Tolomatic
EXCELLENCE *IN MOTION*®

EtherNet/IP USER'S GUIDE

ACS Drive/Controller

EtherNet/IP™

3600-4168_06

LINEAR SOLUTIONS MADE EASY

201503260955

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EtherNet/IP Overview 1

1.1 Introduction

NOTE: This document is intended to provide information on the EtherNet/IP protocol only. Please reference the ACS Hardware/ Installation Guide for all electrical and hardware installation procedures, specifications, and safety instructions when operating the ACS Drive.

EtherNet/IP has been instrumental in realizing high performance and advanced automating manufacturing applications. Common Industrial Protocol (CIP) has enabled the enterprise for:

- Interoperability between legacy, multi-vendor internet technologies
- Near real-time network performance (including low latency, low jitter, and minimal packet loss)
- Security
- Reliability
- Manageability and ease-of-use features
- Ability to add innovative technologies such as mobile technologies

EtherNet/IP provides comprehensive messaging and services for control, safety, synchronization, motion, configuration and information that creates unified communication across manufacturing enterprise.

Tolomatic's implementation of EtherNet/IP connectivity conforms to the Open Systems Interconnection (OSI) model which defines the framework of implementing network protocols in seven layers. The ACS drive EtherNet/IP implementation conforms to Open DeviceNet Vendor Association (ODVA) standard (CIP version 3.10 and EtherNet/IP version 1.11). For more information regarding EtherNet/IP and CIP functionality and conformation standards as regulated by the ODVA, visit their website at www.odva.org.

The ACS drive is ODVA certified.

1.2 Network

A typical EtherNet/IP network forms several point-to-point connections. A typical network in a factory would comprise of variety of complex devices such as HMIs, PLCs, motion controllers, bar code scanners to simple devices such as I/O. This configuration is represented in Figure 1-1.

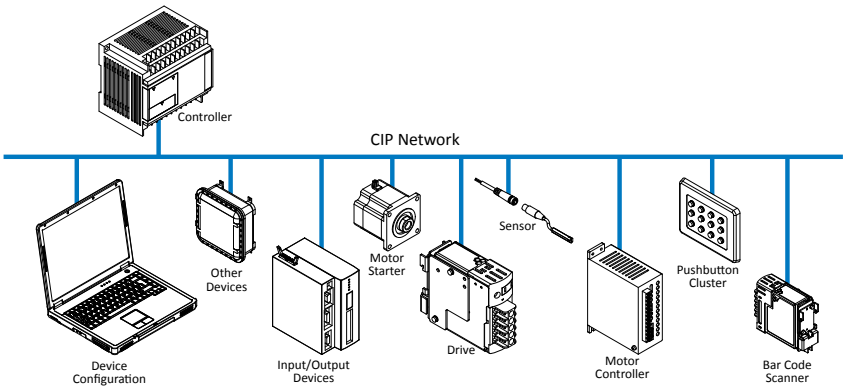


Figure 1-1: EtherNet/IP Network Example

1.3 Definitions

The following definitions provide a general context for terms used in this guide in the EtherNet/IP implementation:

Device: A device is considered any product that supports the EtherNet/IP encapsulation of CIP.

Connection: A connection is a logic link between two devices that may share more than one connection.

Scanner: A master or controlling device that initiates a request or connection.

Adapter: A device that receives a connection request or an individual service request. Multiple adapters can be connected to one scanner on a network. The ACS drive is an adapter device (see Figure 1-2).

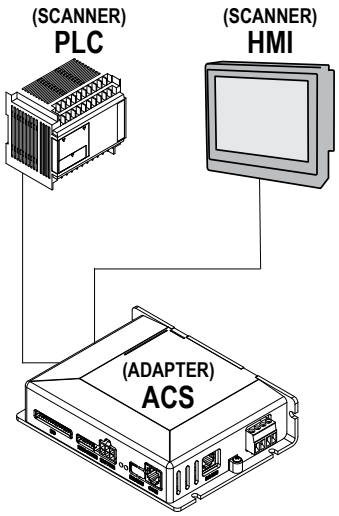


Figure 1-2: ACS Drive as an Adapter Device.

Assembly: A collection of pre-defined data that resides in an adapter. Each datapoint is identified by its own unique instance number, size and type. There are three types of assemblies: producing (data to be sent); consuming (data to be received); and configuration (how the data is to be consumed and interpreted).

Explicit Messaging Connection: A connection used for individual request/response transactions that are handled in the EtherNet/IP protocol via TCP.

For example, an explicit connection request from a scanner device results in a response from the adapter device indicating a successful or failed request. If data payload was part of the request, this information would also be included.

Requests from a scanner device is called a service request and these requests are identified by one-byte service codes inside the request pocket. CIP specifications define the meaning of the majority of these service codes however, codes 0x4B through 0x63 have meanings specific to the destination object of the service request.

Service request destinations are defined by a portion of the request packet, or path that is either an object description or an ASCII character string. The adapter device receiving a service request distinguishes between an object description path ASCII

character string path by the path's header bytes.

Class (type of object reference), instance (object of the type), and the attribute numbers inside the path identify a request to an object. For example, a mixed carton of oatmeal contains 24 packages (objects) and are considered instances 1 through 23. Each object can have multiple attributes. In this example, the carton contains 6 different flavors or attributes 1 through 6. An example service request from a scanner would be to ask for the flavor of package or object number 12. Explicit message commands or data requests can also be sent from the scanner to individual target nodes via connected or unconnected messages. A connected message establishes a formal CIP connection between devices that allows each device to detect and report either established or failed connections. Unconnected messages are managed by the internal stack's Unconnected Message Manager (UCMM) and does not establish a periodic explicit connection.

Implicit or I/O Connection: A connection that establishes a periodic exchange of data between a scanner and adapter. A repetition packet interval or RPI (normally expressed in milliseconds) is established by the scanner device in both directions. An I/O connection request also establishes the size of each assembly and the instance numbers of the assembly types (producing, consuming and configuration). To allow the adapter to interpret subsequent data exchange, an I/O connection may also contain data destined for the adapter's configuration assembly. In EtherNet/IP the I/O connection itself is established via TCP but the subsequent exchange of data uses UDP.

An I/O connection also determines how the adapter device should send its data, either point-to-point (addressed to the scanner only) or multicast (address group that includes the scanner), and allows other devices on the network to receive data from the adapter. NOTE: If the data is sent via multicast, the adapter device itself must support multicast or the connection will fail.

Both, explicit service requests and implicit I/O connections allow scanner access to parameters, however the process differs. Typically, the scanner device utilizes HMI or PLC software such as Allen Bradley's ControlLogix. PLC's normally will make both explicit and I/O connections.

1.4 Layer Structure

Figure 1-3 below shows the seven layers of protocol implementation. Tolomatic's ACS Drive user device profile resides on the seventh layer.

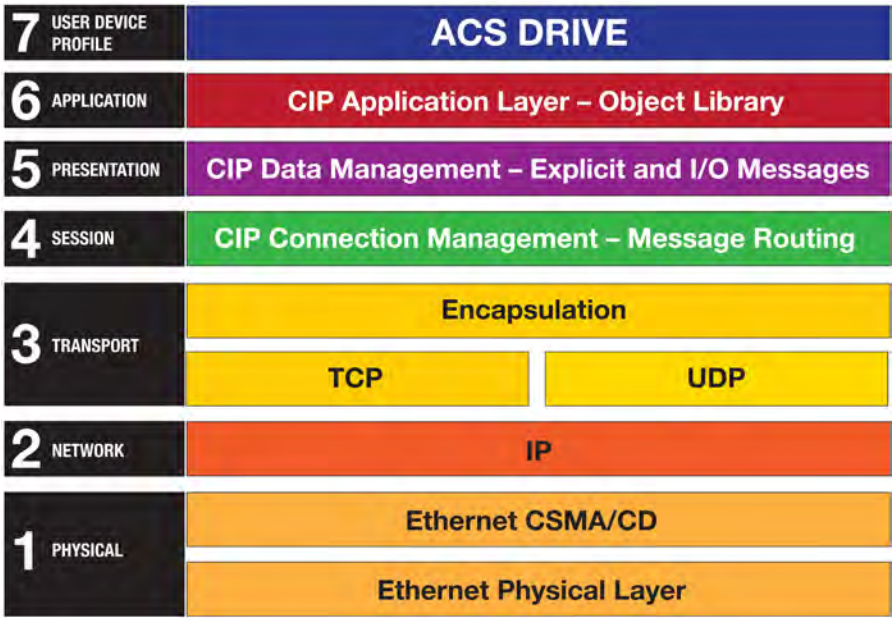


Figure 1-3: EtherNet/IP Layer Structure with the ACS Drive as the User Device Profile

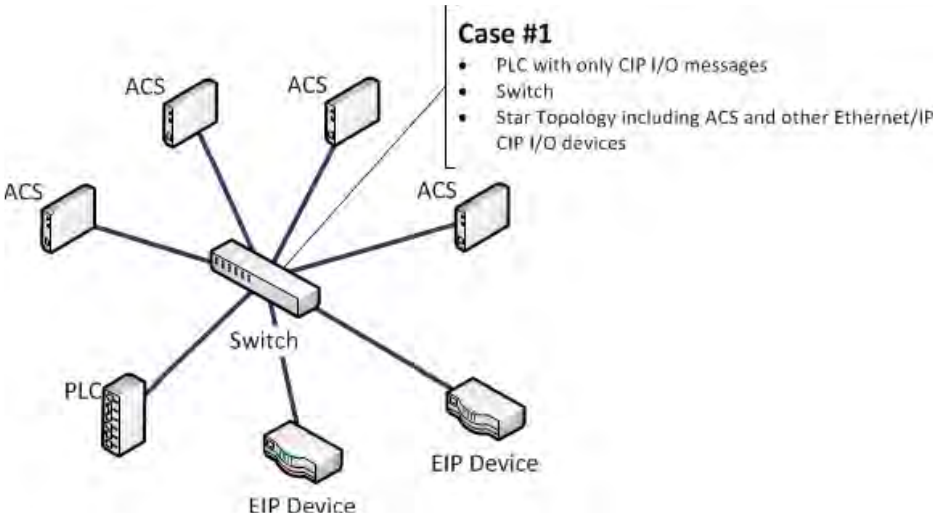
1.5 Supported Features of EtherNet/IP

ACS Servo & Stepper drives support EtherNet/IP using CIP I/O messaging (implicit as well as explicit messaging). This allows Rockwell Automation / Allen Bradley ControlLogix and CompactLogix PLCs (as well as other manufacturers PLCs or controllers) to command ACS drives over EtherNet/IP with CIP I/O messages. The ACS drives do not directly support CIP Motion or CIP Sync (both these are trademarked by ODVA) messages over EtherNet/IP. The ACS drives support QoS (Quality of Service) and support star topology from managed or unmanaged switches. Additionally, the ACS drives have an integrated managed switch to support straight line daisy chain topology. The ACS drives do not support daisy chain with CIP Motion or CIP Sync devices. The ACS drives do not support ring topology or Device Level Ring (DLR) feature of EtherNet/IP. Contact Tolomatic if your application requires DLR, CIP Motion, CIP Sync.

1.6 Recommended Implementation and Alerts

With Ethernet networks, there are many different ways to connect devices, many different ways to configure devices, and many different types of messages/ protocols. Due to the infinite network configurations, it is not possible to document all scenarios and cases. This section describes some more common ways that the ACS drive could be deployed in an EtherNet/IP network along with recommendations and alerts to achieve optimal performance.

1.6.1 Case #1: PLC sending CIP I/O messages through switch with star topology

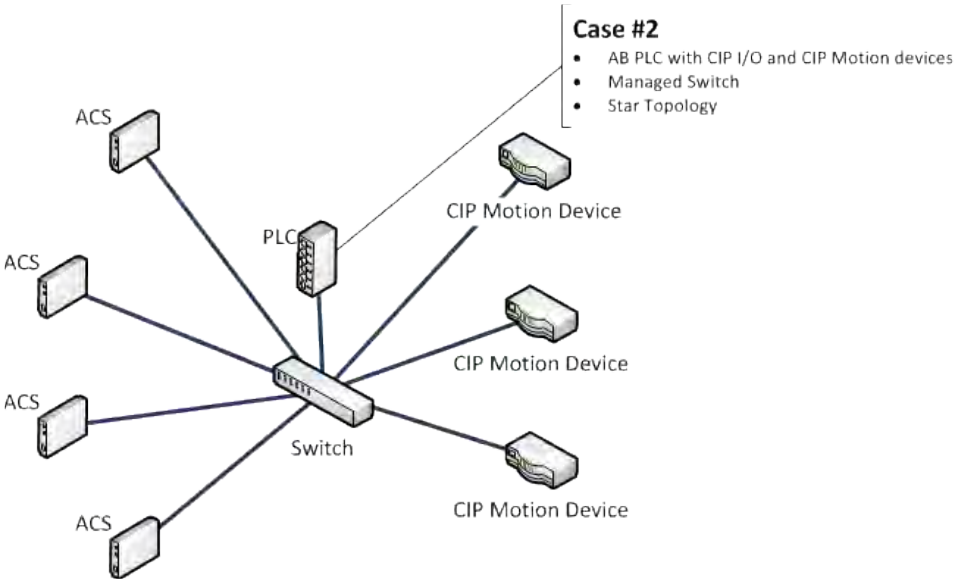


CASE #1: PLC with only CIP I/O messages —> switch —> star topology of ACS drives and other EtherNet/IP devices

☑ **RECOMMENDATION:** Utilize star topology for best network performance and response time / quality from ACS drive.

⚠ **ALERT:** Because the ACS drive can not guarantee recovered communication if a network cable is broken or unplugged, it is best to design your system to be able to power down/up all drives at the same time. (Especially in daisy chain topology)

1.6.2 Case #2: PLC sending CIP I/O and CIP Motion messages through switch with star topology



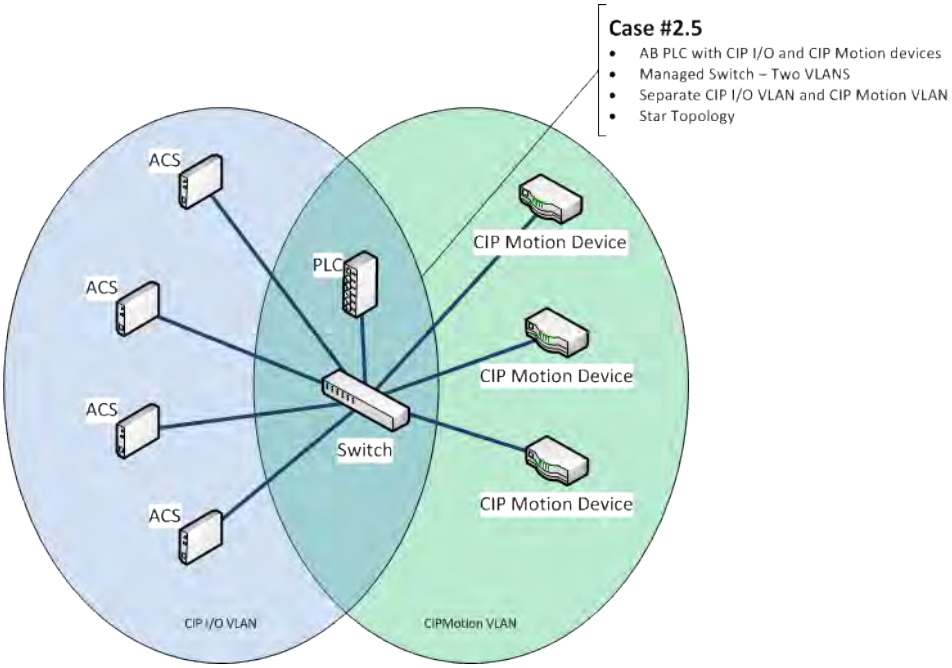
CASE #2: PLC with CIP I/O and CIP Motion messages —> switch —> star topology of ACS drives and other EtherNet/IP devices

☑ **RECOMMENDATION:** If CIP I/O and/or CIP Motion messages are present on the same network, it is recommended to utilize a VLAN to logically separate CIP I/O

devices from CIP Motion devices. (see Case #2.5)

☑ **RECOMMENDATION:** If CIP I/O and/or CIP Motion messages are present on the same network, it is recommended to configure PLC to send CIP I/O messages as Unicast and CIP Motion messages as Multicast.

1.6.2.1 Case #2.5: PLC sending CIP I/O and CIP Motion messages through switch with star topology



CASE #2.5: PLC sending CIP I/O and CIP Motion messages through switch with star topology

☑ **RECOMMENDATION:** It is recommended to use a VLan as best practice in this case to avoid unpredictable network behavior. See Case #2 for more information.

☑ **RECOMMENDATION:** If CIP I/O and/or CIP Motion message are present on same network, it is recommended to configure PLC to send CIP I/O message as Unicast and CIP Motion messages as Multicast.

1.6.2.2 What is VLAN?

Virtual Local Area Networks are used to divide a physical network into several broadcast domains, separating hosts that shouldn't access each other.

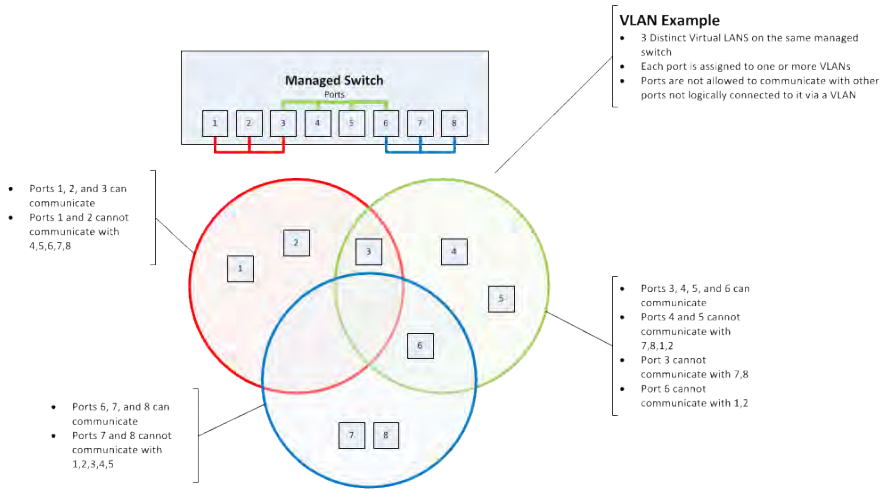
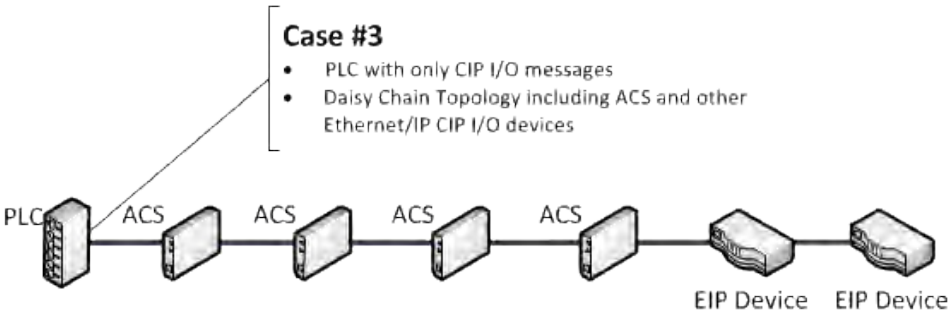


Figure 1-4: VLAN Diagram

1.6.3 Case #3: PLC sending CIP I/O messages to daisy chain of ACS drives and other EtherNet/IP devices



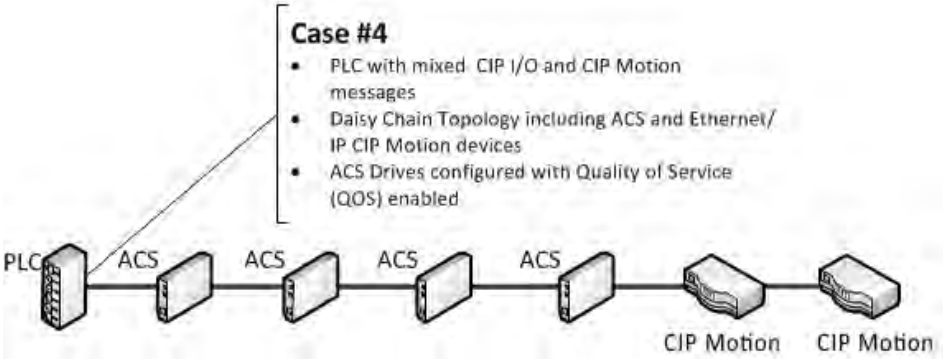
CASE #3: PLC with only CIP I/O messages → daisy chain topology of ACS drives and other EtherNet/IP devices

ALERT: The ACS product does not support the Device Level Ring (DLR) feature of EtherNet/IP. Do not wire the ACS drives in a ring topology or risk unpredictable network behavior or possible network storms.

RECOMMENDATION: In daisy chain, the ACS drive cannot guarantee recovered communication if a network cable is broken or unplugged. It is recommended to design your system such that all drives can be power cycled at the same time.

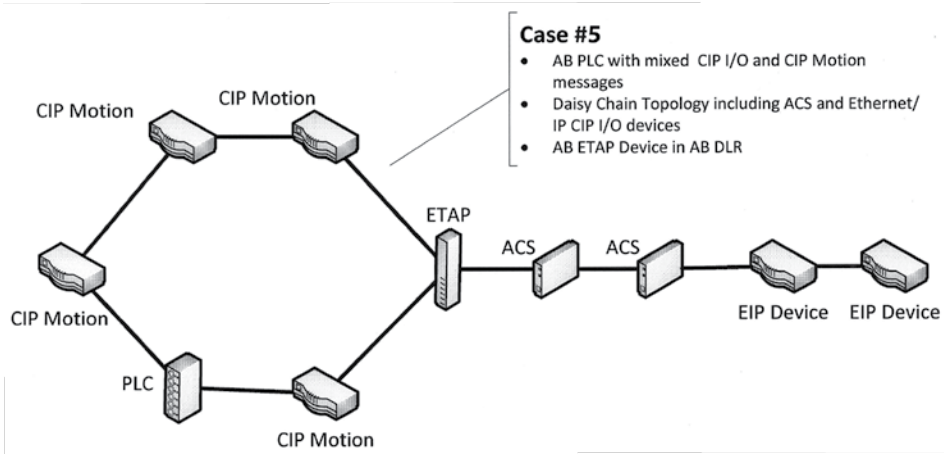
RECOMMENDATION: Daisy chaining a large number of ACS drives can create additional network latencies. The number of ACS drives that can be daisy chained in a particular network is highly dependent on the polling rate of the PLC, additional devices, other network traffic and many other variables. It is recommended to test network speed and minimize number of ACS drives in each daisy chain to ensure optimal performance.

1.6.4 Case #4: (NOT RECOMMENDED) PLC sending CIP I/O and CIP Motion messages to daisy chain of ACS drives and other EtherNet/IP devices



CASE #4: PLC with CIP I/O and CIP Motion messages → daisy chain topology of ACS drives and other EtherNet/IP devices

1.6.5 Case #5: PLC sending CIP Motion messages in Rockwell device level ring (DLR) with ACS drive connected with a 1783-ETAP device



CASE #5: PLC sending CIP Motion messages in Rockwell device level ring (DLR) with ACS drive connected with a 1783-ETAP device

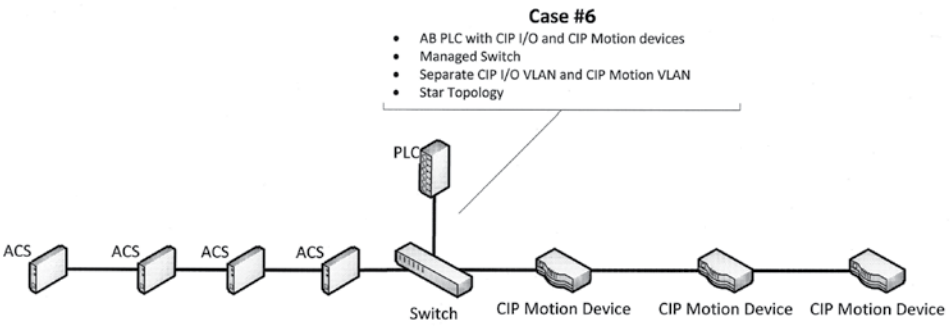
☑ **RECOMMENDATION:** A ETAP device is required to be used to attach the ACS drive and other CIP I/O devise in order to avoid unpredictable network behavior. A suggested ETAP device is the Rockwell 1783-ETAP device. See below for further information on the 1783-ETAP device.

https://www.odva.org/tabid/154/ctl/Detail/mid/520/xmid/28708/xmfid/8/Default.aspx

☑ **RECOMMENDATION:** If CIP I/O and/or CIP Motion message are present on same network, it is recommended to configure PLC to send CIP I/O message as Unicast and CIP Motion messages as Multicast.

ALERT: The ACS drive by itself does not support DLR feature of EtherNet/IP. A 1783-ETAP device is required in order to not interrupt the CIP Motion messages in Rockwell DLR topology. The ACS drive can be daisy chained off of the 1783-ETAP device as well as other CIP I/O devices. When the ACS and other CIP I/O devices are in this configuration, even with the 1783-ETAP device, they will not provide DLR feedback when the chain is broken. They will act as if they are in a daisy chain configuration.

1.6.6 Case #6: AB PLC with CIP I/O and CIP Motion devices through switch



CASE #6: AB PLC with CIP I/O and CIP Motion devices through switch

RECOMMENDATION: It is recommended to use a VLan as best practice in this case to avoid unpredictable network behavior. See Case #2 for more information.

RECOMMENDATION: If CIP I/O and/or CIP Motion message are present on same network, it is recommended to configure PLC to send CIP I/O message as Unicast and CIP Motion messages as Multicast.

1.7 References

{1} The CIP Network Library Volume 1: Common Industrial Protocol, Edition 3.10, April 2011

{2} The CIP Network Library Volume 2: EtherNet/IP Adaptation of CIP, Edition 1.11, April 2011

ACS EtherNet/IP Requirements 2

2.1 Definitions

ACS Drive & Controller Part Number 3603-9654 (Stepper) & 3603-9663 (Servo) are the only part numbers with EtherNet/IP capability. ACS drive part number can be found on the label on the front cover.

2.2 Cabling

The selection of cable has a profound impact on network performance and reliability. Selecting the correct cable requires an understanding of the environment where the cable is installed.

Due to high data rate and reliability considerations, at the minimum, Cat5e cables should be used with the ACS drive. If the cables are made on site, they must be tested to meet performance criteria set according to TIA/EIA-568-B standard. This cable definition is the general cable requirements for copper and fiber cabling installations.

EtherNet/IP specifications limit the channel to 100 meters or up to 90 meters horizontal wiring with two 4-meter patch cords. Some applications will require longer patch cords. In these applications the total length of horizontal wiring must be adjusted to compensate for the added loss of each connector pair and additional patch cord length beyond 10m.

$$\mathbf{C} = \frac{(102\text{-}\mathbf{H})}{(1 + \mathbf{D})} \quad (1)$$

Where:

C is the maximum combined length (m) of the work area cable, equipment cable, and patch cord.

H is the length (m) of the horizontal cable (H + C ≤= 100 m).

D is a de-rating factor for the patch cord type (0.2 for 24 AWG UTP/24 AWG ScTP and 0.5 for 26 AWG ScTP). The derating factors are based on COMMERCIAL cables. Other constructions, such as high flex, may have different performance. Consult the manufacturer for information.

W is the maximum length (m) of the work area cable.

T is the total length of horizontal, patch and equipment cords.

The maximum stranded cable length is limited to 85mm for the channel with the standard 20% derating for standard stranded cables.

WIRE TYPE VERSUS LENGTH					
	D	H	W	C	T
PATCH CABLE GAUGE	PATCH DERATING	HORIZONTAL LENGTH (H+C<=100M)	PATCH LENGTH	TOTAL LENGTH PATCH AND EQUIPMENT	TOTAL LENGTH OF PATCH, EQUIPMENT AND HORIZONTAL
#24	0.2	100	0	0	100
#24	0.2	0	80	85	85
#24	0.2	25	59	64	89
#24	0.2	50	38	43	93
#26	0.5	0	63	68	68
#26	0.5	25	46	51	76
#26	0.5	50	30	35	85
#26	0.5	100	0	0	100

Table 2-1: Cable Wire Type Versus Cable Length

Please refer to Section 8-9.2.3.6 of the ODVA EtherNet/IP Standard v. 1.11 for additional information.

2.3 Tolomatic Motion Interface (TMI) Requirement

The TMI is used to configure the ACS Drive including setting up the Ethernet port. See TMI User Guide #3600-4167 for complete information on configuration using TMI.

2.4 Firmware Requirements

For stepper drives (3603-9654) features described in this manual require Tolomatic ACS Drive firmware version 2.0.0.0 or higher. For servo drives (3603-9662) all firmware versions support these features.

2.5 Add-On Instructions

For QoS support use ACS servo firmware version 1.5.0.0 or higher; ACS stepper firmware version 2.8.0.0 or higher.

The Add-On Instructions Zip file contains an EDS file which can be used to configure the ACS drive. Using ACS Add-On Instructions #3600-4188 document describes this process available at www.tolomatic.com.

The ACS drive will only allow two I/O connections. The ACS drive responds to connection and service requests from a scanner and no commands or parameters from the drive are required to allow these connections. However, certain commands and parameters from the ACS drive allow a user or program to monitor the status and descriptions of the connections.

An implicit or I/O connection sets up the periodic exchange of data between the ACS drive and the data tags in scanner memory. These data tags are collectively referred to as assemblies. Setting up these assemblies is normally part of the PLC configuration process and separate from the PLC ladder programming.

An I/O messaging service request may result from a software driver implementation (such as EIP Scan from Pyramid Systems), or may be part of a message box inside a ladder rung of a PLC program. Service requests always contain a code which specifies what is being requested, and a path which specifies destination object of request. The paths of some of these service codes supported in the ACS drive may take the form of an ASCII character string or tag. Other paths will require specification of class, instance and attribute.

Input and output directions are from the perspective of scanner device. Input assemblies are consumed by scanner devices and produced by adapter devices. Output assemblies are produced by a scanner device and consumed by an adapter device. Refer to Figure 3-1.

Output assemblies are commonly used for controlling the enable/disable state of the drive and for supplying the velocity or position reference.

Input assemblies are commonly used to monitor the drive status and run-time quantities such as current position and faults.

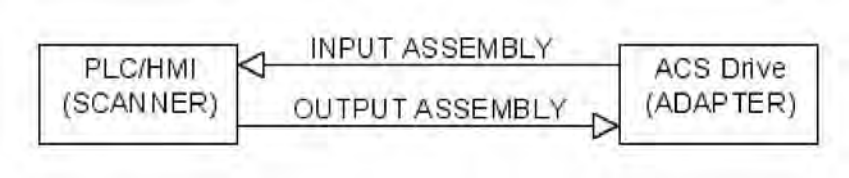


Figure 3-1 EtherNet/IP I/O Assembly

3.1 Data Types

Data Types used in this Object Model are described in Table 3-1 below.

DATA TYPE	DESCRIPTION
USINT	Unsigned Short Integer (8-bit)
UINT	Unsigned Integer (16-bit)
UDINT	Unsigned Double Integer (32-bit)
SHORT STRINGnn	Character String (1st byte is length; up to nn characters)
WORD	Bit String (16-bits)
DWORD	Bit String (32-bits)
REAL	IEEE 32-bit Single Precision Floating Point

Table 3-1: Data Types

3.2 Input Assembly

INSTANCE	ATTRIBUTE ID	BYTES	TYPE	VALUE
Input (T->0) Instance 100	1	0-3	REAL	Current Position
		3-7	DWORD	Drive Status (32 bitmap status)
		8-11	DWORD	Drive Faults (32 bitmap faults)
		12-15	DWORD	Digital Input (8 bits used out of 32)
		16-19	DWORD	Digital Output (4 bits used out of 32)
		20-23	REAL	Analog Input
		23-27	REAL	Analog Output

Table 3-2: ACS EtherNet/IP Input Assembly

ACS DRIVE STATUS	
BIT	**DESCRIPTION**
0	Drive Enable: 0 = Not Enabled; 1 = Enabled
1	Drive Homed: 0 = Not Homed; 1 = Homed
2	Drive In Motion: 0 = Motion Complete; 1 = In Motion
3	Software Stop: 0 = OFF; 1 = ON
4	Stop Motion (internal use) 0 = OFF; 1 = ON
5	(internal use)
6	(internal use)
7	(internal use)
8	(internal use)
9	(internal use)
10-19	(internal use)
20	Brake Not Active (1 - Not Active; 0 - Active)
21-30	**Reserved
31	Drive Control: 0 = OFF (I/O, CTROFF), 1 = ON (Host, CTRON)

Table 3-3: ACS Drive Status

ACS DRIVE FAULTS		
	BIT	DESCRIPTION
	0	Positive Limit
	1	Negative Limit
	2	Software Stop
	3	Position Error
	4	Feedback Error
	5	Overcurrent
	6	Motor Overtemperature
	7	Drive Overtemperature
	8	Drive OverVolatage
	9	Drive UnderVoltage
	10	Flash Error
ACS Servo Drive	11	I2T Limit
	12	Short Circuit
	13	Watchdog Reset
	14-31	Open

Table 3-4: ACS Drive Faults

3.3 Output Assembly

INSTANCE	ATTRIBUTE ID	BYTES	TYPE	VALUE
Input (0->T) Instance 112	3	0	USINT	Network Outputs Bit 0: Enable Bit 1: Start Motion Bit 2: Home Bit 3: Software Stop Bit 4: Stop Motion Bit 5-7: Reserved
		1	USINT	Move Select (0-16)
		2-3	NA	Reserved

Table 3-5: ACS EtherNet/IP Output Assembly

INSTANCE	ATTRIBUTE ID	BYTES	TYPE	VALUE
Output (O->T) Instance 113	3	0	USINT	Network Outputs Bit 0: Enable Bit 1: Start Motion Bit 2: Home Bit 3: Software Stop Bit 4: Stop Motion Bit 5-7: Reserved
		1	USINT	Move Select (0-16)
		2-3	*NA*	*Reserved*
		3-7	REAL	Target 0 Position
		8-11	REAL	Target 0 Velocity
		12-15	REAL	Target 0 Acceleration
		16-19	REAL	Target 0 Deceleration
		20-23	REAL	Target 0 Force
		23-27	DWORD	Target 0 Motion Type (absolute or incremental)
		28-31	DWORD	Digital Output (4 bits used out of 32)

Table 3-6: ACS EtherNet/IP Full Output Assembly

One of the explicit message objects is allocated as part of the predefined slave/adapter connection set as defined in the EtherNet/IP specification.

The other may be allocated using the Unconnected Message Manager (UCMM) protocol.

These objects can be used to access any ACS Drive parameter.

OBJECT ID	OBJECT NAME	PURPOSE
1	Vendor Identity	Identifies the drive as ACS Drive & Controller
4	Assembly	ACS Drive currently supports two (2) Output assembly objects and one (1) Input assembly object as specified by EtherNet/IP standard
245	TCP	ACS Drive TCP/IP Interface Object provides information about TCP/IP network interface such as IP Address, Network Mask, Gateway, Host Name
246	Ethernet Link	ACS Drive Ethernet Link Object provides information about Speed and Duplex connection

Table 4-1: Message Objects

4.1 Identity Object (01_{HEX} - 1 Instance)

The following tables contain the attribute, status, and common services information for the Identity Object.

INSTANCE	ATTRIBUTE ID	NAME	CIP DATA TYPE	DATA VALUE
Class (Instance 0)	1	Revision	UINT	1
Instance 1	1	Vendor number	UINT	1230
	2	Device type	UINT	0
	3	Product code number	UINT	9046
	4	Product major revision	USINT	01
		Product minor revision	USINT	01
	5	Status	WORD	NA
	6	Serial number	UDINT	Unique 32 bit value
	7	Product name	SHORT STRING32	ACS Drive & Controller

Table 4-2: Identity Object (01_{HEX} - 1 Instance)

Identity Object Common Services			
SERVICE CODE	IMPLEMENTED FOR		SERVICE NAME
	CLASS LEVEL	INSTANCE LEVEL	
01_{HEX}	No	Yes	Get_Attribute_All
05_{HEX}	No	Yes	Reset
$0E_{HEX}$	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Table 4-3: Identity Objects Common Services

4.2 Assembly Object

The following tables contain the attribute, instance, data mapping, and common services information for the Assembly Object.

INSTANCE	ATTRIBUTE ID	NAME	CIP DATA TYPE	DATA VALUE
Class (Instance 0)	1	Revision	UINT	2
	2	Max instance	UINT	129
Input (T->0) (Instance 100)	3	Refer to Table 3-2		
Output (0->T) (Instance 112)	3	Refer to Table 3-5		
Output (0->T) (Instance 113)	3	Refer to Table 3-6		
254 (0xFE)	4	Input only heartbeat[1]	Heartbeat	0
255 (0xFF)	5	Listen only heartbeat[2]	Heartbeat	0
253 (0xFD)	6	Output Only heartbeat[3]	Heartbeat	0

[1]This instance allows clients (PLCs) to monitor input data without providing output data.

[2]This instance allows clients (PLCs) to monitor input data without providing output data. To use this connection type, an owning connection must exist from a second client and the configuration of the connection must match exactly.

[3]This instance allows output data without providing input data.

Table 4-4: Assembly Object (04_{HEX} . 6 Instances)

Assembly Object Common Services			
SERVICE CODE	IMPLEMENTED FOR		SERVICE NAME
	CLASS LEVEL	INSTANCE LEVEL	
E_{HEX}	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Table 4-5: Assembly Objects Common Services

4.3 TCP/IP Object ($F5_{HEX}$ - 1 Instance)

Please refer to Volume 2: EtherNet/IP Adaptation of CIP v. 1.11, 4-4.3 for exact format and interpretation of attributes.

INSTANCE	ATTRIBUTE ID	NAME	DATA TYPE
Class (Instance 0)	1	Revision	UINT
Instance 1	1	Status	DWORD
	2	Configuration capability	DWORD
	3	Configuration control	DWORD
	4	Physical Link Object Structure of Path size Path	 UINT Array of Word
	5	Interface configuration Structure of IP Address Network MasK Gateway Address Name Server Name Server 2 Domain Name Size Domain Name	 UDINT UDINT UDINT UDINT UDINT UINT STRING
	6	Host name Structure of Host Name Size Host Name	 UINT STRING

Table 4-6: TCP/IP Object ($0xF5_{HEX}$ - 1 Instance)

TCP/IP Object Common Services			
SERVICE CODE	IMPLEMENTED FOR		SERVICE NAME
	CLASS LEVEL	INSTANCE LEVEL	
E_{HEX}	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Table 4-7: TCP/IP Object Common Services

4.4 EtherNet/IP Link Object ($F6_{HEX}$ - 1 Instance)

Please refer to Volume 2: EtherNet/IP Adaptation of CIP v. 1.11, Section 4-4.4 for exact format and interpretation of attributes.

INSTANCE	ATTRIBUTE ID	NAME	DATA TYPE
Class (Instance 0)	1	Revision	UINT
Instance 1	1	Interface speed	UDINT
	2	Interface flags	DWORD
	3	Physical address	USINT Array (6)

Table 4-8: Ethernet Link Object (0xF6$_{HEX}$ - 1 Instance)

Ethernet Link Object Common Services			
SERVICE CODE	IMPLEMENTED FOR		SERVICE NAME
	CLASS LEVEL	INSTANCE LEVEL	
E_{HEX}	Yes	Yes	Get_Attribute_Single
10_{HEX}	No	Yes	Set_Attribute_Single

Table 4-9: TCP/IP Object Common Services

4.5 QoS Object (48_{HEX} - 1 Instance)

The following tables contain the attribute and common services information for the QoS Object. The default attribute ID for the ACS drive is 6.

QoS Object ($F6_{HEX}$ - 1 Instance)					
INSTANCE	ATTRIBUTE ID	NAME	DATA TYPE	DATA VALUE	ACCESS RULE
Class (Instance 0)	1	Revision	UINT	1	Get
Instance 1	1	802.1Q Tag Enable	UINT	NA	Not Supported
	2	DSCP PTP Event	UINT	NA	Not Supported
	3	DSCP PTP General	UINT	NA	Not Supported
	4	DSCP Urgent	UINT	55	Get / Set
	5	DSCP Scheduled	UINT	47	Get / Set
	6	DSCP High	UINT	43	Get / Set
	7	DSCP Low	UINT	31	Get / Set
	8	DSCP Explicit	UINT	27	Get / Set

*For more details on these attributes, see Volume 2: EtherNet/IP Adaptation of CIP, Section 5-7.4 from ODVA.

Table 4-10: QoS Object (48$_{HEX}$ - 1 Instance)

QoS Object's common services			
	IMPLEMENTED FOR		
SERVICE CODE	CLASS LEVEL	INSTANCE LEVEL	SERVICE NAME
01_{HEX}	NO	YES	Get_Attribute_All
$0E_{HEX}$	YES	YES	Get_Attribute_All
10_{HEX}	NO	YES	Get_Attribute_All

Table 4-11: QoS Object's common services

Default QoS priority levels

By default ACS drives ship out with QoS priority level of 43 (DSCP high). User may under certain circumstances wish to change the priority level across the machine. Contact Tolomatic support if your application requires changing the QoS priority level.

Appendix A: Trouble Shooting

Troubleshooting

For every module connected to the EtherNet/IP system verify that:

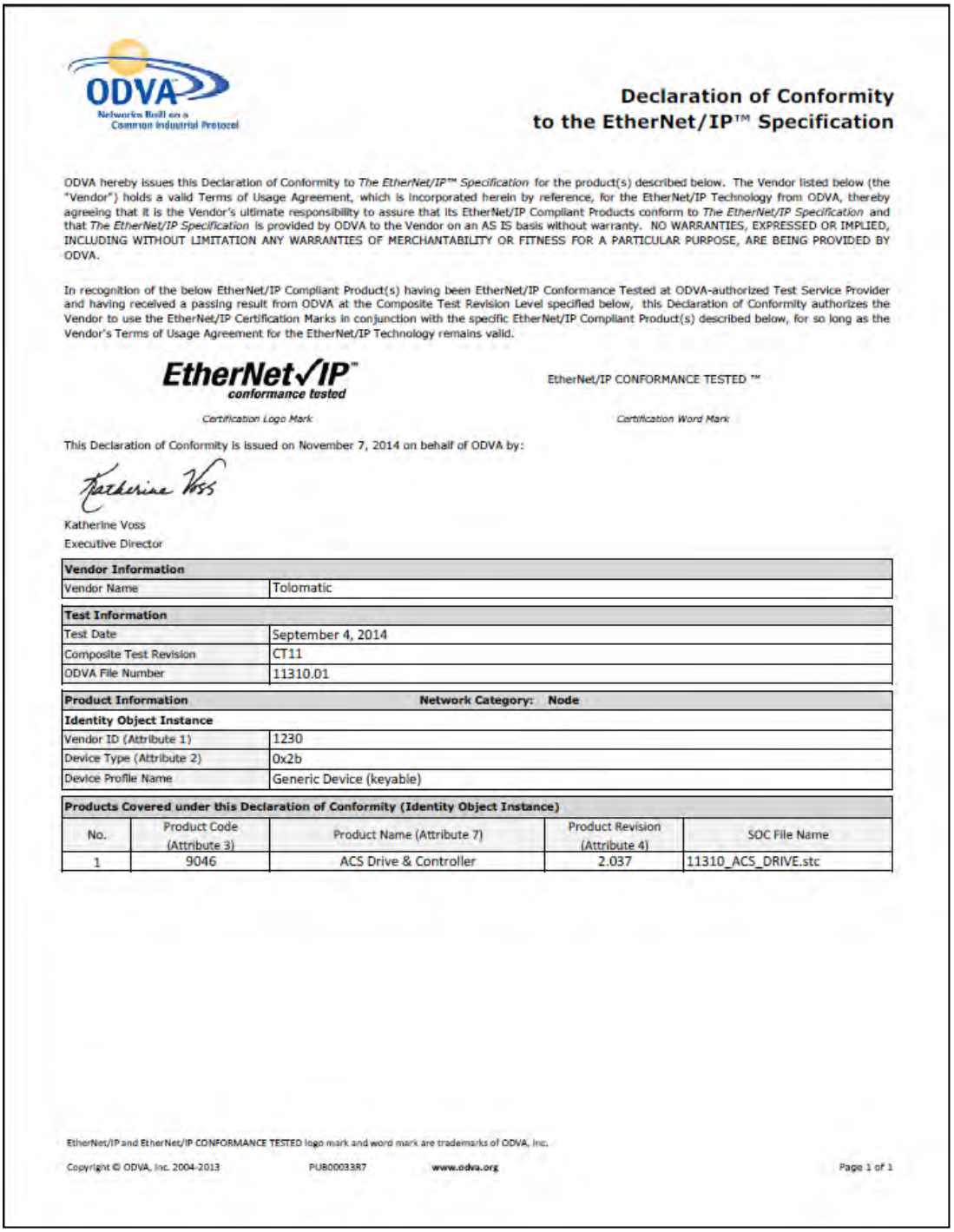
1. Link state: MUST be UP (connected to a powered switch).
2. Duplex: MUST be Full duplex
3. Auto/forced: MUST be able to Autonegotiate the speed
4. Speed: MUST be 100Mbps
5. Errors: MUST be 0 for BOTH, In errors and out errors.
6. CIP connection timeouts: should be 0
7. CIP connections: MUST be<= 80-90% of the module's capacity
8. TCP connections: MUST be<= 80-90% of the module's capacity
9. CPU usage%: MUST be<= 80-90%
10. Missed I/O packets: MUST be NO missed packets i.e. missed I/O packets should be set to 0
11. HMI packets/sec:<= MUST be 80-90% of the module's capacity
12. I/O packets/sec:<= MUST be 80-90% of the module's capacity

SYMPTOM/TROUBLE	POSSIBLE CAUSE/RESOLUTION
No Ethernet Communication	1. Check Ethernet Cable. 2. Verify Ethernet Cable is plugged in securely. 3. Incorrect combination of IP Address, Subnet Mask, Gateway. Check with your network administrator to determine correct combination. 4. Try different Ethernet port on the drive. 5. Verify RPI is not faster than 20 ms. Larger RPI required for larger # drives.
No EtherNet/IP connectivity	1. Check your assembly configuration. 2. Check if Ethernet communication can be established with the drive using PING utility. 3. Check if Digital Outputs can be set/reset using EtherNet/IP O->T assembly. 4. Advanced Troubleshooting Tip: Check Ethernet packets received and sent to the PLC from and to the drive.

SYMPTOM/TROUBLE	POSSIBLE CAUSE/RESOLUTION
Motion cannot be executed over EtherNet/IP	1. Check if Drive Status, Drive Faults, Digital Inputs and Outputs can be queried over EtherNet/IP. If drive is not sending them, then troubleshoot Ethernet communication. 2. Check if drive is configured with EtherNet/IP communication mode using Tolomatic Motion Interface Software. 3. Check if Digital Outputs can be set/reset using EtherNet/IP O->T assembly. If the Digital Outputs of the drive cannot be set or reset using EtherNet/IP O->T assembly then troubleshoot the Ethernet communication. 4. Advanced Troubleshooting Tip: Try different EtherNet/IP scanner to interface with Tolomatic ACS Drive.
The I/O tree in RSLogix5000 has a yellow triangle on a ACS drive.	Note following about the ACS Stepper drive: 1. Only a single device is being lost? Example: Only a single device, a 36049654 (ACS Stepper drive & Controller), has a yellow triangle 2. Was it ever operating correctly or did this start recently? 3. How often does it happen? (constantly, once per hour, once per week?) 4. For how long does the anomaly last? (3 seconds, forever?) 5. How do you recover? (cycle power to device?, recovers by itself?) 6. What additional steps, if any, did you already take to troubleshoot? E.g. hardware changes 7. Contact Tolomatic support

Appendix B: ODVA Documentation

ODVA Declaration of Conformity to EtherNet/IP



ODVA
Networks Built on a Common Industrial Protocol

Declaration of Conformity to the EtherNet/IP™ Specification

ODVA hereby issues this Declaration of Conformity to *The EtherNet/IP™ Specification* for the product(s) described below. The Vendor listed below (the "Vendor") holds a valid Terms of Usage Agreement, which is incorporated herein by reference, for the EtherNet/IP Technology from ODVA, thereby agreeing that it is the Vendor's ultimate responsibility to assure that its EtherNet/IP Compliant Products conform to *The EtherNet/IP Specification* and that *The EtherNet/IP Specification* is provided by ODVA to the Vendor on an AS IS basis without warranty. NO WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, ARE BEING PROVIDED BY ODVA.

In recognition of the below EtherNet/IP Compliant Product(s) having been EtherNet/IP Conformance Tested at ODVA-authorized Test Service Provider and having received a passing result from ODVA at the Composite Test Revision Level specified below, this Declaration of Conformity authorizes the Vendor to use the EtherNet/IP Certification Marks in conjunction with the specific EtherNet/IP Compliant Product(s) described below, for so long as the Vendor's Terms of Usage Agreement for the EtherNet/IP Technology remains valid.

EtherNet/IP conformance tested — *Certification Logo Mark*

EtherNet/IP CONFORMANCE TESTED ™ — *Certification Word Mark*

This Declaration of Conformity is issued on November 7, 2014 on behalf of ODVA by:

Katherine Voss
Executive Director

Vendor Information	
Vendor Name	Tolomatic

Test Information	
Test Date	September 4, 2014
Composite Test Revision	CT11
ODVA File Number	11310.01

Product Information	**Network Category: Node**
Identity Object Instance	
Vendor ID (Attribute 1)	1230
Device Type (Attribute 2)	0x2b
Device Profile Name	Generic Device (keyable)

Products Covered under this Declaration of Conformity (Identity Object Instance)

No.	Product Code (Attribute 3)	Product Name (Attribute 7)	Product Revision (Attribute 4)	SOC File Name
1	9046	ACS Drive & Controller	2.037	11310_ACS_DRIVE.stc

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