to be removed and press the key sequence.
Inserting a rung	[INSERT] [RUNG]	Program	Position the cursor on any instruction in the preceding rung and press the key sequence. Enter instructions and complete the rung.
Removing a rung	[REMOVE] [RUNG]	Program	Position the cursor anywhere on the rung to be removed and press the key sequence. **IMPORTANT:** Only addresses corresponding to output energize latch and unlatch instructions are cleared to zero.

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

Function	Key Sequence	Mode	Description
Change data of a word or block instruction	[INSERT] (Data)	Program	Position the cursor on the word or block instruction whose data is to be changed. Press the key sequence.
Change the address of a word or block instruction	[INSERT] (First Digit) [←] (Address)	Program	Position the cursor on a word or block instruction with data and press [INSERT]. Enter the first digit of the first data value of the instruction. Then use the [←] and [→] key as needed to cursor up to the word address. Enter the appropriate digits of the word address.
Online programming	[SEARCH] [5] [2]		Initiates online programming.
Replace an instruction or Change address of an instruction without data	[Instruction] (Address)	Program	Position the cursor on the instruction to be replaced or whose address is to be changed. Press the desired instruction key (or key sequence) and the required address(es).
Online Data Change	[SEARCH] [5] [1] (Data) [RECORD] [CANCEL COMMAND]	Run/Program	Position the cursor on the word or block instruction whose data is to be changed. Press the key sequence. You can use the cursor keys. Press [RECORD] to enter the new data into memory. To terminate online data change.
All editing functions	[CANCEL COMMAND]	Program Run/Program	Aborts the operation at the current cursor position.

1 These functions can also be used during online programming.
2 When bit address exceeds 5 digits, press the [EXPAND ADDR] key before entering address and enter a leading zero if necessary.

Important: If the memory write protect is active, you can change only data table values between word addresses 010 and 177.

Inserting an Instruction

Only non-output instructions can be inserted in a rung. There are ways of doing this:

- First instruction of an existing rung
- First instruction of another rung
- Another location in the rung.

Keystrokes: You insert an instruction using either of the two ways by performing the following steps.

First Instruction of an Existing Rung

1. Position the cursor of the first instruction of the existing rung.
2. Press [INSERT][←].
3. Insert <instruction>.
4. Insert <address>.

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

First Instruction at the Beginning of Another Rung.

1. Position the cursor on the previous rung's output instruction.
2. Press [INSERT].
3. Insert <instruction>.
4. Insert <address>.

If the cursor is on the END statement, the instruction is inserted before the END statement or subroutine area.

Another Location in the Rung

1. Position the cursor on the instruction immediately preceding your selected location.
2. Press the key sequence [INSERT].
3. Press <instruction>.
4. Press <address>.

The new instruction is inserted after the cursor's present position.

You can enter bit addresses of 6 or 7 digits provided the data table is expanded to a 4- or 5-digit word address and you press [EXPAND ADDR] before you enter the address.

If, at any time, the memory is full, a MEMORY FULL message is displayed and you cannot enter more instructions.

Removing an Instruction
Only non-output instructions can be removed from a rung. Output instructions can be removed only be removing the complete rung.

Keystrokes: To remove an instruction, perform the following steps.

1. Place the cursor on the instruction you are going to remove.
2. Press [REMOVE] <instruction>.

Bit values and data of word instructions are not cleared. The input image table bits are rewritten during the next I/O scan. If you press the wrong instruction, and INSTRUCTIONS DO NOT MATCH message is displayed.

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

Inserting a Rung

A rung can be inserted anywhere within a program. The cursor can be positioned on any instruction of a rung. The new rung is inserted after the rung which contains the cursor. The rung appears as an unconditional rung. you must complete the rung. You cannot edit instructions in the new rung until the rung is complete.

Keystrokes: To insert a rung in a program, perform the following steps.

1. Press [INSERT][RUNG].

2. Insert <output instruction>.

Then:

3. Press [INSERT][←].

4. Insert <instruction>.

5. Insert <address>.

If the cursor is on the END statement, the rung need not be inserted. You can enter the rung as in initial program entry. if, at any time, the memory is full, a MEMORY FULL message is displayed you cannot enter more instructions.

Removing a Rung

Removing a rung is the only way an output instruction can be removed. you can remove any rung, except the last one containing the END statement.

Keystrokes: To remove a rung, perform the following steps.

1. Position the cursor anywhere on the rung you want to remove.

2. Press [REMOVE][RUNG].

Only bits corresponding to Output Energize, Latch, or Unlatch instructions are cleared to zero. All other word and bit addresses are not cleared when a rung is removed.

Changing Data in a Word or Block Instruction

You can change the data of any word or block instruction, except Mathematics and Put instructions, in the program mode without removing and re-entering the instruction.

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

Keystrokes: To change the data of any word or block instruction, perform the following steps.

1. Position the cursor on the appropriate word instruction.

2. Press [INSERT]<data>.

When the last digit of the data is entered, the function is terminated and the data is entered into memory. Once you have entered the first digit, the [→][←] keys can be used. The function can also be terminated and entered into memory before the last digit is entered if you press [CANCEL COMMAND].

Changing the Address of a Word or Block Instruction
You can change the address of a word or block instruction with data, excluding Mathematics and Put instructions, without removing and re-entering the instruction.

Keystrokes: To change the address of a word or block instruction, perform the following steps.

1. Position the cursor on the instruction you want to change.

2. Press [INSERT].

The cursor, although not displayed, positions itself on the first data digit. Enter that digit to display the cursor.

3. Cursor back to the address digits using the [←] key.

4. Change <address> as needed. Use a leading zero if required.

Changing an Instruction or Changing the Address of an Instruction Without Data
You can change an instruction or the address of an instruction without data.

Keystrokes: To change an instruction or the address of an instruction without data, perform the following steps.

1. Place the cursor on the instruction you are going to change.

2. Press the instruction key or key sequence of the desired instruction and the required address(es).

This procedure also can be used when changing the address of an instruction that does not contain data.

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

Online Data Change
Certain data of a word or block instruction, excluding Mathematics and Put instructions, can be changed while the processor is in the run/program mode.

Keystrokes: You can change data while the processor is in the run/program mode by performing the following steps.

1. Position the cursor on the appropriate instruction.

2. Press [SEARCH] 51.

The key sequence displays the message ON-LINE DATA CHANGE, ENTER DIGITS FOR: <Required information> near the bottom of the screen. The new digits are displayed in a command buffer as they are entered. After the new data is displayed:

3. Press [INSERT] to enter the data into memory.

4. You can terminate this function by pressing [CANCEL COMMAND].



ATTENTION: When the address of an instruction whose data is to be changed duplicates the address of other instructions in the user program, this could cause unwanted machine motion. This could result in damage to the equipment and/or injury to personnel. The consequences of the change of each instruction should be thoroughly explored.

Important: When the memory write protect is activated, online data change is not be allowed for addresses above 177. If you attempt to change data above address 177, the industrial terminal displays the error message MEMORY PROTECT ENABLED.

Searching

You can use the 1770-T3 terminal to search your program for:

- specific instruction and specific word addresses
- first condition or output instruction in a rung
- single rung display
- incomplete rung
- first and last rung and user boundaries
- remote mode select

See Table 16.B for a summary of search functions.

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

Table 16.B
Search Functions

Function	Key Sequence	Mode	Description
Locate first rung of program	[SEARCH][↑]	Any	Positions cursor on the first instruction of the program.
Locate last rung of program area	[SEARCH][↓]	Any	Positions cursor on the temporary end instruction, subroutine area boundary, or the end statement depending on the cursor's location. Press key sequence again to move to the next boundary.
Locate first instruction of current rung	[SEARCH][←]	Remote Prog	Positions cursor on first instruction of the current rung.
Move cursor off screen	[SEARCH][←]	Remote Test Run/Program	Moves cursor off screen to left.
Locate output instruction of current rung	[SEARCH][→]	Any	Positions cursor on the output instruction of the current rung.
Locate rung without an output instruction	[SHIFT] [SEARCH]	Any	Locates any rung left incomplete due to an interruption in programming.
Locate specific instruction	[SEARCH] [Instruction key] (Address)	Any	Locates instruction searched for. Press [SEARCH] to locate the next occurrence of instruction.
Locate specific word address	[SEARCH] (address)	Any	Locates this address in the program (excluding -| |- and -| / |- instructions and addresses in files). Press [SEARCH] to locate the next occurrence of this address. 1
Single rung display	[SEARCH] [DISPLAY]	Any	Displays the first rung of a multiple rung display by itself. Press key sequence again to view multiple rungs.
Print	[SEARCH] [4][3]	Any	Prints a single rung.
Print	[SEARCH] [4][4]	Any	Prints a ladder diagram dump.
Print	[SEARCH] [4][5]	Remote Prog	Prints a total memory dump.
Print	[SEARCH] [5][0]	Any	Prints the first 20 lines of data table configuration.
Print	[SEARCH] [5][3]	Any	Prints the first 20 lines of bit manipulation.
Print	[SEARCH] [5][4]	Any	Prints the first 20 lines of memory layout display.
Program controls outputs	[SEARCH] [5][9][0]	Run/Program	Places the processor in run/program mode.
Program executes outputs disabled	[SEARCH] [5][9][1]	Remote Test	Places the processor in remote test mode.
Processor awaits commands	[SEARCH] [5][9][2]	Remote Program	Places the processor in remote program mode.

1 Enter leading zeros when bit address exceeds 5 digits or word address exceeds 3 digits.

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

Specific Instructions and Specific Word Addresses
You can locate any instruction in your program by using methods described in this section. you can search for a block instruction searching for the counter address or the first entered address in the block.

Keystrokes: You can locate any instruction in your program by performing the following steps.

1. Press [SEARCH].

2. Insert <instruction>.

3. insert <address>. Enter leading zeros before the address if necessary.

Keystrokes: You can locate any address (excluding those associated with Examine On and Examine Off instructions and those contained within files) by performing the following steps.

1. Press [SEARCH] 8.

2. Enter <address>.

The address you enter is the word address for the Output instructions. The industrial terminal locates all uses of the word addresses associated with the word address except for -] [- and -]/[-.

Once either key sequence is pressed, this information and an EXECUTING SEARCH message is displayed near the bottom of the screen. The industrial terminal begins to search for the address and/or instruction from the cursor's position. It looks past the temporary end and subroutine area boundaries to the END statement. Then it continues searching from the beginning of the program to the point where the search began.

If found, the rung containing the first occurrence of the address and/or instruction is displayed as well as the rungs after it. If the SEARCH key is pressed again, the next occurrence of the address and/or instruction is displayed. When it cannot be located or all addresses and/or instructions have been found, a NOT FOUND message is displayed.

If the instruction is found in the subroutine area or past the temporary end instruction, the area in which it is found is displayed in the lower portion of the screen.

This function can be terminated at any time by pressing [CANCEL COMMAND]. All other keys are ignored during the search.

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

First Condition or Output Instruction in a Rung
Keystrokes: When the processor is operating in the remote program mode, you can access the first condition instruction of a rung from anywhere in the rung by performing the following steps.

1. Press [SEARCH][←].

When the processor is not in the program mode, the cursor moves off the screen to the left. To bring it back on the screen:

2. Press [→].

Keystrokes: When the processor is operating in any mode, you can access the output instruction by performing the following step.

1. Press [SEARCH][→].

Single Rung Display
Upon power-up, a multiple rung display appears on the screen.

Keystrokes: You can select the single rung format by performing the following steps.

1. Press [SEARCH][DISPLAY].

You can return to the multiple rung display.

2. Press [SEARCH][DISPLAY] again.

Incomplete Rung
You can locate an incomplete rung caused by an interruption in programming in any processor operating mode.

Keystrokes: You can locate the incomplete rung by performing the following steps.

1. Press [SHIFT][SEARCH].

First and Last Rung and User Program Bounds
You can locate the program boundaries including the first or last rung from any point in the program.

Keystrokes: You can locate these boundaries by completing the following steps.

1. Press [SEARCH][↑] or [SEARCH][↓].

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

The user program could contain a temporary end instruction boundary and/or a subroutine area boundary. It always contains an END statement boundary.

When you press [SEARCH][ ], the cursor goes directly to the first rung from anywhere in the program.

When you press [SEARCH] [ ], the display goes to the next boundary in the direction indicated. By pressing the [SEARCH] [ ] key sequence again, a subsequent boundary is displayed until the program end statement is reached.

Boundaries are displayed at the top of the screen with subsequent program rungs displayed beneath. No rungs follow the END statement.

Processor Mode Select
You must use an industrial terminal to change the processor mode of operation.

Keystrokes: To change the processor mode of operation, use the following keystrokes.

Run/Program Mode	Press [SEARCH]590.
Remote Test Mode	Press [SEARCH]591.
Remote Program Mode	Press [SEARCH]592.

Clearing Memory

You can clear the data table, user program and messages using various clear memory functions. When memory write protect is active, the data table cannot be cleared except between and including addresses 010-177 (Table 16.C).

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

Table 16.C
Clear Memory Functions

Function	Key Sequence	Mode	Description
Data table clear	[CLEAR MEMORY] [7][7] (Start Address) (End Address) [CLEAR MEMORY]	Remote Prog	Displays a start address and an end address field. Start and end word addresses determine boundaries for data table clearing. Clears the data table within and including addressed boundaries.
User program clear	[CLEAR MEMORY] [8][8]	Remote Prog	Position the cursor at the desired location in the program. Clears user program from the position of the cursor to the first boundary: i.e. temporary end, subroutine area or end statement. Does not clear data table or messages.
Partial memory clear	[CLEAR MEMORY] [9][9]	Remote Prog	Clears user program and messages from position of the cursor. Does not clear data table.
Total memory clear	[CLEAR MEMORY] [9][9]	Remote Prog	Position the cursor on the first instruction of the program. Clears user program and messages. Does not clear data table, unless the cursor is on the first program instruction.

IMPORTANT: When memory write protect is active, memory cannot be cleared except for data table addresses 010-177 with a programmed EPROM installed.

Data Table Clear

You can clear all or part of the data table.

Keystrokes: To clear all or part of the data of the data table, perform the following steps.

1. Press [CLEAR MEMORY] 77.
2. Enter a start and end word address.
3. Press [CLEAR MEMORY].

The data table is cleared between and including these two word addresses. When memory write protect is active, the data table cannot be cleared except between and including addresses 010-177.

User Program Clear

You can clear all or part of the user program.

Keystrokes: To clear all or part of the program, perform the following steps.

1. Press [CLEAR MEMORY] 88.

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

The user program is cleared from the cursor position to the first boundary: temporary end instruction, subroutine area or END statement. Neither the data table nor messages are cleared.

Partial Memory Clear
You can clear part of the program and the messages.

Keystrokes: To clear part of the memory, perform the following steps.

1. press [CLEAR MEMORY] 99.

The user program and messages are cleared from the cursor position which can not be on the first instruction. None of the bits in the data table are cleared.

Total Memory Clear
You can clear the complete memory.

Keystrokes: To clear the complete memory, perform the following steps.

1. Position the cursor on the first instruction of the program.

2. Press [CLEAR MEMORY] 99.

This resets all the data table bits to zero. Perform a total memory clear before entering the program.

Special Programming Aids

Special programming aids include:

- help directories
- online data change
- online programming
- online programming procedure
- data initialization key

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

Help Directories

The 1770-T3 help directories list the functions or instructions common to a single multipurpose key such as the [SEARCH] or [FILE] (Table 16.D). A master help directory is also available which lists the eight function and instruction directories for the Mini-PLC-2/05 processor and the key sequence to access them. You can display the master help directory by pressing [HELP]. You can press [HELP] any time during a multi-key sequence. The remaining keys in the sequence can be pressed then without having to press [CANCEL COMMAND].

Table 16.D
Help Directories

Function	Key Sequence	Mode	Description
Help directory	[HELP]	Any	Displays a list of the keys that are used with the [HELP] key to obtain further directories.
Control function directory	[SEARCH] [HELP]	Any	Provides a list of all control functions that use the [SEARCH] key.
Record function directory	[RECORD] [HELP]	Any	Provides a list of functions that use the [RECORD] KEY.
Clear memory directory	[CLEAR MEMORY] [HELP]	Remote Prog	Provides a list of all functions that use the [CLEAR MEMORY] key.
Data monitor directory	[DISPLAY] [HELP]	Any	Provides the choice of data monitor display accessed by the [DISPLAY] key.
File instruction directory	[FILE] [HELP]	Any	Provides a list of all instructions that use the [FILE] key.
Sequencer instruction directory	[SEQ][HELP]	Any	Provides a list of all instructions that use the [SEQ] key.
Block transfer directory	[BLOCK XFER] [HELP]	Any	Provides a list of all instructions that use the [BLOCK XFER] key.
All directories	[CANCEL COMMAND]	Any	To terminate.

Important: If a particular function or instruction directory or an item in a directory is not available with the Mini-PLC-2/05 processor, the industrial terminal displays a “FUNCTION NOT AVAILABLE WITH THIS PROCESSOR” message.

Online Data Change

While the processor is in the run/program mode, you can change the lower 12 bits of a word or word instruction. This excludes Mathematics and Put instructions, or certain data of a block instruction.

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

Keystrokes: You can change the lower 12 bits of a word by performing the following steps.

1. Position the cursor on the appropriate instruction and press [SEARCH] 5 1.

The message “ON-LINE DATA CHANGE, ENTER DIGITS FOR: <Required Information>” is displayed near the bottom of the screen. The new digits are displayed in a command buffer as they are entered.

2. Press [INSERT] to enter the data into memory.

3. To terminate this function, press [CANCEL COMMAND].



ATTENTION: When the address of an instruction whose data is to be changed duplicates the address of other instructions in user program, this could cause unwanted machine operation. This may result in damage to equipment and/or injury to personnel. The consequences of the change for each instruction should be examined beforehand.

Important: When the memory write protect is activated by the EEPROM back-up memory, you cannot perform an online data change for addresses above 177. If you attempt this change, the industrial terminal will display the error message: MEMORY PROTECT ENABLED.

Online Programming

Online programming allows you to change the program during machine operation (processor is operating in the run/program mode and memory write protect is not active).



ATTENTION: Assign the task of online programming only to an experienced programmer who understands the nature of Allen-Bradley programmable controllers and the machinery being controlled. Check and re-check proposed online changes for accuracy. Assess all possible sequences of machine operation resulting from the change in advance. Be absolutely certain that the change must be done online and that the change solves the problem without introducing additional problems. Notify personnel in the machine area before changing machine operation online.

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

To minimize the chances of error, maintain accurate data table assignments sheets and use the data initialization key described in this section.

Online Programming Procedure

You can make the following changes to your program in the online programming mode:

- insert an instruction
- remove an instruction
- insert a rung
- remove a rung
- change an instruction or instruction address

The online programming mode is accessible from the industrial terminal by pressing the key sequence [SEARCH] 52. The processor module must be in the run/program mode. The heading, “ON-LINE PROGRAMMING” appears in the top right- hand corner of the screen highlighted in reverse video.

You can not enter the following instructions during online programming:

- temporary end
- MCR
- ZCL
- JMP
- JSR
- block transfer read and write

The procedure for online programming in run/program mode is similar to the procedure for editing in program mode. However, the following three keys have a special purpose in online programming:

- [RECORD}
- [CANCEL COMMAND]
- [DATA INIT]

Use the [RECORD] key to enter a change to your program. Once pressed, the changed program is active.

Use the [CANCEL COMMAND] key to abort any online programming operation prior to pressing the [RECORD] key. Pressing [CANCEL COMMAND] restores the ladder diagram display and program logic to its original state prior to the online programming operation. You can also use it to terminate the online programming mode.

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

Data Initialization Key

You must enter two types of information when programming the following instructions:

- Get
- Equal to
- Less than
- Timers
- Counters
- Files
- Sequencers

The two types of information needed are the instruction and operating parameters.

Important: Operating parameters are used only for file and sequencer instructions.

The data stored at the instruction address is divided into two sections:

- status bits (bits 14-17)
- BCD values (bits 00-13)

During program execution,these bits are constantly changing to reflect current states and values of program instructions. Therefore, when programming on line, you must decide whether to use the current data or enter new data.

Use [DATA INIT] when adding an instruction containing new data. Do not use it when adding an instruction that uses the data at a pre-assigned address.

The [DATA INIT] key performs two functions in the online programming mode:

- It allows entry of BCD data values (stored at the instruction address).
- It resets status bits.

Use the [DATA INIT] key when programming a data instruction whose address is not currently being used in the program. If you do not use [DATA INIT], data at the new address (possibly remaining from previous programming) may interfere with proper machine operation when you insert the new instruction into the program.

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



ATTENTION: When the address of a new instruction duplicates the address of other instructions in the program, the [DATA INIT] key should not be used without first assessing the consequences. Pressing the [DATA INIT] key zeros out the status bits stored at the existing instruction address. This may cause unwanted machine motion and result in equipment damage and/or injury to personnel.

To look for a specific instruction, press [SEARCH] <instruction>. To look for a specific address, press [SEARCH] <address>. This helps you to determine addresses currently used in your program.

To locate all addresses (excluding those associated with Examine On and Examine Off instructions and those contained within files) press [SEARCH][8] <address>. The address entered is the word address for the Output Energize, Latch and Unlatch instructions, the 1770-T3 terminal locates all of the bit addresses associated with the word address.

The message “SEARCH FOR” and the entered key sequences are displayed at the bottom of the screen. The message “EXECUTING SEARCH” appears temporarily. The industrial terminal begins to search for the address and/or instruction from the cursor’s position. It looks past the temporary end and subroutine area boundaries to the END statement. Then, it continues searching from the beginning of the program to the point where the search began.

If found, the rung containing the first occurrence of the address and/or instruction is displayed as well as the rungs after it. If you press [SEARCH] again, the next occurrence of the address and/or instruction is displayed. When another occurrence cannot be located or all addresses and/or instructions have been found, a “NOT FOUND” message appears.

If the instruction is found in the subroutine area or part the temporary end instruction, the area in which it is found is displayed in the lower right hand corner of the screen.

Press [CANCEL COMMAND] at any time to terminate this function. All other keys are ignored during the search.

In summary, use [DATA INIT] to:

- enter a data instruction with an unused address
- enter new data
- clear the status bits of an already used address

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

Chapter Summary

We described how to edit instructions in your program. The next chapter shows how to generate messages.

Chapter 17

Report Generation

Chapter Objectives

This chapter describes how to generate messages containing:

- ASCII characters
- graphic characters
- variable information

You can use the report generation function of the 1770-T3 industrial terminal to generate messages that contain ASCII and graphic characters, and variable data table information. The processor must be in the PLC-2 mode. Messages are stored in the processor's memory after the END of program statement. These messages may be displayed or printed manually or automatically.

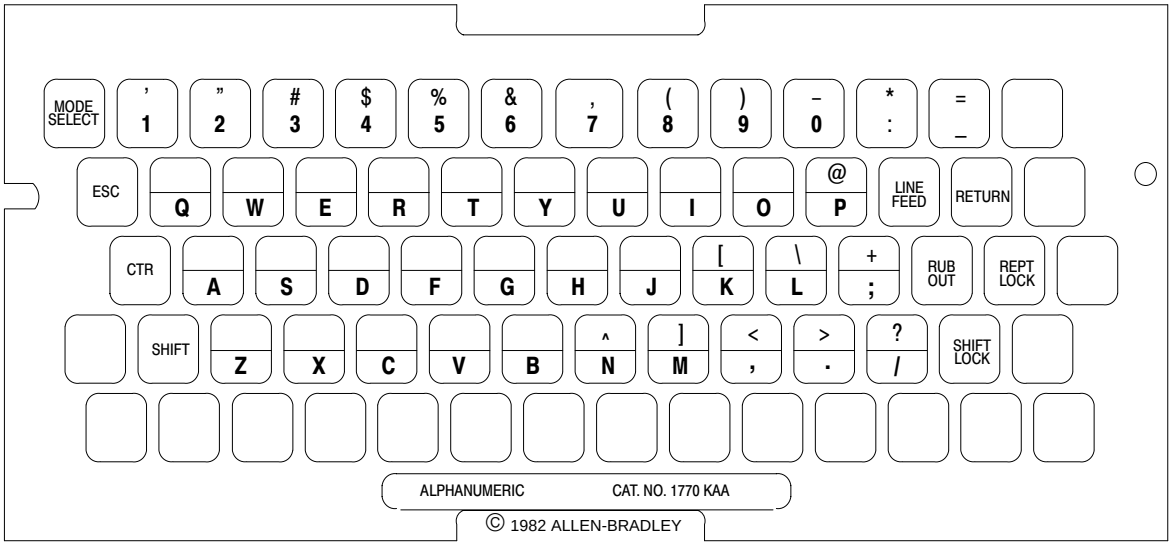
The 1770-T3 industrial terminal report generation features include:

- up to 70 messages - you can choose the number of messages to be stored.
- simple programming - only 20 or 3 rungs of programming are required to display a message by program logic
- selectable communication rates - you can choose from seven communication rates: 110, 300, 600, 1200, 2400, 4800 or 9600 bits per second
- selectable parity bit - you can choose odd, even or no parity

Messages are entered into memory from either the 1770-T3 industrial terminal or a peripheral device connected to channel C of the industrial terminal. Use one of two optional keytop overlays on the 1770-T3 industrial terminal, depending on whether graphic characters are desired (Figure 17.1):

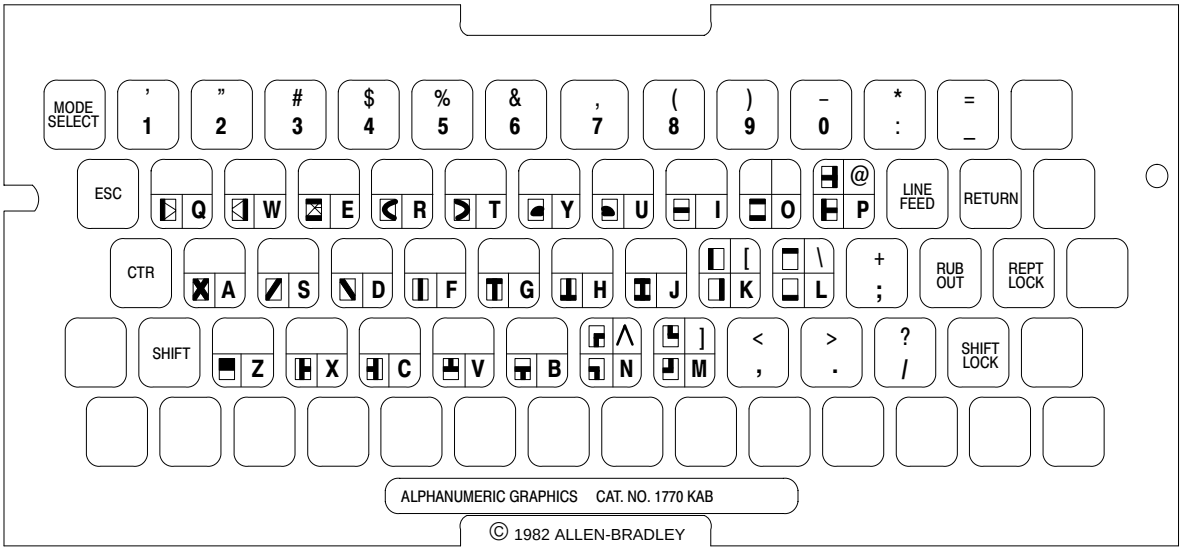
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Figure 17.1
Alphanumeric Keytop Overlays



Alphanumeric Keytop Overlay (1770-KAA)

Alphanumeric/Graphic Keytop Overlay (1770-KAB)



10160-I

- Alphanumeric Keytop Overlay (cat. no. 1770-KAA)
- Alphanumeric/Graphics Keytop Overlay (cat. no. 1770-KAB)

The messages are displayed manually or printed on the 1770-T3 industrial terminal or peripheral device by a key sequence each time a message is desired. They can also be activated program control by programming specific data table bits in the ladder diagram program.

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

Generating Messages

Manually Initiated Report Generation

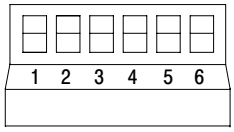
If processor operation is changed to the run/program mode, the processor automatically changes from automatic to manual report generation mode. Every time you change the mode of operation, the peripheral device displays a prompt to indicate the current operating mode.

Automatic Report Generation

Messages are printed through program control automatically by energizing specific message requires bits using Output Latch and Output Unlatch instructions.

You can access automatic report generation is the processor is in the remote test, or run/program mode. To do this press [SEARCH] 40 or [M][R][RETURN]. It can also be activated automatically upon initialization of the industrial terminal if you move parity switches 4 and 5 to the up position on the industrial terminal's main logic board (Figure 17.2).

Figure 17.2
Parity Switch Locations



10664-I

Once automatic report generation is activated, the message request bits are scanned by the industrial terminal for a false-to-true transition. Each time one of the request bits goes true, the corresponding message is printed automatically.

You can terminate automatic report generation by pressing [ESC]. To return to ladder diagram display, press [ESC] again. Pressing [CANCEL COMMAND] also terminates automatic report generation. The display returns to the ladder diagram if automatic report generation was entered by a command from a peripheral device.

Messages 1-6

Messages 1-6 use bits 10-15 of word 027 as message request bits. All other messages have a user-defined file of message request bits for control.

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

The upper byte of word 027 is used to control messages 1-6. Bit 027/10 is the request bit for message number 1 and so on. Bit 027/16, the busy bit is set when any of messages 1-6 are requested and remains set until all requested messages have been printed. Once all messages are printed, bit 027/17 will stay on for 300 milliseconds and is then reset.

Additional Messages

The upper byte of each message control word contains the request bits for eight messages. There is an easy way to determine the message number from the bit which requests it. The three right-most digits in the bit address are coded to the message number. For example, if message number 312 is of interest, bit 12 of the third message control word requests message 312 on a false-to-true transition (Figure 17.3).

Figure 17.3
Bit Address-Message Number Relationship

Control Word Number	Control Word Address	Message Numbers
0	201	010–017
1	202	110–117
2	203	210–217
3	204	310–317
4	205	410–417
5	206	510–517
6	207	610–617
7	210	710–717

The control word addresses are user selected.

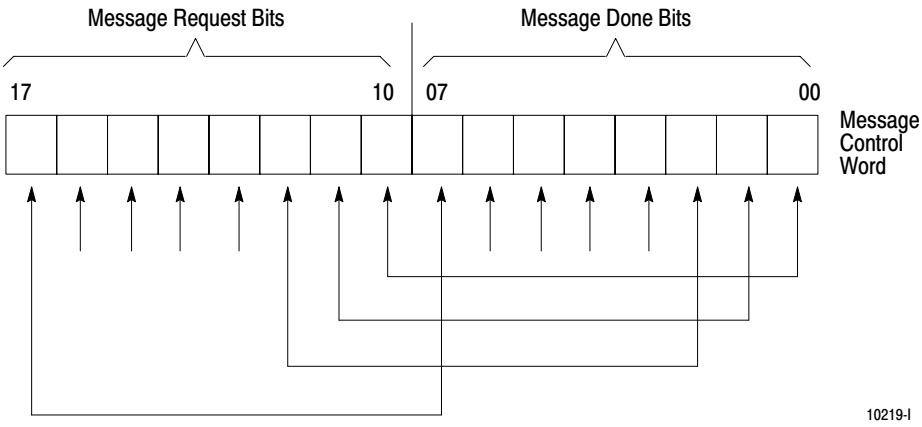
Message number 3XX has a message request bit at address 204/XX. Message request bit 204/XX, when enabled, will activate message number 3XX where XX are bit numbers $00\text{-}17_8$.

10218

Unlike messages 1-6 which share a common done bit (027-17), the additional 64 messages each have a separate done bit. After a particular message is printed, the done bit is set until the user program resets the request bit. Done bits are located in the lower byte of the message control words. Figure 17.4 shows this relationship. For example, if 404/15 is the request bit for a message, the done bit is located at 404/05, one byte below the request bit.

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

Figure 17.4
Message Request Bit-Done Bit Relationship



The message print command is valid for message 0. It prints out the message control word addresses in a form similar to that shown in Table 17.A. If the location of the message control file is to be changed or you no longer need message 0, it can be deleted with the message delete command and re-entered at any time.

Table 17.A
Example Message Control Word-Message Number Relationship

Control Words	Message Numbers
200	010-017
201	110-117
202	210-217
203	310-317
204	410-417
205	510-517
206	610-617
207	710-717

IMPORTANT: This table assumes user selected message control words begin at 200_8.

ATTENTION: Do not use message control words for any other purpose. This warning is especially critical for output image table locations when output or block transfer modules are placed in corresponding slots. Failure to observe this warning could result hazardous or unexpected machine operation. This could result in damage to equipment and/or injury to personnel.

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

Control Codes and Special Commands

When entering a message, there are several keys and special industrial terminal control codes that you can use to move through the display and perform a variety of functions (Table 17.B and Table 17.C). For example, you can access graphic capability with the control code, [CTRL][P][5][G]. In addition, standard ASCII control codes can be used with the industrial terminal (Table 17.B). These codes, although not displayed, can be interpreted and acted on by a peripheral device connected to channel C.

Table 17.B
Alphanumeric/Graphic Key Definitions

Key	Function
[LINE FEED]	Moves the cursor down one line in the same column.
[RETURN]	Returns the cursor to the beginning of the next line.
[RUB OUT]	Deletes the last character or control code that was entered.
[REPT LOCK]	Allows the next character that is pressed to be repeated continuously until [REPT LOCK] is pressed again.
[SHIFT]	Allows the next key pressed to be a shift character.
[SHIFT LOCK]	Allows all subsequent keys pressed to be shift characters until [SHIFT] or [SHIFT LOCK] is pressed.
[CTRL]	Used as part of a key sequence to generate a control code.
[ESC]	Terminates the present function.
[MODE SELECT]	Terminates all functions and returns the mode select display to the screen.
Blank Yellow Keys	Space keys. Move the cursor one position to the right.

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

Table 17.C
Industrial Terminal Control Codes

Control Code Key Sequence	Function
[CTRL][P] [Column #][;] [Line #][A]	Positions the cursor at the specified column and line number [CTRL][P][A] positions the cursor at the top left corner of the screen.
[CTRL][P][F]	Moves the cursor one space to the right.
[CTRL][P][U]	Moves the cursor one line up in the same column.
[CTRL][P][5][C]	Turns cursor on.
[CTRL][P][4][C]	Turns cursor off.
[CTRL][P][5][G]	Turns on graphics capability.
[CTRL][P][4][G]	Turns off graphics capability.
[CTRL][P][5][P]	Turns Channel C outputs on.
[CTRL][P][4][P]	Turns Channel C outputs off.
[CTRL][I]	Horizontal tab that moves the cursor to the next preset 8th position.
[CTRL][K]	Clears the screen from cursor position to end of screen and moves the cursor to the top left corner of the screen.
Key Sequence	**Attribute** [1]
[CTRL][P][0][T]	Attribute 0 = Normal Intensity
[CTRL][P][1][T]	Attribute 1 = Underline
[CTRL][P][2][T]	Attribute 2 = Intensify
[CTRL][P][3][T]	Attribute 3 = Blinking
[CTRL][P][4][T]	Attribute 4 = Reverse Video

[1] Any three attributes can be used at one time using the following key sequence: [CTRL][P][Attribute #][;][Attribute #][;][Attribute #][T]

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

Table 17.D
ASCII Control Codes

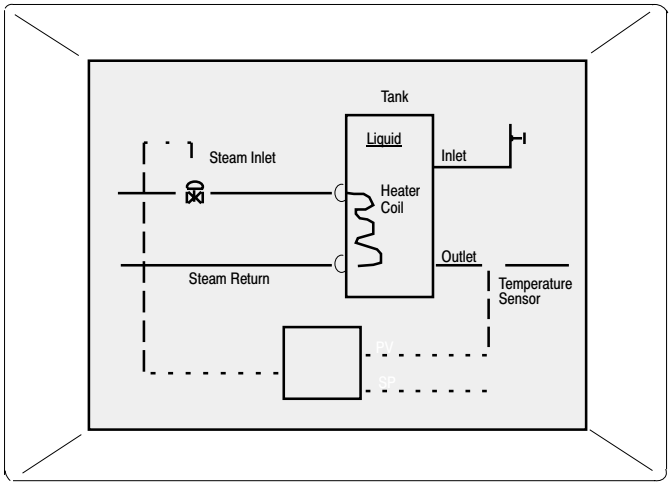
Control Code [1]	Display [2]	ASCII Mnemonic	Name
CTRL 0 [3]	N_U	NUL	NULL
CTRL A [3]	S_H	SOH	START OF HEADER
CTRL B [3]	S_X	STX	START OF TEXT
CTRL C [3]	E_X	ETX	END OF TEST
CTRL D	E_T	EOT	END OF TRANSMISSION
CTRL E	E_Q	ENQ	ENQUIRE
CTRL F	A_K	ACK	ACKNOWLEDGE
CTRL G	B_L	BEL	BELL
CTRL H	B_S	BS	BACKSPACE
CTRL I	H_T	HT	HORIZONTAL TAB
CTRL J	L_F	LF	LINE FEED
CTRL K	V_T	VT	VERTICAL TAB
CTRL L	F_F	FF	FORM FEED
CTRL M	C_R	CR	CARRIAGE RETURN
CTRL N	S_O	SO	SHIFT OUT
CTRL O	S_I	SI	SHIFT IN
CTRL P	D_L	DLE	DATA LINK ESCAPE
CTRL Q	D_1	DC1	DEVICE CONTROL 1
CTRL R	D_2	DC2	DEVICE CONTROL 2
CRTL S	D_3	DC3	DEVICE CONTROL 3
CTRL T	D_4	DC4	DEVICE CONTROL 4
CTRL U	N_K	NAK	NEGATIVE ACKNOWLEDGE
CTRL V	S_Y	SYN	SYNCHRONOUS IDLE
CTRL W	E_B	ETB	END OF TRANSMISSION BLOCK
CTRL X	C_N	CAN	CANCEL
CTRL Y	E_M	EM	END OF MEDIUM
CTRL Z	S_B	SUB	SUBSTITUTE
ESCAPE	E_C	ESC	ESCAPE
CTRL,	F_S	FS	FILE SEPARATOR
CTRL-	G_S	GS	GROUP SEPARATOR
CTRL.	R_S	RS	RECORD SEPARATOR
CTRL/	U_S	US	UNIT SEPARATOR
DELETE	D_T	DEL	DELETE

[1] Some ASCII control codes are generated using non standard keystrokes.
[2] Will be displayed when Control Code Display option is set ON in Alphanumeric mode, only. (Not in Report Generation mode).
[3] Invalid key in Report Generation mode.

A Wilson Display with Dual Control Code Display Enhancement in ASCII Mode SOURCE: http://www.NortisResistor.com

The 1770-T3 industrial terminal screen size is 80 columns across by 24 lines down. An example message using graphic and alphanumeric characters is shown in Figure 17.5.

Figure 17.5
Example Graphic/ Alphanumeric Message



The control code, [CTRL][P]<Column #>[;]<Line #<[A], should be used for cursor positioning to conserve memory when possible. For example, [CTRL][P][3][9][;][9][A] uses 3 words of memory, storing CRTL P in one byte and remaining characters in one byte each. If the cursor had been at column 0, and line 0, normal space, and line feed commands were used, it would have taken 24 words of memory to accomplish the same thing. Note that the column and line numbers begin at zero rather than one.

Report Generation Commands

The report generation function is entered by pressing [RECORD][DISPLAY] on the standard 1770-KCB alphanumeric keytop overlay. There are six report generation commands used to enter control words and to store, print, report and delete messages and to display an index of existing messages. Table 17.E summarizes these commands.

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

Table 17.E
Report Generation Commands

Command	Key Sequence	Description
Enter report generation function	[RECORD][DISPLAY] or Set baud rate, (Message Code Keys)	Puts industrial terminal into report generation function. Same (entered from a peripheral device).
Message store	[M][S][,](Message Number)[RETURN]	Stores message in processor memory. Use [ESC] to end message.
Message print	[M][P][,](Message Number) [RETURN]	Prints message exactly as entered.
Message report	[M][R][,](Message Number) [RETURN]	Prints message with current data table values or bit status.
Message delete	[M][D][,](Message Number) [RETURN]	Removes message from processor memory.
Message index	[M][I][RETURN]	Lists messages used and the number of words in each message.
Automatic report generation.	[SEARCH][4][0] or [M][R][RETURN]	Allows messages to be printed through program control.
Exit automatic report generation	[ESC] or [CANCEL COMMAND] 1	Terminates automatic report generation.
Exit report	[ESC] or [CANCEL COMMAND] 1	Returns to ladder diagram display. Terminates Report Generation Function.

1 [CANCEL COMMAND] can only be used if the function was entered by a command from a peripheral device.

Message Control Word File - MS, 0

Bits from eight consecutive user-selected words control the 64 additional messages (1770-FD series B and all its subsequent revisions).

The eight message control words are determined by establishing a 2 -word message in data table, called message 0. Store Message 0 by using the following keystrokes:

[M][S][,] 0 [RETURN]

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

A prompt, MESSAGE CONTROL WORDS (Y DIGITS REQUIRED): prints. (Y is the number of digits, 3, 4 or 5, of a word address for the selected data table size.) Enter the beginning word address of the message control word file. The industrial terminal calculates and displays the words in the message control word file. You can locate the message control word file in any unused data table area except processor work areas and input image table areas. If memory write protect is active, place the message control word file in the area of data table which can be changed (010-377). Once you choose the start address, the industrial terminal displays a table (Table 17.B) which shows the message numbers associates with each message control word.

Message Store - MS

Accessible only in the run/program mode, use this command to enter messages in memory. Access the message store command by pressing [M][S][,]<message number>[RETURN]. Valid message numbers are:

- 001-006
- 010-017
- 110-117
- 210-217
- 310-317
- 410-417
- 510-517
- 610-617
- 710-717

After pressing the key sequence, a READY FOR INPUT message appears. Any subsequent keys pressed then become part of the message. If you try to use a message number that already exists, the terminal displays MESSAGE ALREADY EXISTS.

While entering a message, each key pressed, except [SHIFT][CTRL][ESC] or [RUB OUT], generates a code that is stored in one byte of memory. This includes ASCII and graphic characters as well as other keys such as [LINE FEED], [RETURN] or the [SPACE]. The [RUB OUT] key is not stored in memory. The [SHIFT] and [CTRL] keys and the next character in the sequence are stored together in one byte of memory.

You can enter messages which when reported give the current value of a data table word or byte. The messages can report the on or off status of a data table bit by using the delimiters shown in Table 17.F.

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

Table 17.F
Address Delimiters

Delimiter Format	Explanation	Message Report Format
XXX	Enter 3-digit word address between delimiters.	Displays BCD value at assigned word address.
XXX1 or *XXX0*	Enter 3-digit word address and a "1" for upper byte or a "0" for lower byte between delimiters.	Displays the octal value at assigned byte address.
XXXXX	Enter 5-digit bit address between delimiters.	Displays the ON or OFF status of the assigned bit address.
#XXX#	Enter 3,4 or 5-digit word address between delimiters.	Displays the BCD value at assigned word address.
!XXX!	Enter 3, 4, or 5-digit word address between delimiters.	Displays the 4-digit hex value at address.
&XXX1& &XXX0&	Enter 3, 4, or 5 digit word address and a "1"for upper byte or a "0" for lower byte between delimiters.	Displays the octal value at the assigned byte address.
XXXXX	Enter 5, 6, or 7-digit bit address between delimiters.	Displays the ON or OFF status of the assigned bit address.

The desired delimiter is entered before and after the bit, byte, or word address. The delimiter is used to tell the industrial terminal to print the current status or value of the bit, byte, or word at the address. You can enter as many consecutive addresses as needed by sharing the same delimiter, such as *XXX*XXX*XXX*. The asterisk delimiters are used if the data table size is less than 512 words (not exceeding address 777).

As an example, to report the on/off condition of a device SR6, during each cycle of machine operation. Delimiters are used to denote the output address 013/05, and the cycle counter accumulative value (stored at 030). The desired message, SR6 is (on or off) in cycle (xxx), is entered into memory with the following keystrokes:

SR6 [space]IS[space]*01305*[space]IN[space]CYCLE[space]#030#[ESC]

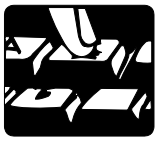
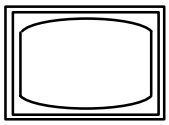
Terminate the message entry with the escape [ESC]key. Until [ESC] is pressed, all key strokes become part of the message. Pressing [ESC]again returns to the display to the ladder diagram. Pressing [CANCEL COMMAND] on the PLC-2 family keytop overlay also terminates message store, and the display returns to the ladder diagram if a peripheral device was used to enter report generation mode.

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

Message Print-MP

Accessible in any mode, the message print command is used to print the contents of a message to verify it. This command is accessed by pressing [M][P][,]<message number>[RETURN]. Valid message numbers are listed under MESSAGE STORE.

In the example, the message print command would give the following

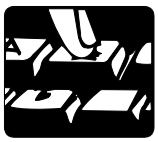
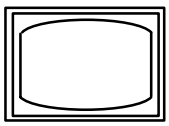
MP,	The screen does not change.
[RETURN]	SR6 IS *01305* IN CYCLE #030#

The message print command is self-terminating. You can press [ESC] or [CANCEL COMMAND] to return to ladder diagram display.

Message Report- MR

Accessible in ay mode, the message report command prints a message with the current data table value or bit status that corresponds to an address between the delimiters. This command is accessed by pressing [M][R][,]<message number>[RETURN].

In the example, the message report command gives the following: (e.g. bit 013/05 is on and counter 030 accumulated value is 5)

MP,	The screen does not change.
[RETURN]	SR6 IS ON IN CYCLE 005

The message report command is self-terminating. When you press [ESC] or [CANCEL COMMAND], ladder diagram operation resumes.

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

Message Delete- MD

Accessible only in rung/program mode, the message delete command is used to delete messages from memory. This command is accessed by pressing [M][D][,] <message number>[RETURN].

The message delete command cannot be terminated before completion. It self terminates after the message has been cleared from memory and a MESSAGE DELETED prompt is printed. you can enter [ESC] or [CANCEL COMMAND] to return to ladder diagram display.

Message Index- MI

Accessible in any mode, the message index command prints a list of the message numbers used and the amount of memory (in words) used for each message. In addition, the number of unused memory words available is listed.

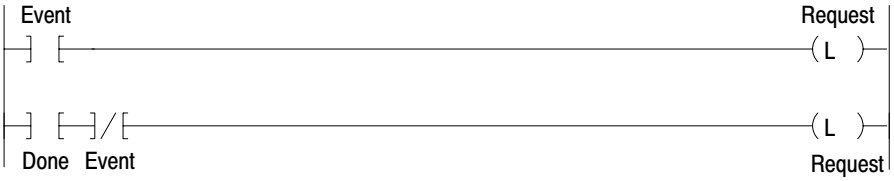
The message index command is accessed by pressing [M][I][RETURN]. This command cannot be terminated before completion. It self-terminates after the list is completed. To return to ladder diagram display,press [ESC] or [CANCEL COMMAND].

Example Programming

Using Latch and Unlatch instructions, you can easily program automatic report generation to handle multiple or simultaneous message requests. Simultaneous requests are handled by a priority system-the lower the message number, the higher the priority.

Figure 17.6 shows a sample program that you can use to activate each message. When the event occurs which requests the message, the request bit is latched. After the event has occurred and the message is printed (the done bit comes on), the request bit is unlatched. This technique also ensures the requested message gets printed once per request.

Figure 17.6
Example Program to Request a Message.



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

Chapter Summary

We showed you how to generate messages that contain ASCII, graphic characters, or variable data. The next chapter shows how to use several special programming technique.

Chapter 18

Programming Techniques

Chapter Objectives

This chapter describes several programming techniques you can use for:

- one-shot programming
- automatic re-start
- cascading timers
- temperature conversions
- program control
- bottle filling application

One-Shot

The one-shot programming technique sets a bit for one program scan only. There are two types of one-shots:

- leading edge
- trailing edge

Leading Edge One-Shot

A leading edge one-shot sets a bit for one scan when its input condition has made a false-to-true transition. The false-to-true transition represents the leading edge of the input pulse (Figure 18.1).

Figure 18.1
Leading Edge One Shot



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

When bit 112/04 makes a false-to-true transition, the one-shot bit (bit 253/00) is set on for one scan. The length of time bit 112/04 remains on does not affect the one-shot bit due to the next two rungs. Bit 011/14 is latched when bit 112/04 is set or bit 011/14 is unlatched when 112/04 is reset. During the next scan, either set of conditions prevents bit 253/00 from being set. The one-shot bit is set for another scan only when bit 112/04 makes a true-to-false and then a false-to-true transition.

Trailing Edge One-Shot

A trailing edge one-shot sets a bit for one scan when its input condition has made a true-to-false transition. The true-to-false transition represents the trailing edge of the input pulse. Figure 18.2 shows programming for a trailing edge one-shot.

Figure 18.2
Trailing Edge One-Shot



When bit 112/04 is set, bit 011/14 is latched. As soon as bit 112/04 makes a true-to-false transition,the one-shot bit (bit 253/00 is set and bit 011/14 is unlatched. Bit 153/00 remains on for only one scan. The input bit 112/04 makes a false-to-true transition then a true-to-false transition to set the one-shot bit for another scan.

Automatic Restart

You can control start-up automatically when using the EEPROM memory module. Anytime that an EEPROM to CMOS RAM memory transfer occurs, bit 02701 in the data table is set by the processor. The program must reset this bit. This allows the data table to be updated automatically to the indicated machine position.

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

The technique shown in Figure 18.3 is used when your program does not contain any other Master Control Restart instruction. The technique shown in Figure 18.4 is an alternative if an unused Label instruction (chapter 13) is available.

Figure 18.3
Automatic Restart Using an MCR Instruction

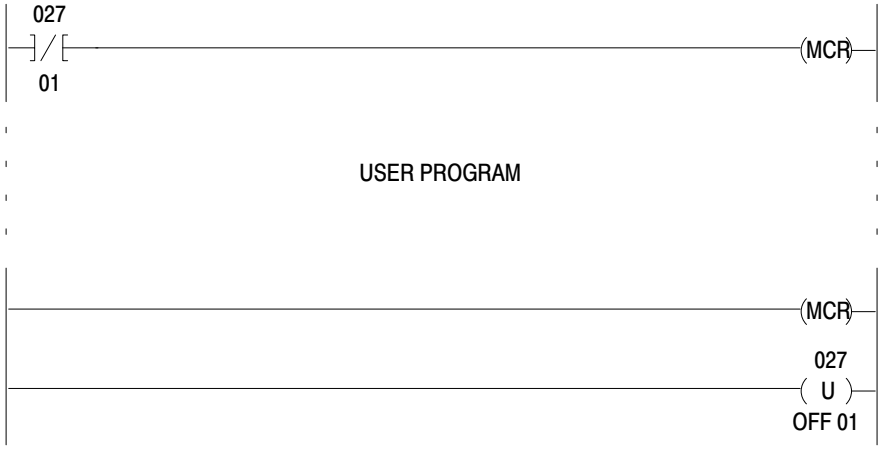
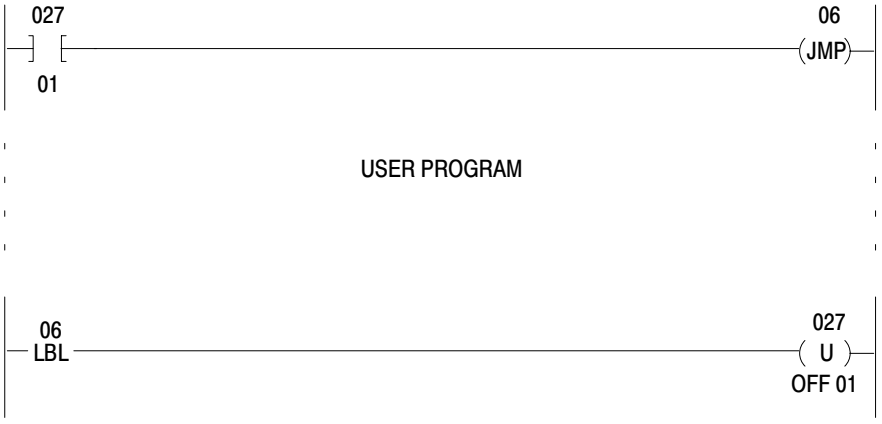


Figure 18.4
Automatic Restart Using JMP Instruction



The values in the data table at start-up depend on whether or not memory was retained by the back-up battery. If a battery was used, the data table contains the values that existed when power was removed. If a battery was not used, the values programmed into EEPROM transfer into the data table at power-up.

Start-up conditions for automatic start-up (using one of the suggested programming techniques) are:

- initial start-up: remove the battery from the system
- in-process start-up after power loss: maintain battery back-up

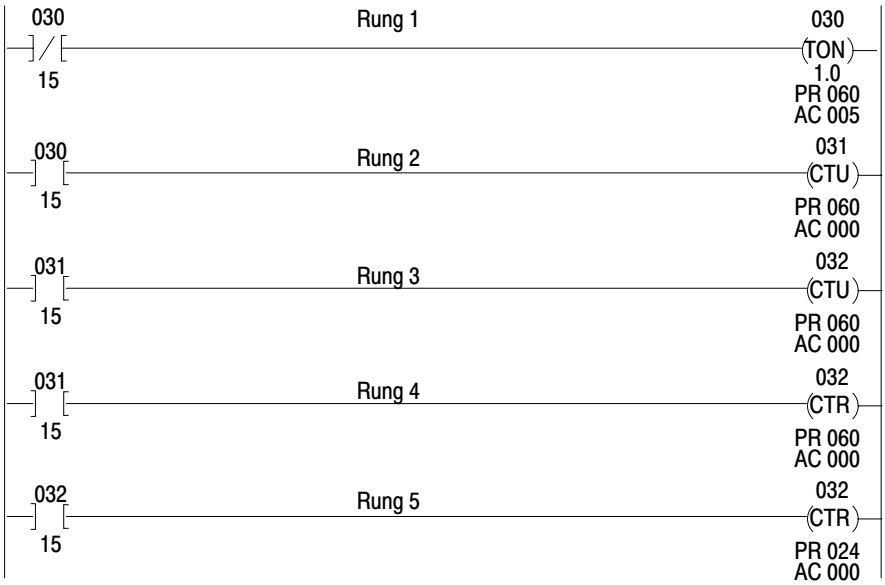
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Switches on the switch assembly of the I/O chassis determine how and when EEPROM to CMOS RAM transfer occurs. A transfer takes place when any change of CMOS RAM memory content occurs while the battery is being changed. If a transfer occurs (memory was altered), the data table contains the values programmed into the EEPROM. If transfer did not occur, memory did not change. The data table contains the values that existed at the time system power was removed.

Cascading Timers

Cascading is a programming technique that extends the ranges of timer and/or counter instructions beyond the maximum values that may be accumulated. Figure 18.5 illustrates a 24-hour clock program. Again, we emphasize not to enter these instructions using your on-line production equipment.

Figure 18.5
24 Hour Clock



ATTENTION: Do not use the clock program as a real time clock device. Failure to observe this caution may result in an inaccurate program.

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

A synopsis of the operation's cycle is:

Rung 1: When the conditions are true the timer starts.

Rung 2: When AC=PR (accumulated value equals preset value) of the timer, counter 031 increments.

Rung 3: When AC=PR of counter 031, counter 032 increments.

Rung 4: When AC=PR of counter 031, 031/15 resets counter 031's accumulated value.

Rung 5: When AC=PR of counter 032, 032/15 resets counter 032's accumulated value.

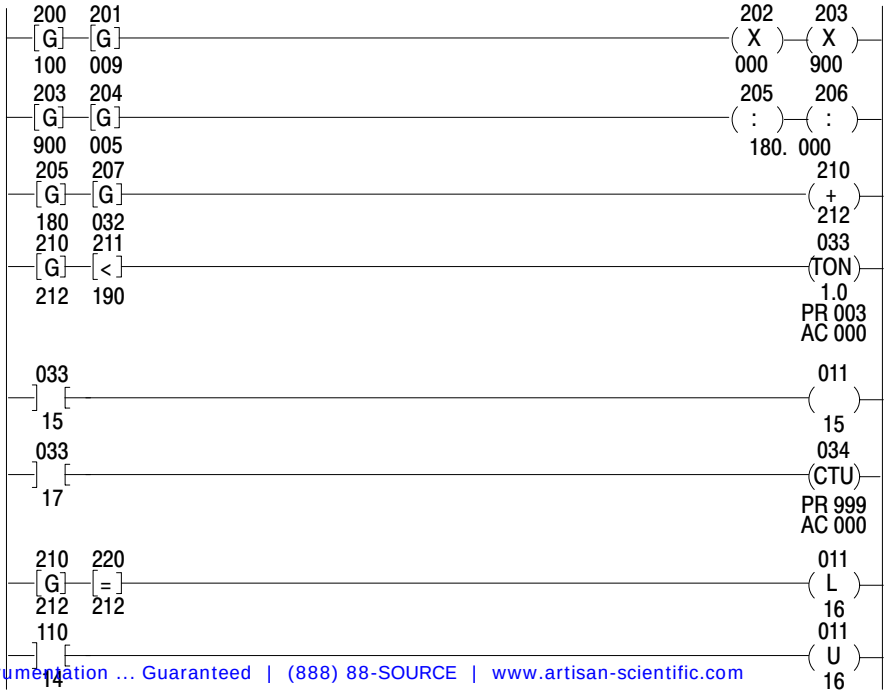
Temperature Conversions

Do not use the following examples to program online production equipment. These examples are for demonstration purposes only.

Application One

This application illustrates the conversion of temperature from degrees Celsius to degrees Fahrenheit (Figure 18.6).

Figure 18.6
Converting Temperature Values



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

Connect a thermocouple to an input module which measures Celsius temperature. A block transfer read transfers the temperature into the processor's data table.

Convert the recorded Celsius temperature in the data table to Fahrenheit values for display (Formula: $^oF = (9/5^oC) + 32$). This temperature must maintain certain range values for your application. You want to:

- monitor the temperature between 87^o to 100^oC
- count the times the value falls below 190^oF
- count the timers the values stay at 212^oF

Here is an explanation of each rung:

Rung 1: The Get instruction at address 200 multiplies the temperature 100^oC by 9 and stores 900 in address 203.

Rung 2: The Get instruction at address 203 divides 5 into 900 and stores the quotient, 180, in address 205.

Rung 3: The Get instruction at address 207 adds 32 to the value 180 which is located at get addresses 205. The sum of 212 is stored at address 210. Thus $100^oC = 212^oF$.

Rung 4: If the displayed temperature is less than 190^oF, the timer initiates timing for three seconds.

Rung 5: If three seconds have elapsed, an output at address 011/15 energizes a heating device that brings the temperature back into the desired range.

Rung 6: Counter 034 counts the number of times the value falls below 190^oF. Therefore, when rung 4 is true the counter increments.

Rung 7: When the temperature equals 212^oF latching 011/16 enables an alarm.

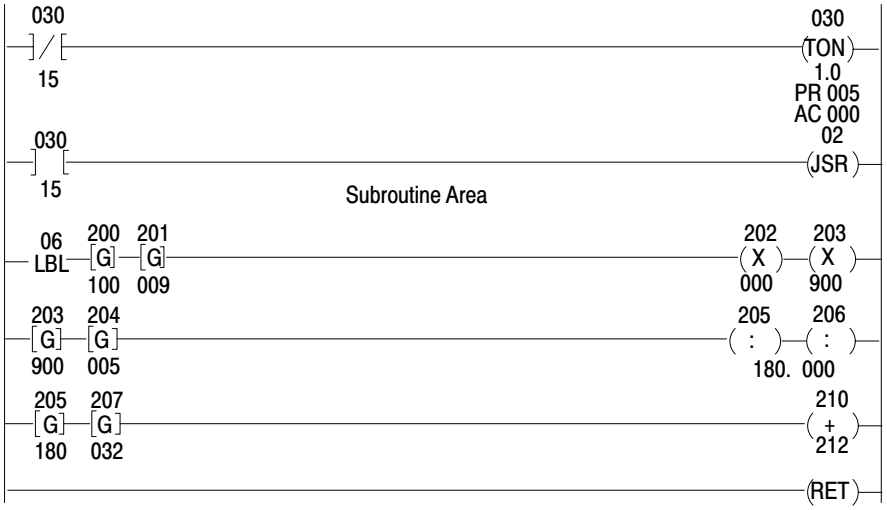
Rung 8: To shut the alarm off, unlatch 011/16. To do this, an operator would press a pushbutton connected to address 011/16.

Application Two

This application is similar to application one, but it only records the converted temperature reading every five seconds (Figure 18.7).

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

Figure 18.7
Recording Temperature Values Every 5 Seconds



Here is an explanation of each rung:

Rung 1: When rung 1 is true, the timer (this is an example of a free running timer) starts timing.

Rung 2: The JSR instruction jumps to the subroutine area label instruction when the timer's accumulated value reaches 5 seconds.

Rungs 3–5: Converts Celsius temperature to Fahrenheit temperature exactly as in application one.

Rung 6: The Return instruction signals the processor to return to the main program area.

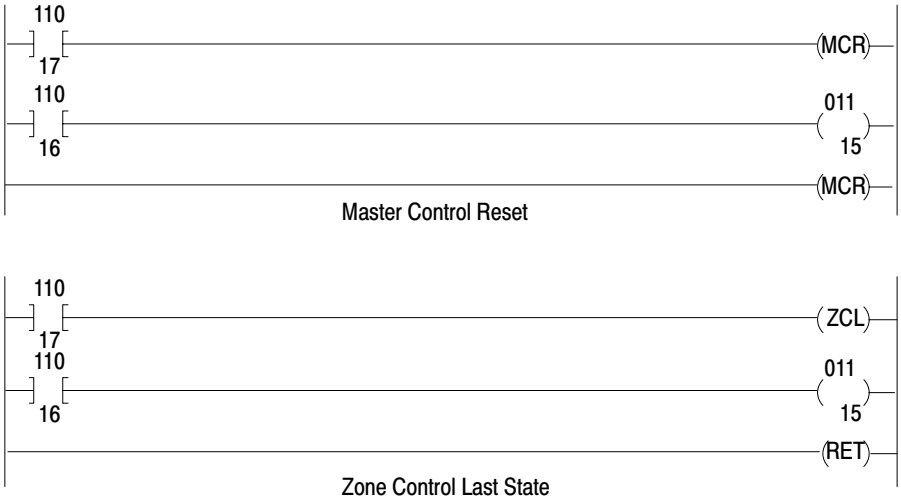
ATTENTION: Make allowances for conditions which could be created by the use of the Jump to Subroutine instruction. Subroutine program rungs are not scanned by the processor unless initiated by the Jump to Subroutine is initiated by the main program. The processor does not scan the subroutine program unless initiated by a Jump to Subroutine in the Main Program. Timers and counters within these rungs cease to function. You should reprogram critical rungs in the main program area.

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

Program Control

This application illustrates the program control instructions, master control reset (MCR) and zone control last state (ZCL) (Figure 18.8).

Figure 18.8
Program Control



Common applications such as varying either packaged size or receipt ingredient use these instructions. For example, packaging a product in two different size of packages or converting a food product to a dietary food product by changing its sugar content.

Before you program these two instructions, think about how you want outputs to react when you change the process or operation.

Using the MCR instruction, rung logic shows:

- If address 110/17 is false, then bit 011/15 is energized if 110/16 is set. This is normal operation.
- If address 110/17 is true, then bit 011/15 is reset regardless of the state of 110/16.

Using the ZCL instruction, rung logic shows:

- If address 110/17 is false, then bit 011/15 is energized if 110/16 is set. This is normal operation.
- If address 11/17 is true, then bit 011/15 if left in its last state regardless of the state 110/16. All outputs within a ZCL zone are left in their last state when the zone is disabled (start fence is false).

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

Bottle Filling Application

This application starts when a bottle is placed on a conveyor, it ends when the bottle is filled and ready for the next sequence of operations. This application is totally automated. This application is only for demonstration purposes. Do not try to program this application using your online production equipment.

Documenting Your Program

Here is a list of tasks for you to practice good documentation habits.

This task:	Is this:
Task 1	Write out the sequence of operation that would explain the production process.
Task 2	Make two lists: one for input devices and one for output devices.
Task 3	Complete the sequence worksheets which are located in this chapter. They are NO TAG and NO TAG. Additional worksheet are available through your local Allen-Bradley distributor or sales engineer.
Task 4	Write out your processor's program using the sequencer instructions.
Task 5	Program your processor. Test out the program then place your worksheets and all related information in a notebook for future reference.

Task 1: Sequence of Operation

1. Four bottles are placed at the beginning of a moving conveyor.
2. The bottles are at station one ready to be filled.
3. Each bottle actuates a photocell indicating that each bottle is present.
4. One fill tube is inserted into each bottle.
5. The file tubes fill each bottle for three seconds.
6. The file tubes are removed from each bottle.
7. A solenoid moves the bottles to the next station.

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

Task 2: Lists Your Devices

Input Devices

The input devices and their abbreviations are:

Input Device	Abbreviation	Comment
Photocell	PC	Bottle in Place
Fill tube extended	LS1	Limit Switch
FIll TUbe retracted	LS2	Limit Switch
Automated	Auto	Type of Operation
Timer	Timer	3 Seconds

Output Devices

The output devices and their abbreviations are:

Output Device	Abbreviation	Comment
Conveyor motor	CM	Initializing motion
Conveyor motion forward	CMF	
Fill tube motor	FTM	
Fill tube forward	FTF	
Fill tube filling	FTS	Fluid starts to flow
Fill tube reverse	FTR	
Solenoid	SOL	Moves the bottles off the conveyor

Task 3: Completing Your Worksheets

Figure 18.9 and Figure 18.10 illustrate completed sequencer worksheets. Notice that the first step of the sequencer output is the last step of your operation. Table 18.A describes each step. To aid you in understanding this documentation concept, read table 18.A while looking at each figure.

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

Figure 18.9
Completed Sequencer Input Worksheet

ALLEN-BRADLEY
Programmable Controller
SEQUENCER TABLE BIT ASSIGNMENTS

PAGE 1 OF 2

PROJECT NAME Bottle Filling Applications PROCESSOR Mini-PLC-2/05

DESIGNER Engineer DATA TABLE ADDR _____ TO _____

SEQUENCER Input

COUNTER ADDR: 200 FILE 400 TO 413 SEQ LENGTH: 006

WORD ADDR: 110 Timer 200

MASK ADDR: 070 071

DEVICE NAME	WORD #1 17–10	WORD #1 07–00	WORD #2 17–10	WORD #2 07–00	WORD #3 17–10	WORD #3 07–00	WORD #4 17–10	WORD #4 07–00
		Auto, LS1, LS2, PC	Timer					
MASK		■ ■ ■ ■	■					
STEP 1		■ ■ ■ ■						
2		■ ■ ■ ■						
3		■ ■ ■ ■						
4		■ ■ ■ ■	■					
5		■ ■ ■ ■						
6		■ ■ ■ ■						
FROM ADDR								
TO ADDR								

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

Note: A filled in box means that each device is actuated.

10145-I

Figure 18.10
Completed Sequencer Output Worksheet

ALLEN-BRADLEY
Programmable Controller
SEQUENCER TABLE BIT ASSIGNMENTS PAGE 1 OF 2

PROJECT NAME Bottle Filling Applications PROCESSOR Mini-PLC-2/05

DESIGNER Engineer DATA TABLE ADDR _____ TO _____

SEQUENCER Input

COUNTER ADDR:	200	FILE 600 TO 613	SEQ LENGTH:	006
WORD ADDR:	012	013		
MASK ADDR:	075	076		

DEVICE NAME	WORD #1 17–10	WORD #1 07–00	WORD #2 17–10	WORD #2 07–00	WORD #3 17–10	WORD #3 07–00	WORD #4 17–10	WORD #4 07–00
		FTS, FTF, SOL, FTR, FTM, CMT, CM	Timer					
MASK		■ ■ ■ ■ ■ ■ ■ ■	■					
STEP 1		■ ■						
STEP 2		■ ■						
STEP 3		■						
STEP 4		■ ■ ■ ■	■					
STEP 5		■ ■ ■ ■						
STEP 6		■ ■ ■ ■						
FROM ADDR								
TO ADDR								

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

Note: A filled in box means that each device is actuated.

10148-I

Table 18.A
Completed Sequencer Steps

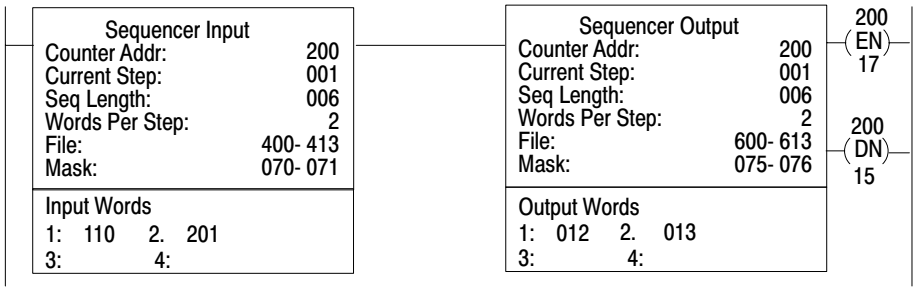
This table outlines sequencer steps.

Sequencer Input Instruction	Sequencer Output Instruction
Step 1 - Automation begins. **NOTE:** This process is fully automated, therefore each block in each step is filled.	**Step 2** - Conveyor motor is started, and the forward motion begins.
Step 2 - A photocell detects a bottle.	**Step 3** - Fill the motor and its forward motion begins. The conveyor motor is on, but not moving forward.
Step 3- The fill tube extension begins closing limit switch 1.	**Step 4** - The fill tube begins filling the bottles, bit 17 of the timer is set.
Step 4 - Bit 15 of the timer is set.	**Step 5** - Filling is completed.
Step 5 - The fill tube retracts closing limit switch 2.	**Step 6** - A solenoid moves the bottles to the next operation; the conveyor moves forward.
Step 6 - The process is left in automation waiting for more bottles	**Step 1** - The conveyor moves forward

Task 4: Processor Instruction Program

Figure 18.11 is an example of a program rung that represents your worksheets.

Figure 18.11
Program Rung Example



Task 5: Programming Your Processor Module

Enter the program written for Task 4.

Chapter Summary

We showed you several programming techniques. The next chapter describes special troubleshooting techniques.

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

Chapter 19

Program Troubleshooting

Chapter Objective

This chapter describes special troubleshooting technique:

- run time errors
- bit monitor/manipulation
- contract histogram
- force functions
- temporary end instruction
- ERR message for an illegal opcode

Run Time Errors

What are Run Time Errors?

Run time errors are errors that occur while the processor executes your program, and are only apparent during this time. These errors result from improper programming techniques. For example, it is possible to program a series of instructions in which the processor cannot properly perform the operation. Or it is possible to program paired instructions, such as a Jump/Label, with improper syntax.

In remote test mode, if a run-time error occurs, your processor module halts program operation. The RUN/FAULT indicator illuminates red. In the run/program mode, you get no indication.

Diagnosing a Run Time Error

The following steps help you diagnose rung time errors:

1. Connect your industrial terminal to the processor.
2. Turn on the industrial terminal and notice the message, RUN-TIME ERROR. If the industrial terminal is already connected, then your ladder diagram is replaced by the display showing the run-time error message.
3. Press 11 to display the instruction that caused the error.
4. Correct the run time error by editing your program

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

Table 19.A
Possible Causes of Run Time Errors

Instruction	Cause
Jump	Jumping from the main program into the subroutine area or vice versa. Jumping backwards. Omitting the label instruction corresponding to the jump instruction. Jumping over a temporary end instruction.
Label	Multiple placement of the same label identification number. Removing a label instruction but leaving its reference, the jump or jump to subroutine instructions.
Jump to subroutine	To begin your main program. To jump forward in your main program. Use in the subroutine area. Omitting a return instruction. Omitting a corresponding label instruction. Jumping over a temporary end instruction.
Return	Processor does not find a return instruction from the subroutine area. Using a return instruction outside the subroutine area.
Files	AC>PR Duplicating counter's address. Manipulating the counter's accumulated value by means of external programming equipment or data highway hardware.
Sequencer	File address is out of range. Preset value equals 0.
Block transfer	Giving the module address a non-existent I/O rack number. Incorrect block length value.

5. Restart your processor.

Bit Monitor/Manipulation

Bit Monitor Function

Bit monitor allows the status of all 16 bits of any data table word to be displayed. It can function when the processor is operating in any mode. By pressing [SEARCH]53<word address>, the status of all 16 bits of the desired word is displayed. While the cursor is in the word address field, you can use the [1] and [0] keys to change address digits.

The status of the 16 bits in the next highest or next lowest word address can be displayed by pressing the [↑] or [↓] keys, respectively. Also, you can use bit monitor to display the status of force conditions.

Bit Manipulation Function

Bit manipulation allows image table bits to be selectively changed. It is useful in setting initial conditions in the data of word instructions. Bit manipulation can function when the processor is operating in the program

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

mode. When in remote test, or run/program, the program can override the bit status in the next scan.

Use the [←] and [→] keys to cursor over to any bit. With the cursor on the desired bit, you can change its status by pressing 1,0.

To terminate this function, press [CANCEL COMMAND].



ATTENTION: If it is necessary to change the status of any data table bit, be sure that the consequences of the change are thoroughly understood. If not, unpredictable machine operation could occur directly or indirectly as a result of changing the bit status. Damage to equipment and/or injury to personnel could result.

Contact Histogram

The contact histogram function displays the on or off history of a specific data table bit. You can monitor this function on the industrial terminal. It can also be printed by a peripheral printer. If you use a peripheral device, set the baud for channel C of the industrial terminal.

Data table bits, excluding those in the processor work areas, can be accessed by the contract histogram command. The on/off status of the bit and the length of time the bit remained on or off (in hours, minutes and seconds) is displayed. The seconds are displayed within 0.01 second (10 ms) resolution.

There are two operating modes for the contact histogram, shown in Table 19.B:

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

Table 19.B
Contact Histogram Functions

Function	Key Sequence	Mode	Description
Continuous contact histogram	[SEARCH][6] (Bit Address) [DISPLAY]	Any	Provides a continuous display of the on/off history of the addressed bit in hours, minutes and seconds. Can obtain a hardcopy printout of contact histogram by connecting a peripheral device to Channel C and selecting proper baud rate before indicated key sequence.
Paged Contact histogram	[SEARCH][7] (Bit Address) [DISPLAY] [DISPLAY]	Any	Displays 11 lines on/off history of the addressed bit in hours, minutes and seconds. Displays the next 11 lines of contact histogram. Can obtain a hard copy printout of contact histogram by connecting peripheral device to Channel C and selecting proper baud rate.
Either	[CANCEL COMMAND]		To terminate.

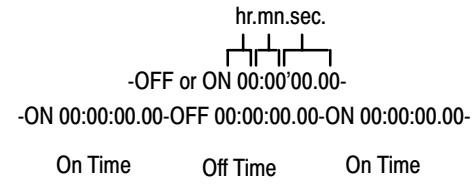
Continuous: Accessed by pressing [SEARCH] 6. The user command displays the histogram from that instant.

Paged: Accessed by pressing [SEARCH]7. The user command displays the histogram one page at a time and requires operator action to continue the histogram once the screen is filled.

After pressing [SEARCH] 6 or [SEARCH] 7, enter the bit address to be monitored. Bit addresses larger than 5 digits do not require leading zeros or the EXPAND ADDR key.

After pressing [DISPLAY], the data of the histogram is displayed on every other line with 5 frames of data per line. Each frame of data contains the on/off status and the length of time in the format shown in Figure 18.1.

Figure 18.1
Contact Histogram Display



If the bit is changing states faster than can be printed or displayed, a buffer stores these changes. If the buffer becomes full, all monitoring stops and a BUFFER FULL message is displayed. Subsequent changes in the on/off status of the device are lost until the histogram function finishes printing

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

out or displaying the data in the buffer. Then a BUFFER RESET message is displayed and the histogram function resumes.

The industrial terminal screen can display up to 11 lines of data at one time. In the continuous mode, the screen automatically displays a new page of data when the screen is full.

In the paged mode, 11 lines fill the screen and the histogram stops. The buffer stores the subsequent changes until you press [DISPLAY] again. One page of data stored in the buffer is displayed.

To terminate the contact histogram, press [CANCEL COMMAND]. Data table words and program words are counted and displayed.

Force Functions

There are two types of force functions:

- force on
- force off

What are Force Functions?

You can use force functions to selectively force an input bit or output on or off. Forcing is used only with real I/O. The processor must be operating in either the remote test or run/program mode.

Force functions determine the on/off status of input and output bits by overriding the I/O scan. You can force an input bit on or off regardless of the actual state of the corresponding input device. However, forcing an output causes the corresponding output device on or off regardless of the rung logic or the actual status of the output image table bit.

When you attempt forcing, the processor I/O scan slows down to do the forcing. When forcing is terminated, the processor automatically switches back to the faster I/O scan mode.

Important: When in remote test mode, the processor holds outputs off regardless of attempts to force them on, even though the output bit instructions are intensified.

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

Using a Force Function

You can apply forcing functions in either of two ways using:

- bit manipulation/monitor display of an I/O word
- ladder diagram display of user program

By pressing [SEARCH] 53 <address>, the bit status and force status of the 16 corresponding input bits or output terminals of the desired word is displayed. use the [<-] and [->] keys to cursor to the desired bit. Or, in the ladder diagram display, you can apply forcing by placing the cursor on an examine or energize instruction. In either case, after you position the cursor, you can use any one of the following key sequences for placing or removing a forced condition:

[FORCE ON][INSERT]
[FORCE OFF][INSERT]
[FORCE ON][REMOVE]
[FORCE OFF][REMOVE]

You can remove all force on or all force off functions at once in ladder diagram display by pressing either of the following key sequences:

[FORCE ON][CLEAR MEMORY]
[FORCE OFF][CLEAR MEMORY]

The on/off status of a forced bit appears beneath the bit instruction in the rung.

In all operating modes, the terminal displays a “FORCED I/O” message near the bottom of the screen when the processor forces the bits on or off. In every mode except the program mode, the terminal displays forced status “ON” or “OFF” below each forced instruction.

Important: The terminal displays the on/off status of Latch/Unlatch instructions below the instruction. However, the terminal displays status only in program mode.

All force functions are cleared when:

- you disconnect the industrial terminal from the processor
- the processor or industrial terminal loses ac power
- you press [MODE SELECT]



ATTENTION: When an energized output is being forced off, keep personnel away from the machine area. Accidental removal of force functions may instantly change the state of the output device. Injury to personnel near the machine could result.

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

Forced Address Display

The industrial terminal displays a complete lists of bit addresses that are forced on or off by pressing:

[SEARCH][FORCE ON]
[SEARCH][FORCE OFF]

If all bits forced on or off cannot be displayed at one time, use the [SHIFT][] and [SHIFT][] keys to display additional forced bits.

Press [CANCEL COMMAND] to terminate this display.

Temporary End Instruction

You can use the temporary end instruction to test or debug a program up to the point where it is inserted. The temporary end instruction acts as a program boundary because instructions below it in user program are not scanned or operated upon. Instead, the processor immediately scans the I/O image table followed by user program from the first instruction to the temporary end instruction.

When you insert the temporary end instruction, the rungs below it, although visible and accessible, are not scanned. You can edit their content, if desired. The displayed section of user program made inactive by the temporary end instruction contains the message “INACTIVE AREA” in the lower right-hand corner of the screen.

Inserting a Temporary End Instruction

Keystrokes: You insert the temporary end instruction in either of two ways:

First Method

1. Cursor to the last rung of the main program to be kept active.

2. Position the cursor on the output instruction.

3. Press [INSERT][T.END]

Second Method

1. Cursor to the first rung of the main program to be made inactive.

2. Position the cursor on the first instruction in the rung.

3. Press [INSERT][ ] [T.END]

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

Removing a Temporary End Instruction

Keystrokes: You remove a temporary end instruction by following steps.

1. Position the cursor on the temporary end instruction you want to remove.
2. Press [REMOVE][T.END]

Entering a Rung After a Temporary End Instruction

Keystrokes: You can enter a rung after the T.END instruction by performing the following steps.

1. Place the cursor on the T.END instruction.
2. Press [INSERT][RUNG].
3. Enter the new rung.

The industrial terminal prevents you from using the temporary end instruction in any of the following ways. These ways result in a rung timer error.

- Using more than one temporary end instruction at a time.
- Using the instruction in the subroutine area.
- Inserting or removing the instruction during on-line programming.
- Placing the instruction in the path of Jump or Jump to Subroutine instructions.

ERR Message for an Illegal Opcode

An illegal opcode is an instruction code that the processor does not recognize. It causes the processor to fault and is displayed as an ERR message in the ladder diagram rung in which it occurs. The 4-digit hex value of the illegal opcode is displayed above the ERR message by the 1770-T3 industrial terminal.

The illegal OP code ERR message should not be confused with ERR messages caused when a 1770-T1 or 1770-T2 industrial terminal is connected to a processor that was using a 1770-T3 industrial terminal. These industrial terminal ERR messages do not contain the 4-digit hexadecimal value and will not cause the processor to fault.

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

If an illegal opcode occurs, compare the rung containing it to the equivalent rung in a hard copy printout of the program. You must either

replace the error with its correct instruction, replace the instruction, or remove it. The ERR message caused by an illegal opcode cannot be removed directly. instead, remove and replace the entire rung. You should identify and correct the cause of the problem in addition to correcting the ERR message.

Chapter Summary

We showed you several special troubleshooting techniques you can use during start-up and processor operation.

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

Appendix A

Number Systems

Objectives

This appendix describes the four numbering systems the Mini-PLC-2/05 processor uses:

- decimal
- octal
- binary
- hexadecimal

These numbering systems differ by their number sets and place values.

Decimal Numbering System

Timers, counters, and math operations word values use the decimal numbering system. This is a numbering system made up of ten digits: the numbers 0 through 9 (Table A.A). All decimal numbers are composed of these digits. The value of a decimal number depends on the digits used and the place value of each digit.

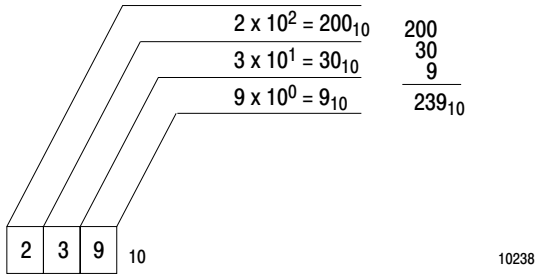
Table A.A
Numbering System Conversion Chart

Hexadecimal	Binary	Decimal	Octal
0	0000	0	000
1	0001	1	001
2	0010	2	002
3	0011	3	003
4	0100	4	004
5	0101	5	005
6	0110	6	006
7	0111	7	007
8	1000	8	010
9	1001	9	011
A	1010	10	012
B	1011	11	013
C	1100	12	014
D	1101	13	015
E	1110	14	016
F	1111	15	017

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

Each place value in a decimal number represents a power of ten starting with ten raised to the zero power (10^0=1) (Figure A.1). You can compute the decimal value of a number by multiplying each digit by its corresponding place value and adding these numbers together.

Figure A.1
Decimal Numbering System

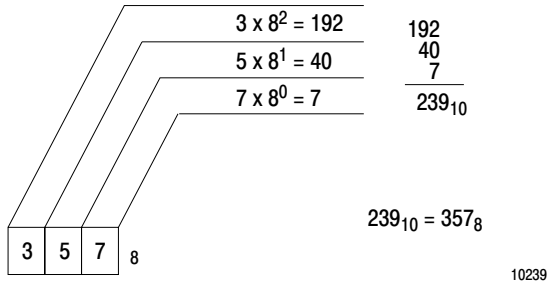


Octal Numbering System

Byte word values use the octal numbering system. This is a numbering system made up eight digits: the numbers 0 through 7 (Table A.A). All octal numbers are composed of these digits. The value of a octal number depends on the digits used and the place value of each digit.

Each place value in an octal number represents a power of eight starting with eight raised to the zero power (8^0=1) (Figure A.2). You can compute the decimal value of an octal number by multiplying each octal digit by its corresponding place value and adding these numbers together.

Figure A.2
Octal Numbering System



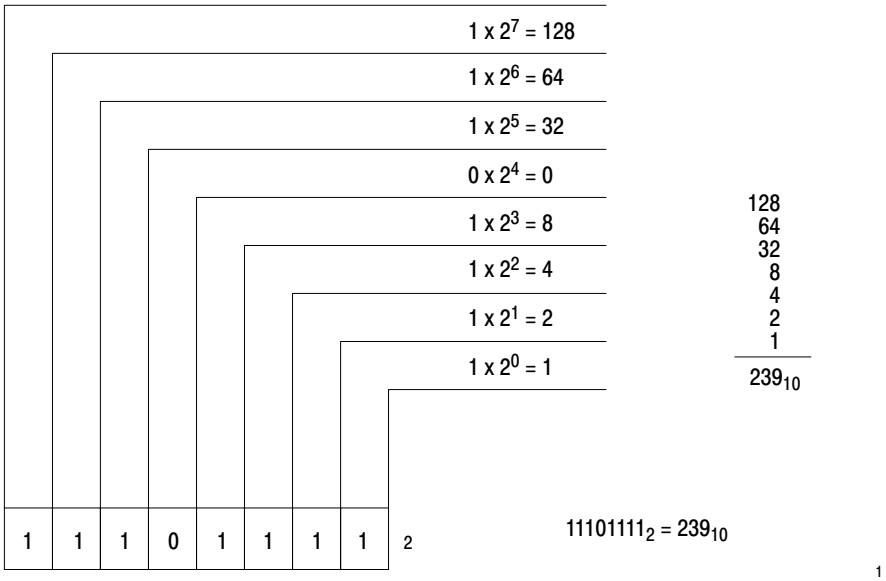
Binary Numbering System

Binary numbering is used in all digital systems to store and manipulate data. This is a numbering system made up of two numbers: 0 and 1 (Table A.A). All binary numbers are composed of these digits. Information in memory is stored as an arrangement of 1 and 0. The value of a binary number depends on the digits used and the place value of each digit.

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

Each place value in a binary number represents a power of two starting with two raised to the zero power (2^0=1) (Figure A.3). You can compute the decimal value of a binary number by multiplying each binary digit by its corresponding place value and adding these numbers together.

Figure A.3
Binary Numbering System



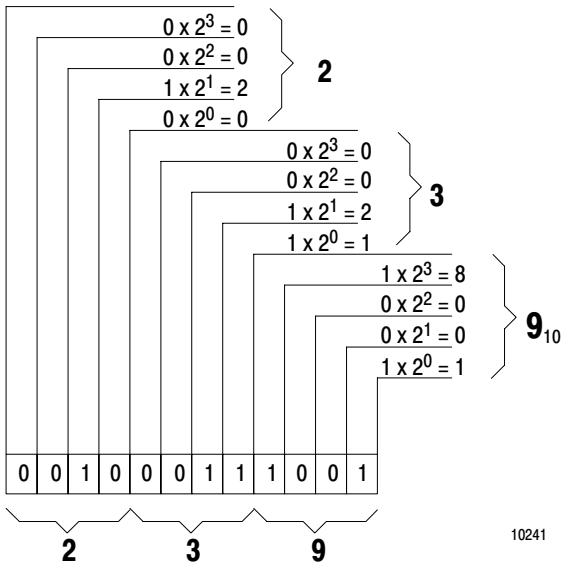
Binary Coded Decimal

Binary coded decimal (BCD) format expresses a decimal value as an arrangement of binary digits. Each group of 4 binary digits is used to represent a decimal number from 0 to 9. All BCD numbers are composed of these digits. The value of BCD number depends on the digits used and the place value of these digits.

Each place value in a BCD number represents a power of two starting with two raised to the zero power (2^0=1) (Figure A.4).

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

Figure A.4
Binary Coded Decimal



You can compute the decimal value of a binary number by multiplying each binary digit by its corresponding place value and adding these numbers together (Table A.B).

Table A.B
BCD Representation

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

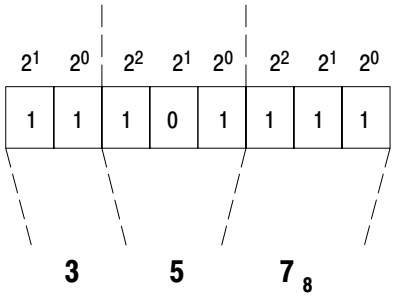
Artisan Scientific - Quality Instrumentation ... Guaranteed | (888) 88-SOURCE | www.artisan-scientific.com

Binary Coded Octal

Binary coded octal (BCO) format expresses an octal value as an arrangement of binary digits (eight bits or one byte). The 8 bits are broken down into three groups: 2 bits, 3 bits and 3 bits. Each group of binary digits is used to represent a decimal number from 0 to 9. All BCO numbers are composed of these digits.

Each place value in a BCD number represents a power of two 1 starting with two raised to the zero power ($2^0 = 1$) (Figure A.5).

Figure A.5
Binary Coded Octal



You can compute the octal number for each group of bits by multiplying the binary digit by its corresponding place value and adding these numbers together (Table A.C).

Table A.C
Octal Representation

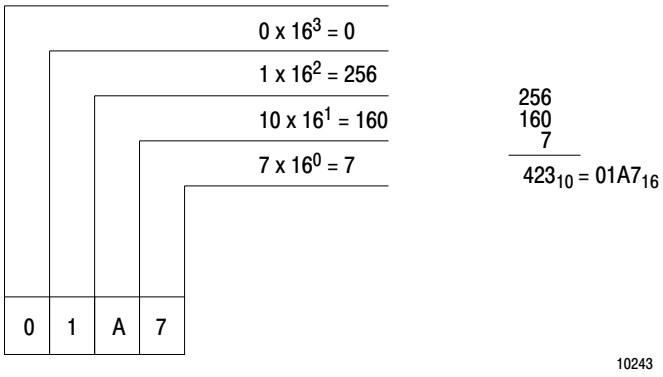
Place Value			Octal Equivalent
2^2 (4)	2^1 (2)	2^0 (1)	
0	0	0	0
0	0	1	1
0	1	0	2
0	1	1	3
1	0	0	4
1	0	1	5
1	1	0	6
1	1	1	7

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

Hexadecimal Numbering System

Get and put word values use the hexadecimal numbering system. This is a numbering system made up of 16 digits: the numbers 0–9 and the letters A–F (Table A.C). The letters A–F represent the decimal numbers 10–15, respectively. Four binary digits represent each hexadecimal character, you can convert between hexadecimal to a binary by writing out the patterns for each hexadecimal character or group of four binary digits (Figure A.6).

Figure A.6
Hexadecimal to Decimal Conversion



Each place value in a hexadecimal character represents a power of 16 starting with 16 raised to the zero power (16^0=1) (Figure A.6). You can compute a decimal number for each group of hexadecimal characters by multiplying the decimal digit equivalent of each hexadecimal character by its corresponding place value and adding these numbers together.

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

Appendix B

Glossary

Introduction

You'll find that each term in this glossary is concisely defined. These definitions will provide you with a basis for understanding Allen-Bradley PCs. In cases where a term may have more than one meaning, we give only those definitions directly related to our products.

When reading this glossary, you'll notice that common electrical terms and symbols are not defined. We assume you have a working knowledge of basic electricity.

This appendix contains defines terms and abbreviations that because of their complexity or recent introduction are not widely understood. These terms are:

AC Input Module
An I/O module that converts various AC signals originating at user devices to the appropriate logic level signal for use within the processor.

AC Output Module
An I/O module that converts the logic level signal of the processor to a usable output signal to control a user AC device.

Adapter Module
A module that provides communication between an I/O chassis and the processor. It transmits I/O chassis input information to and receives output information from the processor.

Address
1) An alphanumeric value that uniquely identifies where data is stored. 2) An alphanumeric value used to identify a specific I/O rack, module group, and terminal.

Algorithm
A set of procedures used for solving a problem in a finite number of steps.

Analog
An expression of values which can vary continuously between specified limits.

Analog Input Module
A module that converts an analog input signal to a number that can be manipulated by the processor.

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

Analog Output Module
A module that outputs a signal proportional to a number transferred to the module from the processor.

Application
1) A machine or process monitored and controlled by a programmable controller. 2) The use of computer-based or processor-based routines for specific purposes.

Arithmetic Capability
The ability to do addition, subtraction, multiplication, division, and other advanced math functions with the programmable controller.

ASCII
American Standards Code for Information Interchange. It is a seven-bit code with an optional parity bit used to represent alphanumerics, punctuation marks, and control code characters.

Asynchronous Scanning
A scanning technique performed by the CPU where two scanners (I/O and user program) operate independently of each other.

Backplane
A printed circuit board, located in the back of a chassis, that contains a data bus, power bus, and connectors for modules to be inserted in the chassis.

Backup
A device or system that is kept available to replace something that may fail in operation. Also see Hot Backup.

Battery Backup
A battery or set of batteries that provide power to processor memory only in case of a system power outage.

Battery Low
A condition that exists when the backup battery voltage drops low enough to require battery replacement. Generally, an indicator or status bit signals this condition.

Baud
A unit of signaling speed equal to the number of discrete conditions or signal events per second.

BCD
See Binary Coded Decimal.

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

Binary
A numbering system using only the digits 0 and 1. Also called base 2.

Binary Coded Decimal (BCD)
A numbering system used to express individual decimal digits (0 through 9) in four-bit binary notation.

Binary Word
A related group of ones and zeros that has meaning assigned by position, or by numerical value in the binary system of numbers.

Bit
Binary digit. The smallest unit of information in the binary numbering system. Represented by the digits 0 and 1. The smallest division of a programmable controller word.

Bit Manipulation
The process of controlling data table bits (on or off) through user instructions or keyboard entry.

Bit Rate
See Baud.

Bit Storage
A user-defined data table area in which bits can be set or reset without directly affecting or controlling output devices. However, any storage bit can be monitored as necessary in the user program.

Block
A group of words transmitted as a unit.

Block Length
The total number of words transferred at one time.

Block Transfer
A programming technique used to transfer up to 64 words of data to, or from, an intelligent I/O module.

Branch
A parallel logic path with a rung.

Buffer
1) In software terms, a register or group or registers used for temporary storage of data, to compensate for transmission rate differences between the transmitter and receiving device. 2) In hardware terms, an isolating circuit used to avoid the reaction of one circuit with another.

Build
A programming concept that takes a user keyboard command (source code) and converts it into hexadecimal format to generate an object code for program execution.

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

Bus
1) One or more conductors considered as a single entity that interconnect various parts of a system. Example: a data bus or address bus. 2) An electrical channel used to send or receive data.

Byte
Equals eight consecutive bits.

Cascading
A programming technique that extends the ranges of timer and/or counter instructions beyond the maximum values that may be accumulated in a single instruction.

Central Processing Unit (CPU)
The circuits in a programmable controller that control the interpretation and execution of the user program stored in programmable controller memory.

Character
One symbol of a set of symbols which normally include alpha codes, numeric codes, punctuation marks, and other symbols which may be read, stored, or written.

Chassis
A hardware assembly used to house devices such as I/O modules, adapter modules, processor modules, and power supplies.

Checksum
A character placed at the end of a data block which corresponds to the binary sum of all characters in that block. A technique used for error detection.

Clear
To return memory to a non-programmed state; erased.

Clock
1) A pulse generator which synchronizes the timing of various logic circuits. 2) Circuitry used to measure time.

CMOS
Complementary Metal Oxide Semiconductor circuitry. See MOS.

Command
A function initiated by a user action

Communication Rate
See Baud.

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

Contact Histogram
A feature which allows a display (or printout) of the on and off times for any selected data table bit.

Control
1) A unit, such as a programmable controller or relay panel, which operates an industrial application. 2) To cause a machine or process to function in a predetermined manner. 3) To energize or de-energize a processor output, or to set a data table bit to on or reset it to off, by means of the user program.

Control Panel
1) A panel which may contain instruments or pushbutton switches. 2) In the Advisor system, a device which allows an operator to access and control plant operations through manipulation of the processor data table.

CPU
See Central Processing Unit

CTR Terminal
A terminal containing a cathode ray tube that displays user programs and information.

Cursor
1) The intensified or blinking element in the user program or file display. 2) A means for indicating on a CRT screen where data entry or editing occurs.

Cursored Rung
The rung containing a cursor.

Data
A general term for any type of information.

Data Address
A location in memory where data can be stored.

Data Files
Groups of data values stored in the data table. These files are manipulated by the user program as required by the application.

Data Table
The part of processor memory that contains I/O values and files where data is monitored, manipulated, and changed for control purposes.

Data Terminal
1) A device used only to send or receive data. 2) A peripheral device which can load, monitor, or dump processor memory data, including the data table or data files. This also includes CRT devices and line printers.

Data Transmission Rate
See Baud.

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

Debugging
The process of detecting locating, and correcting errors in hardware or software.

Decimal
Pertains to the base-10 numbering system.

Delimiter
A character that, when placed before and/or after a string of data, causes the data to be interrupted in a predetermined manner.

Diagnostics
Pertains to the detection and isolation of an error or malfunction.

Digital
Information presented in a discrete number of codes.

Display
The image which appears on a CRT screen or on other image projection systems.

Display Number
The number used to identify a display to be selected from the list in the display menu.

Display Menu
The list of displays from which the user selects specific information for viewing.

Documentation
An orderly collection of recorded hardware and software data such as tables, listings, and diagrams to provide reference information for processor application operation and maintenance.

Dump
To generate a copy of all or part of the processor memory contents through a data terminal**.**

EEPROM
Electrically Erasable PROM. A type of PROM that is programmed and erased by electrical pulses.

Edit
To deliberately modify a program.

Element
A display of a program instruction.

Enable
The ability to respond to program instructions.

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

Encoder
1) A rotary device which transmits position information.

2) A device which transmits a fixed number of pulses for each revolution.

ERR
See Error Message.

Error Message (ERR)
The response to an opcode the industrial terminal cannot interpret.

Execution
The performance of a specific operation that is accomplished through processing one instruction, a series of instructions, or a complete program.

Execution Time
The total time required for the execution of one specific operation.

False
Any malfunction which interferes with normal application operation.

Fault Zone
An area in the program which alters the operation portion of the application if a rack fault occurs. Each fault zone is delimited by fence codes.

Fence Codes
Special program instructions which control and delimit specific program areas such as fault zones.

File
1) One or more data table words used to store related data. See File Organization. 2) A collection of related records treated as a unit. The records are organized or ordered on the basis of some common factor called a key. Records may be fixed or vary in length and can be stored in different devices and storage media.

File Address
The data table address of a file that determines to where, or from where, data will be transferred or moved.

File Creation
Establishing or writing records for a file into some storage device to provide later access by the processor or operator.

File Maintenance
1) Adding, deleting, or changing the contents of records in a file.
2) Reorganizing the structure of a file to improve access to records or to change the storage space required.

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

File Management
1) A term that defines the functions of creation, insertion, deletion, or updating of stored files and records in files. 2) The operations that are performed on files.

File Name
A means of identifying a file on a disk.

File Organization
method of ordering data records stored as a file, while also providing a way to access stored records.

Flag Bit
A processor memory bit, controlled through firmware or a user program, used to signify a certain condition. Example: battery low.

Floating Point
A data manipulation format used to locate the point by expressing the power of the base, and which involves the use of two sets of digits. For example, for a floating decimal notation, the base is 10, so the number 8,700,000 would be expressed as 8.7(1)^.

Force Off Function
A feature which allows the user to reset an input image table bit or de- energize an output, independent of the processor program.

Force On Function
A feature which allows the user to set an image table bit or energize an output, independent of the processor program.

Hardware
The mechanical, electrical, and electronic devices that make up a programmable controller and its application.

Header
A portion of a protocol data unit that contains protocol control information and precedes user data, if present.

Hexadecimal Numbering System
A base 16 numbering system that uses the symbols 0,1,2,3,4,5,6,7,8,9, and A,B,C,D,E,F.

High = True
A signal type where the higher of two voltages indicates a logic state of on (1). See Low = True.

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

Hot Backup
A standby processor in a programmable controller system. It consists of a primary and backup processor. If the primary processor fails, the backup processor takes over processor operations.

Image Table
An area in processor memory dedicated to I/O data. Ones and zeros (1 and 0) represent on and off conditions, respectively. During every I/O scan, each input controls a bit in the input image table; each output is controlled by a bit in the output image table.

Input
Information transmitted from a peripheral device to the input module, and then to the data table.

Input Devices
Devices such as limit switches, pressure switches, push buttons, analog and/or digital devices, that supply data to a programmable controller.

Instruction
A command that causes a programmable controller to perform one specific operation. The user enters a combination of instructions into memory to form a unique application program.

Integer
Any positive or negative whole number or zero.

Intelligent I/O Module
Microprocessor-based modules that perform processing or sophisticated closed-loop, application functions.

Intelligent Terminal
A terminal that has some internal processing capability for manipulating data.

Interface
The boundary (shared) between two systems.

I/O
Input/Output.

I/O Channel
A data transmission link between a processor scanner module and an I/O adapter module.

I/O Chassis
See chassis.

I/O Module
A device that interfaces between the user devices and the processor.

I/O Rack
See rack.

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

I/O Scan Time
The time required for the processor to monitor inputs and control outputs.

I/O Terminal
A terminal on the I/O module. One I/O terminal has a corresponding bit address in the data table.

Isolated I/O Module
A module which has each input or output electrically isolated from every other input or output on that module.

K
10=lK=1024. used to denote size of memory and can be expressed in bits, bytes, or words. Example: 2K = 2048.

k
Kilo, A prefix used with units of measurement to designate quantities a 100 times as great.

Keying
keying bands installed on backplane connectors to ensure that only one type of module can be inserted into a keyed connector.

Ladder Diagram
An industry standard for representing control systems.

Ladder Diagram Programming
A method of writing a user program in a format similar to a relay ladder diagram.

Language
A set of symbols and rules used for representing a communicating information.

Latching Relay
A relay that maintains a given position by mechanical or electrical means until released mechanically or electrically.

Leading Edge One-Shot
A programming technique that sets a bit for one scan when its input condition has made a false-to-true transition. The false-to-true transition represents the leading edge of the input pulse.

Least Significant Bit (LSB)
The bit that represents the smallest value in a nibble, byte, or word.

Least Significant Digit (LSD)
the bit that represents the smallest value in a byte or word.

LED
Light-Emitting Diode.

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

LED Display
An illuminated visual readout composed of alphanumeric character segments.

Limit Switch
An electrical switch actuated by some part and/or motion of a machine or equipment.

Line
1) A component part of a system used to link various subsystems located remotely from the processor. 2) The source of power for operation. Example: 120V AC line.

Load
1) The power used by a machine or apparatus. 2) To place data into an internal register under program control. 3) To place a program from an external storage device into central memory under operator control.

Local I/O Processor
A processor where I/O distance is physically limited and must be located near the processor. However, it may still be mounted in a separate enclosure. See Remote I/O Processor.

Location
A storage position in memory. Uniquely specified in Allen-Bradley processors by a 5-, 6-, 7-, 8-, or 9-digit address.

Logic
A systematic means of solving complex problems through the repeated use of the AND, OR, NOT functions (they can be either true or false). Often represented by ladder diagrams.

Logic Diagram
A diagram which represents the logic elements and their interconnections.

Logic Level
The voltage magnitude associated with signal pulses representing ones and zeros (1 and 0) in binary computation.

Loop
A sequence of instructions which is executed repeatedly until a terminating condition is satisfied.

Low = True
A signal type where the lower of two voltages indicates a logic state of on (1). See High = True.

Lower Nibble
The four least significant bits of a byte.

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

LSB
See Least Significant Bit.

LSD
See Least Significant Digit.

Malfunction
Any incorrect function within electronic, electrical, or mechanical hardware. See Fault.

Manipulation
The process of controlling and monitoring data table bits, bytes, or words by means of the user program to vary application functions.

Masking
A means of selectively screening out data. It allows unused bits in a specific instruction to be used independently.

Master
A device used to control secondary devices.

Master Control Relay (MCR)
A mandatory hardwired relay that can be de-energized by any series-connected emergency stop switch. Whenever the master control relay is de-energized, its contacts open to de-energize all application I/O devices.

Master Control Reset (MCR)
See MCR Zones

Master File
A file of data containing the history or current status of a factor or entity of interest to an organization. A master file must be updated periodically to maintain its usefulness.

MCR Zones
User program areas where all non-retentive outputs can be turned off simultaneously. Each MCR zone must be delimited and controlled by MCR fence codes (MCR instructions).

Memory
A group of circuit elements that can store data.

Memory Map
A diagram showing a system's memory addresses and what programs and data are assigned to each section of memory.

MOS
Metal Oxide Semiconductor. A semiconductor device in which an electric field controls the conductance of a channel under a metal electrode called a gate.

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

Mode
A selected method of operation. Example: run/program, remote test, or remote program.

Module
An interchangeable, plug-in item containing electronic components.

Module Addressing
A method of identifying the I/O modules installed in a chassis.

Module Group
Adjacent I/o modules which relate 16-I/O terminals to a single 16-bit image table word.

Module Slot
A location for installing an I/O module.

Monitor
1) A CRT display. 2) To observe an operation.

Monitoring Controller
Used in an application where the process is continually checked to alert the operator of possible application malfunctions.

Most Significant Bit (MSB)
The bit representing the greatest value of a nibble, byte, or word.

Most Significant Digit (MSD)
The digit representing the greatest value of a byte or word.

Motor Controller
A device or group of devices that serve to govern, in a predetermined manner, the electrical power delivered to a motor.

Motor Starter
See Motor Controller.

MSB
See Most Significant Bit.

MSD
See Most Significant Digit.

Multiple-Rung Display
A feature that allows a number of rungs of program logic to be displayed simultaneously on the industrial terminal.

Noise
Unwanted disturbances imposed upon a signal that tend to obscure its data content.

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

Noise Immunity
The ability to function in the presence of noise.

Noise Spike
A noise disturbance of relatively short duration.

Non-Retentive Output
An output which is continuously controlled by a program rung. Whenever the rung changes state (true or false), the output turns on or off. Contrasted with a retentive output which remains in its last state (on or off) depending on which of its two rungs, latch or unlatch, was last true.

Nonvolatile Memory
A memory that is designed to retain its data while its power supply is turned off.

Octal Numbering System
A numbering system that uses only the digits 0 through 7. Also called base 8.

OffLine
Equipment or devices that are not connected to, or do not directly communicate with, the central processing unit.

OnLine
Equipment or devices which communicate with the device it is connected to.

OnLine Data Change
Allows the user to change various data table values using a peripheral device while the application is operating normally.

OnLine Editing
Allows the user to modify a program using a peripheral device while the application is operating normally.

OnLine Operation
Operations where the programmable controller is directly controlling a machine or process.

One-Shot
A programming technique which sets a storage bit or output for only one program scan. See Leading Edge One-Shot and Trailing Edge One-Shot.

Operating System
A software system that controls the operation of a processor system by providing for input/output, allocation of memory space, or translation of programs.

Output
Information transferred from processor image table words through output modules to control output devices.

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

Output Devices
Devices such as solenoids and motor starters that receive data from the programmable controller.

Parallel Operation
A type of information transfer where all bits, bytes, or words are handled simultaneously.

Parallel Output
Simultaneous availability of two or more bits, channels, or digits.

Parallel Transmission
The simultaneous transmission of bits which constitute a character.

Peripheral Equipment
Units which communicate with the programmable controller, but are not part of the programmable controller. Example: a programming device or computer.

PR
See Preset Value.

Preset Value (PR)
The number of time intervals or events to be counted.

Primary Processor
A PC that controls all the I/O, but has a backup processor to take over system operation in case it fails.

Process
1) Continuous and regular production executed in a definite uninterrupted manner. 2) One or more entities threaded together to perform a requested service.

Processor
The decision making data and storage sections of a programmable controller.

Program
A set of instructions used to control a machine or process.

Program Scan Time
The time required for the processor to execute the instructions in the program. The program scan time may vary depending on the instructions and each instruction's status during the scan.

Program Storage
The portion of memory reserved for saving programs, routines, and subroutines.

Programmable Controller
A solid-state control system which has a user-programmable memory for storage of instructions to implement specific functions such as I/O control, logic, timing, counting, report generation, Data Highway communication, arithmetic, data and file manipulation. A programmable controller consists of a central processor, input/output interface, and memory. A programmable controller is designed as an industrial control system.

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

PROM
Programmable Read Only memory. A type of ROM that requires an electrical operation to store data. In use, bits, or words are read on demand but not changed.

Rack
An I/O addressing unit that corresponds to 8 input image table words and 8 output image table words.

Rack Fault
1) A red diagnostic indicator that lights to signal a loss of communication between the processor and any remote I/O chassis. 2) The condition which is based on the loss of communication.

RAM
Random Access Memory. The type of memory in which data access is independent of the data most recently accessed.

Red
1) To acquire data from a storage device. 2) The transfer of data between devices such as a peripheral device and a computer.

Read/Write Memory
A memory where data can be stored (write mode) or accessed (read mode). The write mode replaces previously stored data with current data; the read mode does not alter stored data.

Record
1) A group of data that is stored together and/or used together in processing. 2) A collection of related data treated as a unit. See File.

Register
A memory word or area used for temporary storage of data used with mathematical, logical, or transferal functions.

Relay Logic
A representation of the program or other logic in a form normally used for relays.

Remote I/O processor
A processor system where some of all of the I/O racks are remotely mounted from the processor. The location of remote I/O racks from the processor may vary depending on the application and the processor used. Also see Local I/O Processor.

Remote Mode Selection
A feature which allows the user to select or change processor modes of operation with a peripheral device from a remote location.

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

Remote Programming
A method of performing programming by connecting the programming device to the network rather than to the processor.

Report Generation
The printing or displaying of user-formatted application data by means of a data terminal. Report generation can be initiated by means of either a user program or a data terminal keyboard.

Routine
A sequence of instructions which monitors and controls a specific application function.

Rung
A group of instructions that controls an output or storage bit, or performs other controls functions such as file moves, arithmetic and/or sequencer instructions. This is represented as one section of a logic ladder diagram.

SBR
See Subroutine Area.

Scan Time
See Program Scan Time and I/O Scan Time

Screen
The viewing surface of a CRT where data is displayed.

Scrolling
The vertical movement of data on a CRT display caused by the dropping of one line of displayed data for each new line added.

Search Function
Allows the user to quickly display any instruction in the programmable controller program.

Self-Diagnostic
The hardware and firmware within a controller that monitors its own operation and indicates any fault which it can detect.

Serial Operation
A type of information transfer where the bits are handled sequentially. Contrasted with Parallel Operation.

Signal
The event or electrical quantity that conveys information from one point to another.

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

Signaling Rate
A measure of signaling speed equal to the number of discrete conditions or signal events per second. See Baud.

State
The logic 0 or 1 condition in processor memory or at a circuit input or output.

Station
Any programmable controller, computer, or data terminal connected to, and communicating by means of, a data highway.

Storage
See Memory.

Storage Bit
A bit in a data table word which can be set or reset, but is not associated with a physical I/O terminal point.

Subroutine
A program segment in the ladder diagram that performs a specific task and is available for use.

Subroutine Area (SBR)
A portion of memory where subroutines are stored.

Syntax
Rules governing the structure of a language.

System
A set of one or more programmable controllers, I/O devices and modules, computers, the associated software, peripherals, terminals, and communication networks, that together, provide a means of performing information processing for controlling machines or processes.

Tasks
A set of instructions, data, and control information capable of being executed by a CPU to accomplish a specific purpose.

Terminal Address
A 5-, 6-, 7-, 8-, or 9-digit number which identifies a single I/O terminal. It is also related directly to a specific image table bit address.

Trailing Edge One-Shot
A programming technique that sets a bit for scan when its input condition has made a true-to-false transition. The true-to-false transition represents the trailing edge of the input pulse.

True
As related to processor instructions, an enabled logic state.

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

Underflow Bit
A bit that is set to indicate the result of an operation which is less than the minimum value that can be contained in a register.

Upload/Download
Commonly refers to the reading/writing of programs and data tables from or into processor memory. The commands to do these processes come from some supervisory device.

Upper Nibble
The four most significant bits of a byte.

Variable
A factor which can be altered, measured, or controlled.

Variable Data
Numerical information which can be changed during application operation. It includes timer and counter accumulated values, thumbwheel settings, and arithmetic results.

Volatile Memory
A memory that loses its information if the power is removed.

Watchdog Timer

A timer that monitors logic circuits controlling the processor. If the watchdog timer is not reset in its programmed time period, it will cause the processor to fault.

Word
A grouping or a number of bits in a sequence that is treated as a unit.

Word Length
A number of bits in a word. In a processor, these are generally only data bits. One processor word equals 16 data bits.

Word Storage
An unused data table word which may be used to store data without directly controlling an output. Any storage word may be monitored as often as necessary by the user program.

Work Area
A portion of the data table reserved for specific processor functions.

Write
1) The process of loading information into memory. 2) Block Transfer; a transfer of data from the processor data table to an intelligent I/O module.

ZCL Instructions
A user-programmed fence for ZCL zones.

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

ZCL Zones
Assigned program areas which may control the same outputs through separate rungs, at different times. Each ZCL zone is bound and controlled by ZCL

instructions. If all ZCL zones are disabled, the outputs would remain in their most recent controlled state.

Zone Control Last State (ZCL)
See ZCL Zones.

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

Appendix C

Quick Reference

Data Table Configuration C-2
Data Table Size C-2
Data Table Organization, Factory Configured Data Table C-33
Approximate Execution Time Per Scan C-4
Relay Type Instructions C-6
Program Control Instructions C-7
Timer Instructions C-8
Counter Instructions C-9
Data Manipulation Instructions C-10
Arithmetic Instructions C-11
File Instructions C-12
Sequencer Instructions C-13
Jump/Subroutine Instructions C-14
Block Transfer Instructions C-15
Editing Functions C-16
Search Functions C-17
Clear Memory Functions C-18
Help Directories C-19
Report Generation Commands C-20
Address Delimiters C-21
Alpha/Graphic Key Definitions C-22
Industrial Terminal Control Codes C-23
Contact Histogram Functions C-24
Troubleshooting Aids C-25

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

Table C.A
Data Table Configuration

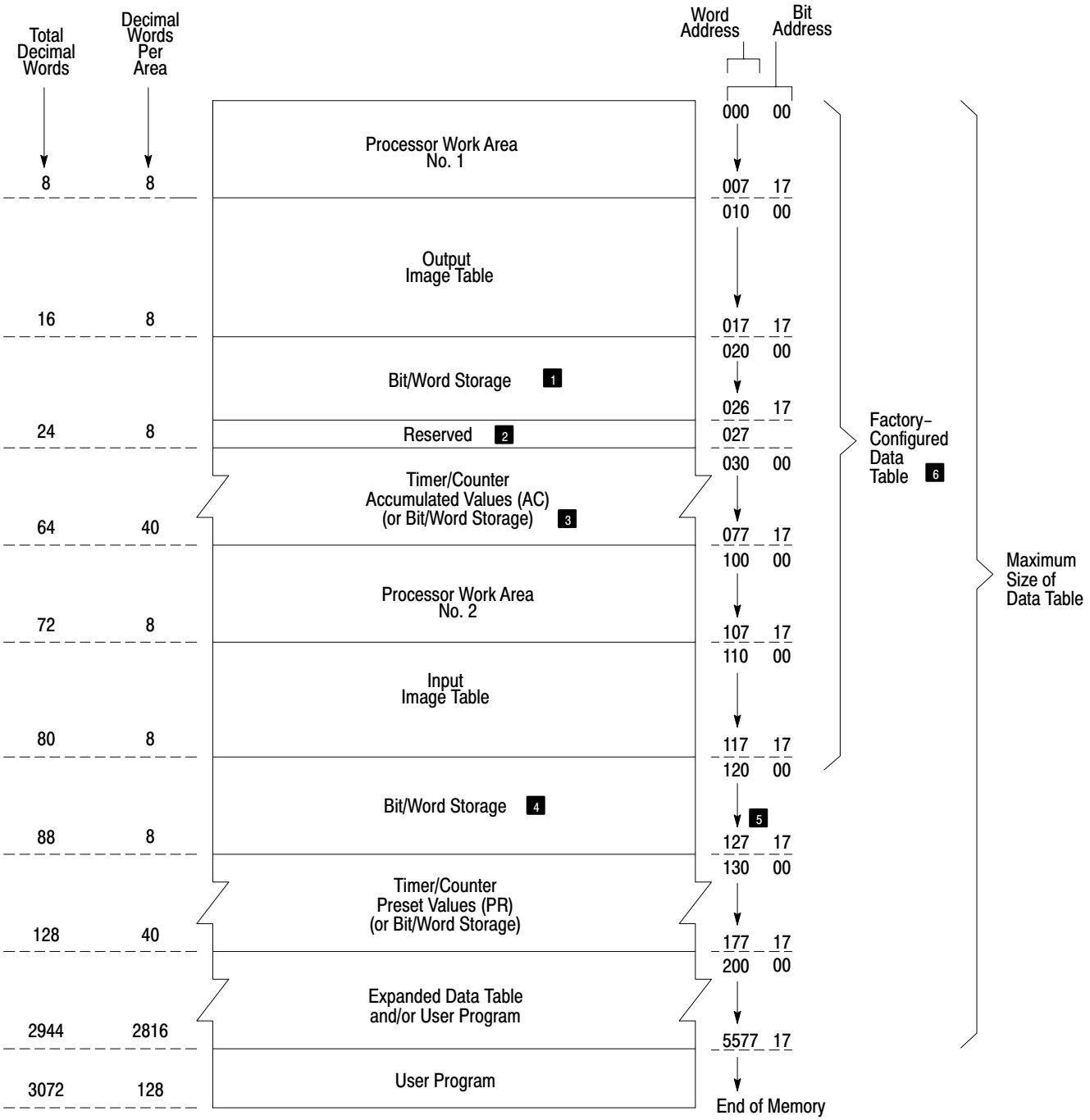
Function	Key Sequence	Mode	Description
Data table configuration	[SEARCH] [5][0] [Numbers]	Program	If the number of 128–word sections is 1 or 2, enter this number, and the number of timers/counters. If the number of 128–word sections is 3 or greater, enter only this number. The industrial terminal will calculate and display the data table size in decimal.
Processor memory layout	[SEARCH] [5][4]	Any	Displays the number of words in the data table area, user program area, message area and unused memory.
Either	[CANCEL COMMAND]		To terminate.

Table C.B
Data Table Size

Enter	Data Table Size
01	128
02	256
03	384
04	512
05	640
06	768
07	896
08	1024
09	1152
10	1280
11	1408
12	1536
13	1664
14	1792
15	1920
16	2048
17	2176
18	2304
19	2432
20	2560
21	2688
22	2816
23	2944

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

Table C.C
Data Table Organization, Factory Configured Data Table



1 May not be used for accumulated values.
2 Not available for bit/word storage. Bits in this word are used by the processor.
3 Unused timer/counter memory words can reduce data table size and increase user program area.
4 May not be used for preset values.
5 Do not use word 127 for block transfer data storage.
6 Can be decreased to 48 words.

10663-I

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

Table C.D
Approximate Execution Time Per Scan
(in average microseconds)

Instruction Name	Symbol	Instruction True	Instruction False
Examine on, Examine off	–| |–.–| / |–	14	11
Output energize	–( )–	16	16
Output latch	–(L)–	17	13
Output unlatch	–(U)–	17	13
Get	–[G]–	28	–
Put	–(PUT)–	26	14
Equal	–(=)–	23	11
Less than	–(<)–	25	13
Get byte	–|B|–	16	–
Limit test	–|L|–	24	11
Counter reset	–(CTR)–	20	14
Retentive timer reset	–(RTR)–	20	14
Timer on-delay	–(TON)–	75	47
Retentive timer on-delay	–(RTO)–	78	48
Timer off-delay	–(TOF)–	82	60
Up counter	–(CTU)–	70	55
Down counter	–(CTD)–	75	60
3 Digit Math			
Add	–(+)–	48	15
Subtract	–(–)–	80	19
Multiply	–(x)–(x)–	615	60
Divide	–(÷)–(÷)–	875	60
Expanded Math			
Add	EAF 01	350–500	
Subtract	EAF 02	350–500	
Multiply	EAF 03	450–2250	
Divide	EAF 04	400–3100	
Square root	EAF 05	1850	
BCD to binary	EAF 13	150–350	
Binary to BCD	EAF 14	250	
Add to any of the above when its address is 400_8 or greater		27	27

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

Instruction Name	Symbol	Instruction True	Instruction False
Master control	–(MCR)–	16	16
Zone control last state [1]	–(ZCL)–	22 (no skip)	20+ (13 per word skipped)
Branch start		16	16
Branch end		18	18
End, temporary end	T.END	27	27
Subroutine Area	SBR	27	27
Immediate input update	–[I]–	45 (with forcing on 55)	–
Immediate output update	–[IOT]–	70 (with forcing on 80)	17
Label	LBL	34	–
Return	–(RET)–	30	15
Jump to subroutine	–(JSR)–	100	15
Jump	–(JMP)–	55	15
Block transfer read	BLOCK X–FER 1	80	75
Block transfer write	BLOCK X–FER 0	80	75
Sequencer load	SEQ 2	390 (80/extra word)	105
Sequencer input	SEQ 1	420 (90/extra word)	55
Sequencer output	SEQ 0	470 (90/extra word)	110
File-to-word move	FILE 12	250	45
Word-to-file move	FILE 11	250	45
File-to-file move	FILE 10440 (+10/word transferred)	200	

[1] When a rung which contains a ZCL instruction is false, the execution time of each instruction between the start fence and end fence is 17 microseconds per word.

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

Table C.E
Relay Type Instructions

NOTE: You can assign input and output addresses, XXXXX, to any location in the data table, excluding the processor work areas. The word address is displayed above the instruction and the bit number below it To enter a bit address larger than 5 digits, press [EXPAND ADDR] after the instruction key and then enter the bit address. Use a leading zero if necessary.

Key Symbol	Instruction Name	1770–T3 Display	Rung Conditions
–| |–	Examine On	XXX –| |– XX	When the addressed memory bit is on, the instruction is true.
–| / |–	Examine Off	XXX –| / |– XX	When the addressed memory bit is off, the instruction is true.
–( )–	Energize	XXX –( )– XX	When the rung is true, the addressed memory bit is set. [1] If the bit controls an output device, that output device will be on.
–(L)–	Output Latch	XXX –(L)– ON XX or OFF	When the rung is true, the addressed memory bit is latched on and remains on until it is unlatched. [1] The output latch instruction is initially off when entered, as indicated below the instruction. It can be preset on by pressing a after entering the bit address. An on will then be indicated below the instruction in program mode. An unlatch instruction will always override a latch instruction, even if the latch rung is true.
–(U)–	Output Unlatch	XXX –(U)– ON XX or OFF	When the rung is true, the addressed bit is unlatched. [1] If the bit controls an output device, that device is de-energized. On or off will appear below the instruction indicating the status of the bit in Program mode only.
	Branch Start		This instruction begins a parallel logic path and is entered at the beginning of each parallel path.
	Branch End		This instruction ends two or more parallel logic paths and is used with branch start instructions.

[1] These instructions should not be assigned input image table addresses because input image table words are reset each I/O scan.

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

Table C.F
Program Control Instructions

NOTE: The MCR and ZCL boundary instructions have no word address.

The word addresses, XXX, of the immediate input and output instructions are limited to the input and output image tables respectively.

Displayed word addresses will be 3 or 4 digits long, depending on data table size. When entering the word address, use a leading zero if necessary.

Key Symbol	Instruction Name	1770–T3 Display	Explanation and Rung Conditions
–(MCR)–	Master Control Reset	–(MCR)–	Two MCR instructions are required to control a group of outputs. The first MCR instruction is programmed with input conditions to begin the zone. The second MCR instruction is programmed unconditionally to end the zone. When the MCR rung is true, each rung condition controls their output instruction. When the first MCR rung is false, all non–retentive bits in the zone are reset. **WARNING**: Do not overlap MCR zones, or nest with ZCL zones. Do not jump to a label in MCR zones.
–(ZCL)–	Zone Control Last State	–(ZCL)–	Two ZCL instructions are required to control a group of outputs. The first ZCL instruction is programmed with input conditions to begin the zone. The second ZCL instruction is programmed unconditionally to end the zone. When the ZCL rung is true, all output instructions within the zone act according to the logic conditions preceding them. When the first ZCL rung is false, outputs in the zone will remain in their last state. **WARNING:** Do not overlap ZCL zones, or nest with MCR zones. Do not jump to a label in ZCL zones.
–[I]–	Immediate Input	XXX –[I]–	Processor interrupts program scan to update input image table with data from the corresponding module group. It is updated before the normal I/O scan and executed each program scan.
–(IOT)–	Immediate Output	XXX –(IOT)–	When rung is true, the processor interrupts program scan to update a module group with data from its corresponding output image table word address. It is updated before the normal I/O scan and executed each program scan when the rung is true. Can be programmed unconditionally.

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

Table C.G
Timer Instructions

NOTE: The timer word address, XXX, is assigned to the timer accumulated areas of the data table. To determine which addresses are valid accumulated areas, the most significant digit in the word address must be an even number.

The time base, TB, is user-selectable and can be 1.0, 0.1, or 0.01 second. Preset values, YYY, and accumulated values, ZZZ, can vary from 000 to 999.

Bit 15 is the timed bit. Bit 17 is the enable bit.

The word address displayed will be 3 or 4 digits long depending on the data table size. When entering the word address, use a leading zero if necessary.

Key Symbol	Instruction Name	1770–T3 Display	Rung Conditions	Status Bits
–(TON)–	Timer On Delay	XXX –(TON)– TB PR YYY AC ZZZ	When the rung is true, the timer begins to increment the accumulated value at a rate specified by the time base. When the rung is false, the timer reset the accumulated value to 000.	When the rung is true: bit 15–set when AC=PR bit 17–set When the rung is false: bits 15 and 17–reset
–(TOF)–	Timer Off Delay	XXX –(TOF)– TB PR YYY AC ZZZ	When the rung is true, the timer resets the accumulated value at 000. When the rung is false, the timer begins to increment the accumulated value.	When the rung is true: bit 15–set bit 17–set. When the rung is false: bit 15–resets when AC=PR bit 17–reset
–(RTO)–	Retentive Timer	–(RTO)– TB PR YYY AC ZZZ	When the rung is true, the timer begins to increment the accumulated value. When false, the accumulated value is retained.	When the rung is true: bit 15–set when AC=PR bit 17–set When the rung is false: bit 15–no action is taken bit 17–reset
–(RTR)–	Retentive Timer Reset	XXX –(RTR)– PR YYY AC ZZZ	XXX – Word address of the retentive timer it is resetting. The preset and accumulated values are automatically entered by the industrial terminal. When the rung is true, the accumulated value and status bits are reset.	When the rung is true: bit 15 and 17–reset When the rung is false: no action is taken

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

Table C.H
Counter Instructions

NOTE: The counter word address, XXX, is assigned to the counter accumulated area of the data table. To determine which addresses are valid accumulated areas, the most significant digit in the word address must be an even number.

Bit 14 is the overflow/underflow bit.
Bit 15 is the count complete bit.
Bit 16 is the enable bit for the CTD instruction.
Bit 17 is the enable bit for the CTU instruction.

The word address displayed will be 3 or 4 digits long depending on the data table size. When entering the word address, use a leading zero if necessary.

Key Symbol	Instruction Name	1770–T3 Display	Rung Conditions	Status Bits
–(CTU)–	Up Counter	XXX –(CTU)– PR YYY AC ZZZ	Each time the rung goes true, the accumulated value is incremented one count. The counter will continue counting after the preset value is reached. The accumulated value can be reset by the CTR instruction.	When the rung is true: bit 14–set if AC>999 bit 15–set when AC≥PR PR bit 17–set When the rung is false: bits 14–15–retained if it was set bit 17–reset
–(CTR)–	Counter Reset	XXX –(CTR)– PR YYY AC ZZZ	XXX–Word address of the CTU is resetting. The preset and accumulated values are automatically entered by the industrial terminal. When the rung is true, the CTU or CTD accumulated value and status bits are reset to 000.	When the rung is true: bits 14–17–reset When the rung is false: No action is taken
–(CTD)–	Down Counter	XXX –(CTD)– PR YYY AC ZZZ	Each time the rung goes true, the accumulated value is decreased by one count.	When the rung is true: bit 14–set when AC<000 bit 15–set when AC<PR bit 16–set When the rung is false: bits 14–15– retained if it was set bit 16–reset

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

Table C.I
Data Manipulation Instructions

NOTE: Data manipulation instructions operate on BCD values and/or 16 bit data in the data table. The word address, XXX, is displayed above the instruction; the BCD value or data operated upon, YYY, is displayed beneath it. The data is stored in the lower 12 bits of the word address and can be any value from 000 to 999 BCD, except as noted.

Word address displayed will be either 3 or 4 digits depending upon the data table size. When entering the word address, use a leading zero if necessary.

Key Symbol	Instruction Name	1770-T3 Display	Rung Conditions
-[G]-	Get	XXX -[G]- YYY	The get instruction is used with other data manipulation or arithmetic instructions. When the rung is true, all 16 bits of the get instruction are duplicated and the operation of the instruction following it is performed.
-(PUT)-	Put	XXX -(PUT)- YYY	The put instruction should be preceded by the get instruction. When the rung is true, all 16 bits at the get instruction address are transferred to the put instruction address.
-[<]-	Less Than	XXX -[<]- YYY	The less than instruction should be preceded by a get instruction. 3-digit BCD values at the get and less than word addresses are compared. If the logic is true, the rung is enabled.
-[=]-	Equal To	XXX -[=]- YYY	The equal to instruction should be preceded by a get instruction. 3-digit BCD values at the get and equal to word addresses are compared. if equal, the rung is enabled.
-[B]-	Get Byte	XXXD -[B]- YYY	D-Designates the upper or lower byte of the word. 1=upper byte, 0=lower byte. YYY-Octal value from 000 to 377 stored in the upper or lower byte of the word address. The get byte instruction should be followed by a limit test instruction. A duplicate of the designated byte is made and compared with the upper and lower limits of the limit test instruction.
-[L]-	Limit Test	XXX AAA -[L]- BBB	AAA-Upper limit of limit test, an octal value from 000 to 377. BBB-Lower limit of limit test, an octal value from 000 to 377. The limit test instruction should be preceded by a get byte instruction. Compares the value at the get byte instruction with the values at the limit test instruction. If found to be between or equal to the limits, the rung is enabled.

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

Table C.J
Arithmetic Instructions

NOTE: Arithmetic instructions operate on BCD values in the data table. The word address XXX is displayed above the instruction; the BCD value YYY which is the result of the arithmetic operation, is displayed beneath it. The BCD value is stored in the lower 12 bits of the word address and can be any value from 000 to 999.

Displayed word addresses will be 3 or 4 digits depending on the data table size. When entering the word address, use a leading zero if necessary.

Key Symbol	Instruction Name	1770-T3 Display	Rung Conditions
-(+)-	Add	XXX -(+)- YYY	The add instruction is an output instruction. It is always preceded by two get instructions which store the BCD values to be added. When the sum exceeds 999, bit 14 is set. A 1 is displayed in front of the result YYY.
-(-)-	Subtract	XXX -(-)- YYY	The subtract instruction is an output instruction. It is always preceded by two get instructions. The value in the second get address is subtracted from the value in the first. When the difference is negative, bit 16 is set and a minus sign is displayed in front of the result YYY.
-(X)-	Multiply	XXX XXX -(X)-(X)- YYY YYY	The multiply instruction is an output instruction. It is always preceded by two get instructions which store the values to be multiplied. Two word addresses are required to store the 6 digit product.
-(÷)-	Divide	XXX XXX -(÷)-(÷)- YYY YYY	The divide instruction is an output instruction. It is always preceded by two get instructions. The value of the first is divided by the value of the second. Two word addresses are required to store the 6 digit quotient. its decimal point is placed automatically by the industrial terminal.

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

Table C.K
File Instructions

Key Sequence	1770–T3 Display	Instruction Notes
FILE 10	File to File Move Counter Addr: 030 Position: 001 File Length: 001 File A: 110- 110 File R: 110- 110 Rate per Scan 001 030 EN 17 030 DN 15	Output Instruction. Modes: Complete, Distributed and Incremental. Counter is internally incremented by the instruction. Requires 5 words of user program.
FILE 11	Word to File Move Counter Addr: 030 Position: 001 File Length: 001 Word Addr: 010 File R: 110- 110 030 DN 15	Output instruction. Counter must be externally indexed by user program. Data is transferred every scan that rung is true. Requires 4 words of user program.
FILE 12	File to Word Move Counter Addr: 030 Position: 001 File Length: 001 File A: 110- 110 Word Addr: 010 030 DN 15	Same as word–to–file.

NOTE: Numbers shown are default values. Numbers in shaded areas must be replaced by user–entered values. The number of default address digits initially displayed (3 or 4) will depend on the size of the data table.

To access the Data Monitor Display, enter all instruction parameters. Press key sequence:
[DISPLAY][0] for the binary monitor mode;
[DISPLAY][1] for the hexadecimal monitor mode.

This Value:	Stores the:
Counter Address	Address of the instruction's file position in the accumulated value area of the data table
Position	Current word being operated upon (accumulated value of the counter)
File Length	Number of words in the file (preset value of the counter)
File A	Starting address of the source file
File R	Starting address of the destination file
Word Address	Address of the source word or destination word outside of the file
Rate Per Scan	Number of data words moved per scan

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

Table C.L
Sequencer Instructions

Key Sequence	1779-T3 Display	Instruction Notes
SEQ 0	Sequencer Output Counter Addr: 030 Current Step: 001 Seq Length: 001 Words per Step: 1 File: 110- 110 Mask: 010- 010 Output Words 1: 010 2: 3: 4: 030 EN 17 030 DN 15	Output instruction. Increments, then transfers data. Same data transferred each scan that the rung is true. Counter is indexed by the instruction. Unused output bits can be masked. Requires 5-8 words of your program.
SEQ 1	Sequencer Input Counter Addr: 030 Current Step: 000 Seq Length: 001 Words per Step: 1 File: 110- 110 Mask: 010- 010 Input Words 1: 010 2: 3: 4:	Input instruction. Compares input data with current step for equality. Counter must be externally indexed by your program. Unused input bits can be masked. Requires 5-8 words of your program.
SEQ 2	Sequencer Load Counter Addr: 030 Current Step: 000 Seq Length: 001 Words per Step: 1 File: 110- 110 Output Words 1: 010 2: 3: 4: 030 EN 17 030 DN 15	Output instruction. Increments, then loads data. Counter is indexed by the instruction. Does not mask. Requires 4-7 words of your program.

NOTE: Numbers shown are default values. Numbers in shaded areas must be replaced by your entered values. The number of default address digits initially displayed (3 or 4) will depend on the size of the data table.

To access the Data Monitor Display, enter all instruction parameters. Press key sequence:
[DISPLAY][0] for the binary monitor mode;
[DISPLAY][1] for the hexadecimal monitor mode.

This Value:	Stores the:	This Value:	Stores the:
Counter Address	Address of the instruction in the accumulated value area of the data table	Mask	Starting address of the mask file
Position	Position in the sequencer table (accumulated value of counter)	Word Address	Address of the source word or destination word outside of the file
Seq Length	Number of steps (preset value of the counter)	Output Words	Words controlled by the instruction
Words per Step	Width of the sequencer table	Load Words	Words fetched by the instruction
File	Starting address of the source file	Input Words	Words monitored by the instruction

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

Table C.M
Jump/Subroutine Instructions

Key Symbol	Instruction Name	1770–T3 Display	Explanation and Rung Conditions
SBR T.END	Subroutine Area	SUBROUTINE AREA	Establishes the boundary between main program and subroutine area. Subroutine area is not scanned unless directed to do so by a JSR instruction.
–(LBL)–	Label	XX –(LBL)–	This condition instruction is the target destination for JUMP and JSR instructions. XX–two digit octal identification number, 00–07
–(JMP)–	Jump	XX –(JMP)–	When rung is true, processor jumps forward to the referenced label in main program. XX–two digit octal identification number. Same as LBL with which it is used.
–(JSR)–	Jump To Subroutine	XX –(JSR)–	When the rung is true, processor jumps to referenced label in subroutine area. XX–two digit octal identification number. Same as LBL with witch it is used.
–(RET)–	Return	–(RET)–	No identification number. Can be used unconditionally . Returns the processor to the instruction immediately following the JSR in the main program that initiated the jump to subroutine.

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

Table C.N
Block Transfer Instructions

Key Sequence	1770–T3 Display	Instruction Notes
BLOCK XFER 0	Block Xfer Write Data Addr: 030 Module Addr: 100 Block Length: 001 File: 110- 110 010 (EN) 06 110 (DN) 06	Output instruction. Block length depends on kind of module. Entire file transferred in one scan. Done bit remains on for one scan after valid transfer.
BLOCK XFER 1	Block Xfer Write Data Addr: 030 Module Addr: 100 Block Length: 001 File: 110- 110 010 (EN) 06 110 (DN) 06	Data read from I/O module must be buffered. Uses two words of user program for each instruction
BLOCK XFER 0 BLOCK XFER 1	Enter both instruction blocks for bidirectional block transfer.	Set block lengths equal or to default value for module. Same module address used for read and write instruction. Enable read and write instructions in same scan. Order of operation determined by the module. See the module user's manual.

NOTE: Numbers shown are default values. Numbers in shaded areas must be replaced by user–entered values. The number of default address digits initially displayed (3 or 4) will depend on the size of the data table.

To access the Data Monitor Display, enter all instruction parameters. Press key sequence:
[DISPLAY][0] for the binary monitor mode;
[DISPLAY][1] for the hexadecimal monitor mode.

This Value:	Stores the:
Data Address	First possible address in the timer/counter accumulated value area of the data table
Module Address	RGS for R = rack, G = module, S = slot number
Block Length	Number of words to be transferred (enter 00 for default value or for 64 words)
File	Address of the first word of the file
Enable bit -(EN)-	Automatically entered from the module address Set on when the rung containing the instruction is true
Done bit -(DN)-	Automatically entered from the module address Remains on for 1 program scan following successful transfer

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

Table C.O
Editing Functions [1]

Function	Key Sequence	Mode	Description
Inserting a condition instruction	[INSERT] (Instruction) (Address) or [INSERT][ ] (Instruction) (Address)	Program	Position the cursor on the instruction that will precede the instruction to be inserted. Then press key sequence. Position the cursor on the instruction that will follow the instruction to be inserted. Then press key sequence.
Removing a condition instruction	[REMOVE] (instruction)	Program	Position the cursor on the instruction to be removed and press the key sequence.
Inserting a rung	[INSERT] [RUNG]	Program	Position the cursor on any instruction in the preceding rung and press the key sequence. Enter instructions and complete the rung.
Removing a rung	[REMOVE] RUNG]	Program	Position the cursor anywhere on the rung to be removed and press the key sequence. **IMPORTANT**: Only addresses corresponding to output energize, latch and unlatch instructions are cleared to zero.
Change data of a word or block instruction	[INSERT] (Data)	Program	Position the cursor on the word or block instruction whose data is to be changed. Press the key sequence.
Change the address of a word or block instruction	[INSERT] (first Digit) [←] (Address)	Program	Position the cursor on a word or block instruction with data and press [INSERT]. Enter the first digit of the first data value of the instruction. Then use the [ ] and [ ]key as needed to cursor up to the word address. Enter the appropriate digits of the word address.
Online programming	[SEARCH] [5][2]		Initiates online programming.
Replace an instruction or Change address of an instruction without data	[Instruction] (Address)	Program	Position the cursor on the instruction to be replace or whose address is to be changed. Press the desired instruction key (or key sequence) and the required address(es).
Online Data Change	[SEARCH] [5][1] (Data) [RECORD] [CANCEL COMMAND]	Run/Program	Position the cursor on the word or block instruction whose data is to be changed. Press sequence. Cursor keys can be used. Press [RECORD] to enter the new data into memory. To terminate online data change.
All editing functions	[CANCEL COMMAND]	Program Run/Program	Aborts the operation at the current cursor position.

These functions can also be used during online programming.

[1] When bit address exceeds 5 digits, press the [EXPAND ADDR] key before entering address and enter a leading zero if necessary.

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

Table C.P
Search Functions

Function	Key Sequence	Mode	Description
Locate first rung program	[SEARCH][↑]	Any	Positions cursor on the first instruction of the program.
Locate last rung program area	[SEARCH][↓]	Any	Positions cursor on the temporary end instruction, subroutine area boundary, or the end statement depending on the cursor's location. Press key sequence again to move to the next boundary.
Locate first instruction of current rung.	[SEARCH] [←]	Remote Prog	Position cursor on first instruction of the current rung.
Move cursor off screen	[SEARCH][←]	Remote Test Run/Program	Moves cursor off screen to left.
Locate output instruction of current rung	[SEARCH][→]	Any	Position cursor on the output instruction of the current rung.
Locate rung without an output instruction	[SHIFT] [SEARCH]	Any	Locates any rung left incomplete due to an interruption in programming.
Locate specific instruction	[SEARCH] [Instruction key] (Address)	Any	Locates instruction searched for. Press [SEARCH] to locate the next occurrence of instruction.
Locate specific word address	[SEARCH] (address)	Any	Locates this address in the program (excluding -| |- and -| / |- instructions and addresses in files). Press [SEARCH] to locate th next occurrence of this address. 1
Single rung display	[SEARCH] [DISPLAY]	Any	Displays the first rung of a multiple rung display by itself. Press key sequence again to view multiple rungs.
Print	[SEARCH] [4] [3]	Any	Prints single rung.
Print	[SEARCH] [4] [4]	Any	Prints ladder diagram dump.
Print	[SEARCH] [4] [5]	Remote Prog	Prints total memory dump.
Print	[SEARCH] [5] [0]	Any	Prints first 20 lines of data table configuration.
Print	[SEARCH] [5] [3]	Any	Prints first 20 lines of bit manipulation.
Print	[SEARCH] [5] [4]	Any	Prints first 20 lines of memory layout display.
Program controls outputs	[SEARCH] [5][9][0]	Run/Program	Places the processor in run/program mode.
Program executes outputs disabled	[SEARCH] [5][9][1]	Remote Test	Places the processor in remote test mode.
Processor awaits commands	[SEARCH] [5][9][2]	Remote Program	Places the processor in remote program mode.

1 Enter leading zeros when bit address exceeds 5 digits or word address exceeds 3 digits.

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

Table C.Q
Clear Memory Functions

Function	Key Sequence	Mode	Description
Data table clear	[CLEAR MEMORY] [7][7] (Start Address) (End Address) [CLEAR MEMORY]	Program	Displays a start address and an end address field. Start and end word addresses determine boundaries for data table clearing. Clears the data table within and including addressed boundaries.
User program clear	[CLEAR MEMORY] [8][8]	Program	Position the cursor at the desired location in the program. Clears user program from the position of the cursor to the first boundary: i.e. temporary end, subroutine area, or end statement. Does not clear data table or messages.
Partial memory clear	[CLEAR MEMORY] [8][8]	Program	Clears user program and messages from position of the cursor. Does not clear data table.
Total memory clear	[CLEAR MEMORY] [9][9]	Program	Position the cursor on the first instruction of the program. Clears user program and messages. Does not clear data table, unless the cursor is on the first program instruction.

NOTE: When memory write protect is active, memory cannot be cleared except for data table addresses 010–177 with a programmed EPROM installed.

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

Table C.R
Help Directories

Function	Key Sequence	Mode	Description
Help directory	[HELP]	Any	Displays a list of the keys that are used with the [HELP] key to obtain further directories.
Control function directory	[SEARCH] [HELP]	Any	Provides a list of all control functions that us the [SEARCH] key.
Record function directory	[RECORD] [HELP]	Any	Provides a list of functions that use the [RECORD] key.
Clear memory directory	[CLEAR MEMORY] [HELP]	Program	Provides a list of all functions that use the [CLEAR MEMORY] key.
Data monitor directory	[DISPLAY] [HELP]	Any	Provides the choice of data monitor display accessed by the [DISPLAY] key.
File instruction directory	[FILE][HELP]	Any	Provides a list of all instructions that use the [FILE] key.
Sequencer directory	[SEQ][HELP]	Any	Provides a list of all instructions that use the instruction [SEQ] key.
Block transfer directory	[BLOCK XFER]	Any	Provides a list of all instructions that use the [BLOCK XFER] key.
All directories	[CANCEL COMMAND]	Any	To terminate.

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

Table C.S
Report Generation Commands

Command	Key Sequence	Description
Enter report generation function	[RECORD][[DISPLAY] or Set baud rate, (Message Code Keys)	Puts industrial terminal into report generation function. Same (entered from a peripheral device).
Message store	[M][S][,](Message Number) [RETURN]	Stores message in processor memory. Use [ESC] to end message.
Message print	[M][P][,](Message Number) [RETURN]	Prints message exactly as entered.
Message report	[M][R][,](Message Number) [RETURN]	Prints message with current data values or bit status.
Message delete	[M][D][,](Message Number) [RETURN]	Removes message from processor memory.
Message index	[M][I][RETURN]	Lists messages used and the number of words in each message.
Automatic report generation	[SEARCH][4][0] or [M][R][RETURN]	Allows messages to be printed through program control. Same (entered from a peripheral device).
Exit automatic report generation	[ESC] or [CANCEL COMMAND] 1	Terminates automatic report generation.
Exit report	[ESC] or [CANCEL COMMAND] 1	Returns to ladder diagram display. Terminates Report Generation Function.

1 [CANCEL COMMAND] can only be used if the function was entered by a command from a peripheral device.

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

Table C.T
Address Delimiters

Delimiter Format	Explanation	Message Report Format
XXX	Enter 3–digit word address between delimiters.	Displays BCD value at assigned word address.
XXX1 or *XXX0*	Enter 3–digit word address and a "1" for upper byte or a "0" for lower byte between delimiters.	Displays the octal value at assigned byte address.
XXXXX	Enter 5–digit bit address between delimiters.	Displays the ON or OFF status of the assigned bit address.
#XXX#	Enter 3,4 or 5–digit word address between delimiters.	Displays the 4–digit hex value at address.
&XXX1& &XXX0&	Enter 3,4 or 5–digit word address and a "1" for upper byte or a "0" for lower byte between delimiters.	Displays the octal value at the assigned byte address.
XXXXX	Enter 5,6 or 7–digit bit address between delimiters.	Displays the ON or OFF status of the assigned bit address.

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

Table C.U
Alphanumeric/Graphic Key Definitions

Key	Function
[LINE FEED]	Moves the cursor down one line in the same column.
[RETURN]	Returns the cursor to the beginning of the next line.
[RUB OUT]	Deletes the last character or control code that was entered.
[REPT LOCK]	Allows the next character that is pressed to be repeated continuously until [REPT LOCK] is pressed again.
[SHIFT]	Allows the next key pressed to be a shift character.
[SHIFT LOCK]	Allows all subsequent keys pressed to be shift characters until [SHIFT] or [SHIFT LOCK] is pressed.
[CTRL]	Used as part of a key sequence to generate a control code.
[ESC]	Terminates the present function.
[MODE SELECT]	Terminates all functions and returns the mode select display to the screen.
Blank Yellow Keys	Space keys. Move the cursor one position to the right.

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

Table C.V
Industrial Terminal Control Codes

Control Code Key Sequence	Function
[CTRL][P] [Column#][;] [Line#][A]	Positions the cursor at the specified column and line number. [CTRL][P][A] will position the cursor at the top left corner of the screen.
[CTRL][P][F]	Moves the cursor one space to the right.
[CTRL][P][U]	Moves the cursor one line up in the same column.
[CTRL][P][5][C]	Turns cursor on.
[CTRL][P][4][C]	Turns cursor off.
[CTRL][P][5][G]	Turns on graphics capability.
[CTRL][P][4][G]	Turns off graphics capability.
[CTRL][P][5][P]	Turns Channel C outputs on.
[CTRL][P][4][P]	Turns Channel C output off.
[CTRL][1]	Horizontal tab that moves the cursor to the next preset 8th position.
[CTRL][K]	Clears the screen from cursor position to end of screen and moves the cursor to the top left corner of the screen.
Key Sequence	**Attribute[1]**
[CTRL][P][0][T]	Attribute 0 = Normal Intensity
[CTRL][P][1][T]	Attribute 1 = Underline
[CTRL][P][2][T]	Attribute 2 = Intensify
[CTRL][P][3][T]	Attribute 3 = Blinking
[CTRL][P][4][T]	Attribute 4 = Reverse Video

[1] Any three attributes can be used at one time using the following key sequence:
[CTRL][P][Attribute #][;][Attribute #][;][Attribute #][T]

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

Table C.W
Contract Histogram Functions

Function	Key Sequence	Mode	Description
Continuous contact histogram	[SEARCH][6] (Bit Address) [DISPLAY]	Any	Provides a continuous display of the on/off history of the addressed bit in hours, minutes and seconds. Can obtain a hardcopy printout of contact histogram by connecting a peripheral device to Channel C and selecting proper baud rate before indicated key sequence.
Paged Contact	[SEARCH][7] (Bit Address) [DISPLAY] [DISPLAY]	Any	Displays 11 lines on/off history of the addressed bit in hours, minutes and seconds. Displays the next 11 lines of contact histogram. Can obtain a hard copy printout of contact histogram by connecting peripheral device to Channel C and selecting proper baud rate.
Either	[CANCEL COMMAND]		To terminate.

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

Table C.X
Troubleshooting Aids

Function	Key Sequence	Mode	Description
Bit monitor	[SEARCH] [5][3] [Address] [↑]or[↓]	Any	Displays the on/off status of all 16 bits at specified word address and corresponding force conditions if they exist. Displays the status of 16 new bits at the next lowest or highest word address, respectively.
Bit manipulation	[SEARCH] [5][3] [←] or [→] [1] or [0] See FORCING below	Test or Run/Program	Displays the on/off status of all 16 bits at specified word address and corresponding force conditions if they exist. Moves cursor to the bit to be changed. Enter a 1 to set bit on or a 0 to reset a bit. Forcing or removing forces from input bits or output devices.
Either of above	[CANCEL COMMAND]		To terminate.
Force On	[FORCE ON] [INSERT]	Test or Run/Program	Position the cursor on the image table bit to be forced on and press the key sequence. The input bit or output device is forced on.
Removing a Force On	[FORCE ON] [REMOVE]	Test or Run/Program	Position the cursor on the image table bit whose force on is to be removed and press the key sequence.
Removing all Force On	[FORCE ON] [CLEAR MEMORY]	Test or Run/Program	Position cursor anywhere in program and press key sequence.
Force Off	[FORCE OFF] [INSERT]	Test or Run/Program	Position the cursor on the image table bits to be whose force off is to be removed and press the key sequence.
Removing all Force Off	[FORCE OFF] [CLEAR MEMORY]	Test or Run/Program	Position the cursor anywhere in program and press key sequence.
Forced address display	[SEARCH] [FORCE ON] or [SEARCH] [FORCE OFF]	Any	Displays a list of the bit addresses that are forced on and forced off. The [SHIFT][] and [SHIFT][] keys can be used to display additional forces.
	[CANCEL COMMAND]		To terminate.
Inserting a temporary end instruction	[INSERT] [←][T.END] or [INSERT] [T.END]	Program	Position the cursor on the instruction that willfollow the temporary end instruction. The remaining rungs, although displayed and accessible, are not scanned. Position the cursor on the instruction that will precede the temporary end instruction. The remaining rungs, although displayed and accessible, are not scanned.
Remove a temporary end instruction	[REMOVE] [T.END]	Program	Position cursor on temporary end instruction and press key sequence.

NOTE: When in test mode, the processor will hold outputs off regardless of attempts to force them on.

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

Numbers

1770–T3, 1-2, 3-3, 3-6, 17-9, C-23
1772–LS, 3-2
1772–LSP, 3-4
1784–T50, 3-3, 3-6
3–digit math, 10-1

A

accumulated values, 4-7, 8-1
addition, 10-2, 10-11
additional messages, 17-4
address delimiters, 17-12, C-21
addresses, 6-2
ASCII control codes, 17-8
automatic restart, 18-2

B

battery backup, 3-6
BCD, A-3
BCD to binary, 10-18
BCO, A-5
before you begin, 1-1
bidirectional block transfer, 14-11
binary coded decimal, BCD. *See* BCD
binary coded octal. *See* BCO
binary numbering, A-2
binary to BCD, 10-20
bit, 4-1
bit controlling instructions, 6-4
bit examining instructions, 6-3
bit manipulation, 19-2
bit monitor, 19-2
block length, 14-6
block transfer
  basic operation, 14-1
  bidirectional block transfer, 14-11
  block transfer read, 14-8
  block transfer write, 14-10
  buffering data, 14-16
  data address, 14-5
  enable/done bits, 14-8
  equal block lengths, 14-7
  file address, 14-7
  format, 14-4
  I/O scan, 14-3
  length, 14-6
  module address, 14-6
  multiple reads, 14-14
  program scan, 14-3
  quick reference, C-15
  run–time errors, 14-8
  unequal block lengths, 14-7
bottle filling application, 18-9
branching, 6-6
  expanded math instructions, 10-9
  nesting, 6-8
  start/end, 6-7
buffering data, 14-16
byte, 4-1

C

cascading timers, 18-4
central processing unit. *See* CPU
changing an address, 16-5
changing an instruction, 16-5
changing data, 16-4, 16-6
clearing memory, 16-10, C-18
CMOS RAM, 1-2, 3-12
compare instruction
  equal to, 9-3
  equal to or greater than, 9-9
  equal to or less than, 9-7
  get byte, 9-10
  get byte/out, 9-11
  greater than, 9-9
  less than, 9-4
  limit test, 9-5
complete mode, 11-3
conditioning instruction, 10-7
contact histogram, 19-3, C-24
control code, message, 17-6
control codes, C-23
control sequence, 2-8
controls
  programmable, 2-2
  traditional, 2-1

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

conventions, 1-2
counter instruction
  counter reset, 8-7
  down counter, 8-7
  quick reference, C-9
  up counter, 8-6
counter reset, 8-7
CPU, 2-3

D

data address, 10-5, 14-5
data initialization key, 16-16
data manipulation instruction, quick reference, C-10
data manipulation instructions, 9-1
  compare, 9-3
  transfer, 9-1
  transfer and compare, 9-7
data monitor display, 11-5
data table, 2-4, 4-3
  accumulated values and internal storage, 4-7
  areas, 4-7
  configuration, quick reference, C-2
  expanding, 4-5
  factory configuration, quick reference, C-3
  preset values, 4-7
  processor work area, 4-7
  size, quick reference, C-2
data table clear, 16-11
data transfer file instruction, 11-1
decimal numbering, A-1
decimal values, 1-2
diagnosing run time errors, 19-1
distributed complete mode, 11-3
division, 10-3, 10-12
down counter, 8-7

E

EAF, 1-2, 10-4
editing
  BCD to binary, 10-20
  binary to BCD, 10-21
  counter reset, 8-8
  down counter, 8-8
  equal to, 9-4
  equal to or greater than, 9-10
  equal to or less than, 9-8
  examine on/examine off, 6-4
  expanded math instruction, 10-15
  file to file move, 11-14
  functions, 16-1
  get, 9-3
  get byte, 9-11
  get byte/put, 9-13
  greater than, 9-9
  immediate input/output update, 7-6
  instruction, rules, 16-1
  jump instruction, 13-3
  label, 13-4
  less than, 9-5
  limit test, 9-7
  MCR/ZCL, 7-3
  output energize, 6-5
  output latch/unlatch, 6-6
  put, 9-3
  quick reference, C-16
  retentive timer on/reset, 8-5
  square root, 10-18
  three–digit math instruction, 10-4
  timer on/timer off, 8-3
  up counter, 8-8
editing functions, C-16
EEPROM, 1-2, 3-12
equal to, 9-3
equal to or greater than, 9-9
equal to or less than, 9-7
ERR message, 19-8
error handling, 10-10
examine off, 6-3
examine on, 6-3
execute auxiliary function. *See* EAF
execution time, program, 15-2
executive auxiliary function. *See* EAF
expanded math, 10-4
  addition, 10-11
  BCD to binary, 10-18
  binary to BCD, 10-20
  branch, 10-9
  conditioning, 10-7
  data address, 10-5
  division, 10-12
  error handling, 10-10
  function number, 10-10
  multiplication, 10-12
  operations, 10-11
  result address, 10-8
  square root, 10-15
  subtraction, 10-11
expanding, data table, 4-5, 11-8

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

externally indexed, 11-2

F

file address, block transfer, 14-7
file instruction
  data monitor display, 11-5
  externally indexed, 11-2
  file to file move, 11-9
  file to word move, 11-16
  internally indexed, 11-2
  modes of operation, 11-3
  quick reference, C-12
  sequencer, comparison with, 12-1
  types, 11-1
  word to file move, 11-16
file to file move, 11-9
file to word move, 11-16
forcing, 19-5
function numbers, 10-10
fuse, 3-5

G

generating messages, 17-3
get, 9-1
get byte, 9-10
get byte/put, 9-11
greater than, 9-9

H

hardware, relates to image tables, 4-1
help directories, 16-13, C-19
hexadecimal numbering, A-6
hexadecimal values, 1-2

I

I/O image tables, 2-4
I/O scan, 2-9, 5-1, 14-3
illegal opcode, 19-8
immediate input/output update, 7-4
incomplete rung, 16-9
incremental mode, 11-4
indicator, processor status, 3-3, 3-4
industrial terminal, 1-2, 3-6, C-23
industrial terminal keyboard, 3-11
input
  conditioning, 2-7
  indication, 2-6
  isolation, 2-7
  termination, 2-6
input image table, 2-4
inserting
  branch start/end, 6-8
  instruction, 16-2
  rung, 16-4
installing the T3, 3-7
instruction
  addition, 10-2, 10-11
  BCD to binary, 10-18
  binary to BCD, 10-20
  bit controlling, 6-4
  bit examining, 6-3
  block transfer, 14-1
  branch start/end, 6-7
  branching, 6-6
  compare, 9-3
  conditioning, 10-7
  counter, 8-1, 8-5
  counter reset, 8-7
  data manipulation, 9-1
  data transfer file, 11-1
  division, 10-3, 10-12
  down counter, 8-7
  EAF, 10-4
  editing rules, 16-1
  equal to, 9-3
  equal to or greater than, 9-9
  equal to or less than, 9-7
  execution time, C-4
  expanded math, 10-4
  file, 11-1
  file to file move, 11-9
  file to word move, 11-16
  get, 9-1
  get byte, 9-10
  get byte/put, 9-11
  greater than, 9-9
  immediate input/output update, 7-4
  inserting, 16-2
  jump, 13-1
  jump to subroutine, 13-2
  label, 13-3
  less than, 9-4
  limit test, 9-5
  master control reset, 7-1
  math, 10-1
  multiplication, 10-3, 10-12
  output latch/unlatch, 6-5
  output override, 7-1
  program control, 7-1

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

programming, 6-3
put, 9-2
relay, 6-1
retentive timer on, 8-4
retentive timer reset, 8-4
return, 13-2
sequencer, 12-1
sequencer input, 12-5
sequencer load, 12-19
sequencer output, 12-13
square root, 10-15
subroutine, 13-4
subtraction, 10-2, 10-11
temporary end, 19-7
three–digit math, 10-1
timer, 8-1
timer on/timer off, 8-2
transfer, 9-1
up counter, 8-6
word to file move, 11-16
zone control last state, 7-1
instruction execution times, 5-4
instructions, 2-6
interface socket, 3-3
internal storage, 4-7
internally indexed, 11-2
INTFC, 3-3, 3-7

J

jump, 13-1
jump instruction
jump, 13-1
jump to subroutine, 13-2
label, 13-3
quick reference, C-14
return, 13-2
jump to subroutine, 13-2

K

key definitions, 3-8, C-22
keyboard, 3-11
keystroke directions, 1-3
keytop overlay, 3-8, 17-2

L

label, 13-3
leading edge one shot, 18-1
less than, 9-4
limit test, 9-5
limitations, sequencer instructions, 12-3

M

machine control, 2-1
main program, 4-8
mask, 12-2
master control reset. *See* MCR
math instruction
addition, 10-2
division, 10-3
expanded math, 10-4
multiplication, 10-3
quick reference, C-11
subtraction, 10-2
three–digit, 10-1
MCR, 7-1
memory, 2-4
areas, 4-3
data table, 4-3
message storage area, 4-9
organization, 4-1
user program, 4-8
memory store switch, 3-3
message control code, 17-6
message control word, 17-5, 17-10
message delete, 17-14
message index, 17-14
message print, 17-13
message report, 17-13
message storage area, 4-9
message store, 17-11
messages 1–6, 17-3
modes of operation, 3-11
complete, 11-3
distributed complete, 11-3
file instruction, 11-3
incremental, 11-4
module address, block transfer, 14-6
module group, 6-3
multiple block transfer reads, 14-14
multiplication, 10-3, 10-12

N

nesting branches, 6-8
number systems, A-1

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

O

octal numbering, A-2
octal values, 1-2
one shot, 18-1
online data change, 16-6, 16-13
online programming, 16-14
opcode, illegal, 19-8
operation, block transfer, 14-1
operations, expanded math, 10-11
output
  conditioning, 2-7
  indication, 2-7
  isolation, 2-8
  termination, 2-7
output energize, 6-4
output image table, 2-4
output latch/unlatch, 6-5
output override instruction, 7-1

P

P/S ACTIVE, 3-4
P/S PARALLEL, 3-4
paralleling cable, 3-12
partial memory clear, 16-12
POWER (switch), 3-5
power supply, 2-3, 2-8
power switch, 3-4
preset values, 4-7, 8-1
PROC RUN/FAULT, 3-3
processor, 1-2
processor mode select, 16-10
processor status indicator, 3-3, 3-4
processor work area, 4-7
program
  execution time, 15-2
  instructions, 6-3
  language, 2-5
  logic, 6-1
  main, 4-8
  scan, 14-3
  storage, 2-5
  subroutine area, 4-8
  troubleshooting, 19-1
  user, 4-8
program control, example, 18-8
program control instruction
  immediate input/output update, 7-4
  master control reset, 7-1
  quick reference, C-7
  zone control last state, 7-1
program scan, 2-11, 5-1
programmable controller
  CPU, 2-3
  data table, 2-4
  I/O image tables, 2-4
  input, 2-6
  instructions, 2-6
  memory, 2-4
  output, 2-7
  power supply, 2-8
  program language, 2-5
  program storage, 2-5
  sections, 2-2
programmable controls, 2-2
programming, STI, 15-1
programming aids, 16-12
programming techniques
  automatic restart, 18-2
  bottle filling application, 18-9
  cascading timers, 18-4
  one shot, 18-1
  program control, 18-8
  temperature conversions, 18-5
put, 9-2

R

relay–type instruction
  branch start/end, 6-7
  examine on/examine off, 6-3
  output energize, 6-4
  output latch/unlatch, 6-5
  quick reference, C-6
remote program, 3-11
remote test, 3-11
removing
  branch start/end, 6-8
  equal to, 9-4
  examine on/examine off, 6-4
  get, 9-2
  immediate input/output update, 7-6
  instruction, 16-3
  label, 13-4
  less than, 9-5
  output energize, 6-5
  put, 9-2
  rung, 16-4
  temporary end, 19-8
report generation
  additional messages, 17-4

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

address delimiters, 17-12
commands, 17-9, 17-10
generating messages, 17-3
message control word, 17-10
message delete, 17-14
message index, 17-14
message print, 17-13
message report, 17-13
message store, 17-11
messages 1–6, 17-3
programming example, 17-14
quick reference, C-20

reset, 6-2

result address, 10-8

retentive timer on, 8-4

retentive timer reset, 8-4

return, 13-2

run time errors
block transfer, 14-8
diagnosing, 19-1

run/program mode, 3-11

S

scan
average time, 5-3
function, 5-1
sequence, 5-2
theory, 5-1

scan sequence, 2-9

search functions, 16-7, C-17

searching, 16-6

sections, 2-2

selectable timed interrupt. *See* STI

sequencer input, 12-5

sequencer instruction
comparison with file instruction, 12-1
limitations, 12-3
mask, 12-2
quick reference, C-13
sequencer input, 12-5
sequencer load, 12-19
sequencer output, 12-13
table, 12-1

sequencer load, 12-19

sequencer output, 12-13

sequencer table, 12-1

set, 6-2

single rung display, 16-9

square root, 10-15

start-up conditions, 18-3

STI
overview, 15-2
programming, 15-1

subroutine, 13-1, 13-4, 15-1

subroutine area, 4-8

subroutine instruction, quick reference, C-14

subtraction, 10-2, 10-11

switch
assembly, 3-5
memory store, 3-3
power, 3-4
settings, 3-5

T

temperature conversions, 18-5

temporary end, 19-7

terminal strip, 3-5

three-digit math, 10-1

timer instruction
cascading, 18-4
quick reference, C-8
retentive timer on, 8-4
retentive timer reset, 8-4
timer on/timer off delay, 8-2

timer on/timer off, 8-2

timer/counter storage, 2-4

total memory clear, 16-12

traditional controls, 2-1

trailing edge one shot, 18-2

transfer instruction
equal to or greater than, 9-9
equal to or less than, 9-7
get, 9-1
get byte, 9-10
get byte/put, 9-11
greater than, 9-9
put, 9-2

troubleshooting
bit manipulation, 19-2
bit monitor, 19-2
contact histogram, 19-3
ERR message, 19-8
forcing, 19-5
quick reference, C-25
run time errors, 19-1

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

temporary end instruction, 19-7

U

up counter, 8-6
user program, 4-8
user program clear, 16-11

V

vocabulary, 1-2

W

word, 4-1
word to file move, 11-16

Z

ZCL, 7-1
zone control last state. *See* ZCL

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 worlds 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

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

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

Publication 1772-6.8.6 – May 1994
Supersedes Publication 1772–6.8.6 October 1984

PN 955118–05
Copyright 1994 Allen-Bradley Company, Inc. Printed in USA

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