Programming Manual

Allen-Bradley

Logix5000 Data Access

1756 ControlLogix, 1756 GuardLogix, 1769 CompactLogix, 1769 Compact GuardLogix, 1789 SoftLogix, 5069 CompactLogix, Studio 5000 Logix Emulate

Important User Information

Solid-state equipment has operational characteristics differing from those of electromechanical equipment. Safety Guidelines for the Application, Installation and Maintenance of Solid State Controls (publication SGI-1.1 available from your local Rockwell Automation sales office or online at http://www.rockwellautomation.com/literature/) describes some important differences between solid-state equipment and hard-wired electromechanical devices. Because of this difference, and also because of the wide variety of uses for solid-state equipment, all persons responsible for applying this equipment must satisfy themselves that each intended application of this equipment is acceptable.

In no event will Rockwell Automation, Inc. be responsible or liable for indirect or consequential damages resulting from the use or application of this equipment.

The examples and diagrams in this manual are included solely for illustrative purposes. Because of the many variables and requirements associated with any particular installation, Rockwell Automation, Inc. cannot assume responsibility or liability for actual use based on the examples and diagrams.

No patent liability is assumed by Rockwell Automation, Inc. with respect to use of information, circuits, equipment, or software described in this manual.

Throughout this manual, when necessary, we use notes to make you aware of safety considerations.

	**WARNING:** Identifies information about practices or circumstances that can cause an explosion in a hazardous environment, which may lead to personal injury or death, property damage, or economic loss.
	**ATTENTION:** Identifies information about practices or circumstances that can lead to personal injury or death, property damage, or economic loss. Attentions help you identify a hazard, avoid a hazard, and recognize the consequence
	**SHOCK HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that dangerous voltage may be present.
	**BURN HAZARD:** Labels may be on or inside the equipment, for example, a drive or motor, to alert people that surfaces may reach dangerous temperatures.
IMPORTANT	Identifies information that is critical for successful application and understanding of the product.

This manual contains new and updated information.

There are a number of minor changes throughout this publication that were made to clarify existing information. The major changes are listed below.

Change	Page
Updated supported controller models.	Cover

Notes:

Studio 5000 Engineering and Design Environment and Logix Designer Application

The Studio 5000™ Engineering and Design Environment combines engineering and design elements into a common environment. The first element in the Studio 5000 environment is the Logix Designer application. The Logix Designer application is the rebranding of RSLogix™ 5000 software and will continue to be the product to program Logix5000™ controllers for discrete, process, batch, motion, safety, and drive-based solutions.

The Studio 5000 environment is the foundation for the future of Rockwell Automation® engineering design tools and capabilities. It is the one place for design engineers to develop all the elements of their control system.

Purpose

This manual describes how to access data within a controller from another product or application that connects to the controller through the EtherNet/IP network or the serial port. The following methods of data access from a Logix5000 controller are described in this manual:

- Common Industrial Protocol (CIP)

  This native mode of communication for Logix5000 controllers is based on the CIP, which is common to all of these networks:

  – EtherNet/IP
  – ControlNet
  – DeviceNet

  These services are also supported over the DF1 serial port by using Programmable Controller Communication Commands.

  The EtherNet/IP network (CIP over standard Ethernet network) is the preferred method of data access and therefore the focus of this manual. The ControlNet network can also be used for data access, but generally speaking, not the DeviceNet network.

- Programmable Controller Communication Commands (PCCC), for compatibility with PLC and SLC controllers:
  - CIP Over the Controller Serial Port on page 67
  - PLC-2 Communication Commands on page 73
  - PLC-5 Communication Commands on page 75
  - SLC Communication Commands on page 80

  The DF1/PCCC method via the serial port is sometimes the most convenient way to access the controller, typically because of physical proximity, but it requires using multiple protocols and can require that tag be mapped to data tables, which is an extra configuration step. However, this should not be considered a long term solution because newer Logix controllers like the L7x family do not have a serial port. This is likely to be the case as the family of ControlLogix and CompactLogix controller evolve.

  Visit http://www.rockwellautomation.com/enabled/guides.html for more information.

This manual is one of a set of related manuals that show common procedures for programming and operating Logix5000 controllers. For a complete list of common procedures manuals, see the *Logix5000 Controllers Common Procedures Programming Manual*, publication 1756-PM001.

The term *Logix5000 controller* refers to any controller that is based on the Logix5000 operating system, such as:

- CompactLogix controllers
- ControlLogix controllers
- DriveLogix controllers
- FlexLogix controllers
- SoftLogix5800 controllers

Who Should Use This Manual

Before using this document, make sure you:

- Have a thorough understanding of CIP and EtherNet/IP.
- Have purchased a copy of the pertinent volumes of the CIP Networks Library.
- Are properly licensed through ODVA to use the CIP technology.

For more information on the CIP Networks Library and CIP technologies, contact ODVA at http://www.odva.org/.

Additional Resources

Some of the information in this manual is covered in more detail in the CIP specification (listed below). In case of discrepancies, the specification is the authoritative source of information.

For additional information, refer to the following manuals.

Resource	Author
DF1 Protocol and Command Set Reference Manual, 1770-6.5.16	Rockwell Automation
Logix5000 Controllers Common Procedures Programming Manual, 1756-PM001	Rockwell Automation
Integration with ControlLogix Programmable Automation Controllers Using EtherNet/IP, http://www.rockwellautomation.com/enabled/guides.html	Rockwell Automation
Logix5000 Controllers Design Considerations Reference Manual (Chapter 3, Guidelines for Data Types), 1756-RM094	Rockwell Automation
Logix5000 Controllers Import/Export Reference Manual 1756-RM084	Rockwell Automation
The Common Industrial Protocol, Pub 122(1)	ODVA
The Common Industrial Protocol (CIP) and the Family of CIP Networks, Pub 123(1)	ODVA
EtherNet/IP Quick Start for Vendors Handbook, Pub 213(1)	ODVA
CIP Networks Library (Specifications) - subscription required, Volumes 1 and 2	ODVA

(1) To locate publications on the ODVA website, use the Search function and type 'pub ###', where ### is the publication number.

You can view or download Rockwell Automation publications at http://www.rockwellautomation.com/literature/. To order paper copies of technical documentation, contact your local Rockwell Automation distributor or sales representative.

You can view or download ODVA publications at http://www.odva.org/.

Glossary

This document uses the following acronyms and terms.

Term	Definition
CIP	Common Industrial Protocol.
PCCC	Programmable Controller Communication Command.
PLC-2	An older, chassis-based, modular programmable controller.
PLC-5	A chassis-based, modular programmable controller.
SLC	A small, chassis-based, modular programmable controller.
STS/EXT STS	Status of the message transmission.
tag	Character name of data.
user-created tag	Tags the user creates of an atomic data type, a UDT structured data type, or arrays of these types. The user also creates tags from system structures (For example, Module-Defined and Predefined), primarily for use by the Logix system.The tags created from system structures are referred to as *system tags* not *user-created* tags, and include any tags from UDTs that contain nested system structures.
UDT	User-Defined Structure data type.

Notes:

CIP Services

Introduction

Communicating with the Logix5000 controller requires using CIP explicit messaging, which is described in great detail in the CIP Specification. This section highlights the subset of the CIP explicit messaging constructs that are pertinent for understanding the service explanations that follow. This is not meant to replace the need to understand CIP explicit messaging, which can be found by reading the materials referenced in Additional Resources on page 9.

CIP Services Overview

Before you use CIP services, review the following introductory information.

CIP Data Types

Data type information is very important in all aspects of CIP communication. The type information is used for reading, writing, and, if necessary, deciphering structures. The Logix5000 controller supports a large variety of data types.

- **Atomic** – a bit, byte, 16-bit word, or 32-bit word, each of which stores a single value. (CIP refers to these as Elementary Data Types.)
- **Structure** – a grouping of different data types that functions as a single unit and serves a specific purpose. Depending on the needs of your application, you can create additional structures, which are referred to as user-defined structures.
- **Array** – a sequence of elements, each of which is the same data type.
  - You can define data in one, two, or three dimensions, as required (one dimension is the most common).
  - You can use either atomic or structure data types.

Data in the controller is organized as tags. The tags come in two basic types: atomic and structures. Atomic types can be arrayed or singular, and are very easy to work with. Structure types provide a great deal of flexibility, but are more challenging to access. The following table identifies the atomic data type sizes.

Atomic Data Type Sizes

To store a	Use this data type
Bit	BOOL
Bit array	DWORD (32-bit boolean array)
8-bit integer	SINT
16-bit integer	INT
32-bit integer	DINT
32-bit float	REAL
64-bit integer	LINT

Logix5000 Data

The Logix5000 controller stores data in tags, in contrast to a PLC-5 or SLC controller, which stores data in data files. Logix5000 tags have these properties:

- Name that identifies the data:
  - up to 40 characters in length.
- Scope:
  - Controller (global), which you can access directly.
  - Program (local), which cannot be directly accessed, but can be copied to a controller scope tag.
- Data type, which defines the organization of the data.
  See CIP Data Types on page 11 for more information.

In the Logix Designer application, version 21 and later, and in RSLogix 5000 software, version 18 and later, external access to controller scope tags is user selectable. If a tag's External Access attribute is set to *None,* then the tag cannot be accessed from outside the controller.

For more information about external access to controller scope tags see chapter 4 of the *Logix5000 Controllers I/O and Tag Data Programming Manual*, publication 1756-PM004-EN-P.

For more information about tags and data types, see Chapter 3 of the *Logix5000 Controllers Design Considerations Reference Manual*, publication 1756-RM094.

Tag Type Service Parameter

The Read Tag, Write Tag, Read Tag Fragmented, Write Tag Fragmented, and Read-Modify-Write Tag services require a service parameter that identifies the data type of the tag being referenced. This tag type parameter is:

- A 16-bit value for atomic tags
- Two 16-bit values for structured tags

The value used for structures is a calculated value. For details, see "Tag Type Parameters for Structure" on page 35.

The tag type values used for atomic tags and the resulting data size are shown in the table below.

Tag Type Service Parameter Values Used with Logix Controllers

Data Type	Tag Type Value	Size of Transmitted Data
BOOL	0x0nC1[2]	1 byte
SINT	0x00C2	1 byte
INT	0x00C3	2 bytes[1]
DINT	0x00C4	4 bytes[1]
REAL	0x00CA	4 bytes[1]
DWORD	0x00D3	4 bytes[1]
LINT	0x00C5	8 bytes[1]

1 - Multi-byte data values are transmitted low-byte first
2- The BOOL value includes an additional field (n) for specifying the bit position within the SINT (n = 0-7).

Analysis

These values are based on the CIP Data Type Reporting Values that are defined in Volume 1, Appendix C of the CIP Networks Library, but are extended to 16-bits.

Segment Encoding

The Request Path in a CIP explicit message contains addressing information that indicates to which internal resource in the target node the service is directed. This addressing information is organized by using Logical Segments, Symbolic Segments, or both.

For more detailed information about segments, see the CIP Networks Library, Volume 1, Appendix C.

The following is a summary of the Logical Segment types defined by CIP that are supported by the Logix5000 controller.

Logical Segments

These tables explain the Logical Segments. Not all segment types defined by CIP are supported by Logix5000 controllers.

Segment Type	Value	Byte Order Representation of Element ID Value (low byte first)				
		0	**1**	**…**	**n**	**n+1**
8-bit Element ID	0x28	Value	N/A	N/A	N/A	N/A
16-bit Element ID	0x29	00	Low	High	N/A	N/A
32-bit Element ID	0x2A	00	Lowest	Low	High	Highest

Segment Type	Value	Byte Order Representation of Class ID Value (low byte first)				
		0	**1**	**…**	**n**	**n+1**
8-bit Class ID	0x20	Value	N/A	N/A	N/A	N/A
16-bit Class ID	0x21	00	Low	High	N/A	N/A

Segment Type	Value	Byte Order Representation of Instance ID Value (low byte first)				
		0	**1**	**…**	**n**	**n+1**
8-bit Instance ID	0x24	Value	N/A	N/A	N/A	N/A
16-bit Instance ID	0x25	00	Low	High	N/A	N/A

Segment Type	Value	Byte Order Representation of Attribute ID Value (low byte first)				
		0	**1**	**…**	**n**	**n+1**
8-bit Attribute ID	0x30	Value	N/A	N/A	N/A	N/A
16-bit Attribute ID	0x31	00	Low	High	N/A	N/A

Symbolic Segments

CIP also defines a way to reference items by their symbolic name. The segment used is the ANSI Extended Symbol Segment defined in the CIP Networks Library, Volume 1, Appendix C.

The Read/Write tags services can use these segments in the request path to indicate which target tag to operate on. When addressing an arrayed tag, the Logical Segment for Element ID is also used with the Symbolic Segment.

Segment Type	Value	Byte Order Representation (low byte first)				
		0	1	**…**	**N**	**N+1**
ANSI Extended Symbolic	0x91	Length	1st char	…	Nth Char	(1)

(1) Optional pad byte (00) when length of string (length) is odd. (The pad byte is not added to the length.)

CIP Service Request/Response Format

All CIP services follow the Message Router Request/Response format defined in the CIP Networks Library, Volume 1, Chapter 2. For complete descriptions, refer to the CIP Networks Library.

All *requests* take the following form.

Message Request Field	Description
Request Service	Indicates to the object referenced in the request path what task is to be performed. These can be defined by CIP or by the device manufacturer. Most of the services covered in this manual are defined by Rockwell Automation's vendor-specific objects, and will not be found in the CIP Networks Library.
Request Path Size	A byte value that indicates the number of 16-bit words in the Request Path.
Request Path	A variable sized field that consists of one or more segments. The path refers to the item in the controller that the service operates on. It can contain Logical or Symbolic segments or both.
Request Data	The service-specific data to be delivered to the object referenced in the Request Path. Some services have no service-specific data, so this field is not present in the message frame.

This same form is used for ControlNet and EtherNet/IP communication. Both are CIP-based networks. (Requests received via the serial port use a different protocol, which is discussed in Chapter 5.)

The CIP service format is used for CIP-explicit messages and can be delivered to the controller as connected or unconnected messages. These are sometimes referred to as Transport Class 3 and UCMM, respectively. The mechanisms for doing this are CIP-network specific. For example, for EtherNet/IP access, see the CIP Networks Library, Volume 1, Chapter 3 and the EtherNet/IP Adaptation of CIP, Volume 2.

For more information about using the EtherNet/IP network to communicate with the controller, see http://www.rockwellautomation.com/enabled/guides.html. We recommend using connected messaging whenever possible. Be aware that the information presented here does not replace the need to be properly authorized by ODVA, Inc. to use the Ethernet/IP protocol. See "Who Should Use this Manual" on page 9.

The examples used throughout the manual show only the explicit message protocol elements and *not* the network-specific details. The exception to this is the information in Chapter 4, which shows more details of unconnected versus connected explicit messages, and of the PCCC and DF1 layers. All *responses* take the following general form as shown in the table that follows.

Message Response Field	Description
Reply Service	The request service with the MSB set to 1.
00	Reserved.
General Status	An 8-bit value indicating success or error status. The CIP Networks Library, Volume 1, Appendix B has a list of the general status codes. The object class specified in the request path defines any extended status codes for each service defined for that class.
Extended Status Size	An 8-bit value that indicates how many 16-bit values follow in the additional status field. For status=0 (success) this will be 0.
Extended Status	The array of 16-bit values that further describe the general status code. Only present when the size field is > 0.
Reply Data	The data returned by the specific service request. Some services have no service-specific reply data, so this field is not present in the message frame.

Services Supported by Logix5000 Controllers

The following sections describe the inherent mode of communication and addressing of the Logix5000 controller. The following vendor-specific services operate on tags in the controller using symbolic addressing:

- Read Tag Service (0x4c)
- Read Tag Fragmented Service (0x52)
- Write Tag Service (0x4d)
- Write Tag Fragmented Service (0x53)
- Read Modify Write Tag Service (0x4e)

The first four services above can be used with two different addressing methods:

- Symbolic Segment Addressing
- Symbol Instance Addressing (available in version 21 and above.)

The differences between the methods are described below.

Addressing Method	How it Works	When to Use
Symbolic Segment	• Uses the name of the tag in an ASCII format using ANSI Extended Symbolic Segments • Allows direct access to the tags as displayed in the Logix Designer application Data Monitor • The number of characters in the name affects: – packet size – number of services that can fit in the Multiple Service Packet service – the parsing time of the incoming message in the controller	• Best performance in applications where small to moderate amounts of data are being accessed. • Performance using this method can be improved by organizing the data into user-defined structures and accessing those structures as a whole.
Symbol Instance	• Uses the instance ID of the symbol class for the specific tag you want to access. • To use this method, the client application that accesses the controller *must*: a. Retrieve the symbol instance information from the controller to associate the name of the tag with its instance ID b. Use the instance ID to access the tag.	Best performance in applications where a large number of tags are accessed.

The *Multiple Service Packet Service* (0x0a) may also be used to combine multiple requests in one message frame. Using this will help improve performance when accessing many tags by minimizing the time to transmit and process multiple packets. The number of requests that can be included is limited by the size of each request, which is dependent on the content of the request. The number of characters in the tag names, for example, will have a big impact on the number of requests that can be combined by the Multiple Service Packet Service.

For more information on the Multiple Service Packet Service, see page 31.

The services described here have changed to more descriptive names since earlier versions of this publication. See the table below for previous names of Tag Services.

Service	In earlier versions of this manual, the service was called	In the Logix Designer application, the service was called
Read Tag Service	CIP Read Data	CIP Data Table Read
Read Tag Fragmented Service	Read Data Fragmented Format	N/A
Write Tag Service	CIP Write Data	CIP Data Table Write
Write Tag Fragmented Service	Write Data Fragmented Format	N/A
Multiple Service Packet Service	Multiple Service Packet Service	Multi-Request Service

The Read Tag, Write Tag, Read Tag Fragmented and Write Tag Fragmented services are described on the following pages along with examples of both the Symbolic Segment Addressing and the Symbol Instance Addressing.

For examples showing more complex addressing using both types of addressing, see Chapter 3.

The Request Data and Reply Data are shown in the required order shown in the examples that follow. Any deviation from the order shown will likely result in an error.

Read Tag Service

The Read Tag Service reads the data associated with the tag specified in the path.

- Any data that fits into the reply packet is returned, even if it does not all fit.
- If all the data does not fit into the packet, the error 0x06 is returned along with the data.
- When reading a two or three dimensional array of data, all dimensions must be specified.
- When reading a BOOL tag, the values returned for 0 and 1 are 0 and 0xFF, respectively.

Example Using Symbolic Segment Addressing

Read a single tag named *rate* using *Symbolic Segment* Addressing. The tag has a data type of DINT and a value of 534 The value used for Instance ID was determined using methods described in Chapter 2.

1st Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	01 00	Number of elements to read (1)

1st Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	16 02 00 00	0000216 = 534 decimal

Example Using Symbol Instance Addressing

Read a single tag named *rate* using *Symbol Instance* Addressing. The tag has a data type of DINT and a value of 534.

1st Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 8F F6	Logical Segment for Symbol Class ID Logical Segment for Instance ID of the tag *rate*
Request Data	01 00	Number of elements to read (1)

1st Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	16 02 00 00	0000216 = 534 decimal

Read Tag Service Error Codes

Both Symbolic Segment Addressing and Symbol Instance Addressing may return the following errors.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: Probably instance number is not present.
0x06	N/A	Insufficient Packet Space: Not enough room in the response buffer for all the data.
0x13	N/A	Insufficient Request Data: Data too short for expected parameters.
0x26	N/A	The Request Path Size received was shorter or longer than expected.
0xFF	0x2105	General Error: Access beyond end of the object.

Read Tag Fragmented Service

The Read Tag Fragmented Service allows a client application to read a tag whose data will not fit into a single packet (approximately 500 bytes). The client must issue a series of requests to the controller to retrieve all of the data using this service. The Service, Path, and Number of Elements fields remain the same for each request. The client must change the Offset field value with each request by the number of bytes transferred in the response to the previous request.

The Byte Offset field is always expressed in number of bytes regardless of the data type being read. In the example below, the data type being read is SINT, which happens to be a byte. The elements and offset are in the same units, which will not be the case for other data types.

Example Using Symbolic Segment Addressing

Reading the tag *TotalCount* that has 1750 SINTs consists of the following four service requests with service data, as shown in the tables that follow.

1st Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
	00 00 00 00	Start at this byte offset (0) and return as much as will fit

1st Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 0 through 489

2nd Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
	EA 01 00 00	Start at this byte offset (490) and return as much as will fit

2nd Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 490 through 979

3rd Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
	D4 03 00 00	Start at this offset (980) and return as much as will fit

3rd Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 980 through 1469

4th Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
	BE 05 00 00	Start at this offset (1470) and return as much as will fit

4th Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 1470 through1749

Example Using Symbol Instance Addressing

Reading the tag *TotalCount* that has 1750 SINTs using Symbol Instance Addressing would consist of the following four service requests with service data, as shown in the tables below. The value used for Instance ID was determined using methods described in Chapter 2.

1st Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
Data Offset	00 00 00 00	Start at this element (0) and return as much will fit

1st Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 0 thorough 489

2nd Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*)
Request Data	D6 06	Number of elements to read (1750)
Data Offset	EA 01 00 00	Start at this element (490) and return as much will fit

2nd Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Element 490 through 979

3rd Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
Data Offset	D4 03 00 00	Start at this element (980) and return as much will fit

3rd Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 980 through 1469

4th Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	52	Read Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	D6 06	Number of elements to read (1750)
Data Offset	BE 05 00 00	Start at this element (1470) and return as much will fit

4th Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D2	Read Tag Fragmented Service (Reply)
Reserved	00	
General Status	06	Reply Data Too Large
Extended Status Size	00	No extended status
Reply Data	C2 00	SINT Tag Type Value
	nn nn nn…nn	Data for Elements 1490 through 1749

Each response, except the last one, carries the General Status of 06, *Reply Data Too Large,* to indicate that more data is present than is in this particular frame. The last response carries the General Status of 0 indicating that the data read did not exceed the message size limit. This means that the entire sequence of bytes has been read.

Read Tag Fragmented Service Error Codes

Both Symbolic Segment Addressing and Symbol Instance Addressing may return the following errors.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: probably instance number is not present.
0x06	N/A	Insufficient Packet Space: Not enough room in the response buffer for all the data.
0x13	N/A	Insufficient Request Data: Data too short for expected parameters.
0x26	N/A	The Request Path Size received was shorter or longer than expected.
0xFF	0x2105	General Error: Number of Elements or Byte Offset is beyond the end of the requested tag.

Write Tag Service

The Write Tag Service writes the data associated with the tag specified in the path. The tag type must match exactly for the write to occur; the controller will validate the tag type matches before executing the service.

- When writing a two or three dimensional array of data, all dimensions must be specified.
- When writing to a BOOL tag, any non-zero value will be interpreted as 1.

Example Using Symbolic Segment Addressing

Write the value of 14 to a DINT tag named *CartonSize* using Symbolic Segment Addressing.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4D	Write Tag Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 43 61 72 74 6F 6E 53 69 7A 65	ANSI Ext. Symbolic Segment for *CartonSize*
Request Data	C4 00	DINT Tag Type Value
	01 00	Number of elements to write (1)
	0E 00 00 00	Data 0000000E=14 decimal

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CD	Write Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

Example Using Symbol Instance Addressing

Write the value of 14 to a DINT tag named *CartonSize* using Symbolic Instance Addressing. The value used for Instance ID was determined using methods described in Chapter 2.

Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	4D	Write Tag Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 36 71	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *CartonSize*
Request Data	C4 00	DINT Tag Type Value
	01 00	Number of elements to write (1)
	0E 00 00 00	Data 0000000E=14 decimal

Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	CD	Write Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended statu

Write Tag Service Error Codes

Both Symbolic Segment Addressing and Symbol Instance Addressing may return the following errors.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: Probably instance number is not present.
0x10	0x2101	Device state conflict: keyswitch position: The requestor is attempting to change force information in HARD RUN mode.
0x10	0x2802	Device state conflict: Safety Status: The controller is in a state in which Safety Memory cannot be modified.
0x13	N/A	Insufficient Request Data: Data too short for expected parameters.
0x26	N/A	The Request Path Size received was shorter or longer than expected.
0xFF	0x2105	General Error: Number of Elements extends beyond the end of the requested tag.
0xFF	0x2107	General Error: Tag type used n request does not match the target tag's data type.

Write Tag Fragmented Service

The Write Tag Fragmented Service allows a client application to write to a tag in the controller whose data will not fit into a single packet (approximately 500 bytes). The client must issue a series of requests to the controller to write all of the data using this service.

The Request Service, Request Path Size, Request Path, and Number of Elements fields remain the same for each request. The client must change the byte offset field value with each request by the number of bytes it transferred in the previous request.

The Byte Offset field is always expressed in number of bytes regardless of the data type being read. In the examples that follow, the data type being read is SINT, which happens to be a byte. In this case, the elements and offset are in the same units, which will *not* be the case for other data types.

Example Using Symbolic Segment Addressing

Writing 1750 SINTs to the tag *TotalCount* using Symbolic Segment Addressing would consist of the following four service requests with service data as shown in the tables that follow. The value used for Instance ID was determined using methods described in Chapter 2.

1st Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	53	Read Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	C2 00	SINT Tag Type Value
	D6 06	Total number of elements to write (1750)
	00 00 00 00	Start at this offset.
	nn, nn, . . . nn	Element Data for Elements 0 through 473

1st Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

2nd Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	C2 00	SINT Tag Type Value
	D6 06	Total number of elements to write (1750)
	DA 01 00 00	Start at this offset.
	nn, nn, . . . nn	Element Data for Elements 474 through 947

2nd Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

3rd Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	C2 00	SINT Tag Type Value
	D6 06	Total number of elements to write (1750)
	B4 03 00 00	Start at this offset
	nn, nn, . . . nn	Element Data for Elements 948 through 1421

3rd Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

4th Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	06	Request Path is 6 words (12 bytes) long
Request Path	91 0A 54 6F 74 61 6C 43 6F 75 6E 74	ANSI Ext. Symbolic Segment for *TotalCount*
Request Data	C2 00	SINT Tag Type Value
	D6 06	Total number of elements to write (1750)
	8E 05 00 00	Start at this Offset
	nn, nn, . . . nn	Element Data for Elements 1422 through 1749

4th Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

Example Using Symbol Instance Addressing

Writing 1750 SINTs to the tag *TotalCount* using Symbol Instance Addressing would consist of the following four service requests with service data as shown in the tables that follow.

1st Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	C2 00	SINT Tag Type Value
	D6 06	Number of elements to write (1750)
	00 00 00 00	Start at this Offset
	nn,nn,...nn	Element Data for Elements 0 through 473

1st Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

2nd Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segments for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	C2 00	Tag Data Type
	D6 06	Number of elements to write (1750)
	EC 01 00 00	Start at this Offser
	nn,nn,...nn	Element Data (474 through 947)

2nd Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

3rdMessage Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	C2 00	Tag Data Type
	D6 06	Number of elements to write (1750)
	B4 03 00 00	Start at this Offset
	nn,nn,...nn	Element Data (948 through 1421)

3rd Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

4th Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	53	Write Tag Fragmented Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 1A E0	Logical Segment for Symbol Class ID Logical Segment for Instance ID for the tag *TotalCount*
Request Data	C2 00	Tag Data Type
	D6 06	Number of elements to write (1750)
	8E 05 00 00	Start at this Offset
	nn,nn,...nn	Element Data (1422 through 1749)

4th Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	D3	Write Tag Fragmented Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

The response to each request carries a General Status value of 00, *Success* status indication, to indicate that the write operation was successful. No other Reply Data is returned for this service.

Write Tag Fragmented Service Error Codes

Both Symbolic Segment Addressing and Symbol Instance Addressing may return the following errors.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: probably instance number is not present.
0x10	0x2101	Device state conflict: keyswitch position: The requestor is attempting to change force information in HARD RUN mode.
0x10	0x2802	Device state conflict: Safety Status: The controller is in a state in which Safety Memory cannot be modified.
0x13	N/A	Insufficient Request Data: Data too short for expected parameters.
0x26	N/A	The Request Path Size received was shorter or longer than expected.
0xFF	0x2104	General Error: Offset is beyond end of the requested tag.
0xFF	0x2105	General Error: Offset plus Number of Elements extends beyond the end of the requested tag.
0xFF	0x2107	General Error: Data type used in request does not match the target tag's data type.

Read Modify Write Tag Service

The Read Modify Write Tag Service provides a means to modify Tag data with individual bit resolution. Within ControlLogix, the Tag data is read, the logical or modification masks, or both, are applied, and finally the data is written back to the Tag. It can be used to modify a single bit within a Tag without disturbing other data. Its purpose is similar to the PLC-5 style Read Modify Write PCCC command described in Chapter 5.

Service Request Parameters

Name	Description of Reply Data	Semantics of Values
Size of masks	Size in bytes of modify masks	Only 1,2,4,8,12 accepted
OR masks	Array of OR modify masks	1 mask sets bit to 1
AND masks	Array of AND modify masks	0 mask resets bit to 0

The size of masks must be the same or smaller than the size of the data type being accessed. For complete data integrity (for example, to avoid the possibility of a mix of old and new data when modifying dynamic data), the size of the mask should match the size of the data type.

Example

Set bit 2 and reset bit 5 of the DINT named *ControlWord*.

Message Request Field	Bytes (in hex)	Description
Request Service	4E	Read Modify Write Tag Service (Request)
Request Path Size	07	Request Path is 7 words (14 bytes) long
Request Path	91 0B 43 6F 6E 7H 72 6F 6C 57 6F 72 64 00	ANSI Ext. Symbolic Segment for *ControlWord*
Request Data	04 00	Size of Masks (shall be 4)
	04 00 00 00	Array of OR modify masks
	DF FF FF FF	Array of AND modify masks

Message Reply Field	Bytes (in hex)	Description
Reply Service	CE	Read Modify Write Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

Read Modify Write Tag Service Error Codes

Read Modify Write Tag Service may return the following errors.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x03	N/A	Bad parameter, size > 12 or size greater than size of element.
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: Probably instance number is not present.
0x10	0x2101	Device state conflict: keyswitch position: The requestor is attempting to change force information in HARD RUN mode.
0x10	0x2802	Device state conflict: Safety Status: The controller is in a state in which Safety Memory cannot be modified.
0x13	N/A	Insufficient Request Data: Data too short for expected parameters.
0x26	N/A	The Request Path Size received was shorter or longer than expected.

Multiple Service Packet Service

The Multiple Service Packet Service carries more than one CIP request in a single CIP explicit-message frame. Use this service to optimize CIP reads and writes by grouping service requests together for faster request processing.

For details on this service, see the CIP Networks Library, Volume 1, Appendix A.

Example

Message Request Field	Bytes (in hex)	Description
Request Service	0A	Multiple Service Packet Service (Request)
Request Path Size	02	Request Path is 2 words (4 bytes) long
Request Path	20 02 24 01	Logical Segment: CLass 0x02, Instance 01 (Message Router)
Request Data	02 00	Number of Services contained in this request
	06 00 12 00	Offsets for each Service; from the start of the Request Data
	4C 04 91 05 70 61 72 74 73 00 01 00	First Request: Read Tag Service Tag name: *parts* Read 1 element
	4C 07 91 0B 43 6F 6E 74 72 6F 6C 57 6F 72 64 00 01 00	Second Request: Read Tag Service Tag name: *ControlWord* Read 1 element

The Multiple Service Packet Request Path contains the Message Router object (Class 2, Instance 1). This is always the destination of the Multiple Service Packet's Request Path. The Request Data field contains the Number of Services followed by byte offsets to the start of each service, followed by each of the CIP requests, each following the standard Message Router Request format.

Message Reply Field	Bytes (in hex)	Description
Reply Service	8A	Multiple Service Packet Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	02 00	Number of Service Replies
	06 00 10 00	Offsets for each Service Reply; from the start of the Reply Data
	CC 00 00 00 C4 00 2A 00 00 00	Read Tag Service Reply, Status: Success DINT Tag Type Value Value: 0x0000002A (42 decimal)
	CC 00 00 00 C4 00 DC 01 00 00	Read Tag Service Reply, Status: Success DINT Tag Type Value Value: 0x000001DC (476 decimal)

The Multiple Service Packet response follows the same Message Router Response format as all CIP services; therefore, the General Status, Ext Status Size fields are in the same CIP Service Request/Response Format as described in previous examples. The Reply Data field contains the number of service replies followed by the byte offset to the start of each reply, followed by each of the CIP responses. Each of the responses follows the standard Message Router Response format.

Logix Data Structures

A structure is a compound data type that stores a group of possibly different data types that function as a single unit and serve a specific purpose. (For example, a combination of values.)

- A structure contains one or more members.
- Each member can be an:
  - Atomic data type.
  - Another structured data type.
  - A single dimension array of an atomic or structure data type.

The controller contains four basic types of structures.

- Module-Defined data types - created by adding modules to the I/O tree
- Predefined data types - created by default in the controller (for example, TON, CTU, and Motion)
- Add-On-Defined data types
- User-Defined data types (UDT) - created by the user

You can group most structures into arrays or use them in other structures.

For more information on data types and for information on creating structures, including what types are not allowed, see the *Logix5000 Controllers Design Considerations Reference Manual,* publication 1756-RM094.

The Predefined, Add-On-Defined, and Module-Defined types, as well as Booleans within these structures, are difficult to deal with for various reasons and are beyond the scope of this publication. For alternatives for working with these and other structures, see the information that follows.

Working with Data Structures

- Complete UDT structure tags, or individual members can be accessed. Access to complete structure Tags requires full knowledge of the organization and alignment of structure members, which is relatively straight-forward and follows a small set of rules. The UDT organization is also described in the structure Template, explained in Chapter 2. However, do not access complete UDT Tags that contain nested system structures. (For example, Module-Defined, Predefined, or Add-On Defined.)

- Predefined, Module-Defined, and Add-On-Defined structure tags have a more complex set of rules than UDTs, and have a greater potential to change in the future. Do *not* access complete structure tags of these types, or complete UDTs with nested tags of these types. Instead, access atomic members of these tags that are visible in the Logix Designer application Data Monitor, using either *one* of the methods that follow.

  – Create an alias of the atomic member and access the alias instead of the structure.
  – Create an atomic tag or UDT structure tag with an atomic member, and then have the user program copy the data to and from the tag or atomic member. Access the new tag or atomic member instead.

- In the Logix Designer application, version 21 and later, and in RSLogix 5000 software, version 18 and later, external access to controller scope tags is user-selectable. If a tag's External Access attribute is set to *None,* the tag cannot be accessed from outside of the controller. Therefore, structures that contain members whose external access is set to *None* cannot be accessed as a whole (that is, by reading or writing the entire structure). Similarly, structures that have one or more members whose External Access is set to *Read Only* cannot be written to as a whole (that is, by reading or writing the entire structure*)*, but the members that are not restricted in access can be accessed by using symbolic segment addressing to the specific member.

  Further information on data access control and the effect it has on structure access can be found in *Logix5000 Controllers I/O and Tag Data Programming Manual*, publication 1756-PM004.

- To improve tag access performance and to simplify the task of accessing structured tags via a network, create UDTs for the data that needs to be accessed via the network with members of the types listed below only, and access the UDTs as a whole.

  – Atomic tags
  – Arrays of atomic tags
  – Other UDTs of atomic tags
  – Arrays of UDTs of atomic tags

Understanding Structure Boundaries and Member Order

Structure Boundaries

Structures begin and end on 32-bit boundaries. A Logix5000 controller aligns every data type along:

- an 8-bit boundary for SINTs
- a 16-bit boundary for INTs

- a 32-bit boundary for DINTs, REALs arrays and BOOL arrays (BOOL[nx32])

In a UDT structure, BOOLs are mapped to a host SINT member, and if they are placed next to each other in a UDT structure, they are mapped so that they share the same SINT. The host SINT is not visible in the Logix Designer application Data Monitor, but the individual BOOLs are visible. The Pad bits or bytes that are added as necessary to achieve this required alignment are not visible in the Data Monitor.

For more details, see the Guidelines for User-Defined Structures section in Chapter 3 of the *Logix5000 Controllers Design Considerations Reference Manual*, publication 1756-RM094.

Member Order

It is also important for the client application to understand the byte order of the data in the structure as it will be transmitted on the wire.

For normal UDTs that do not include any nested system structures, the size and member order will be as shown in the Data Monitor view of the structure definition in the Logix Designer application with padding to meet the alignment rules, and hidden host members for BOOLs. Atomic members of the structure are always sent low byte first on the wire. Data Monitor shows the Data Type Size (in bytes) of the resulting structure, and the UDT structure template includes the hidden BOOL host members.

In some cases, a UDT that has been manipulated by Import/Export may contain other members that are not visible in Data Monitor. This document does not address UDTs that have been modified using Import/Export.

Tag Type Service Parameters for Structures

Structures use a Tag Type Service Parameter that is different from the one used with atomic tags. Like atomic tags, writing to UDT-based tags as a whole (that is, the whole structure, not just individual members) requires supplying the proper value for this parameter in the service request to successfully write to the tag. The value is also returned when the structure is read.

The Tag Type Service Parameter for structures is always a 4-byte sequence. The first two bytes are the values A0 and 02, followed by the latter two bytes, which

contain a 16-bit calculated field called a Structure Handle. When transmitted on the wire, it looks like this:

A0	02	Structure Handle Low Byte	Structure Handle High Byte

The Structure Handle comes from Template instance attribute 1 of the template instance associated with the tag. It is a calculated field, but generally it is not necessary to calculate the value. Reading and understanding the template information provides you with all the required information about the structure makeup to unambiguously access it. With that understanding, the client application can use the Structure Handle value read from the template instance attribute 1, rather than calculating it. For more information about structure templates, see Chapter 2.

If you chose to calculate a Structure Handle, the process used to calculate this value can be found on this website:

http://www.rockwellautomation.com/enabled/pdf/TypeEncode_CIPRW.pdf

In Logix controllers, arrays report the data type of its members. An array of an atomic type reports the corresponding 2 byte Tag Type Service Parameter, while an array of structures reports the corresponding 4 byte Tag Type Service Parameter.

IMPORTANT Reading a structure before writing to it is one way to obtain the value for this parameter, but that does not provide any understanding of the structure makeup, which is critical information when manipulating structure data. Also, the Structure Handle value is not unique among structures. Some positional changes of members within an otherwise identical structure will yield the same value.

The most appropriate way to access structures as a whole is to first read their template information and understand the data packing. This assures that the application knows what data type is in what position.

If you read the structure to get the Structure Handle value before writing to it, be aware that the results may be ambiguous. Reserve this method only in cases where the control system development is complete and no further data structure changes will be made.

CIP Services and User-created Tags

Introduction

This chapter describes processes that CIP clients may need to utilize when interacting with Logix5000 controller data, specifically, user-created tags. The processes are as follows.

- Finding the controller-scope tags that are created in a Logix5000 controller
- Isolating user created tags from system tags and identify structured tags
- Locating the structure template for a specific structure
- Determining the structure makeup of a specific structure
- Determining the data packing of the members of a structure when accessed as a whole (that is, not member by member)
- Determining when the list of tags and structure information needs to be refreshed

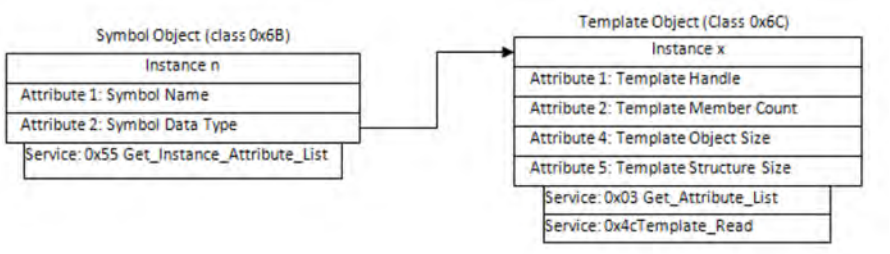
How tags are organized in the controller

Before examining the processes, let us look at how tags are organized in the controller.

A client application must interact with two vendor-specific objects that are associated with tags in Logix5000 controllers: the symbol object and the template object. Through this interaction, the client application learns the following.

- What tags are created
- If a tag is structure
- What the structure members are
- How the data is packed in a message when reading a structure

The following diagram shows the two objects in the Logix5000 controller that are associated with tags. A client application must make use of the attributes and services of these objects to assure it has an understanding of the tag data makeup when reading or writing to tags.



Symbol object

When a *tag* is created, an instance of the *Symbol* class (Class ID 0x6B) is created inside the controller. The name of the tag is stored in attribute 1 of the instance. The data type of the tag is stored in attribute 2.

Instances of the Symbol class are not created in numerical order when a tag is created, so the Symbol class defines a class-specific service called Get_Instance_Attribute_List. This service helps with the process of finding a specific instance of the class. It allows retrieval of the name and type attributes for each instance of the class that has been created.

The names of structure members contained in the template instance information are not found in instances of the Symbol object. The member names for structures only exist in the template definition. It is not uncommon, however, to see a UDT template definition that contains members whose names are the same as other tags in the controller.

Template object

When a UDT is created, an instance of the *Template* object (Class ID 0x6C) is created to hold information about the structure makeup. This instance of the Template object provides information about the template structure such as:

- Its name.
- The member list.
- The number of members.
- The size of the structure when read or written.
- The Structure Handle.

The Get_Attribute_List service directed to the Template object allows the client application to retrieve one or more attributes from a specific instance of the Template class. Template instance attributes provide information about the template structure itself so the application can interpret what it receives when using the Template_Read service.

The Template Read service is used to retrieve the template structure information that describes the members of the structure, their ordering, and data types. This information is required when accessing a structured tag as an entire structure to understand the data packing in the message frame.

Other structures within the Logix5000 controller, including Module-Defined, Add-On-Defined, and Predefined data types, are also described in instances of the Template object. However, for these data types, accessing entire structured tags is outside the scope of this manual. Instead, use the Logix Designer application to implement one of the following indirect methods to access individual member tags.

Access atomic or arrayed atomic members of Module-Defined, Add-On-Defined, or Predefined structure tags using *one* of the following methods:

- Create a corresponding atomic tag (or atomic member of a structured tag) and use ladder logic to periodically copy the atomic member of the structure to the atomic tag.
- Create an alias tag for the atomic member that needs to be accessed.

These tags will then be present in the Symbol object instances and can be accessed like any other atomic tag.

The above methods can also be used with structured tags of a UDT that contain a nested Module-Defined, Add-On-Defined, or Predefined type member.

IMPORTANT	The information described in this manual about accessing and understanding structures should not be used to access complete Module-Defined structures, Predefined structures, Add-On-Defined structures, or system tags, whether they are stand alone, an alias, or nested within another user created tag. Tags of these types have different rules for dealing with host members and mapping of BOOLS, which are beyond the scope of this document. If such structures are manipulated or accessed, results can be unpredictable.

The STRING data type is a form of Predefined structure that would normally be excluded after executing steps that will be described later. However, there is an alternate method for the STRING type. The user can easily create UDT String structures, including Strings of the same format as the standard STRING. Doing this will allow external access to the string and avoid the issues of Predefined structures.

To access any atomic tag that is visible in the Logix Designer application Data Monitor, the user also has the option of manually entering into client SW the full symbolic tag address (NAME in the Data Monitor). This includes atomic members of any structure that are visible in Data Monitor. This only applies to visible atomic tags and atomic members of structured tags.

Creating and maintaining a symbol object list

Some client applications will access atomic tags or atomic members of structured tags simply by knowing the name of the tags it wants to access, while other client applications require the ability to learn what tags are present in the controller and allow the user to pick the data they want to access. The former may not need to go through all the steps indicated here. For example, if the name of the tags are known and the Symbolic Segment Addressing method is used to access only atomic tags or atomic members of structured tags, then reading all the symbol instances or interpreting the template information is not required.

If the client application does need to know what tags are available or does attempt to access structures as a whole, then it is important that the client have a list of the key information about the tags necessary for proper access before attempting to manipulate tag data. Having this information on-hand is required to unambiguously identify the data type of each tag so that the application understands how to interpret the data value associated with the tag.

You also need to make sure that this list is kept up to date. User program changes frequently create or delete tags, as well as add, delete, and modify UDTs.

Use the steps that follow to create and maintain a list of controller-scope symbol objects in a Logix5000 controller, associate each instance with a template object instance if it is a structured tag, and then eliminate the symbol instances of data that should not be accessed or manipulated by a client application.The rest of this chapter outlines these steps in detail.

1. Find all controller-scope tags.
2. Isolate user-created tags from system tags.
3. Determine the makeup of the structures.
   Note that structure members are not separate Symbol instances, although an alias to a structure member is a Symbol instance.
4. Determine the data packing of structure members in a message.
5. Determine when Symbol Instances have changed.

Step 1: Finding user-created controller scope tags in a Logix5000 controller

This section describes the process used to learn what controller-scoped tags are located in the Logix5000 controller by retrieving the Symbol Name and Symbol Type attributes for each instance of the Symbol Object.

The Get_Instance_Attribute_List (0x55) service returns instance IDs for each created instance of the Symbol class, along with a list of the attribute data associated with the requested attributes.

Retrieving all symbol object instances

The maximum size of a single packet is approximately 500 bytes, which is normally insufficient to return all instances and attributes in a single request. Therefore, the client application must issue a series of requests to the controller, adjusting the starting instance with each request, in order to retrieve all of the instances.

The steps the client application must use to retrieve all the instances are as follows:

1. Set initial instance to zero.
2. Send request.
3. When General Status = 06 is returned, there is more data to read. To determine the last instance sent in the reply, parse the data received from the Logix5000 controller to find the last instance ID returned.
4. Add one to the instance number determined in step 3.
5. Send the request again using the new instance value in the Request Path.

When General Status = 00 *Success*, then all the symbol instances that are created have been returned.

Example of retrieving the first group of tags

The table below shows the format of the initial service request, which starts with Symbol Object, Instance 0. This will return as much of the requested data as will fit in the reply. Most controller programs will require multiple attempts to get all the tags.

Message Request Field	Bytes (in hex)	Description
Request Service	55	Get_Instance_Attribute_List Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 00 00	Logical Segments: Class 0x6B, Instance 0 (starting instance)
Request Data	02 00	Number of attributes to retrieve
	01 00	Attribute 1 – Symbol Name
	02 00	Attribute 2 – Symbol Type

Message Reply Field	Bytes (in hex)	Description
Reply Service	D5	Get_Instance_Attribute_List Service (Reply))
Reserved	00	
General Status	06	Status of 06 means: Too Much Data
Extended Status Size	00	No extended status

Message Reply Field	Bytes (in hex)	Description
Reply Data	12 03 00 00	First 32-bit Instance ID (The 1st Instance ID after the instance specified in the Request Path)
	0D 00 43 69 70 52 65 61 64 44 61 74 61 31 30	16-bit Symbol Name Length Characters in the symbol name
	FF 8F	Symbol Type
	51 0E 00 00	Second 32-bit Instance ID
	06 00 63 6F 75 6E 74 73	16-bit Symbol Name Length Characters in the symbol name
	82 CF	Symbol Type
	…	Next …
	34 5D 00 00	Last 32-bit Instance ID in this reply
	0A 00 50 61 72 74 73 5F 44 65 73 74	16-bit Symbol Name Length Characters in the symbol name
	C3 00	Symbol Type

Analysis

- The Reply Data includes the Instance ID along with the data values for attributes 1 and 2.
- The Symbol Name attribute is a variable length structure of type STRING that consists of a UINT character count followed by the single octet characters (ASCII encoded) in the name.
- The Symbol Type attribute is a WORD, which is a 16-bit string, representing the symbol data type that is described in the next step.

  The example above returned some number of instances, starting with instance 0x0312 and ending with instance 0x5D34. Only instances that are created will be returned. For this reason, gaps in the instance numbers are normal and to be expected.

  Any symbol instances that represent tags whose External Access is set to *None* will not be included in the reply data.

Continuing the retrieval process

The following example is a continuation from the previous one, assuming that the controller had more symbols than would fit in one reply. The last instance number shown in the previous example was 0x5D34 which, when incremented, is 0x5D35.

Example of the next set of instances/attribute data

The table that follows shows the request for the next set of instances or attribute data. The value 0x5D35 is used as the starting instance ID in the path.

Message Request Field	Bytes	Description
Request Service	55	Get_Instance_Attribute_List Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 35 5D	Logical Segments: Class 0x6B, Instance 0 x5D35(starting instance)
Request Data	02 00	Number of attributes to retrieve
	01 00	Attribute 1 – Symbol Name
	02 00	Attribute 2 – Symbol Type

The Logix5000 controller will retrieve data beginning with instance 0x5D35 and return as much data as will fit in the message frame. Subsequent responses will look like those in the following table.

Message Reply Field	Bytes (in hex)	Description
Reply Service	D5	Get_Instance_Attribute_List Service (Reply)
Reserved	00	
General Status	06	Status of 06 means: Too Much Data
Extended Status Size	00	No extended status
Reply Data	43 63 00 00	First 32-bit Instance ID (The 1st Instance ID after the instance specified in the Request Path)
	0C 00 43 69 70 52 65 61 64 44 61 74 61 33	16-bit Symbol Name Length Characters in the symbol name
	FF 8F	Symbol Type
	54 72 00 00	Second 32-bit Instance ID
	0F 00 73 61 6D 70 6C 65 54 69 6D 65 5F 44 65 73 74	16-bit Symbol Name Length Characters in the symbol name
	83 8F	Symbol Type
	…	Next …
	E8 08 00 00	Last 32-bit Instance ID in this reply
	13 00 50 72 65 67 72 61 6D 3A 4D 61 69 6E 50 72 6F 67 72 61 6D	16-bit Symbol Name Length Characters in the symbol name
	68 10	Symbol Type

The retrieval process is repeated until the General Status of 00 is received from the Logix5000 controller, indicating the last of the data has been sent.

When the retrieval process is complete, the client has a list of the following items.

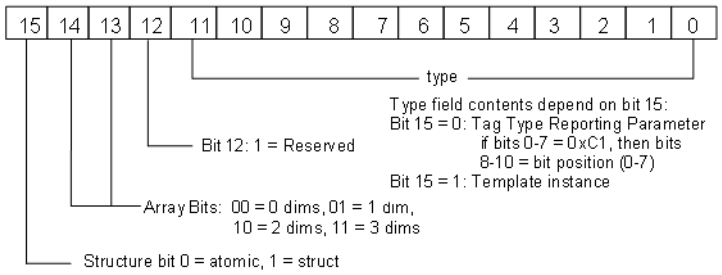
- All the controller scope tags in the controller, including atomics, structures, arrays, and aliases
- Which instance of the Symbol class is associated with each controller scope tag
- Information about the data type of each controller scope tag, including whether or not it is a structured tag

Step 2: Isolating user-created tags from system tags/ identifying structured tags

Once the application has retrieved the last of the data, the next step is to remove the system tags, Predefined tags, Add-On-Defined tags, and Module-Defined tags. This is accomplished by interpreting the Symbol Type, Symbol Name, and structure Template Name, structure first Member Name, and the Type of each structure member.

Symbol Type Attribute

The Symbol Type attribute can be examined to learn more about the tag. The Symbol Type value is decoded as follows:



Atomic and structured tags are differentiated according to the value of bit 15. Symbols where bit 12 =1 is a system tag are beyond the scope of this document and should not be accessed.

Tag Type	Symbol Type Attribute	Description
Atomic tag	Bit 15 = 0, Bit 12 = 0	There is no template instance because this is an atomic tag.The value of bits 0-11 of the Symbol Type attribute is the Tag Type Service Parameter used in the Read/Write Tag services.
Structured tag	Bit 15 = 1, Bit 12 = 0	Bits 0-1 1 of the SymbolType attribute are the instance ID of the template object that contains the structure definition for this tag.

For *any* tag type, the value of bits 13 and 14 indicates the dimensions of this tag as shown in the following table:

Bit 14	Bit 13	Meaning
0	0	0 dimensions (not an array)
0	1	1 dimension array
1	0	2 dimension array
1	1	3 dimension array

The Template object contains information about structures. There are many instances of the object class created to hold structures associated with data inside the Logix5000 controller. When you create new User-Defined Types, a new instance of the object class is created, and, like the Symbol class, the instance ID numbers do not follow any particular order.

Structured tags are linked to the appropriate template object instance through the Symbol Type attribute. For this reason, it is not necessary to read all the instances of the Template class. Simply refer to the Symbol Type attribute. When Bit 12=0; Bit15=1, then Bits 0-11 represent the instance ID of the template associated with this tag.

For example, assume a tag exists in the controller named *MachineSummary* and that it is a structure of type STRUCT_B. The Symbol Type attribute(attribute 2) for this tag has the value 0x82E9. Bit 15 is set indicating this tag is a structured tag and Bit 12 is reset so it is not a reserved tag. The value of bits 0-11 is 0x2E9 is the instance ID of the Template object where this tag's structure makeup is defined and its value is within the range of values that can be accessed. (See the rules below.)We will use instance ID 0x2E9 in the example in the next step to retrieve the structure information for a tag of this type.

Knowing how to interpret the Symbol Type attribute, you can begin to identify tags that are *not* user-created from those that *are* user-created.

Eliminating tags by applying rules

Beginning with the full list of symbol instances, eliminate tags that should not be accessed or manipulated by applying the following rules.

1. Discard tags that are not in *either* of these valid ranges (eliminates Predefined and String)
   - the Symbol Type, Bit 12=0, Bit 15=0, and Bits 0-11 range from 0x001-0x0FF (atomics)
   - the Symbol Type, Bit 12=0, Bit 15=1, and Bits 0-11 range from 0x100-0xEFF (structures, not including Predefined)

2. Discard tags that contain *either* of the following characters
   - the Symbol Name contains leading double underscores (for example, __ABC) (eliminates some system tags)
   - the Symbol Name contains a colon (:) (for example, eliminates Module-Defined tags)
3. For the structure tags that remain (bit 15=1), access the Templates and discard tags where the Template Name, or the name of the first member of the structure, contains leading double underscores or a colon (:) This eliminates Add-On-Defined tags and alias' of Module-Defined tags.

   For template details, see Step 3: Determining the structure makeup for a specific structure.
4. Locate any nested member structures within the remaining structures, by checking the Type of each member. For any nested structures, repeat the checks above for Type in valid range, Template Name and first Member Name, and discard the total structure if a check fails. Continue until all nested structures have been checked.

Following all the steps described above will leave only those tags that are completely user-created.

Step 3: Determining the structure makeup for a specific structure

From the tags that remain, any tag where the Symbol Type Bit 15 = 1 is a structured data type. It is necessary for the client application to read information from the Template object Instance ID that is associated with this tag. This Instance ID is the value of Symbol Type, Bits 0-11. There are four attributes of this instance that contain information about structured data types that are useful to a client application that will interact with a UDT-based tag.

Read the following Template Instance attributes, using the instance ID in the Request Path of the Get_Attribute_List service (0x03) to the Template class (0x6C).

Attribute	Description/Characteristics
1	• This is the Tag Type Parameter used in Read/Write Tag service • Structure Handle • Data Type: UINT
2	• This is the number of structure members • Template Member Count • Data Type: UINT
4	• This is the number of 32-bit words • Template Object Definition Size • Data Type: UDINT
5	• This is the number of bytes of the structure data • Template Structure Size • Data Type: UDINT

The table that follows shows how to read the list of attributes for a specific instance of the Template Object associated with the STRUCT_B example.

Example of reading template attributes

Message Request Field	Bytes (in hex)	Description
Request Service	03	Get Attributes, List Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6C 25 00 E9 02	Logical Segment Class 0x6C, Instance ID 0x02E9
Request Data	04 00	Attribute Count
Request Data	04 00 05 00 02 00 01 00	Attribute List: Attributes 4, 5, 2 and 1 are requested

The response in the table below contains a count of the items requested, followed by a structured response for each item consisting of the attribute ID (16-bits), status of retrieval (16-bits), and the attribute data (size varies).

Message Reply Field	Bytes (in hex)	Description
Reply Service	83	Get_Attributes_List Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	04 00	Count of Items returned
	04 00 00 00 IE 00 00 00	Attribute 4, Template Object Definition Size Status: 0000 = success Size of the template definition structure in 32-bit words
	05 00 00 00 20 00 00 00	Attribute 5, Template Structure Size Status: 0000 = success Number of bytes transferred on the wire when the structure is read using the Read Tag service
	02 00 00 00 04 00	Attribute 2, Member Count Status: 0000 = success Number of members defined in the structure
	01 00 00 00 CD 9E	Attribute 1, Structure Handle Status: 0000 = success Calculated CRC value for members of the structure.

The following error codes may be returned by the Get_Attribute_List service to the Template object.

Error Code (Hex)	Extended Error (Hex)	Description of Error
0x04	0x0000	A syntax error was detected decoding the Request Path.
0x05	0x0000	Request Path destination unknown: probably instance number is not present.
0x06	N/A	Insufficient Packet Space: Not enough room in the response buffer for all the data.
0x0A	N/A	Attribute list error, generally attribute not supported. The status of the unsupported attribute will be 0x14.
0x1C	N/A	Attribute List Shortage: The list of attribute numbers was too few for the number of attributes parameter.
0x26	N/A	The Request Path Size received was shorter than expected.

Analysis

With the information returned in the previous example, the client application now has all the information necessary to use the Template Read service to retrieve the template member information.

- Attribute 4 (Template Object Definitions Size) will be used to calculate how much data to read when using the Template Read service (0x4C) to get the template definition structure from the Template instance. The service data includes the starting byte offset (initially = 0) and the number of bytes to read.

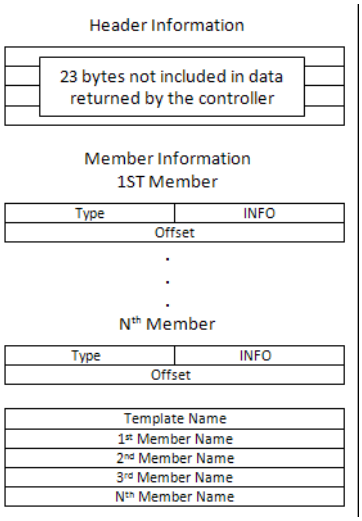
  The number of bytes to read is calculated as:
  (Template Object Definition Size * 4) – 23.

  Use the entire size calculated here in the request, regardless of how big it is.

- The service handler in the Logix5000 controller will only return as much data as will fit in the message frame, and will use the General Status = 06 to indicate there's more to read. The client can then adjust the starting offset (that is, new starting offset = bytes received +1)and reissue this request, repeating the process until General Status = 0 is returned, indicating that all data has been read. For smaller structures, these extra steps may not be required, as all the data will fit in a single reply.

- The structure data returned by the Template Read service has the format shown in the figure that follows.

Structure data format



The response to the Template Read service is the Member Information above, which consists of two 32-bit data values for each structure member.

Contents of the member information

The first 32-bit value contains the following:

- The lower 16-bits are the INFO value. It can be *one* of following values:
  - If the member is an atomic data type, the value is zero.
  - If the member is an array data type, the value is the array size (max 65535).
  - If the member is a Boolean data type, the value is the bit location (0-31; 0-7 if mapped to a SINT).
- The upper 16-bits represent the data type. For the meaning of this data, see the description of the Symbol Type.
- The second 32-bit value is the offset location of the member in the UDT structure.

The offset given in the Member *n* offset value in the example that follows is where the member is located in the stream of bytes returned from reading a tag of this type that has been created in the controller.

Example of retrieving member information

Below is an example using the Template Read service to retrieve the member information for a specific instance of the Template object. The example should help you understand how to interpret the member information stored in the template instance.

The structure that is accessed in this example is a user defined structure named *STRUCT_B* that was defined with the following members:

- BOOL named *pilot_on*
- INT array of 12 elements named *hourlyCount*
- REAL named *rate*

A tag of the type STRUCT_B was created and given the name *MachineSummary*. This tag name is used in the following example. The instance ID used in this example was determined by examining the Symbol Type attribute of the tag *MachineSummary*, as described in Step 2, earlier in this chapter. The Template Read service request and response to that instance is shown in the tables that follow.

Example

Reading the structure information for the tag *MachineSummary*, which is a user defined type called *STRUCT_B*.

Message Request Field	Bytes	Description
Request Service	4C	Read Template Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6C 25 00 E9 02	Logical Segment: Class 0x6C, Instance 0x02E9
Request Data	00 00 00 00 61 00	Offset to start reading from (should be zero, initially) The number of bytes to be read.

Message Reply Field	Bytes	Description
Reply Service	CC	Read Template Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No Extended Status
Reply Data	00 00 C2 00 00 00 00 00	Member 1 info, type, offset: non-array (0000) SINT (00C2) Offset (00000000)
	00 00 C1 00 00 00 00 00	Member 2 info, type, offset: bit 0 (0000) BOOL (00C1) Offset (00000000) (bit 0 in the above SINT)
	0C 00 C3 20 04 00 00 00	Member 3 info, type, offset: 12 element array (000c) INT (C3 20) Offset (00000004)
	00 00 CA 00 1C 00 00 00	Member 4 info, type, offset: non-array (0000) REAL (00CA) Offset (0000001C)
	53 54 52 55 43 54 5F 42 3B 6E 45 42 45 43 45 41 48 41 00	Template Name (STRUCT_B) The structure name precedes the 0x3B in the stream of bytes. All remaining bytes are outside the scope of this document.
	5A 5A 5A 5A 5A 5A 5A 5A 5A 5A 53 54 52 55 43 54 5F 42 30 00	Member 1 Name: The name of this member for one or more members is chosen by the Logix Designer application. This is a host member for the BOOL (Member 2) that follows. Member 1 is sent on the wire but not visible in Data Monitor to the user in the Logix Designer application Data Monitor view. As indicated by the offset value for Member 3, there are 3 bytes of pad inserted after the SINT for this host member, for data alignment purposes. These pad bytes are sent on the wire when the entire structure is read/written.

Message Reply Field	Bytes	Description
	70 69 6C 6F 74 5F 6F 6E 00	Member 2 Name: This is the first member of the structure that is visible to the user in the Logix Designer application Data Monitor view. This is the *pilot_on* member. Because Member 2 information from earlier in the packet indicates that this is a BOOL type and that the data offset is zero, the client can infer that this BOOL is part of the host member at the zero data offset (that is, Member_1) and that this is bit 0 of that member. The other 7 bits of Member_1 are not used and are not visible. Member 2 is not sent separately on the wire because it is part of Member_1.
	68 6F 75 72 6C 79 43 6F 75 6E 74 00	Member 3 Name: This is the *hourlyCount* member. It is a DINT data type and is at offset 4.
	72 61 74 65 00	Member 4 Name: This is the *rate* member. It is a REAL data type and is at offset 1C.

Following the member information are the UDT Template Name string and structure member names, stored as null-terminated strings. For a UDT structure, the Template Name string contains the Template Name followed by the characters *;n* plus additional characters. This may also be true for some non-UDT structures. For other non-UDT structures, the semi-colon may be followed by other characters, or just a NULL instead of the semi-colon and characters. Non-UDT structures are beyond the scope of this publication and should not be accessed as whole structures.

In the example above, the first and second members have the same offset. This is typical of how BOOL members are mapped into UDTs. The first member is the host member for the data described by the second member. The second member, the visible member, is what is seen in Logix Designer application Data Monitor.

More about BOOLS in UDTs

This description applies only to UDTs, not Module-Defined, Add-On-Defined or Predefined structures.

BOOLs in UDTs are typically mapped to a previous SINT (whose name begins with the prefix ZZZZZZZZZZ) in the structure data stream. This SINT does *not* appear in the Logix Designer application Data Monitor view. With SINT host members, if more than eight contiguous BOOLs are defined, multiple adjacent SINTs will be created to hold them. The bits are always mapped into each SINT beginning with bit 0 thru bit 7 for contiguous BOOLS. If BOOLS are defined non-contiguously in a UDT, there will be more than one host member to which they are mapped. The Member Offset in the Template identifies where the host SINT is located and the bit order of the BOOL in the SINT is determined by the order of the bit in the structure. The host member is sent on the wire when the tag is accessed, but the visible BOOL is only present in the structure definition to enumerate the value and is not part of what is sent on the wire.

Logix BOOL arrays are always multiples of BOOL[32] and are implemented as a DWORD array.

To better understand structure encoding, refer to the information on structured definitions in the *Logix5000 Controllers Import/Export Manual*, publication 1756-RM084.

Step 4: Determining the data packing of the members of a structure when accessed as a whole

An example of reading an entire structure to show how that data is transmitted follows. The values for the tag accessed in this example are shown below.

Continuing with the example structured tag named *MachineSummary* is a tag of type STRUCT_B. The members of the tag *MachineSummary* have the following values:

- pilot_on = 1
- hourlyCount[0] = 0x00
- hourlyCount[1] = 0x01
- hourlyCount[2] = 0x02
- ...
- hourlyCount[11] = 0x0b
- rate = 1.0

The Read Tag service is used to retrieve this entire structure is formatted as follows.

Example of reading an entire structure

Message Request Field	Bytes	Description
Request Service	4C	Read Tag Service (Request)
Request Path Size	08	Request Path is 8 words (16 bytes) long
Request Path	91 0E 4D 61 63 68 69 6E 65 53 75 6D 6D 61 72 79	ANSI Ext. Symbol Segment for *Machine Summary*
Request Data	01 00	Number of elements to read (1)

The data returned would be packed like this:

Message Reply Field	Bytes	Description
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No Extended Status
Reply Data	A0 02 CD 9E	=Tag Type Service Parameter (The Structure Handle, Template Instance Attribute 1. See Step 3.)
	01	= host SINT (for BOOLs)

Message Reply Field	Bytes	Description
	00	= Pad byte
	00	= Pad byte
	00	= Pad byte
	00 00	= hourlyCount[0] (array of INT)
	01 00	= hourlyCount[1]
	02 00	= hourlyCount[2]
	03 00	= hourlyCount[3]
	04 00	= hourlyCount[4]
	05 00	= hourlyCount[5]
	06 00	= hourlyCount[6]
	07 00	= hourlyCount[7]
	08 00	= hourlyCount[8]
	09 00	= hourlyCount[9]
	0a 00	= hourlyCount[10]
	0b 00	= hourlyCount[11]
	00 00 80 3F	= rate (REAL)

The amount of data returned (0x20 bytes) agrees with the value of Attribute # 5 (Template Structure Size = 0x20 as determined in Step 3) using the Get_Attributes_List service.

Step 5: Determining when the tags list and structure information need refreshing

The client application should periodically check for changes in the controller to determine if it needs to repeat the process outlined in this chapter. Once controller program development is complete, tags and UDT definitions generally remain constant; however, it is possible that a the PLC program developer may create or delete tags from time to time, or change a UDT definition. When that happens, the symbol object instance associated with a tag may change, the relationship between the template instance and the symbol instance may change, or the data makeup of a UDT-based tag can change.

How to detect changes

There are several attributes of an object inside the controller that indicate a change was made to the controller. A change in these values can indicate that there were changes to symbol instances, template instances, or both. These are not the only changes indicated by these attributes, but these provide the most straightforward way to determine when the client application should refresh the list of created tags, while keeping the number of false indications to a minimum.

The client application should use the Get_Attribute_List service to periodically retrieve attributes 1, 2, 3, 4 and 10 of class 0xAC in the controller. If the value of these attributes changes between reads, then the client application must refresh the:

- List of symbols
- Association between symbols and templates
- Template information.

One method that can be used to check these attributes is to use the Multi Service Packet Service (0x0a) to group the Get_Attribute_List service with the Read Tag services. If either of the following situations occur, discard the Tag Read reply data and refresh the symbol and template information:

- The values returned for these attributes are different than the last time they were read.
- The General Status 0x05 (Path Not Known) is returned, which indicates that a project download is in progress.

IMPORTANT	Do not use the Multi Service Packet service to group the attribute check with the Tag Write service, as this would allow data to be written before determining whether the tag information needs to be re-read.

When writing to tags, first prepare the tags to be written then check these attributes. If no change is indicated and the General Status of the request is *Success,* proceed with writing the tag data, otherwise, refresh the tag and template information as described. The tag write can then be followed by the attribute reads to confirm that the tag was not changed in the small window before the write. If the attribute check fails, the tag itself can be checked to confirm it did not change.

The client application should always refresh this information after re-establishing its CIP network connection with the Logix5000 controller (that is, after the EtherNet/IP or ControlNet connection is broken and restored), or if ever a General Status of 0x05 is returned when attempting to read these attributes.

The service request and reply are shown as follows.

Message Request Field	Bytes (in hex)	Description
Request Service	03	Get_Attribute_List Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 AC 25 00 01 00	Logical Segments: Class 0xAC, Instance 0x0001
Request Data	05 00	Number of attribute IDs that follow(5)
	 01 00 02 00 03 00 04 00 0A 00	Attribute list: Attribute 1 Attribute 2 Attribute 3 Attribute 4 Attribute 10

Message Reply Field	Bytes (in hex)	Description
Reply Service	83	Get_Attributes_List Service (Reply)
Reserved	00	Reserved
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	02 00	Number of attribute responses that follow
	01 00	Attribute number (attribute 1)
	00 00	Success
	05 00	Attribute value (INT)
	02 00	Attribute number (attribute 2)
	00 00	Success
	01 00	Attribute value (INT)
	03 00	Attribute Number (Attribute 3)
	00 00	Success
	03 B2 80 C5	Attribute value (DINT)
	04 00	Attribute Number (Attribute 4)
	00 00	Success
	03 B2 80 C5	Attribute value (DINT)
	0A 00	Attribute Number (Attribute 10)
	00 00	Success
	F8 DE 47 B8	Attribute value (DINT)

The CPU Lock feature of Logix5000 controllers causes this specific service request to return a General Status 0x10, Device State Conflict when the controller is password locked. When in this state, controller memory is unable to be altered, so the client application can assume that memory will not change. Rockwell Automation suggests that upon receipt of the Device State Conflict for the first time, the client application should refresh the tag information one time, and then again, only upon a connection loss and reconnect or upon the receipt of General Status 0x05, or upon a success response to this service that indicates that the CPU is once again unlocked.

CIP Addressing Examples

The following examples show Request Path strings for various data accesses using native CIP service requests and addressing.

These examples show only a portion of a message frame for requests and responses. References to atomic data types that are not dimensioned (not an array) are fairly straightforward to construct. References to arrays, portions of arrays, or atomic members of structures are not as straightforward. This section will use examples to show how various references are constructed.

Visit http://www.rockwellautomation.com/enabled/guides.html to download:

- The traffic capture files that contain these services.
- The controller project file used as the target in these examples.

Atomic Members of Predefined Data Types

The following examples access tags that return atomic data types.

Example 1 (Symbolic Segment Addressing Method)

Read a single integer tag named *parts*.The tag has a data type of INT and a value of 42.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	04	Request Path is 4 words (8 bytes) long
Request Path	91 05 70 61 72 74 73 00	ANSI Ext. Symbolic Segment for *parts*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C3 00	INT Tag Type Value
	2A 00	0x002A= 42 decimal

Example 2 (Symbol Instance Addressing Method)

Read a single integer tag named *parts*.The tag has a data type of INT and a value of 42.

Message Request Field	Bytes (in hex)	Description - Symbol Instance Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	03	Request Path is 3 words (6 bytes) long
Request Path	20 6B 25 00 82 25	Logical Segment for Symbol Class ID Logical Segment for Instance ID for tag *parts*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbol Instance Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C3 00	INT Tag Type Value
	2A 00	002A = 42 decimal

Example 3 (Symbolic Segment Addressing Method)

Write the value of 14.5 to the 6th element of an array of REALs named *setpoints*(setpoints[5]).

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4D	Write Tag Service (Request)
Request Path Size	07	Request Path is 7 words (14 bytes) long
Request Path	91 09 73 65 74 70 6F 69 6E 74 73 00 28 05	ANSI Ext. Symbolic Segment for *setpoints* and . . .the Member segment for *5*
Request Data	CA 00	REAL Tag Type Value
	01 00	Number of elements to write (1)
	00 00 68 41	0x41680000 = 14.5 decimal

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CD	Write Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

Example 4 (Symbolic Segment Addressing Method)

Read two elements of *profile[0,1,257*], which is a three dimensional DINT array The values of the tag are 572 and 50988.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	09	Request Path is 9 words (18 bytes) long
Request Path	91 07 70 72 6f 66 69 6c 65 00 28 00 28 01 29 00 01 01	ANSI Ext. Symbolic Segment for *profile* Member Segment for 0 Member Segment for 1 Member Segment for 257
Request Data	02 00	Number of elements to read (2)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	F0 02 00 00 2C C7 00 00	0x000002F0 = 752 decimal 0x0000C72C=50988 decimal

Example 5 (Symbol Instance Addressing Method)

Read one element of *profile[0,1,257]* which is a three dimensional array of DINTs.

Message Request Field	Bytes (in hex)	Description
Request Service	4C	Read Tag Service (Request)
Request Path Size	07	Request Path is 7 words (14 bytes) long
Request Path	20 6B 25 00 97 8A 28 00 28 01 29 00 01 01	Logical Segment for Symbol Class ID Logical Segment for Instance ID for tag *profile* Member Segment for 0 Member Segment for 1 Member Segment of 257
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	F0 02 00 00	0x000002F0 = 752 decimal

Example 6 (Symbolic Segment Addressing Method)

Read the accumulated value of a timer named *dwell3* (dwell3.ACC).

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	07	Request Path is 7 words (14 bytes) long
Request Path	91 06 64 77 65 6C 6C 33 91 03 61 63 63 00	ANSI Ext. Symbolic Segment for *dwell3* ANSI Ext. Symbolic Segment for *ACC*'
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	25 02 00 00	0x00000252 = 549 decimal

Example 7 (Symbolic Segment Addressing Method)

Write a preset value of 50 to the .PRE member of the counter *ErrorLimit* (ErrorLimit.PRE).

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4D	Read Tag Service (Request)
Request Path Size	09	Request Path is 9 words (18 bytes) long
Request Path	91 0A 45 7272 6F 72 4C 69 60 69 74 91 03 50 52 45 00	ANSI Ext. Symbolic Segment for *ErrorLimit* ANSI Ext. Symbolic Segment for *PRE*
Request Data	C4 00 01 00 32 00 00 00	DINT Tag Type Value Number of elements to write (1) 0x00000032 = 50 decimal

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status

Example 8 (Both Addressing Methods)

Read the tag *struct3.today.rate*, which is a structure of type STRUCT_C, using both the Symbol Instance and Symbolic Segment Addressing methods.

Message Request Field	Bytes (in hex)	Description- Symbol Instance and Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	0A	Request Path is 9 words (18 bytes) long
Request Path	20 6B 25 00 D1 18 91 05 74 6F 64 61 79 00 91 04 72 61 74 65	Logical Segment for Symbol Class ID Logical Segment for Instance ID for tag *struct3* ANSI Ext. Symbolic Segment for member *today* ANSI Ext. Symbolic Segment for member *rate*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbol Instance and Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	CA 00	REAL Tag Type Service Parameter
	00 00 80 41	16.0 decimal

Example 9 (Both Addressing Methods)

Read the tag *my2Dstruct4[1].today.hourlyCount[3]* using both Symbolic Instance and Symbolic Segment Addressing methods.

Message Request Field	Bytes (in hex)	Description - Symbol Instance and Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	16	Request Path is 22 words (44 bytes) long
Request Path	20 6B 25 00 4B 0D	Logical Segments for Symbol Class ID and Instance ID for *myDstruct4*
	28 00	Element ID for element 0
	91 07 6D 79 61 72 72 61 79 00	ANSI Ext. Symbolic Segment for *myarray*
	28 01	Element ID for element 1
	91 05 74 6F 64 61 79 00	ANSI Ext. Symbolic Segment for *today*
	91 0B 68 6F 75 72 6C 79 43 6F 75 6E 74 00	ANSI Ext. Symbolic Segment for *hourlyCount*
	28 03	Element ID for element 3
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description- Symbol Instance and Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C3 00	Data Type for INT
	D0 5C	0x5CD0 = 23760 decimal

Example 10 (Symbolic Segment Addressing Method) with BOOLs

Read the value of a BOOL named struct2.pilot_on using Symbolic Segment Addressing. The value of the BOOL is 1.

The values for BOOL 0 and 1 returned by the controller are 0x00 and 0xFF respectively.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	0A	Request Path is 10 words (20 bytes) long
Request Path	91 07 73 74 72 75 63 74 32 00 91 08 70 69 6C 6F 74 5F 6F 6E	Symbolic Segment for *struct2* Symbolic Segment for *pilot_on*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C1 00	BOOL Tag Type Value
	FF	BOOL value for *1*

Accessing User-Defined Structures

This section shows examples of accessing simple structures to help illustrate the message formats needed. The examples all use the Symbolic Segment Addressing method. The four structures below are defined and then various members of the structures are accessed in the examples that follow.

Structure Name: STRUCT_A	
Member	**Data Type**
limit4	BOOL
limit7	BOOL
travel	DINT
errors	SINT
wear	REAL

Structure Name: STRUCT_B	
Member	**Data Type**
pilot_on	BOOL
hourlyCount	INT [12]
rate	REAL

Structure Name: STRUCT_C	
Member	**Data Type**
hours_full	BOOL
today	STRUCT_B
sampleTime	DINT
shipped	DINT

Structure Name: STRUCT_D	
Member	**Data Type**
myint	INT
myfloat	REAL
myarray	STRUCT_C[8]
mypid	REAL

For the controller project file and EtherNet/IP traffic capture files examples shown here, go to http://www.rockwellautomation.com/enabled/guides.html.

Example 1

Read the tag *struct1* that is a tag of type STRUCT_A. This reads the entire structure.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	05	Request Path is 5 words (10 bytes) long
Request Path	91 07 73 74 72 75 63 74 31 00	ANSI Ext. Symbolic Segment for *struct1*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	A0 02 C1 FA	Tag Type for STRUCT_A
	03 00 00 00 55 00 00 00 77 00 00 00 33 33 2B 41	limit4 and limit7 members (bits 0 and 1 respectively) (BOOL) = 1, travel member (DINT) = 0x55 (85 decimal), errors member (SINT) = 0x77 (119 decimal), wear member (REAL) = 10.7 decimal

Example 2

Read the tag *struct1.wear*.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	08	Request Path is 8 words (16 bytes) long
Request Path	91 07 73 74 72 75 63 74 31 00 91 04 77 65 61 72	ANSI Ext. Symbolic Segment for *struct1*, ANSI Ext. Symbolic Segment for *wear*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	CA 00	REAL Tag Type Value
	33 33 2b 41	0x412B3333=10.7 decimal

Example 3

Read the tag *str1Array[8].travel* which is a one dimensional array of STRUCT_A.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	0B	Request Path is 11 words (22 bytes) long
Request Path	91 09 73 74 72 31 41 72 72 61 79 00 28 08 91 06 74 72 61 76 65 6c	ANSI Ext. Symbolic Segment for *str1Array*, Member ID for element 8, ANSI Ext. Symbolic Segment for *travel*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C4 00	DINT Tag Type Value
	0F 27 00 00	0x0000270F=9999 decimal

Example 4

Read two elements of the tag *struct2.hourlyCount[4]*, which is a structure of type STRUCT_B.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	0D	Request Path is 13 words (26 bytes) long
Request Path	91 07 73 74 72 75 63 74 32 00 91 0B 68 6f 75 72 6c 79 43 6F 75 6E 74 00 28 04	ANSI Ext. Symbolic Segment for *struct2*, ANSI Ext. Symbolic Segment for *hourlyCount*, Member Segment for element 4
Request Data	02 00	Number of elements to read (2)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C3 00	INT Type Value
	05 00 06 00	0x0005=5 decimal 0x0006=6 decimal

Example 5

Read the tag *struct3.today.rate* which is a structure of type STRUCT_C.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	0C	Request Path is 12 words (24 bytes) long
Request Path	91 07 73 74 72 75 63 74 33 00 91 05 74 6F 64 61 79 00 91 04 72 61 74 65	ANSI Ext. Symbolic Segment for *struct3*, ANSI Ext. Symbolic Segment for *today,* ANSI Ext. Symbolic Segment for *rate*
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	CA 00	REAL Tag Type Value
	00 00 80 41	0x41800000=16.0 decimal

Example 6

Read the tag *myDstruct4[0].myarray[1].today.hourlyCount[3]* in the controller, which is a one dimensional array of type STRUCT_D.

Message Request Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Request Service	4C	Read Tag Service (Request)
Request Path Size	19	Request Path is 25 words (50 bytes) long
Request Path	91 0A 6D 79 44 73 74 72 75 63 74 34 28 00 91 07 6D 79 61 72 72 61 79 00 28 01 91 05 74 6F 64 61 79 00 91 0B 68 6F 75 72 6C 79 43 6F 75 6E 74 00 28 03	ANSI Ext. Symbolic Segment for *myDstruct4*, Element ID for element 0 ANSI Ext. Symbolic Segment for *myarray* Element ID for element 1 ANSI Ext. Symbolic Segment for *today* ANSI Ext. Symbolic Segment for *hourlyCount* Element ID for element 3
Request Data	01 00	Number of elements to read (1)

Message Reply Field	Bytes (in hex)	Description - Symbolic Segment Addressing
Reply Service	CC	Read Tag Service (Reply)
Reserved	00	
General Status	00	Success
Extended Status Size	00	No extended status
Reply Data	C3 00	INT Tag Type Value
	D0 5C	0x5CD0=23760 decimal

CIP Over the Controller Serial Port

Introduction

The information in this chapter helps you to communicate with ControlLogix controllers using CIP over the serial port. For more information about DFI, refer to the *DF1 Protocol and Command Set Reference Manual*, publication 1770-6.5.16. For more information about CIP services used with Logix5000 controllers, see CIP Services on page 11.

The controller's serial port supports the DF1 protocol and PCCC commands. CIP messages can also be delivered by encapsulating CIP explicit messages inside of the PCCC commands 0x0A and 0x0B. All of the CIP services described in Chapter 1 can be sent by using this method.

PCCC has an inherent format limit of 244 bytes of application data. If an application tries to send a message larger than 244 bytes, an error is returned. The PCCC commands described here were designed to support a PCCC fragmentation protocol to allow the transmission of larger CIP messages (up to 510 bytes). For more information, see Fragmentation Protocol on page 70.

Unconnected Messaging (UCMM) via PCCC

PCCC Command Code 0B provides CIP unconnected explicit-message capability over the controller's serial port. This can be used for infrequent requests to the controller (for example, to read or write ControlLogix tags) or to establish an explicit message connection with the controller. See Connected Explicit Messages via PCCC on page 68 for connected communication).

The contents of this PCCC message is a CIP explicit-message service request or response, such as those described earlier in this manual.

Name	Type	Description of Request Parameter	Semantics of Values
CMD	USINT	Command = 0x0B	
STS	USINT	Status (0 in request)	See the *DF1 Protocol and Command Set Reference Manual*, publication 1770-6.5.16
TNSW	UINT	Used to match response with request	
FNC	USINT	Fragmentation protocol function	See CIP Services on page 11.
Extra	USINT	Additional information for fragmentation protocol	
Request Service	USINT	CIP Service Code	
Request Path Size	USINT	Number of 16-bit words in the Request Path	
Request Path	EPATH	Logical or Symbolic Segments, or both	
Service Request Data		Service data as defined by the service. Size and type varies	

Similarly, the CIP service response is returned in a PCCC command reply, as shown in the following table.

Name	Type	Description of Request Parameter	Semantics of Values
CMD	USINT	Response = 0x0B + 0x40	*See the DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16
STS	USINT	Status (0 == Success)	
TNSW	UINT	Used to match response with request	
FNC	USINT	Fragmentation protocol function	See Fragmentation Protocol on page 70
Extra	USINT	Additional information for fragmentation protocol	
Reply Service	USINT	CIP Service Code + 0x80	See CIP Services on page 11
Reserved	USINT	00	
General Status	USINT	ss	
Extended Status Size	USINT	nn	
Extended Status		Only present if Size > 0	
Service Response Data		Service determines whether present or not, and the size/ data type	

Connected Explicit Messages via PCCC

PCCC Command Code 0A provides CIP explicit-message connection behavior. The services described in CIP Services on page 11 are used within these commands. For example, the only difference between connected explicit messages via PCCC and an EtherNet/IP explicit message connection is the wrapper that the CIP service is carried in. EtherNet/IP network uses Ethernet and TCP/IP technology and this uses DF1 and PCCC.

TIP We assume that you are familiar with CIP and the information related to CIP that is discussed here. Therefore, the details of the CIP portions of the frame will not be fully described here. References to where more detailed information can be found are provided below. If you are not familiar with CIP, a tutorial CD ROM is available for purchase at http://www.rockwellautomation.com/enabled/cipetraining.html.

The following table shows the fields used and where more information can be found about specific fields of the command structure.

Name	Type	Description of Request Parameter	Semantics of Values
CMD	USINT	Command = 0x0A	*See the DF1 Protocol and Command Set Reference Manual*, publication 1770-6.5.16
STS(1)	USINT	Status (0 in request)	
TNSW	UINT	Transaction sequence number	
FNC	USINT	Fragmentation protocol function	See Fragmentation Protocol on page 70.
Extra	USINT	Additional information for fragmentation protocol	
CID(2)	UINT	Connection ID	Determined in the Forward_Open request or reply. One unique ID for requests and another for replies. Refer to the CIP Specification.
Trans. Header **	UINT	Transport class 3 Sequence Count	Increments with each new data request, echoed in response. Refer to Chapter 3 of the CIP Specification.
Data	-	CIP Explicit Message	See CIP Services on page 11.

(1) Only STS is supported; there is no EXT STS for this command.

(2) These appear only in the First_req., First_response, and Only messages, if fragmentation is used.

The CIP explicit message connection must be established before the 0A command can be used. This is accomplished by sending the 0B command to the controller with the CIP Forward_Open service request. The successful Forward_Open response will provide the information for the fields shown below. The Forward_Open service is described in Chapter 3 of the CIP Specification and in the aforementioned CIP tutorial CD.

The 0A command supports only Transport Class 3 connections to the Message Router object. No other transport classes are supported. The contents of the data field are CIP services that follow the CIP Service Request/Response Format on page 15.

Like all CIP connections, there is an RPI value associated with the connection that establishes the rate at which messages must be sent. If they are not sent at this rate, timeouts can occur. The RPI timer should be reset whenever a message is sent. If the timer ever reaches the RPI value, the connection should retransmit the last sent message and keep the same sequence count. Upon detecting the same sequence count, the target will not reprocess the whole message; it just resends the same response already sent (it looks to the responder like a retry due to a lost response). The connection timeout should be short enough that recovery from noise or a temporary disconnect is relatively quick. It is better to scale the timeout to something reasonable for noise recovery (20 seconds or so) and then do RPI rate productions, rather than allow connections to repeatedly time out.

The PCCC status (STS) in the PCCC response indicates the success or failure of the PCCC system to deliver the data across the PCCC link. It does not indicate the success or failure of the CIP service in the reply. The status for that will be present in the CIP service response, within the data field. See the CIP Services on page 11 for details.

Connections are usually kept open for very long periods of time. However, it may be necessary for the client to close the connection from time to time. In that case, the client application must close the connection using the 0B command with a CIP Forward_Close service request in it. It is *not* acceptable to allow connections to timeout naturally and clean themselves up.

The following is an example of the fields for a CIP explicit message connection using a Class 3 Transport encapsulated in PCCC sent unfragmented, using DF1 Full Duplex on RS-232.

Name	Type	Description of Request Parameter	Semantics of Values
DLE	USINT	ASCII escape character	See the *DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16
STX	USINT	Start of message	
DST	USINT	Address of destination	
SRC	USINT	Address of source	
CMD	USINT	Command = 0Ahex	
STS	USINT	Status (0 in request)	See *the DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16
TNSW	UINT	Transaction sequence number	
FNC	USINT	Fragmentation protocol function	Fragmentation Protocol 00hex (*Only* function)
Extra	USINT	Additional information for fragmentation protocol	Fragmentation Protocol 00hex (*Only* has no Extra)
CID	UINT	O-T Connection ID	See CIP Specification
Transport Header	UINT	Transport class 3 Sequence Count	
Request Service	USINT	CIP Service Code	See CIP Services on page 11
Request Path Size	USINT	Number of 16-bit words in the Request Path	
Request Path	EPATH	Logical or Symbolic Segments, or both	
Service Data		Service data	
DLE	USINT	ASCII escape character	*See the DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16
ETX	USINT	End of message	
BCC or CRC	USINT or UINT	Block Check Character	
Cyclic Redundancy Check	See *DF1 Protocol and Command Set Reference Manual*		

Fragmentation Protocol

The fragmentation protocol allows messages up to 510 bytes to be sent over PCCC/DF1, which has an inherent limit of 240 bytes. It allows each fragment to be identified as it is transferred, with each fragment being acknowledged (Ack or Nak) before the next fragment is sent, and provides the ability for the client device to abort the fragmentation sequence if necessary. This fragmentation protocol is used only with the 0A and 0B PCCC commands.

For more information on the PCCC fragmentation protocol, go to http://www.rockwellautomation.com/enabled/guides.html. Look for supplemental information on the *Logix Data Access Manual*.

PCCC Commands

Introduction

PCCC commands are carried within DF1 packets to the serial port of the Logix5000 controller. This option for accessing data table mappings inside the Logix5000 controller is provided for backward compatibility with legacy controllers that do not understand CIP. CIP is the native language of a Logix5000 controller. Other applications that worked with our legacy controllers over serial port could, with proper mapping of Logix5000 tags to data tables, be used to access information in the Logix5000 controller.

IMPORTANT	For details on mapping of tags to PLC/SLC data files or data tables, refer to the *Logix5000 Controllers Design Considerations Reference Manual*, publication 1756-RM094, and the user assistance/online help in the "Map PLC/SLC Messages" function within the Logix Designer application. To avoid data mismatch, use an array tag of the same data type as the PLC/SLC file.

CIP messaging is the preferred method of interacting with Logix5000 controllers, but PCCC messaging is serviceable for many applications, especially where the legacy communications product is not able to be modified, and where the Logix5000 customer is willing to do the extra configuration of data table mappings in the Logix5000 controller. Remote applications that depend on serial communication over a modem or serial radio link can also use this method.

PCCC commands can also arrive at the controller in the following ways:

- Via the RS-232 serial port
- Encapsulated inside a ControlNet message
- Encapsulated inside a EtherNet/IP message

This chapter identifies the PCCC commands supported by Logix and the formatting required. A license from ODVA is *not r*equired for you to use the PCCC commands described in this chapter.

Supported Subset of PCCC Commands

Logix controllers support the following subset of PCCC commands.

- PLC-2 Communication Commands
  - Unprotected Read
  - Protected Write
  - Unprotected Write
  - Protected Bit Write
  - Unprotected Bit Write

- PLC-5 Communication Commands
  - Read Modify Write
  - Read Modify Write N
  - Typed Read
  - Typed Write
  - Word Range Read
  - Word Range Write
  - Bit Write
- SLC Communication Commands
  - SLC Protected Typed Logical Read with 3 Address Fields
  - SLC Protected Typed Logical Write with 3 Address Fields
  - SLC Protected Typed Logical Read with 2 Address Fields
  - SLC Protected Typed Logical Write with 2 Address Fields

Initial Fields of All PCCC Commands

This section describes the initial fields present in all PCCC commands. These fields are followed by command-specific fields, which are described in the rest of this chapter. (A PCCC Request/Reply has nothing to do with a CIP Request/Reply as described in earlier chapters.)

In the following sections, the name of each command is listed in the following format:

Command Name (CMD=xx,yy; FNC=zz), where:

- xx= CMD code in the Request
- yy= CMD code in the Reply
- zz = Function code

All Requests Start with these Fields: [CMD] [STS] [TNS] [FNC]
• [CMD] 1-byte, Request command code – 0x0F in PLC-5 and SLC commands – 0x0N in PLC2 commands (N is the hex value for the command) • [STS] 1-byte, status code, always 0x00 in commands • [TNS] 16-bits, transaction identifier • [FNC] 1 byte, function code (not included in some PLC2 commands)
All Replies Start with these Fields: [CMD] [STS] [TNS]+[EXT STS]
• [CMD] 1-byte, Reply command code – 0x4F in PLC-5 and SLC commands – 0x4N in PLC2 commands (N is the same hex value in the corresponding Request CMD) • [STS] 1-byte, status code – 0x00 (success) – 0xNN is error code (N is any hex value) – 0xF0 means fourth field present (EXT STS] See below. • [TNS] 16-bits, unique transaction identifier • [EXT STS] 1-byte, extended status error code – only present if [STS]=0xF0

PLC-2 Communication Commands

Use the PLC-2 commands to access one tag (only one tag) in a Logix5000 controller. In addition to sending the command, you must also map the message to an INT(16 bit integer) tag in the Logix5000 controller. All the PLC2 commands will access the same tag, typically an INT array.

Logix handles *protected and unprotected* commands the same way, whether the access for the data is set to Read/Write, Read Only, or None.

Unprotected Read (CMD=01, 41; FNC not present)

This command provides the read capability for the PLC-2 commands.

Request Format: [PLC-2 address] [size]
• [PLC-2 address] 2-bytes; byte offset from start of file, on 16-bit boundary, low byte first • [size] 1-byte; must be an even number of bytes
Reply Format: [data]
[data] is up to 244 bytes

Protected Write (CMD=00, 40; FNC not present)

This command provides a protected write capability for the PLC-2 commands.

Request Format: [PLC-2 address] [data]
• [PLC-2 address] 2-bytes; byte offset from start of file, on 16-bit boundary, low byte first • [data]
Reply Format:
no data- only status

Unprotected Write (CMD=08, 48; FNC not present)

This command provides a basic write capability for the PLC-2 commands.

Request Format: [PLC-2 address] [data]
• [PLC-2 address] 2-bytes; byte offset from start of file, on 16-bit boundary, low byte first • [data]
Reply Format:
no data - only status

Protected Bit Write (CMD=02, 42; FNC not present)

This command provides a protected bit write capability for the PLC-2 commands.

For each 3-field set, this command performs the following sequence:

1. Copy the specified byte from limited areas of memory
2. Set the bits specified in the [SET mask]
3. Reset the bits specified in the [RESET mask]
4. Write the byte back.

Request Format: [PLC-2 address][SET mask] [RESET mask] + repeats(1)
• [PLC-2 address] 2-bytes; byte offset from start of file, on 16-bit boundary, low byte first • [SET mask] is 1 byte (1=set to 1) • [RESET mask] is 1 byte (1=reset to 0)
Reply Format:
no data - only status

(1) These fields can be repeated up to 61 times.

Unprotected Bit Write (CMD=05, 45; FNC not present)

This command provides a bit write capability for the PLC-2 commands. For each 3-field set, this command performs the following sequence:

1. Copy the specified byte from limited areas of memory
2. Set the bits specified in the [SET mask]
3. Reset the bits specified in the [RESET mask]
4. Write the byte back.

Request Format: [PLC-2 address] [SET mask][RESET mask] + repeats(1)
• [PLC-2 address] 2-bytes; byte offset from start of file, on 16-bit boundary, low byte first • [SET mask] is 1 byte (1=set to 1) • [RESET mask] is 1 byte (1=reset to 0)
Reply Format:
no data - only status

(1) These fields can be repeated up to 61 times.

PLC-5 Communication Commands

Each PLC-5 command requires a *system address* in one of the following forms:

- *Logical binary or logical ASCII*, which addresses data by *file* and *element*.
  - The first level of the logical binary must always be 0. This is required to access controller-scoped tags.
  - The second level is the *file* number. This is also the level following the letters in the logical ASCII form.
  - The next 1, 2, or 3 levels correspond to the array dimension indices as follows: data[1][2][3].
  - Any subsequent levels of logical address access parts of the complex types. Refer to CIP Data Types on page 11.

IMPORTANT	Logical addressing *requires* use of data table mapping. Use a Logix array tag that matches the data type of the PLC5 file. Members of SINT, INT, DINT, and REAL arrays are contiguous in Logix memory. For more information on Logical addressing, refer to the *DF1 Protocol and Command Set Manual,* publication 1770-6.5.16

- *Symbolic,* which addresses data directly by a tag name.
  - The symbol string starts with a NULL character and ends with a NULL character.
  - In the simplest case, the symbol string consists of just the tag name.
  - To address an array, delimit the array indices with square brackets.

The following examples depict symbolic addresses.

EXAMPLE	Symbolic addresses: tag_name tag_name[x] tag_name[x,y,z] tag_name[x][y][z]

IMPORTANT	The PLC-5 TYPED READ and TYPED WRITE commands access tags (elements) of SINT, INT, DINT, or REAL only. The other PLC-5 commands access only INTs, that is, 16-bit words. Use the PLC-5 file data type that matches the data type of the Logix tag.

Addressing examples

The table below shows addressing examples for PLC-5 PCCC Messages.

To access	This entry is specified (1)	
Single integer tag named *parts*	PCCCsymbolic	parts
The sixth element of the array of REALs named *setpoints*	PCCC Logical ASCII	$F8:6
	PCCC symbolic	setpoints[5]
Single integer [2,5,257] of three dimensional array named *profile*	PCCC Logical ASCII	$N7:2:5:257
	PCCC symbolic	profile[2,5,257]

(1) Leading and trailing NULL characters are not shown.

Read Modify Write (CMD=0F, 4F; FNC=26)

For each 3-field sequence (address, AND mask, OR mask), this RMW command performs the following procedure.

1. Copy the specified word.
2. Reset the bits specified in the [AND mask].
3. Set the bits specified in the [OR mask].
4. Write the word back.

Request Format: [PLC-5 system address] [AND mask] [OR mask] + repeats(1)
• [PLC-5 system address] specifies the word to be modified • [AND mask] 2 bytes (low byte first) specifying which bits in the word to reset (0=reset to 0) • [OR mask] 2 bytes (low byte first) specifying which bits in the word to set (1=set to 1)
Reply Format:
no data - only status

(1) These fields can be repeated up to 243 bytes.

Read Modify Write N (CMD=0F, 4F; FNC=79)

For each 4-field sequence, this RMW-N command performs the following procedure:

1. Copy the specified word.
2. Reset the bits specified in the [AND mask].
3. Set the bits specified in the [OR mask].
4. Write the word back.

Request Format: [no of sets][PLC-5 system address] [mask length][AND mask][OR mask] +repeats(1)
• [no of sets] indicates the number of sets of the following four fields. • [PLC-5 system address] specifies the word to be modified • [mask length] specifies either 2 or 4 byte masks. **For this command, most Logix controllers only support 4-byte mask; use RMW command (FNC=26) for 2-byte mask** • [AND mask] 2 or 4 bytes (low byte first) specifying which bits in the word to reset (0=reset to 0) • [OR mask] 2 or 4 bytes (low byte first) specifying which bits in the word to set (1= set to 1)
Reply Format: [data]
[data] – for a successful command ([STS]=0x00), data may be returned, but the Logix data format is not documented – for an unsuccessful command ([STS]=0xF0), a byte (error code) occurs; data may be returned, but the Logix data format is not documented.

(1) The last four fields, starting with address can be repeated up to 243 bytes.

Typed Read (CMD=0F, 4F; FNC=68)

The typed read command reads a block of data starting at the PLC-5 system address plus the packet offset.

Request Format: [packet offset][total transaction][PLC-5 system address][size]
• [packet offset] 2 bytes, offset in number of elements • [total transaction] 2 bytes, number of elements in complete transaction • [PLC-5 system address] • [size] is 2 bytes; number of elements to return in this reply
Reply Format: [Type/ID][data]
• [Type/ID] 1 byte, (for integers) or 2 bytes (for float) type and size of elements – SINT, INT, DINT (type: integer; size 1,2,4 bytes) REAL (type: float, size 4 bytes) – For details about Type/ID encoding, refer to the *DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16 • [data]

Typed Write (CMD=0F, 4F; FNC=67)

The typed write command writes a block of data starting at the PLC-5 system address plus the packet offset.

Request Format: [packet offset] [total transaction][PLC-5 system address] [type/ID] [data]
• [packet offset] 2 bytes, offset in number of elements • [total transaction] 2 bytes, number of elements in complete transaction • [PLC-5 system address] • [type/ID] 1 byte (for integers) or by 2 bytes (for float), type and size of elements. – SINT, INT, DINT (type: integer; size 1,2,4 bytes) REAL (type: float, size 4 bytes) – Integer conversion; error if data value too large for target integer type (SINT or INT) – For details about Type/ID encoding, refer to the *DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16 • [data]
Reply Format:
no data, only status

Word Range Read (CMD=0F, 4F; FNC=01)

The word range read command reads a block of words starting at the PLC-5 system address plus the word offset.

Request Format: [packet offset] [total transaction][PLC-5 system address] [size]
• [packet offset] 2 bytes, offset in number of 16-bit words • [total transaction] 2 bytes, number of 16-bit words in complete transaction • [PLC-5 system address] • [size] is 1 byte, number of bytes and must be even in number
Reply Format: [data]
[data] up to 244 bytes

Word Range Write (CMD=0F, 4F; FNC=00)

The word range write command will write a block of words starting at the PLC-5 system address plus the word offset.

Request Format: [packet offset] [total transaction][PLC-5 system address] [data]
• [packet offset] 2 bytes, offset in number of 16-bit words • [total transaction] 2 bytes, number of 16-bit words in complete transaction • [PLC-5 system address] • [data]
Reply Format:
no data; only status

Bit Write (CMD=0F, 4F; FNC=02)

This command will set and reset bits in a single word specified by the PLC-5 logical address. It can change only a single word in any given command.

For the 3-field sequence, this command performs the following procedure:

1. Copy the specified word.
2. Set the bits specified in the [SET mask].
3. Reset the bits specified in the [RESET mask].
4. Write the word back.

Request Format: [PLC-5 system address][SET mask][RESET mask]
• [PLC-5 system address] specifies the word to be modified. • [SET mask] is 2 bytes (low byte first) specifying which bits in the word to set (1=set to 1) • [RESET mask] is 2 bytes (low byte first) specifying which bits in the word to reset (1=reset to 0)
Reply Format:
no data; only status

SLC Communication Commands

The SLC commands use strictly a logical form of addressing (for example, file/element/sub-element). For details about mapping the SLC files to Logix5000 tags, refer to the *Logix5000 Controllers Design Considerations Reference Manual*, publication 1756-RM094.

Logix handles *protected* and *unprotected* commands the same way, whether the access for data is set to Read/Write, Read Only, or None.

IMPORTANT For the SLC Typed Read and Typed Write commands, map the data files to Logix tags of types INT, DINT, or REAL only. Use an SLC or MicroLogix file data type that matches the data type of the Logix tag.

For INT tags, use file type 85hex (Binary) or 89hex (Integer)

For DINT tags, use file type 91hex (Long - *MicroLogix only*)

For REAL tags, use file type 8Ahex (Float)

For more information on SLC file types, refer to the *DF1 Protocol and Command Set Reference Manual,* publication 1770-6.5.16

SLC logical addressing has a limited number of logical address levels so there are some special concerns.

In a	The element number is used as the
One-dimension array	Dimension index for addressing (data[elem])
Two-dimensional array	Index of the second dimension and the first dimension index is always 0 (data[0][elem])
Three-dimensional array	Index of the third dimension and the first and second dimension indices are both 0 (data[0][0][elem])

SLC Protected Typed Logical Read with 3 Address Fields (CMD=0F, 4F; FNC=A2)

The service is supported for compatibility with SLC modules. It reads data from the logical address.

Request Format: [byte size][file number][file type][element number][sub-element number]
• [byte size] 1 byte, number of data bytes to be read • [file number]1 byte for 0-254; for >=255, 3 bytes, 0xFF followed by 2-byte number, low byte first • [file type] 1 byte. For file types and codes, refer to the *DF1 Protocol and Command Set Reference Manual* See *IMPORTANT* at beginning of the SLC Communication Command section. • [element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first • [sub-element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first
Reply Format: [data]
[data]

SLC Protected Typed Logical Write with 3 Address Fields (CMD=0F, 4F, FNC=AA)

This service is supported for compatibility with older modules. It writes to the logical address.

Request Format: [byte size][file number][file type][element number][sub-element number]
• [byte size] 1 byte, number of data bytes to be written • [file number]1 byte for 0-254; for >=255, 3 bytes, 0xFF followed by 2-byte number, low byte first • [file type] 1 byte. For file types and codes, refer to the *DF1 Protocol and Command Set Reference Manual*. See *IMPORTANT* at beginning of the SLC Communication Command section. • [element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first • [sub-element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first
Reply Format:
no data - only access

SLC Protected Typed Logical Read with 2 Address Fields (CMD=0F, 4F; FNC=A1)

This read command provides a simpler version for reading data.

Request Format: [byte size][file number][file type][element number]
• [byte size] 1 byte, number of data bytes to be read • [file number]1 byte for 0-254; for >=255, 3 bytes, 0xFF followed by 2-byte number, low byte first • [file type] 1 byte. For file types and codes, refer to the *DF1 Protocol and Command Set Reference Manual.* See *IMPORTANT* at beginning of the SLC Communication Command section. • [element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first
Reply Format: [data]
[data]

SLC Protected Typed Logical Write with 2 Address Fields (CMD=0F, 4F; FNC=A9)

This write command provides a simpler version for writing data.

Request Format: [byte size][file number][file type][element number]
• [byte size] 1 byte, number of data bytes to be written • [file number]1 byte for 0-254; for >=255, 3 bytes, 0xFF followed by 2-byte number, low byte first • [file type] 1 byte. For file types and codes, refer to the *DF1 Protocol and Command Set Reference Manual*. See *IMPORTANT* at beginning of the SLC Communication Command section. • [element number] 1 byte, 0-254; 3 bytes for >=255, first byte=0xFF then 2-byte number, low byte first • [data]
Reply Format:
no data - only access

Notes:

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At http://www.rockwellautomation.com/support/, you can find technical manuals, a knowledge base of FAQs, technical and application notes, sample code and links to software service packs, and a MySupport feature that you can customize to make the best use of these tools.

For an additional level of technical phone support for installation, configuration, and troubleshooting, we offer TechConnect support programs. For more information, contact your local distributor or Rockwell Automation representative, or visit http://www.rockwellautomation.com/support/.

Installation Assistance

If you experience a problem within the first 24 hours of installation, review the information that is contained in this manual. You can contact Customer Support for initial help in getting your product up and running.

United States or Canada	1.440.646.3434
Outside United States or Canada	Use the Worldwide Locator at http://www.rockwellautomation.com/support/americas/phone_en.html, or contact your local Rockwell Automation representative.

New Product Satisfaction Return

Rockwell Automation tests all of its products to ensure that they are fully operational when shipped from the manufacturing facility. However, if your product is not functioning and needs to be returned, follow these procedures.

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