EtherNet/IP Interoperability Test Procedures

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1 Introduction

This document identifies test procedures for interoperability testing of EtherNet/IP devices. The test procedures are derived from a series of documents that have been produced by ODVA and the North American EtherNet/IP Implementors Workshop.

This document is one of a set of documents that will lay out the test plans, procedures, and logistics for performing interoperability testing on EtherNet/IP devices. This document consists of a specific set of test procedures that describe the way to perform interoperability testing for EtherNet/IP devices. Other documents may describe the specific way in which the tests will be conducted at a particular event. Test results will be recorded in a test results document that will be provided only to the vendor. If the product has a valid Declaration of Conformance (DoC), upon successfully completing the advisory test followed by PlugFest Completion at a TSP, the product's DoC will be updated to indicate that it has passed the Advisory Test for EtherNet/IP Interoperability. Devices that do not have a valid Declaration of Conformance may use the Interoperability Advisory Test results in the future (within 6 months of completing the Interoperability Advisory test) if the same device revision passes the ODVA Conformance and PlugFest Completion tests at a TSP.

The EtherNet/IP Interoperability Advisory Test will consist of testing products for compliance to the following recommendations:

- Recommended IP Addressing Methods for EtherNet/IP Devices, see Section 2, Normative Reference Documents, item [4] for publication number and revision.
- Recommended Functionality for EtherNet/IP Devices, see Section 2, Normative Reference Documents, item [5] for publication number and revision.
- Address Conflict Detection per Appendix F, see Section 2, Normative Reference Documents, item [2].
- Performance Test Methodology for EtherNet/IP Devices, see Section 2, Normative Reference Documents, item [7] for publication number and revision.

This document describes both required and informational interoperability test cases. A device must pass all of the required test cases in order to have successfully completed the EtherNet/IP Interoperability Tests. Some of the test cases in this document are informational. These are test cases that have been determined to aid interoperability but are not required for it. A device may attempt to complete these steps, but the device will not fail the EtherNet/IP interoperability tests for unsuccessfully completing those steps. Unless specifically noted in this document, all test cases presented are required.

2 Normative Reference Documents

The following list contains a set of normative references that are the basis for these test procedures. The test procedures in this document refer to the particular test plan line items.

1. CIP Common Specification, Edition 3.13, November 2012 or later.
2. EtherNet/IP Adaptation of CIP, Edition 1.14, November 2012 or later.
3. EtherNet/IP Terms and Definitions, Revision 0.3, April 3, 2002.
4. Recommended IP Addressing Methods for EtherNet/IP Devices, Version 1.0, June 10, 2003, PUB00028R0.
5. Recommended Functionality for EtherNet/IP Devices, Version 4, February 19, 2013, PUB00070R4.
6. Performance Test Terminology for EtherNet/IP Devices, Version 1.1, March 14, 2005, PUB00080R1.1.
7. Performance Test Methodology for EtherNet/IP Devices, Version 1.0, March 14, 2005, PUB00081R1.

3 Abbreviations & Definitions

CIP	Common Industrial Protocol
DOC	Declaration of Conformity
DLR	Device Level Ring
DUT	Device Under Test
EDS	Electronic Data Sheet
EO	Exclusive Owner
I/O	Input/Output
IO	Input Only
IP	Internet Protocol
LO	Listen Only

Exclusive Owner (EO) Connection
A connection where the Originator opens a connection to both the input and output connection points of the Target (both O→T and T→O directions).

Heartbeat Connection
A special type of CIP connection where a small message is sent over the connection at regular intervals to allow either the Originator or Target of a connection to monitor the connection status even if the actual data only flows in one direction (either O→T or T→O).

Input Only (IO) Connection
A connection where the Originator opens a connection to the input connection point of the Target (T→O direction) and an O→T connection to the IO heartbeat connection point.

Listen Only (LO) Connection
A connection where the Originator opens a connection to the input connection point of the Target (T→O direction) and an O→T connection to the LO heartbeat connection point. A Listen Only connection differs from an Input Only connection in that it cannot initiate a connection to a device or remain active if a connection is terminated, it can only monitor an existing connection.

IP Frame
An Ethernet frame containing IP address information in contrast to other frames that do not contain such information, e.g. a Beacon frame within the DLR protocol.

4 Software and Tool Versions

This document mentions several tools and software packages. The following minimum revisions are required to perform a complete set of the tests described in this document. All links were validated on April 30, 2014.

- EZ-EDS (ODVA) version 3.21 or later
  - https://secure.odva.org/forms/ez-eds.htm
- RSLinx Classic Lite (Rockwell Automation) version 3.60 or later
  - http://compatibility.rockwellautomation.com/Pages/MultiProductDownload.aspx?Keyword=Free&crumb=112
- EIP-CT (Molex) version 3.1 or later
  - http://www.molex.com/molex/products/datasheet.jsp?part=active/1121065011_SOFTWARE_DEV_KITS.xml
- EDITT (Pyramid Solutions), version 1.23 or later
  - http://network.pyramidsolutions.com/software-products/development-testing-tools/ethernetip-interoperability-editt/
- Molex EtherNet/IP Tool, latest version 2.3(ODVA) or later (EIPTools.exe)
  - http://www.molex.com/molex/common/staticLoader.jsp?fileName=/mx_upload/superfamily/iccc/EtherNet_IPTool.html
- Wireshark, any version will suffice
  - http://www.wireshark.org/download.html
- At least 1 PC with Windows is needed for most tests. Make sure that VPN and firewall is shut down as it will interfere with most tests
- DHCP Server is needed for many tests. Any such server will suffice
- CIP Tool – a CIP Explicit client that allows the user to build CIP explicit messages. A tool such as Pyramid Solutions' EIP Scan will suffice.
  - http://network.pyramidsolutions.com/software-products/development-testing-tools/ethernetip-scanner-simulator-eipscan/
- ODVA Example Code application – use current version on ODVA website
- ACD Test Tool (HMS) v1.13.0.1 or later
  - https://marketplace.odva.org/products/1812-address-conflict-detection-test-tool
- Molex Plugfest Performance Packet Generator v1.1 or later (for comparison only; the official injection tool is TCP replay as compiled by NIST)
- NIST Industrial Ethernet Network Performance (IENetP) Test Tool v1.1.2 or later.
  - http://sourceforge.net/projects/ienetp/
- TCP replay files as provided through http://ienetp.sourceforge.net/EtherNet-IP_Testing.zip
- Hilscher netAnalyzer PCI-card (NANL-C500-RE) installed in a Microsoft Windows PC.
  - http://hilscher.com/products_details_hardware.html?p_id=P_474ae22a48950&bs=14

5 Proposed Test Configurations

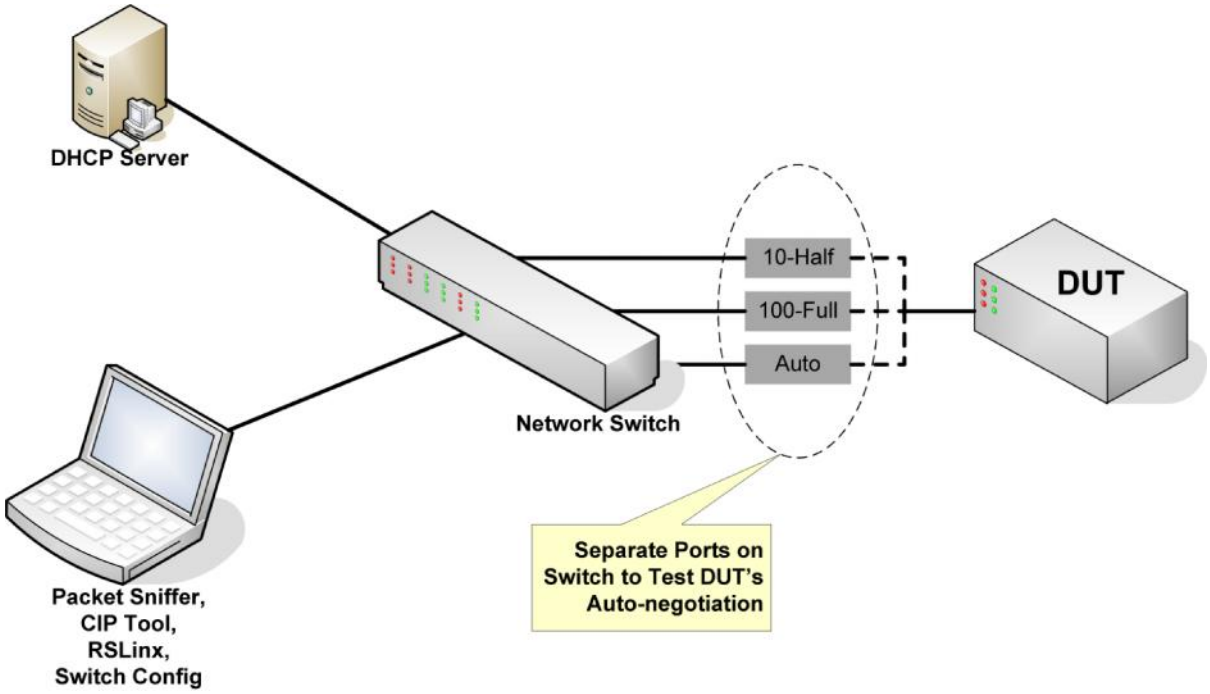

Figure 1 Proposed Network Interoperability Test Setup

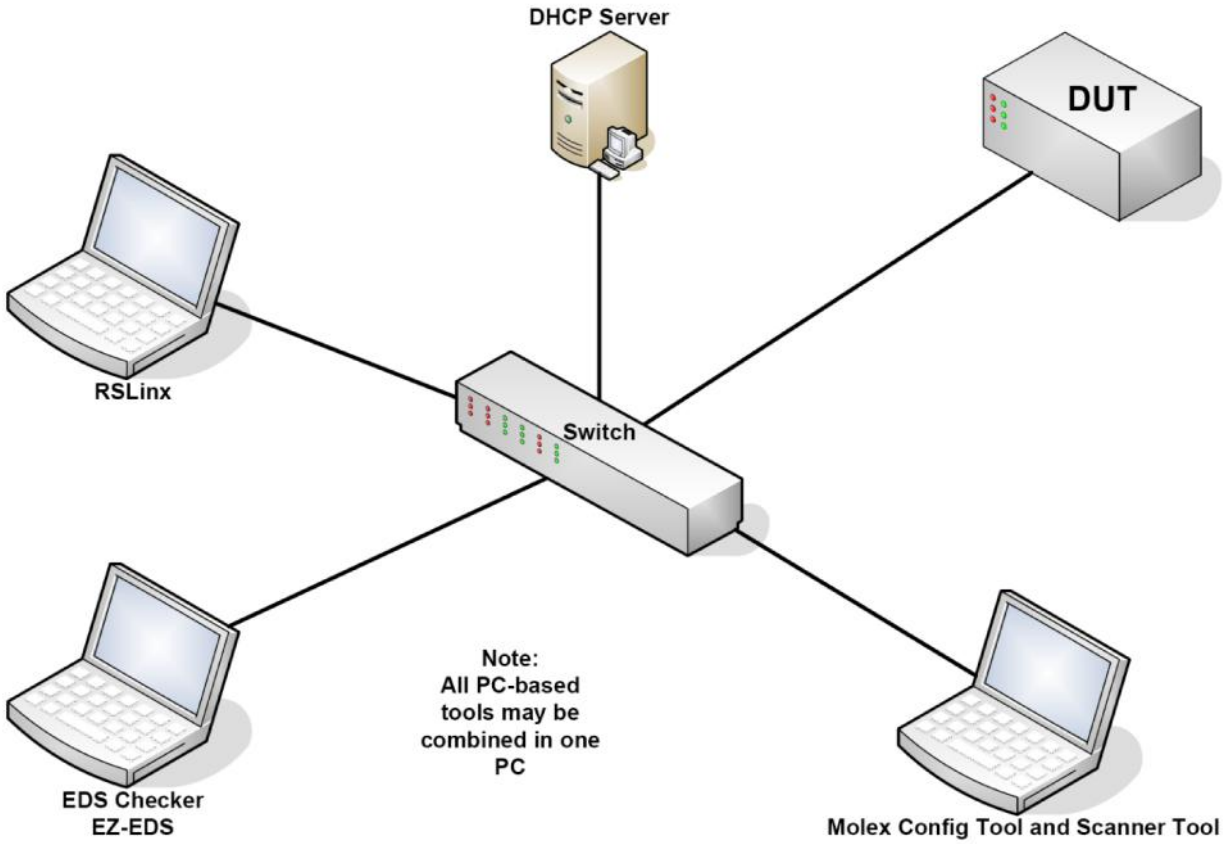

Figure 2 Proposed Setup for EDS test

For the ACD test configurations (see below), the infrastructure device used shall be an Ethernet Hub or Ethernet Switch. If an Ethernet Switch is used it must support port mirroring and be capable of transmitting data from the Test Tool thru the mirroring port. In addition, the Ethernet Switch shall be configured to mirror traffic from the port connected to the DUT to the port connected to the PC running the IPv4 ACD Test Tool.

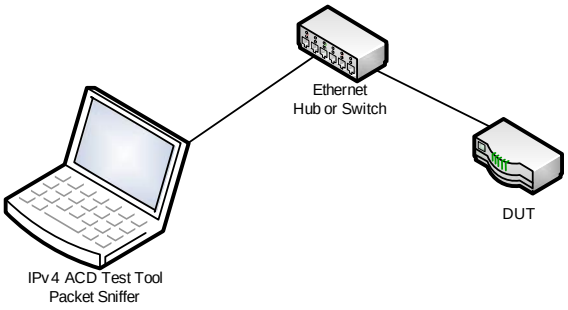

Figure 3 Proposed test configuration for single port device

For multi port devices an additional Ethernet device is required in order to perform some of the ACD tests. The only use for this additional Ethernet device is to establish a link between itself and the DUT, meaning that any device could be used.

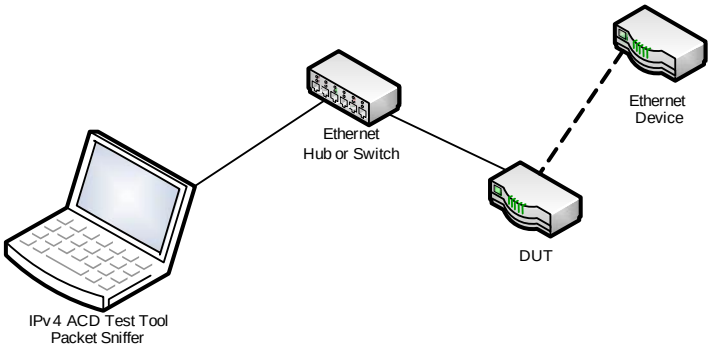

Figure 4 Proposed test configuration for multi port device

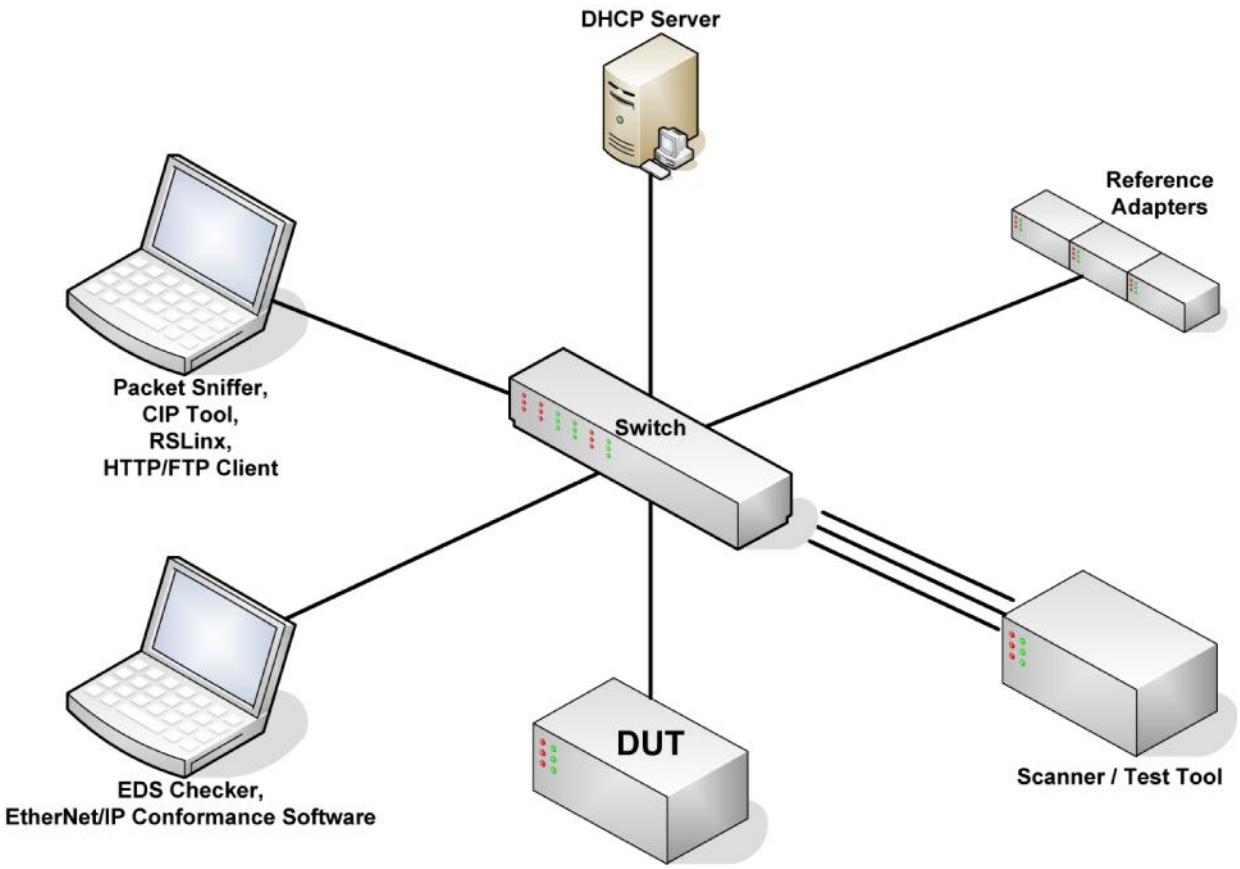

Figure 5 Proposed Common Interoperability Test Setup

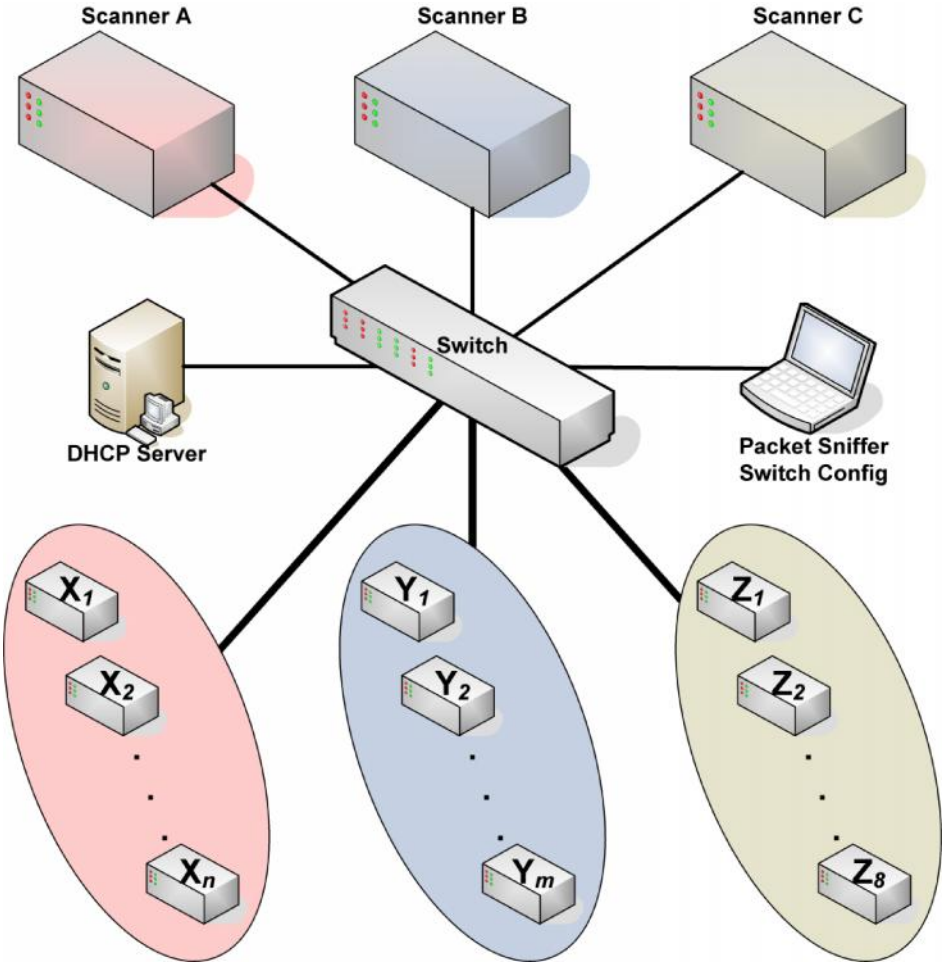

Figure 6 Proposed System Interoperability Test Setup

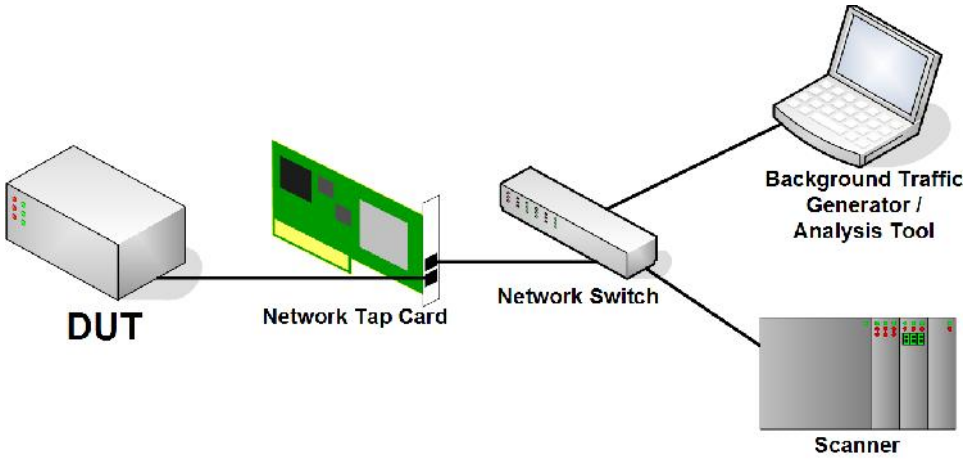

Figure 7 Proposed Performance Test Setup

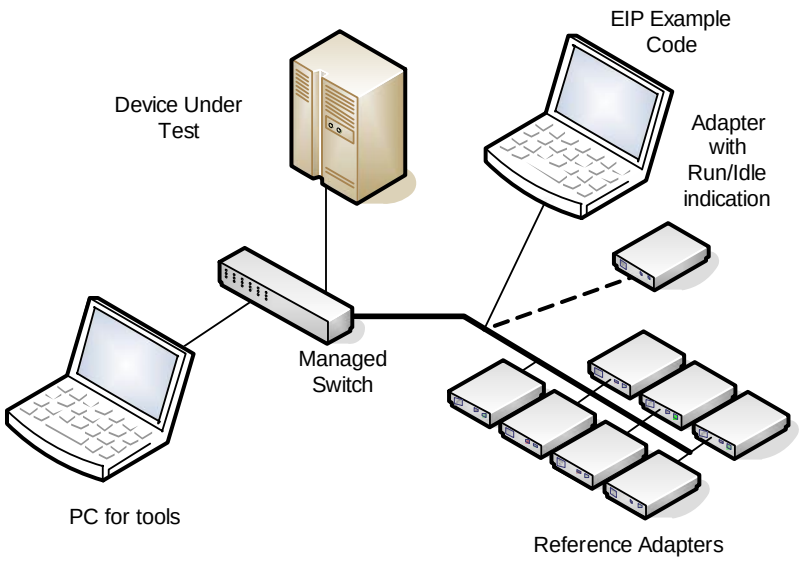

Figure 8 Proposed Scanner Interoperability Test Setup

6 EDS File Verification Test

This test is intended to verify that the EDS file for the EtherNet/IP device conforms to the appropriate requirements. This test MUST be successfully completed before proceeding to further tests.

A proposed test setup is shown in Figure 2. The software required for this test is listed below. See Section 4, Software and Tool Versions for specific version information.

- EZ EDS
- RSLinx
- EIP-CT from Molex

P6 EDS File Verification Test Procedure

P6.1 Offline EDS File Verification with EZ-EDS

P6.1.1 Open EDS of DUT with EZ-EDS. Minor deficiencies can be fixed at this stage if the missing information is available.

P6.1.2 Check for the I/O capacity section and verify that the section exists and is correctly formatted. (The performance numbers presented in the I/O capacity section will not be validated.)
NOTE: This does not apply to messaging only devices.

P6.1.3 Verify that the EDS file includes the specification of the format of the I/O connection assembly object in the [Assembly] section if the DUT is an Adapter. “Format” in this context means that assembly members are described by parameters (e.g. ParamN, AssemN, etc. entries): assembly members that resolve to pad bits/bytes alone with nothing else are not regarded as “format”.
NOTE1: This does not apply to rack-based, technology enabler, or explicit messaging-only devices. Or devices with user-defined I/O data content (e.g. EtherNet/IP to other network gateway, target connections of a PLC).
NOTE2: Devices that support symbolic tags rather than assembly objects may not have an [Assembly] section, but shall have “SYMBOL_ANSI” specified in the ConnectionN entries of the [Connection Manager] section.

P6.1.4 Verify that the EDS file includes the [Connection Manager] section with appropriate ConnectionN entries if the DUT is either an Adapter or a Scanner that accepts CIP transport class 1 connections.
NOTE: This does not apply to messaging only devices.

P6.1.5 Verify that the EDS file includes the specification of the format of the configuration assembly in the [Assembly] section if the DUT is an Adapter and supports configuration data with the Fwd_Open. “Format” in this context means that assembly members are described by parameters (e.g. ParamN, AssemN, etc.); assembly members that resolve to pad bits/bytes alone with nothing else are not regarded as “format”.

P6.2 Online EDS File Verification with RSLinx and EIP-CT

P6.2.1 Verification of DUT's EDS file with RSLinx

P6.2.1.1 When launching RSLinx you must instantiate the proper communications driver. From the main menu select "Communications" then "Configure Drivers"; pick EtherNet/IP Driver from "Available Drivers" and select "Add New". You can keep the default name (AB_ETHIP-x) or choose new name. Also, to avoid any confusion, make sure that the "Ethernet devices" driver is not listed in the "Configured Drivers" list. If it is, select the driver and then select "Stop" or "Delete".

P6.2.1.2 Install the EDS of the DUT using the Hardware Installation Tool. This is typically installed as Programs → Rockwell Software →RSLinx→ Tools →EDS Hardware Installation Tool. Warnings during the install process are ok as long as no essential parts of the EDS, e.g. ConnectionN entries are severely affected, i.e. removed. It is advisable to assign an icon to the DUT, either a vendor-supplied icon or an icon from the ones that come with the tool.

P6.2.1.3 Power up the DUT and run the RSWho utility in RSLinx.Open the RSWho window within RSLinx (Connections →RSWho) and browse the network with the DUT using the EtherNet/IP driver. Verify that the DUT is discovered by RSWho and is displayed correctly. NOTE: The requirement is that the device is displayed as a recognized device type based on the EDS; the device should not be displayed as a question mark. If the DUT does not show up with this driver but can be detected when the RSLinx Ethernet driver is used, then this either means there is something wrong with the Ethernet settings of the test PC (Firewall, VPN etc.) or the DUT does not properly support the List Identity request.

Shut down RSLinx before proceeding to the next step.

P6.2.2 Verification of DUT's EDS file with EIP-CT

P6.2.2.1 Check existing configuration of EIP-CT for usability or create a new configuration by right-clicking in the Configurations pane to open the Configuration Manager. From the list, select an EIP_DiagnosticScanner Type. If the existing configuration is ok apart from the IP address of the scanner, then this address can be changed by double-clicking on "EIP_DiagnosticScanner" in the Configuration pane.

P6.2.2.2 Install the EDS using the Library → Add function (or use icon ). The EDS must install without errors; warnings may be displayed during the install process. If the EDS file has previously been installed with the same major revision, remove it and install the new version. NOTE: the EIP-CT configuration software may indicate warnings during the installation; the requirement is that the installation completes without errors.

P6.2.2.3 Select the interface to use to communicate on EtherNet/IP using Network → Choose Network Adapter (or use icon  in the "Network Detection" pane on the left side)

P6.2.2.4 Power up the DUT and go online using the File → Go Online function (or use icon ) and start the Network Detection process using Network → Read Network Configuration… (or use icon ). The EIP-CT must detect the DUT and associate it with the proper EDS. NOTE: The requirement is that the device is displayed as a recognized device type based on the EDS; the device should not be displayed as an unrecognized device. If the device does not appear at all, this could be an indication of a ListIdentity issue (which is a Protocol Conformance issue).

P6.2.3 (Informational):

P6.2.3.1 When the above required test procedure with the EIP-CT has completed successfully, go offline using the File → Go Offline function (or use icon ).

P6.2.3.2 Drag and drop the newly detected device from the Network Detection pane to the main window (or right-click on the device and select “Insert in Configuration”).

P6.2.3.3 Go to the “Connections” tab, check whether the desired connection has been chosen and hit “Ok” when this is the case.

P6.2.3.4 Save the configuration.

P6.2.3.5 Go online using the File → Go Online function (or use icon ). Start the Diagnostic Scanner Tool using Devices -> Diagnostic function (or use icon ) and set it on RUN mode by Devices -> Run function (or use icon ). You can use Wireshark to check the I/O frames on the wire.

P6.2.3.6 The target module should be displayed with a green check mark  . If a red check mark is displayed  , there may be a problem with the connection.

P6.2.3.7 Check functionality of the other available connections (Exclusive Owner and Input Only) by removing the existing connection and inserting others. To do so, use the following procedure:

- Stop diagnostics in EIP-CT, go Offline
- Double-click on target device in EIP-CT and go to the Connections tab
- Mark existing connection and remove it
- Add new connection and pick one that has not been used so far
- Close the configuration window by hitting “Ok”
- Save this configuration
- Go Online then start Diagnostic
- Check if the new connection is ok
- Repeat the above until all connections have been verified

P6.2.3.8 Stop Diagnostics and go Offline before testing another device.

P6.2.4 On the Test Results form, record the O→T and T→O connection information (Conn Points, Sizes & RPI range) used for each connection tested in P6.2.3. These numbers will

be used in the Adapter Interoperability test (section P12) and System Interoperability test (section 0). If the device supports more than one of each type, pick the one(s) the vendor wants to use with the above noted tests. Also record the connection names for those scanner tools that only allow picking connections by name.
If the device was previously tested at the Adapter Interoperability test station and comes to this station with the connection values filled in on the test results form, verify that the values recorded correspond to the entries in the EDS file. The goal is that EDS file has valid information and that information is used in the other testing at Plugfest to verify that it is correct.

7 EtherNet/IP Protocol Conformance Test

This test is intended to verify that the DUT meets the minimum requirements to be considered an EtherNet/IP device per Section 2, Normative Reference Documents [1] and [2]. This establishes a baseline that the other tests in this document use for the additional interoperability tests. In most cases, this test procedure will be conducted before the other test procedures as part of the pre-test qualification for a particular event.

It is recommended that all EtherNet/IP devices have passed a self-administered protocol conformance test at the latest revision of the EtherNet/IP Protocol Conformance Test Software Tool.

P7 EtherNet/IP Protocol Conformance Test Procedure (Informational)

P7.1 Verify that the DUT has passed the EtherNet/IP conformance self-test. The vendor shall have run the latest version of the conformance test prior to Plug Fest attendance. The results of this test (log file) shall be presented upon request.

8 Network Interoperability Test

This test is intended to determine if the DUT meets the minimum recommended behavior for network functionality. A proposed test setup is shown in Figure 1. For multiport devices the following tests will be performed on two ports. For devices with more than two ports, the tester will choose which two ports will be tested.

Software needed for this test. See Section 4, Software and Tool Versions for specific version information:

- RSLinx
- CIP Tool
- Wireshark
- DHCP server
- A tool that can configure the managed switch for different duplex/baud settings. Tool is provided by the switch manufacturer

P8 Network Interoperability Test Procedure

P8.1 Verify that the DUT has the Ethernet MAC address visible on the outside of the device. NOTE: The address may be hidden after the device is installed. A device with an integral display (e.g.: an HMI) that can be made to display the MAC address is an acceptable alternative to a label in devices where a label is not practical (e.g.: PC-based software).

P8.2 Initial Test Setup

P8.2.1 On the DHCP server, setup a static MAC-to-IP mapping for the DUT.

P8.2.2 Put the DUT in an "out-of-box" state with auto-negotiation, then power cycle the DUT while it is disconnected from the switch.

P8.2.3 Setup at least 1 port on the network switch to auto-negotiate its speed and duplex.

P8.2.4 Setup at least 1 port on the network switch to 100 Mbps and full duplex.

P8.2.5 Setup at least 1 port on the network switch to 10 Mbps and full duplex.

P8.2.6 Attach the DUT to the auto-negotiate port on the network switch.

P8.2.7 Prepare a PC with the traffic sniffer software and connect it to the network switch. Set up the network switch so that all traffic to/from the DUT can be monitored via the port where the sniffer is connected.

P8.3 IP Address Configuration

P8.3.1 Verify that the DUT has reached its steady state operation.

P8.3.2 Connect one of the DUT's Ethernet ports to the port on the switch configured for auto-negotiation.

P8.3.3 Using a packet sniffer, verify that the DUT issues a BOOTP/DHCP request at initial power up from an 'out-of-box' configuration state. Record which request is used on the test results form for use in step P8.3.5.

P8.3.4 Verify that the DUT obtained the pre-configured IP address from the BOOTP/DHCP server.

P8.3.4.1 Ping the DUT and verify that it responds correctly.

P8.3.4.2 Using RSLinx, refresh the RSWho utility to send a ListIdentity message and verify that the DUT responds correctly.

P8.3.5 Verify that Configuration Control attribute of the TCP/IP object indicates either BOOTP or DHCP and that the request issued in P8.3.3 is of the indicated type.

P8.3.5.1 Use a Get_Attribute_Single to read class 0xF5, attribute 3 and verify that bits 0-3 are either 1 (BOOTP) or 2 (DHCP).

P8.3.6 Using the packet sniffer, verify that the device has stopped issuing BOOTP or DHCP requests.

P8.3.7 Send the DUT a CIP message to make its IP address permanently stored in non-volatile memory via the TCP/IP interface object

P8.3.7.1 Use a Set_Attribute_Single to set class 0xF5, attribute#3 to a value of zero (use previously stored value or hardware switch value).

P8.3.8 Shut down the DHCP server.

P8.3.9 Power down the DUT, start the traffic sniffer then reapply power to the DUT.

P8.3.10 Verify that the DUT retained its IP address.

P8.3.10.1 Ping the DUT and verify that it responds correctly.

P8.3.10.2 Using RSLinx, refresh the RSWho utility to send a ListIdentity message and verify that the DUT responds correctly.

P8.3.11 Using the packet sniffer, verify that the device has not issued any BOOTP or DHCP requests.

P8.3.12 Send the DUT a CIP message to make its IP address volatile again

P8.3.12.1 Use a Set_Attribute_Single to set class 0xF5, attribute #3 to a value of 1 or 2 (1 = BOOTP; 2 = DHCP) and reboot the device.

P8.3.13 Using the packet sniffer, verify that the device is issuing BOOTP or DHCP requests again.

P8.3.14 Ping DUT to verify that it does not use its previous IP address any more.

P8.3.15 For DUTs with multiple Ethernet ports: Repeat test P8.3 with at least one other port and record which ports were used.

P8.4 Speed & Duplex Configuration Tests (not required for optical Ethernet ports)

P8.4.1 Determine whether the DUT requires a reset to change interface settings by using a Get_Attribute_Single to read the Ethernet Link Object (class 0xF6), attribute 2. Note the value of bit 5 on the test results form for later.

P8.4.2 Verify that auto-negotiate is enabled. Use a Get_Attribute_Single service to read the Ethernet Link Object (class 0xF6), attribute 6 and verify that bit 0 is set.

P8.4.3 Verify that the DUT properly auto-negotiated its speed and duplex to 100/full using the switch configuration tool.

P8.4.4 Set the DUT to 100 Mbps and full duplex. Use a Set_Attribute_Single to the Ethernet Link object (class 0xF6), attribute 6 and set the value to 02 00 64 00.

P8.4.5 If the value from test P8.4.1 was 1, power cycle the DUT now.

P8.4.6 Attach the DUT to the 100 Mbps and full duplex port on the network switch.

P8.4.7 Using RSLinx, refresh the RSWho utility to send a ListIdentity message using broadcast UDP and verify that the DUT responds properly.

P8.4.8 Power cycle the DUT and repeat step P8.4.7 to make sure it retained the 100 Mbps & full duplex settings.

P8.4.9 Set the DUT to 10 Mbps and full duplex. Use a Set_Attribute_Single to the Ethernet Link object (class 0xF6), attribute 6 and set the value to 00 00 0A 00.

P8.4.10 If the value from test P8.4.1 was 1, power cycle the DUT now.

P8.4.11 Attach the DUT to the 10 Mbps and full duplex port on the network switch.

P8.4.12 Using RSLinx, refresh the RSWho utility to send a ListIdentity message using broadcast UDP and verify that the DUT responds properly.

P8.4.13 Power cycle the DUT and repeat set P8.4.12 to make sure it retained the 10 Mbps & full duplex settings.

P8.4.14 Return the DUT to auto-negotiate. Use a Set_Attribute_Single to the Ethernet Link object (class 0xF6), attribute 6 and set the value to 01 00 00 00.

P8.4.15 If the value from test P8.4.1 was 1, power cycle the DUT now.

P8.4.16 Attach the DUT to the auto-negotiate port on the network switch.

P8.4.17 Using the switch configuration tool, verify that the DUT properly auto-negotiated its speed and duplex to 100/full.

P8.4.18 For DUTs with multiple Ethernet ports: Repeat test P8.4 with at least one other port and record which ports were used.

P8.5 IP Address Conflict Detection Tests

This section provides test cases for the ACD mechanism specified in Appendix F of Volume 2. The applicable test setups are shown in Figure 3 and Figure 4. The DUT shall be configured using a static IP address in all ACD tests. The ACD Test Tool (see Section 4, Software and Tool Versions) may be used to perform these tests.

All timing verifications will allow for an extra 10% in each direction.

P8.5.1 Verification that no IP frames are sent until IP address has been successfully probed

- P8.5.1.1 Assign a static IP address to the DUT
- P8.5.1.2 For multi-port devices: Only have one Ethernet port connected
- P8.5.1.3 Power up the DUT
- P8.5.1.4 Capture all traffic until the DUT sends its second ARP announce
- P8.5.1.5 Verify that the DUT does not use the IP address in any frames other than ARP probes until the first ARP announce has been sent

P8.5.2 Verification of ACD probe timing and ACD announce timing

- P8.5.2.1 Power cycle the DUT
- P8.5.2.2 Verify that the DUT sends out 4 ARP probes
- P8.5.2.3 Verify that the delta time between two ARP probes is between 180 ms and 220 ms
- P8.5.2.4 Verify the contents of each ARP field for all ARP probes

P8.5.2.5 Verify that the DUT sends out 2 ARP announcements

P8.5.2.6 Verify that the delta time between the last ARP probe and the first ARP announce is between 180 ms and 220 ms

P8.5.2.7 Informational: Verify that the delta time between the two ARP announce is between 1800 ms and 2200 ms

P8.5.2.8 Verify the contents of each ARP field for all ARP announce frames

P8.5.3 Verification that ACD process is restarted when Ethernet cable is reconnected

Note: This test is dependent on that test P8.3.2 has been completed successfully.

P8.5.3.1 Disconnect and reconnect the Ethernet cable

P8.5.3.2 Verify that the DUT sends out 4 ARP probes

P8.5.3.3 Verify that the delta time between two ARP probes is between 180 ms and 220 ms

P8.5.3.4 Verify the contents of each ARP field for all ARP probes

P8.5.3.5 Verify that the DUT sends out 2 ARP announcements

P8.5.3.6 Verify that the delta time between the last ARP probe and the first ARP announce is between 180 ms and 220 ms

P8.5.3.7 Informational: Verify that the delta time between the two ARP announce is between 1800 ms and 2200 ms

P8.5.3.8 Verify the contents of each ARP field for all ARP announce frames

P8.5.4 Verification of ongoing ACD probe timing

Note to tester: Due to time constraints, skip this test on the first pass. If all other ACD tests pass, perform a second pass and include this test.

P8.5.4.1 Power cycle the DUT

P8.5.4.2 Monitor ARP probes from the DUT for 10 minutes

P8.5.4.3 Verify that the delta time between two ARP probes is between 90 s and 150 s

P8.5.4.4 Verify the contents of each ARP field for all ARP probes

P8.5.5 Verification of semi-active state for multi port devices supporting ACD per Vol.2

P8.5.5.1 Power cycle the DUT and wait until the initial probe and announce phase has passed

P8.5.5.2 Connect a cable with an Ethernet device attached to one of the unconnected ports

P8.5.5.3 Verify that the DUT sends out 2 ARP probes

P8.5.5.4 Verify that the delta time between the two ARP probes is between 180 ms and 220 ms.

P8.5.5.5 Verify the contents of each ARP field for all ARP probe frames

P8.5.5.6 Repeat test P8.5.5 with at least one other port and record which ports were used

P8.5.6 Verification that multi port devices restart the ACD process on link up

P8.5.6.1 Power cycle the DUT (with cable on second Ethernet port connected) and wait until the initial probe and announce phase has passed

P8.5.6.2 Disconnect and reconnect the second Ethernet cable

P8.5.6.3 Verify that the DUT sends out 2 ARP probes

P8.5.6.4 Verify that the delta time between two ARP probes is between 180 ms and 220 ms

P8.5.6.5 Verify the contents of each ARP field for all ARP probes

P8.5.6.6 Disconnect the second Ethernet cable

P8.5.6.7 Repeat test P8.5.6 with at least one other port and record which ports were used

P8.5.7 Verification of IP address conflict detection during probe phase – ARP announce

P8.5.7.1 Power cycle the DUT

P8.5.7.2 During the probe phase, between probe 1 and 4,test tool shall send an ARP announce with Sender IP address equal to the IP address used by the DUT

P8.5.7.3 Verify that the DUT immediately stops sending ARP announces and/or probes

P8.5.7.4 Verify that the DUT exhibits IP conflict. If the DUT supports NS LED, verify that the DUT sets the NS LED to solid red

P8.5.7.5 If the DUT supports MS LED, verify that the DUT flashes the MS LED red

P8.5.8 Verification of IP address conflict after probe phase

P8.5.8.1 Power cycle the DUT

P8.5.8.2 During the announce phase, between probe 4 and announce 1,test tool shall send an ARP announce with Sender IP address equal to the IP address used by the DUT

P8.5.8.3 Verify that the DUT immediately stops sending ARP announces and/or probes

P8.5.8.4 Verify that the DUT exhibits IP conflict. If the DUT supports NS LED, verify that the DUT sets the NS LED to solid red

P8.5.8.5 If the DUT supports MS LED, verify that the DUT flashes the MS LED red

P8.5.9 Verification of LastConflictDetected attribute for devices supporting ACD per Vol.2, Appendix F

P8.5.9.1 Power cycle the DUT

P8.5.9.2 Wait until the DUT has transmitted its second ARP Announce frame

P8.5.9.3 Use a Set_Attribute_Single to set class 0xF5 (TCP/IP Interface Object), instance 1, attribute 11 (LastConflictDetected) to all zeros. Allow up to 60 seconds (or more) for the DUT to become accessible via CIP messaging.

P8.5.9.4 Use a Get_Attribute_Single to read class 0xF5, instance 1, attribute 11 and verify that it is all zeros

P8.5.9.5 Send an ARP announce with Sender IP address equal to the IP address used by the DUT

P8.5.9.6 Power cycle the DUT

P8.5.9.7 Wait until the DUT has transmitted its second ARP Announce frame

P8.5.9.8 Use a Get_Attribute_Single to read class 0xF5, instance 1, attribute 11 and verify that the contents of the LastConflictDetected attribute match the ARP announce used to generate the conflict

P8.5.10 Verification that IP address conflict isn't declared between announce frames

P8.5.10.1 Power cycle the DUT

P8.5.10.2 During the announce phase, between announce 1 and 2, send an ARP announce with Sender IP address equal to the IP address used by the DUT

P8.5.10.3 Verify that the DUT keeps and defends its IP address

P8.5.10.4 Verify the contents of each ARP field in the defending ARP announce frame

P8.5.10.5 Verify that the DUT doesn't declare a conflict

P8.5.11 Verification of ACD defend

P8.5.11.1 Power cycle the DUT and wait until the initial probe and announce phase has passed

P8.5.11.2 Wait for 3s (so the DEFEND_INTERVAL has elapsed)

P8.5.11.3 Send an ARP announce with Sender IP address equal to the IP address used by the DUT
P8.5.11.4 Verify that the DUT sends ARP announce (defending its IP address)
P8.5.11.5 Verify that all fields in the ARP announce are correct
P8.5.11.6 Verify that the DUT doesn't declare a conflict

P8.5.12 Verification of IP address conflict after IP address successfully has been probed

P8.5.12.1 Power cycle the DUT and wait until the initial probe and announce phase has passed
P8.5.12.2 Send a gratuitous ARP with Sender and Target IP addresses equal to the IP address used by the DUT
P8.5.12.3 Verify that the DUT defends its IP address
P8.5.12.4 Verify that all ARP fields in the defend packet are correct
P8.5.12.5 Wait for 3 s (so the DEFEND_INTERVAL has elapsed)
P8.5.12.6 Send a gratuitous ARP with Sender and Target IP addresses equal to the IP address used by the DUT
P8.5.12.7 Verify that the DUT defends its IP address
P8.5.12.8 Verify that all ARP fields in the defend packet are correct
P8.5.12.9 Verify that the DUT doesn't declare a conflict
P8.5.12.10 Wait for 3s (so the DEFEND_INTERVAL has elapsed)
P8.5.12.11 Send a gratuitous ARP with Sender and Target IP addresses equal to the IP address used by the DUT
P8.5.12.12 Verify that the DUT defends its IP address
P8.5.12.13 Verify that all ARP fields in the defend packet are correct
P8.5.12.14 Wait for 1s(so the next DEFEND_INTERVAL has not elapsed yet)
P8.5.12.15 Send a gratuitous ARP with Sender and Target IP addresses equal to the IP address used by the DUT
P8.5.12.16 Verify that the DUT exhibits IP conflict. If the DUT supports NS LED, verify that the DUT sets the NS LED to solid red
P8.5.12.17 If the DUT supports MS LED, verify that the DUT flashes the MS LED red

P8.5.13 Verification that IP address isn't used when conflict has been declared

P8.5.13.1 Power cycle the DUT and wait until the initial probe and announce phase has passed
P8.5.13.2 Generate a conflict so the DUT ceases using its IP address
P8.5.13.3 Send an ARP request to the DUT
P8.5.13.4 Verify that the DUT does not respond to the ARP request

P8.5.14 Verification that directed ARP during probe phase does not cause a conflict

P8.5.14.1 Power cycle the DUT
P8.5.14.2 During the probe phase, between probe 1 and 4, send a directed ARP request with Sender IP address equal to 0.0.0.0 and with the DUT's MAC address as the destination MAC address
P8.5.14.3 Verify that the DUT does not declare a conflict

P8.5.15 Verification of directed ARP response in ongoing detection

P8.5.15.1 Power cycle the DUT
P8.5.15.2 Wait until the DUT has transmitted its second ARP announce frame

P8.5.15.3 Send a directed ARP request with Sender IP address equal to 0.0.0.0 and with the DUT's MAC address as the destination MAC address

P8.5.15.4 Verify that the DUT responds to the ARP request

P8.5.15.5 Wait for 1s (so the DEFEND_INTERVAL has not elapsed yet)

P8.5.15.6 Send a directed ARP request with Sender IP address equal to 0.0.0.0 and with the DUT's MAC address as the destination MAC address

P8.5.15.7 Verify that the DUT responds to the ARP request

P8.5.15.8 Verify that the DUT does not declare a conflict

P8.5.16 Verification of IP address conflict detection during probe phase – ARP probe

P8.5.16.1 Power cycle the DUT

P8.5.16.2 During the probe phase, between probe 1 and 4, test tool shall send a broadcast ARP probe with Sender IP address equal to the IP address used by the DUT

P8.5.16.3 Verify that the DUT immediately stops sending ARP announces and/or probes

P8.5.16.4 Verify that the DUT exhibits IP conflict. If the DUT supports NS LED, verify that the DUT sets the NS LED to solid red

P8.5.16.5 If the DUT supports MS LED, verify that the DUT flashes the MS LED red

9 Common Interoperability Test

The test is intended to determine the minimum set of interoperability functional requirements for all EtherNet/IP devices. A proposed test setup is shown in Figure 5. This test MUST be successfully completed before proceeding to further tests.

Software needed for this test. See section 4, Software and Tool Versions for specific version information:

- EDITT
- DHCP Server
- Optional – Wireshark (used if debugging is necessary)

P9 Common Interoperability Test Procedure

Default Class 3 Connection Parameters

Class 3 connections in this section should be opened with the following parameters unless they are specified in the test case:

RPI 250ms
Timeout multiplier 4
Priority Low

P9.1 Verify support for 3 concurrent encapsulation sessions.

P9.1.1 Open 3 encap sessions to the DUT using 3 independent network interfaces.

P9.1.2 Send a Get_Attribute_Single request to an Identity Object attribute over each encap session and verify a successful response from each request.

P9.2 Verify support for concurrent connected and unconnected messaging on an encapsulation session.

P9.2.1 Open a class 3 connection to the DUT and send a Get_Attribute_Single command to request an Identity Object attribute. Use a connection RPI of 250 ms and a timeout multiplier of 4.

P9.2.2 Send an unconnected CIP message over the same encap session containing a Get_Attribute_Single request to the same Identity Object attribute. Repeat the request every 500 ms.

P9.2.3 Maintain the messaging and connection for 1 minute.

P9.2.4 Verify that there are no connection or response timeouts.

P9.3 Verify support for concurrent connected and unconnected messaging on multiple encapsulation sessions.

P9.3.1 Using a Scanner or test tool, generate request messages to read attributes from the Identity object of the DUT using the following configuration.

P9.3.1.1 Six separate, and concurrent, CIP transport class 3 connections from three independent network interfaces of the reference Scanner to two separate attributes

from the Identity object of the DUT using a Get_Attribute_Single command. Use a connection RPI of 250 ms and a timeout multiplier of 4.

P9.3.1.2 One unconnected CIP message to a third attribute from the Identity object. This request should be repeated every 500 ms

P9.3.2 Maintain the messaging and connections for 1 minute.

P9.3.3 Verify that there are no connection or response timeouts.

P9.4 If another TCP-based protocol is supported by the DUT:

P9.4.1 Connect to the DUT using the appropriate other protocol. Connection must be made from a different IP address than that running the CIP connections to guarantee that a new TCP connection is established.

P9.4.2 Run the test described in P9.3.

P9.4.3 Verify that there is no connection or response timeouts and that the other protocol responds properly.

P9.4.4 Disconnect the appropriate other protocol from the DUT.

P9.5 If another protocol is supported by the DUT (HTTP, FTP, etc.),

P9.5.1 Run the test described in P9.3.

P9.5.2 Connect to the DUT using the appropriate other protocol while the test is in progress. Connection must be made from a different IP address than that running the CIP connections to guarantee that a new TCP connection is established.

P9.5.3 Verify that there is no connection or response timeouts and that the other protocol responds properly.

P9.6 If the DUT supports Module Status and Network Status LEDs, verify visually that the DUT conforms to the EtherNet/IP Industrial Conformance Level LED behavior. This behavior can be handled with an equivalent indicator (e.g. HMI screen). NOTE: Does not apply to transitory or PC-based devices.

P9.6.1 Verify the module status indicator behavior referring to Section 2, Normative Reference Documents [2].

P9.6.2 Verify the network status indicator behavior referring to Section 2, Normative Reference Documents [2].

P9.7 Support for class 3 connection priority High.

P9.7.1 Open a class 3 connection to the DUT with a priority of High and send a Get_Attribute_Single command to request an Identity Object attribute. Use a connection RPI of 250 ms and a timeout multiplier of 4.

P9.7.2 Maintain the messaging and connection for 30 seconds.

P9.7.3 Verify that there are no connection or response timeouts.

10 Explicit Message Server Interoperability Test

This is a list of additional tests above and beyond the Common Interoperability Test for explicit message server devices.

P10 Explicit Message Server Interoperability Test Procedure

P10.1 No additional tests are required.

11 Explicit Message Client Interoperability Test

This is a list of additional tests above and beyond the Common Interoperability Test for explicit message client devices. The same test setup as shown in Figure 8 Proposed Scanner Interoperability Test Setup can be used for this test. One of the reference adapters can be used as the explicit target node.

No software other than the software provided by the DUT manufacturer to configure its explicit message subsystem is needed.

P11 Explicit Message Client Interoperability Test Procedure

P11.1 Unconnected Messaging

P11.1.1 Send an unconnected explicit request from the DUT to another CIP device to retrieve information from a suitable object within the scope of the target device's function.

P11.1.2 Repeat the read request every 500 ms for 1 minute. Verify that there are no response timeouts.

P11.1.3 Send an unconnected explicit request from the DUT to another CIP device to set information in a suitable object within the scope of the target device's function. NOTE: This test can only be performed on a target device that supports settable attributes.

P11.1.4 Repeat the set request every 500 ms for 1 minute. Verify that there are no response timeouts.

P11.2 Connected Messaging

P11.2.1 Originate a CIP transport class 3 explicit connection from the DUT to the message router of another CIP device. Use a connection RPI of 250 ms and a timeout multiplier of 4. NOTE: The target device must support class 3 connections.

P11.2.2 Send an explicit request across the connection to retrieve information from a suitable object within the scope of the target device’s function.

P11.2.3 Maintain the connection with the read request for 1 minute. Verify there are no connection timeouts.

P11.2.4 Send an explicit request across the connection to set information in a suitable object within the scope of the target device’s function. NOTE: This test can only be performed on a target device that supports settable attributes.

P11.2.5 Maintain the connection with the set request for 1 minute. Verify there are no connection timeouts.

12 Adapter Interoperability Test

This is a list of additional tests above and beyond the Common Interoperability Test for adapter devices.

Software needed for this test. See Section 4, Software and Tool Versions for specific version information:

- EDITT
- DHCP Server
- Optional – Wireshark (used if debugging is necessary)

The tester shall use the connection point, RPI range and connection size info recorded in test P6.2, EDS File Verification Test for the tests in this section. If any of the connections fail to work because the information derived from the EDS file in Test P6.2 was incorrect, note the discrepancy in the appropriate test comments, and remark the EDS section "Failed". The device may return to the EDS station with a corrected EDS file, to be retested.

If the device has not yet been to the EDS station, record the connection point information used in this test in the EDS section of the test results form.

P12 Adapter Interoperability Test Procedure

Default Connection Parameters

Class 3 connections in this section should be opened with the following parameters unless they are specified in the test case:

RPI 250ms
Timeout multiplier 4
Priority Low

Class 1 connections in this section should be opened with the following parameters unless they are specified in the test case:

RPI 100ms
Timeout multiplier 4
Priority Scheduled

P12.1 Target of CIP Transport Class 1 I/O Connections, 32-bit Real Time Header (Run/Idle Header).

P12.1.1 Bidirectional Connections, Multicast T→O and Unicast O→T, Cyclic Trigger, 32-bit Real Time Header

P12.1.1.1 For devices supporting output data

P12.1.1.1.1 Open an exclusive owner connection from the reference Scanner to the DUT with a multicast T→O, unicast O→T, a cyclic trigger type, and a 32-bit Real Time Header in the O→T direction. Use a connection RPI of 100ms with a timeout

multiplier of 4 and a connection priority of Scheduled. Include appropriate configuration data in the fwd_open data segment.

P12.1.1.2 For input-only devices

P12.1.1.2.1 Open an input only connection from the reference Scanner to the DUT with a multicast T→O, a cyclic trigger type. Use a connection RPI of 100ms with a timeout multiplier of 4 and a connection priority of Scheduled. Include appropriate configuration data in the fwd_open data segment.

P12.1.1.3 Verify that the connection is established with no errors and can send data.

P12.1.1.4 Maintain the connection for 30 seconds and verify there are no connection timeouts.

P12.1.1.5 For devices supporting output data

P12.1.1.5.1 Put the connection in Idle state by clearing bit 0 of the 32-bit Real Time Header.

P12.1.1.5.2 Verify that the DUT exhibits Idle state behavior.

P12.1.1.5.3 Put the connection in Run state by setting bit 0 of the 32-bit Real Time Header.

P12.1.1.5.4 Verify that the DUT exhibits Run state behavior.

P12.1.1.5.5 Return the connection to Idle state by clearing bit 0 of the 32-bit Real Time Header.

P12.1.1.5.6 Verify that the DUT exhibits Idle state behavior.

P12.1.2 Change of State (COS) Connections. *(Optional for non-discrete devices and for rack connections on rack-based devices)*

P12.1.2.1 For devices supporting output data

P12.1.2.1.1 Open an exclusive owner connection from the reference Scanner to the DUT with a multicast T→O, unicast O→T, a COS trigger, non-zero PIT, and a 32-bit Real Time Header in the O→T direction. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.1.2.2 For input-only devices

P12.1.2.2.1 Open an input only connection from the reference Scanner to the DUT with a multicast T→O, a COS trigger, non-zero PIT. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.1.2.3 Verify that the connection is established with no errors and can send data.

P12.1.2.4 Maintain the connection for 30 seconds and verify there are no connection timeouts.

P12.1.2.5 For devices supporting output data

P12.1.2.5.1 Put the connection in Idle state by clearing bit 0 of the 32-bit Real Time Header.

P12.1.2.5.2 Verify that the DUT exhibits Idle state behavior.

P12.1.2.5.3 Put the connection in Run state by setting bit 0 of the 32-bit Real Time Header.

P12.1.2.5.4 Verify that the DUT exhibits Run state behavior.

P12.1.2.5.5 Return the connection to Idle state by clearing bit 0 of the 32-bit Real Time Header.

P12.1.2.5.6 Verify that the DUT exhibits Idle state behavior.

P12.1.3 Bidirectional Connections, Unicast T→O and Unicast O→T, Cyclic Trigger, 32-bit Real Time Header

P12.1.3.1 For devices supporting output data

P12.1.3.1.1 Open an exclusive owner connection from the reference Scanner to the DUT with unicast T→O and unicast O→T, a cyclic trigger type, and a 32-bit Real Time Header in the O→T direction. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.1.3.2 For input-only devices

P12.1.3.2.1 Open an input only connection from the reference Scanner to the DUT with unicast T→O, a cyclic trigger type. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.1.3.3 Verify that the connection is established with no errors and can send data.

P12.1.3.4 Maintain the connection for 30 seconds and verify there are no connection timeouts.

P12.2 Target of 2 CIP Transport Class 1 I/O Connections, Exclusive Owner Connection, Listen Only or Input Only Connection

P12.2.1 Multicast T→O on all connections

P12.2.1.1 For devices supporting output data

P12.2.1.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.1.2 For input-only devices

P12.2.1.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.1.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment. NOTE: The choice of Input Only or Listen Only depends on the capabilities of the DUT.

P12.2.1.4 Verify that both connections are established with no errors and can send data.

P12.2.1.5 Maintain both connections for 30 seconds and verify there are no connection timeouts.

P12.2.2 Multicast T→O on owning connection, Unicast T→O on second connection

P12.2.2.1 For devices supporting output data

P12.2.2.1.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.2.2 For input-only devices

P12.2.2.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.2.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with unicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.2.4 Verify that both connections are established with no errors and can send data.

P12.2.2.5 Maintain both connections for 30 seconds and verify there are no connection timeouts.

P12.2.3 Unicast T→O on all connections

P12.2.3.1 For devices supporting output data

P12.2.3.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with unicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.3.2 For input-only devices

P12.2.3.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with unicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.3.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with unicast T→Oand unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.3.4 Verify that both connections are established with no errors and can send data.

P12.2.3.5 Maintain both connections for 30 seconds and verify there are no connection timeouts.

P12.2.4 Unicast T→O owning, Multicast T→O on second connection

P12.2.4.1 For devices supporting output data

P12.2.4.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with unicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.4.2 For input-only devices

P12.2.4.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with unicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.4.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with multicast T→Oand unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.4.4 Verify that both connections are established with no errors and can send data.

P12.2.4.5 Maintain both connections for 30 seconds and verify there are no connection timeouts.

P12.2.5 Support of 6 Class 3 connections simultaneously with 2 Class 1 connections

P12.2.5.1 For devices supporting output data

P12.2.5.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.5.2 For input-only devices

P12.2.5.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.2.5.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment. NOTE: The choice of Input Only or Listen Only depends on the capabilities of the DUT.

P12.2.5.4 Open 6 separate, and concurrent, CIP transport class 3 connections from three independent network interfaces of the reference Scanner to two separate attributes from the Identity object of the DUT using a Get_Attribute_Single command. Use a connection RPI of 250 ms and a timeout multiplier of 4.

P12.2.5.5 Verify that all 8 connections are established with no errors and can send data.

P12.2.5.6 Maintain all connections for 1 minute and verify there are no connection timeouts.

P12.2.6 Support for Class 1 connection priority High

P12.2.6.1 For devices supporting output data

P12.2.6.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4 and a connection priority of High. Include appropriate configuration data in the fwd_open data segment.

P12.2.6.2 For input-only devices

P12.2.6.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4 and a connection priority of High. Include appropriate configuration data in the fwd_open data segment.

P12.2.6.3 Verify that connection is established with no errors and can send data.

P12.2.6.4 Maintain all connections for 30 seconds and verify there are no connection timeouts.

P12.3 Electronic Keys

P12.3.1 Non-Null Electronic Key

P12.3.1.1 Open a connection from the reference Scanner to the DUT with an exact match electronic key segment.

P12.3.1.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.3.1.3 Close the connection

P12.3.1.4 Open a connection from the reference Scanner to the DUT with an electronic key segment with invalid (non-matching) information.

P12.3.1.5 Verify that the connection is rejected.

P12.3.2 Null Electronic Key

P12.3.2.1 Open a connection from the reference Scanner to the DUT with a null electronic key (all key field values are 0) segment.

P12.3.2.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.3.2.3 Close the connection

P12.3.3 No Electronic Key

P12.3.3.1 Open a connection from the reference Scanner to the DUT with no electronic key segment.

P12.3.3.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.3.3.3 Close the connection

P12.4 Configuration Path – NOTE: Informational for rack-based devices.

P12.4.1 Non-Null Configuration Data

P12.4.1.1 For devices supporting configuration data, verify acceptance of configuration data

P12.4.1.1.1 For devices supporting output data

12.4.1.1.1.1 Open an Exclusive Owner connection from the reference Scanner to the DUT with a non-null configuration data segment. The size and content of the data shall be valid for the device configuration requirements.

12.4.1.1.1.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

12.4.1.1.1.3 Close the connection

P12.4.1.1.2 For devices supporting an Input Only connection

12.4.1.1.2.1 Open an Input Only connection from the reference Scanner to the DUT with a non-null configuration data segment. The size and content of the data shall be valid for the device configuration requirements.

12.4.1.1.2.2 Verify that the connection is established with no errors and can be maintained for 15 seconds

12.4.1.1.2.3 Close the connection

P12.4.1.2 For all devices, verify rejection of invalid configuration data size

P12.4.1.2.1 For devices supporting output data

12.4.1.2.1.1 Open an Exclusive Owner connection from the reference Scanner to the DUT with a non-null configuration data segment. The size of the data is non-zero and arbitrary but must be invalid for the device.

12.4.1.2.1.2 Verify that the connection is rejected.

P12.4.1.2.2 For devices supporting an Input Only connection

12.4.1.2.2.1 Open an Input Only connection from the reference Scanner to the DUT with a non-null configuration data segment. The size of the data is non-zero and arbitrary but must be invalid for the device.

12.4.1.2.2.2 Verify that the connection is rejected.

P12.4.2 Null Configuration Data

P12.4.2.1 For devices supporting output data

P12.4.2.1.1 Open an Exclusive Owner connection from the reference Scanner to the DUT with a null configuration data segment (e.g. data size of zero). A configuration path must be present in the fwd_open.

P12.4.2.1.2 Verify that the connection is established with no errors and can be maintained for 15 seconds

P12.4.2.1.3 Close the connection

P12.4.2.2 For devices supporting an Input Only connection

P12.4.2.2.1 Open an Input Only connection from the reference Scanner to the DUT with a null configuration data segment (e.g. data size of zero).A configuration path must be present in the fwd_open.

P12.4.2.2.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.4.2.2.3 Close the connection

P12.4.3 No Configuration Data

P12.4.3.1 For devices supporting output data

P12.4.3.1.1 Open an Exclusive Owner connection from the reference Scanner to the DUT with no configuration data segment. A configuration path is optional in the fwd_open.

P12.4.3.1.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.4.3.1.3 Close the connection

P12.4.3.2 For devices supporting an Input Only connection

P12.4.3.2.1 Open an Input Only connection from the reference Scanner to the DUT with no configuration data segment. A configuration path is optional in the fwd_open.

P12.4.3.2.2 Verify that the connection is established with no errors and can be maintained for 15 seconds.

P12.4.3.2.3 Close the connection

P12.5 Series of CIP Transport Class 1 I/O Connections, Heartbeat Connection, multicast T→O only

P12.5.1 Using the table below, open a connection from one interface of the reference Scanner to the DUT with the connection type listed in the first column of the table. Include

appropriate configuration data in the fwd_open data segment. NOTE: Use a heartbeat connection in the O→T direction for IO and LO connections. Use a connection RPI of 100 ms and a timeout multiplier of 4.All T→O connections are multicast. NOTE: Input-only devices that do not support EO connections will only utilize rows of the table without EO entries.

P12.5.2 Open a connection from another interface of the reference Scanner to the same input connection point of the DUT with the connection type listed in the second column of the table. Use a connection RPI of 100ms and a timeout multiplier of 4. All T→O connections are multicast. Include appropriate configuration data in the fwd_open data segment. NOTE: Use a heartbeat connection in the O→T direction for IO and LO connections. NOTE: Input-only devices that do not support EO connections will only utilize rows of the table without EO entries.

P12.5.3 Verify that the connection establishment success matches that indicated in the following table.

Table 1 Connection Combinations Attempted with the DUT

1st Connection	2nd Connection w/ Same Input Point	Expected Result
IO	EO	Success
IO	IO	Success
IO	LO	Success
EO	IO	Success
EO	LO	Success
EO	EO	Error
LO	-	Error

P12.5.4 If connections were established, maintain the connections for 30 seconds and verify there are no connection timeouts.

P12.5.5 Referring to the following table, test the DUT behavior when the first connection is closed, and when it is timed out. Verify that the second connection in the DUT behaves as indicated in the following table.

Table 2 Behavior of 2nd I/O Connection

1st Connection	2nd Connection w/ Same Input Point	Expected Behavior of 2nd Connection When:	
		1st Connection TimesOut	1stConnectionIs Closed
IO	EO	EO stays open (Data continues)	EO stays open (Data continues)
IO	IO	2nd IO stays open (Data continues)	2nd IO stays open (Data continues)
IO	LO	LO closes (Data stops)	LO closes (Data stops)
EO	IO	IO closes (Data stops)*	IO stays open (Data continues)
EO	LO	LO closes (Data stops)	LO closes (Data stops)
EO	EO	Not Applicable	Not Applicable
LO	-	Not Applicable	Not Applicable

* The IO connection is closed to guarantee that the owner of the EO is no longer receiving multicast data; making it clear to the owner that the output data is not making it to the adapter. (Refer to specification Edition 3.1, section 3-6.4.3)

P12.6 Configuration Parameters via Explicit Messaging

NOTE: This does not apply to rack-based, technology enabler, or devices with user-defined I/O data content (e.g. EtherNet/IP to other network gateway, target connections of a PLC).

P12.6.1 Send an explicit request from the CIP tool to the DUT to retrieve data from several configuration parameters. NOTE: These may, or may not, be accessible via the Parameter object. Parameters used for the test will be specified by the vendor and should be in the EDS.

P12.6.2 Send an explicit request from the CIP tool to the DUT to set data for several writable configuration parameters. Read the parameters back and verify that the value is correct. NOTE: These may, or may not, be accessible via the Parameter object. Parameters used for the test will be specified by the vendor and should be in the EDS.

P12.7 I/O Data Attributes via Explicit Messaging

P12.7.1 For devices supporting output data

P12.7.1.1 Open an Exclusive Owner I/O connection from the reference Scanner to the DUT.

P12.7.2 For input-only devices

P12.7.2.1 Open an Input Only connection from the reference Scanner to the DUT.

P12.7.3 Send an explicit read request (using unconnected or connected class 3) from the reference Scanner to the DUT to retrieve data from the I/O assembly objects associated with the connection established above. (Attribute 3).

P12.7.3.1 Input Data

P12.7.3.2 Output Data (only for devices supporting output data)

P12.7.4 Verify that the data is consistent between the class 1 connection and the explicit request.

P12.7.4.1 Input data must be the same size

P12.7.4.2 Output data must be the same size and same data content

P12.7.5 For devices supporting output data

P12.7.5.1 Send an explicit request (using unconnected or connected class 3) from the reference Scanner to the DUT to write data to the output assembly object associated with the connection established above.

P12.7.5.2 Verify that an error response is returned to the explicit request.

P12.7.6 Close the class 1 connection.

P12.7.7 For devices supporting output data

P12.7.7.1 Send an explicit request (using unconnected or connected class 3) from the reference Scanner to the DUT to write data to the output assembly object.

P12.7.7.2 Verify that the write request succeeds. Verify that the DUT responds accordingly to the data written.

P12.8 *Deleted*

P12.9 Verify that connection information recorded on the Test Results form from the Online EDS file test (section P6.2.4) is valid for this test. If they are not valid, the device vendor must repair the misinformation in the EDS and repeat the EDS file test. Record on the test results form, the actual values used, if different than what was recorded in section P6.2.4. **NOTE**: If the EDS section of the Test Results form has not yet been filled in, enter the connection information used in the Adapter test.

P12.10 Connection Handling through Ethernet Link Loss

P12.10.1.1 For devices supporting output data

P12.10.1.1.1 Open a CIP transport class 1 I/O Exclusive Owner connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.10.1.2 For input-only devices

P12.10.1.2.1 Open a CIP transport class 1 I/O Input Only connection from one interface of the reference Scanner to the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment.

P12.10.1.3 Open a CIP transport class 1 I/O Input Only or Listen Only connection from another interface of the reference Scanner to the same input connection point as used by the Exclusive Owner (or Input Only) connection above on the DUT with multicast T→O and unicast O→T. Use a connection RPI of 100 ms with a timeout multiplier of 4. Include appropriate configuration data in the fwd_open data segment. NOTE: The choice of Input Only or Listen Only depends on the capabilities of the DUT.

P12.10.1.4 Open 6 separate, and concurrent, CIP transport class 3 connections from three independent network interfaces of the reference Scanner to two separate attributes from the Identity object of the DUT using a Get_Attribute_Single command. Use a connection RPI of 250 ms and a timeout multiplier of 4.

P12.10.1.5 Verify that all 8 connections are established with no errors and can send data.

P12.10.1.6 Maintain all connections for 10 seconds and verify there are no connection timeouts.

P12.10.1.7 Disconnect the Ethernet cable from the DUT for 5 seconds and reconnect.

P12.10.1.8 Verify that all 8 connections resume.

P12.10.1.9 Maintain all connections for 10 seconds and verify there are no connection timeouts.

P12.10.1.10 Disconnect the Ethernet cable from the DUT for 30 seconds and reconnect.

P12.10.1.11 Verify that all 8 connections resume.

P12.10.1.12 Maintain all connections for 10 seconds and verify there are no connection timeouts.

P12.10.1.13 Disconnect the Ethernet cable from the DUT for 3 minutes and reconnect.

P12.10.1.14 Verify that all 8 connections resume.

P12.10.1.15 Maintain all connections for 10 seconds and verify there are no connection timeouts.

13 Scanner Interoperability Test

This is a list of additional tests above and beyond the Common Interoperability Test for scanner devices. If the scanner device includes adapter functionality, then the adapter interoperability tests MUST be performed first. A proposed test setup is shown in Figure 8 Proposed Scanner Interoperability Test Setup.

Suggested Target Adapters
Seven of the target adapters are HMS Anybus Communicator modules. These so-called Reference Adapters are used in this test and can be used as general purpose target adapters or explicit servers in other tests, as needed.

At least one of the target adapters to be used for the following test procedure must have the following abilities:

- Indication of connection establishment and loss
- Indication of Run/Idle status
- Ability to change input data being sent to the scanner
- Ability to display output data being received from the scanner

Additional/alternative adapters that can satisfy these requirements are acceptable.

Software needed for this test. See section 4, Software and Tool Versions for specific version information:

- Wireshark
- CIP Tool

P13 Scanner Interoperability Test Procedure

The proposed setup for this test is shown in Figure 8 Proposed Scanner Interoperability Test Setup.

Software needed for this test is listed below. See Section 4, Software and Tool Versions for specific version information:

- Optional – Wireshark
- Software to configure the managed switch, provided by the switch vendor.

P13.1 Originator of CIP Transport Class 1 I/O Connections, 32-bit real time Header(Run/Idle Header)

P13.1.1 Bidirectional Connections, Multicast T→O and Unicast O→T, Cyclic Trigger, 32-bit real time Header

P13.1.1.1 Open a connection from the DUT to the reference Adapter with a multicast T→O and unicast O→T, a cyclic trigger type, and a 32-bit real time Header. Use a connection RPI of 100ms and a timeout multiplier of 4.

P13.1.1.2 Verify that the connection is established with no errors

P13.1.1.3 Have the DUT put the connection in a Run state using the 32-bit real time Header.

P13.1.1.4 Verify data changes at the DUT are reflected in the target adapter output data. Verify data changes in the target adapter input data are reflected at the DUT.

P13.1.1.5 Maintain the connection for 30 seconds and verify that there are no connection timeouts.

P13.1.1.6 Have the DUT put the connection in an idle state using the 32-bit real time Header.

P13.1.1.7 Verify that the reference Adapter exhibits idle behavior.

P13.1.2 Unidirectional Connections, currently not tested

P13.1.3 Informational: Change of State (COS) with Production Inhibit Timer (PIT).

P13.1.3.1 Open a connection from the DUT to the reference Adapter with a COS trigger and PIT set to non-zero. Use a connection RPI of 100 ms and a timeout multiplier of 4.

P13.1.3.2 Verify that the connection is established with no errors and can send data.

P13.1.3.3 Maintain the connection for 30 seconds and verify that there are no connection timeouts.

P13.1.4 Bidirectional Connections, Unicast T→O and Unicast O→T, Cyclic Trigger, 32-bit real time Header

P13.1.4.1 Open a connection from the DUT to the reference Adapter with unicast T→O and unicast O→T. Use a connection RPI of 100 ms and a timeout multiplier of 4.

P13.1.4.2 Verify that the connection is established with no errors and can send data.

P13.1.4.3 Have the DUT put the connection in a Run state using the 32-bit real time Header.

P13.1.4.4 Verify data changes at the DUT are reflected in the target adapter output data. Verify data changes in the target adapter input data are reflected at the DUT.

P13.1.4.5 Maintain the connection for 30 seconds and verify that there are no connection timeouts.

P13.1.4.6 Have the DUT put the connection in an idle state using the 32-bit real time Header.

P13.1.4.7 Verify that the reference Adapter exhibits idle behavior.

P13.2 Originator of 8 CIP Transport Class 1 I/O Connections, Exclusive Owner Connection, Listen Only or Input Only Connection, Explicit Messaging

P13.2.1 Open 8 CIP transport class 1 I/O connections from the DUT to the reference Adapter(s) with a cyclic trigger type, 100 ms RPI, and 32-bit real time header. Use a connection RPI of 100 ms and a timeout multiplier of 4. The connections should be as follows:

P13.2.1.1 1 CIP transport class 1 I/O Exclusive Owner connection with a configuration data segment (size to be determined by the target device, ≤ 400 Bytes).

P13.2.1.2 2 CIP transport class 1 I/O Input Only or Listen Only connections with heartbeat connections in the O→T direction.

P13.2.1.3 5 additional transport class 1connections. Note that these connections can be of any format and data size.

P13.2.2 Verify the connections are established with no errors.

P13.2.3 Maintain the connections for 30 seconds and verify that there are no connection timeouts.

P13.2.4 While the connections are active, send an explicit message from the CIP tool to the DUT requesting the data being scanned in the above connections. NOTE: The class, instance, and attribute for this message are to be specified by the scanner vendor.

P13.2.5 Adapter reset tests

P13.2.5.1 Maintaining all connections and messages from P13.2.1, reset all 8 reference adapters by powering them off and back on.

P13.2.5.2 Verify that all connections and messages resume after the adapters come back online.

P13.3 IGMP v2

P13.3.1 Attach a packet sniffer to a mirror port on the network switch. Setup the packet sniffer to filter on IGMP packets.

P13.3.2 Clear the multicast group table in the network switch.

P13.3.3 Open a CIP transport class 1 multicast I/O connection from the DUT to the reference Adapter.

P13.3.4 Verify that the DUT issued a join to the network switch for the appropriate multicast group.

P13.3.5 Close the connection.

P13.3.6 Verify that the DUT issued a leave to the network switch for the appropriate multicast group.

P13.4 If the DUT has adapter capabilities, run the Adapter Interoperability Test Procedure as described in section P12.

14 System Interoperability Test

This test is intended to determine if the DUT behaves properly in a system of EtherNet/IP devices. A proposed setup is shown in Figure 6.

If the device passes the Common Interoperability Test and the relevant additional tests, it will be tested along with a set of other devices in a larger System Interoperability Test. This test may uncover problems that did not occur during the individual device testing due to the larger number of devices and EtherNet/IP network traffic, or different vendor's implementations. A device can pass all of the relevant individual tests but may still fail the System Interoperability Test. The EtherNet/IP Interoperability Advisory Test will be considered failed if any problem occurs during the System Interoperability Testing that prevents interoperability with other devices.

The test procedure and system model outlined below is provided as a general guideline. The actual configuration will be determined by the Plug Fest Committee after event registration is closed and before the event. The Committee will make a best effort configuration for coverage of interoperability concerns. The resulting configuration will be sent to all scanner vendors, who will be responsible for creating their part of the documented configuration. Scanner vendors are expected to arrive at the event as prepared as possible for the documented configuration and any changes that may take place.

The flow of the system test for each system test configuration follows this general process:

1) Configure all nodes for multicast and turn off IGMP Snooping (P14.1)
    a. Run sustained tests at fastest RPIs allowed (P14.3)
    b. Run disturbance tests (P14.4-P14.7)
2) If any devices fail tests with IGMP Snooping off, reconfigure switch to turn on IGMP Snooping (P14.8)
    a. Repeat sustained tests at fastest RPI settings (P14.3)
    b. Run disturbance tests (P14.4-P14.7)
3) Configure all nodes for unicast (P14.9)
    a. Repeat sustained tests at fastest RPI settings (P14.3)
    b. Run disturbance tests (P14.4-P14.7)

Software needed for this test is listed below. See Section 4, Software and Tool Versions for specific version information:

- Optional – Wireshark
- Software to configure the managed switch, provided by the switch vendor
- Other software specific to the DUTs, as necessary. Provided by DUT vendors.

P14 System Interoperability Test Procedure

P14.1 "Out-of-Box" network startup

P14.1.1 Return all EtherNet/IP devices to their "out-of-box" configuration.

P14.1.2 Configure the DHCP server for all EtherNet/IP devices on same subnet.Power-cycle all EtherNet/IP devices.

P14.1.3 Verify that all EtherNet/IP devices obtained the correct IP address from the DHCP server. Suggested procedure: Use RSWho to verify that all devices appear on the network at the expected IP addresses.

P14.1.4 Configure infrastructure switch(es) to disable IGMP Snooping

P14.2 Group devices into cells (The actual configuration to be determined by the Plug Fest Committee prior to the initiation of the system test.)

P14.2.1 Only one scanner per cell group. Figure 6 shows three scanners: Scanner A, Scanner B, and Scanner C. NOTE: It may be necessary to have multiple identical scanners if the numbers of adapters exceeds the maximum number of adapters per cell group.

P14.2.2 No more than 8 adapters per cell group. At least one group with the full 8 adapters. Figure 6 shows three groups of adapters associated with the three scanners: Group X1-Xn, Group Y1-Ym, and Group Z1-Z8. Groups X and Y may have less than or equal to 8 adapters associated with them ($n \leq 8$ & $m \leq 8$).

P14.3 System messaging tests

P14.3.1 Inside-group system testing

P14.3.1.1 Scanner opens connections to all adapters in its cell group in a step wise manner. It is suggested that connections be added to each target one at a time to aid in determining any problems that may occur with an individual device.

P14.3.1.1.1 CIP transport class 1 I/O exclusive owner connections to input and output connection points. Use the fastest connection RPI supported by the device as indicated in the device's EDS file. Note: May need to limit RPIs so as not to exceed the capacity of the scanners in use. Devices must support 100ms or faster to pass the system test.

P14.3.1.1.2 CIP transport class 3 connections to message routers (If the scanner supports class 3 connections). Use a connection RPI of 250 ms and timeout multiplier of 4.

P14.3.1.2 Verify that all connections are established with no errors and can send data.

P14.3.2 Outside-group system testing

P14.3.2.1 Maintain connections from inside-group system testing.

P14.3.2.2 Scanner opens connections to all adapters in the next group in a step wise manner. It is suggested that connections be added to each target one at a time to aid in determining any problems that may occur with an individual device.

P14.3.2.2.1 CIP transport class 1 I/O input only or listen only connections to the input connection points. Use the fastest connection RPI supported by the device, as indicated in the device's EDS file. Note: May need to limit RPIs so as not to

exceed the capacity of the scanners in use. Devices must support 100ms or faster to pass the system test.

P14.3.2.3 Informational: Scanner sends an unconnected message to each adapter in the next group. Message to be repeated every 500 ms.

P14.3.2.4 Verify that all connections are established with no errors.

P14.3.3 Maintain all connections and repeated messaging for 10 minutes. Verify that there are no connection timeouts or response timeouts.

P14.4 Scanner reset tests

P14.4.1 Maintaining all connections and messages from the previous test, reset a scanner by powering it off and back on.

P14.4.2 Verify that all connections and messages resume within 60 seconds after the scanner receives its IP address.

P14.4.3 Repeat for each scanner in the system test.

P14.5 Adapter reset tests

P14.5.1 Maintaining all connections and messages from the previous test, reset an adapter by powering it off and back on.

P14.5.2 Verify that all connections and messages resume within 60 seconds after the adapter receives its IP address.

P14.5.3 Repeat for each adapter in the system test.

P14.6 Cable pull tests

P14.6.1 Maintaining all connections and messages from the previous test, disconnect the cable from a scanner for approximately 2 seconds then reconnect.

P14.6.2 Verify that all connections and messages resume within 120 seconds after the cable is reconnected.

P14.6.3 Repeat for each scanner in the system test.

P14.6.4 Repeat P14.6.1 through P14.6.3 but disconnect the cable for 2 minutes.

P14.7 Switch reset tests

P14.7.1 Maintaining all connections and messages from the previous test, reset an Ethernet switch by powering it off and back on.

P14.7.2 Verify that all connections and messages resume after the switch comes back online.

P14.7.3 Repeat for each switch in the system test.

P14.8 If any devices failed P14.3 through P14.7, configure infrastructure switch(es) to enable IGMP Snooping. If all devices passed, skip to P14.9.

P14.8.1 Repeat tests P14.3 through P14.7.

P14.9 Configure all devices for unicast I/O connections. Use the fastest connection RPI supported by the device, as indicated in the device's EDS file. Note: May need to limit RPIs so as not to exceed the capacity of the scanners in use. Devices must support 100ms or faster to pass the system test.

P14.9.1 Repeat tests P14.3 through P14.7.
NOTE: The outside-group tests of section P14.3.2 may not be usable with all target devices since they may not support concurrent unicast I/O connections. Such target devices fail during the adapter device tests (Tests P12.2.2 and P12.2.3).

P14.10 Change group assignments (Group configuration to be determined by the Plug Fest Committee.)

P14.10.1 Change scanner configuration to next group assignment.

P14.10.2 Repeat test procedures P14.3 through P14.9 for the new group assignments. NOTE: This is to test interoperability of adapters on different scanners.

P14.11 Other testing, as time permits, tests are TBD by local Plugfest committee on test day.

15 Device Performance Test

This test is intended to verify that the DUT behaves is capable of handling network traffic under possible conditions that may occur on a plant-floor EtherNet/IP network. A proposed test setup is shown in Figure 7 Proposed Performance Test Setup. All devices with Adapter functionality are subject to this test.

When setting up the performance test system, either a hardware or software scanner can be used. If a software scanner is chosen, it is important that the scanner software not be run on the same computer as the background traffic generator. The Molex traffic generator and the EIPScan software have been shown to load down a computer to the point of causing connection issues with the DUT.

The performance analysis tool can run on either the computer housing the network tap card or the computer used for the background traffic generator. If using a software scanner, the performance analysis tool should not be run on that computer due to the process intensive analysis that will run extremely slow while the scanner is running.

The performance tests conducted during the PlugFests are representative of some situations that may occur on a plant floor, but are not intended to be exhaustive. More complex and rigorous testing needs more time than allowed at the PlugFest.

The traffic amounts that were chosen for the PlugFest represent three basic categories with a total of five tests. The first test simulates benchtop testing of a device with no extra background traffic. This is represents the best performance for the device and provides a baseline for the additional performance testing being conducted. The second two tests use different amounts of background traffic in a steady-state case. This represents the case where a device is operating on a plant-floor network with a certain number of other devices on the network. The two steady-state cases both reflect a large, flat plant-floor network, one that uses managed switches (IGMP turned on) and one that uses unmanaged switches (IGMP turned off). The last two tests represent the situation where the managed and unmanaged networks above have a random incident occur that causes a short spike in the network traffic load. The incident chosen in this case is a laptop being plugged into the network with RSLinx installed and operating. The laptop will send out an EtherNet/IP ListIdentity broadcast to every device on the network. The devices, unless they have their ARP cache pre-populated, will respond back on the network with an ARP request for the laptop. The result will be a short burst of ARP requests on the network that may affect a device's ability to maintain its Class 1 I/O connections. The burst tests also use the managed and unmanaged steady-state background traffic.

Table 3 shows the traffic patterns for the different test cases.

Table 3 Traffic Amounts for Performance Tests

Traffic Type	Rate	Baseline	Steady-State Managed	Steady-State Unmanaged	Burst, Managed	Burst, Unmanaged
ARP Request Broadcasts	180 packets/s	✗	✓	✓	✓	✓
Gratuitous ARP Broadcasts	180 packets/s	✗	✓	✓	✓	✓
DHCP Request Broadcasts	100 packets/s	✗	✓	✓	✓	✓
ICMP (ping) Request Broadcasts	100 packets/s	✗	✓	✓	✓	✓
NTP Multicasts	10 packets/s	✗	✓	✓	✓	✓
EtherNet/IP ListIdentity Requests	10 packets/s	✗	✓	✓	✓	✓
EtherNet/IP Connected Class 1 I/O	1800 packets/s	✗	✗	✓	✗	✓
ARP Request Burst	240 packets @ 4000 packets/s = 60 ms burst	✗	✗	✗	✓	✓

The different amounts of background traffic used during the performance tests were chosen for specific reasons. The large, flat network was assumed to have around 200 industrial devices. The number 180 was chosen during the test development to allow for simulated devices used by the performance test system. For the burst test, the number 240 was chosen based on input from both users and vendors given situations they had seen occur on real plant-floor networks.

The tests in this section conform to the basic methodology in the cyclic accepted packet interval (API)/jitter test as described in the Performance Test Methodology document, sections 3.2 and 3.3 (see Section 2, Normative Reference Documents, item [7]).

P15 Device Performance Test Procedure

P15.1 Baseline Performance Test

P15.1.1 Start capturing traffic using the network tap card.

P15.1.2 Establish a Connected Class 1 I/O connection from the scanner to the DUT at the minimum RPI (fastest RPI speed) that the DUT supports and at the desired connection size. NOTE: The connection multiplier should be set as high as possible (512x multiplier recommended) to allow the analysis software to measure potential 4x multiplier connection timeouts without the scanner actually shutting down and reestablishing the connection.

P15.1.3 Maintain the connection with the DUT for a minimum of 60 seconds.

P15.1.4 Stop capturing traffic on the test network.

P15.1.5 Export the captured network traffic to a Wireshark pcap file using the network tap card software.

P15.1.6 Using Wireshark, review the connection establishment sequence to determine the RPI and API.

P15.1.7 Analyze the capture file using the performance analysis tool.

P15.1.8 Record the analyzed performance results.

P15.1.9 If any of the following conditions is met, increase the RPI (decrease the production rate) and repeat the Baseline Performance Test.

P15.1.9.1 The mean of the device's measured packet interval (MPI) is not within 10% of the device's API.

P15.1.9.2 The standard deviation jitter of the device's MPI is not within 10% of the mean MPI.

P15.1.9.3 The maximum jitter of the device's MPI is not within 50% of the mean MPI.

P15.2 Steady-State Managed Background Traffic Test

P15.2.1 Start capturing traffic using the network tap card.

P15.2.2 Using the background traffic generator tool, start the steady-state managed traffic set.

P15.2.3 If the connection established in the previous performance test(s) was terminated after testing, reestablish the Connected Class 1 I/O connection at the fastest RPI that passed the previous test(s). NOTE: The connection multiplier should be set as high as possible again.

P15.2.4 Maintain the connection with the DUT for a minimum of 30 seconds.

P15.2.5 Stop capturing traffic on the test network.

P15.2.6 Export the captured network traffic to a Wireshark pcap file using the network tap card software.

P15.2.7 Analyze the capture file using the performance analysis tool.

P15.2.8 Record the analyzed performance results.

P15.2.9 If any of the following conditions is met, increase the desired RPI (decrease the production rate) and repeat the Steady-State Managed Background Traffic Test.

P15.2.9.1 The device's mean MPI is not within 10% of the device's API.

P15.2.9.2 The standard deviation jitter of the device's MPI is not within 25% of the mean MPI.

P15.2.9.3 The maximum jitter of the device's MPI is not within 100% of the mean MPI. NOTE: This makes sure that the DUT does not drop packets due to a steady-state amount of background traffic.

P15.3 Steady-State Unmanaged Background Traffic Test

P15.3.1 Repeat the test procedure fromP15.2Steady-State Managed Background Traffic Test using the steady-state unmanaged background traffic set instead in step P15.2.2.

P15.3.2 If any of the following conditions is met, increase the desired RPI (decrease the production rate) and repeat the Steady-State Unmanaged Background Traffic Test.

P15.3.2.1 The device's mean MPI is not within 10% of the device's API.

P15.3.2.2 The standard deviation jitter of the device's MPI is not within 25% of the mean MPI.

P15.3.2.3 The maximum jitter of the device's MPI is not within 100% of the mean MPI. NOTE: This makes sure that the DUT does not drop packets due to a steady-state amount of background traffic.

P15.4 Burst Managed Background Traffic Test

P15.4.1 Start capturing traffic using the network tap card.

P15.4.2 If the connection established in the previous performance test(s) was terminated after testing, reestablish the Connected Class 1 I/O connection at the fastest RPI that passed the previous test(s). NOTE: The connection multiplier should be set as high as possible again.

P15.4.3 Verify that the connection is operational and stable before proceeding any farther. NOTE: This will probably be verified using the scanner software or by visually verifying that the device has not faulted.

P15.4.4 Using the background traffic generator tool, start the burst managed traffic set.

P15.4.5 Maintain the connection with the DUT for a minimum of 30 seconds.

P15.4.6 Stop capturing traffic on the test network.

P15.4.7 Export the captured network traffic to a Wireshark pcap file using the network tap card software.

P15.4.8 Analyze the capture file using the performance analysis tool.

P15.4.9 Record the analyzed performance results.

P15.4.10 If any of the following conditions is met, increase the desired RPI (decrease the production rate) and repeat the Burst Managed Background Traffic Test.

P15.4.10.1 The device's mean MPI does not return to within 10% of the device's API by the end of the test time.

P15.4.10.2 The maximum jitter of the device's MPI is greater than 400% of the mean MPI at any time during the test.

P15.5 Burst Unmanaged Background Traffic Test

P15.5.1 Repeat the test procedure fromP15.4Burst Managed Background Traffic Test using the burst unmanaged traffic set instead in step P15.4.4.

P15.5.2 If any of the following conditions is met, increase the desired RPI (decrease the production rate) and repeat the Burst Unmanaged Background Traffic Test.

P15.5.2.1 The device's mean MPI does not return to within 10% of the device's API by the end of the test time.

P15.5.2.2 The maximum jitter of the device's MPI is greater than 400% of the mean MPI at any time during the test.

P15.6 Reporting

P15.6.1 Give the vendor copies of all the packet capture files and test data collected during the series of tests, especially failed tests.

P15.6.2 Report the minimum RPI (fastest RPI speed) that passed all the tests.

Table 4 Document Revision Log

Rev.	Section	Remarks	Date	Editor	RT Appr
1.0d4	All	Reorganized document to split out test plan and test procedure into multiple documents.	Jan 7, 2005	Jim Gilsinn	
1.0d5	All	Incorporated comments from Plug-Fest planning committee	Jan 20, 2005	Jim Gilsinn	
1.0d7	5	Delete tests P5.2.4 and P5.2.5.	Feb 8, 2005	Kevin Knake	
1.0d8	Various	Updated after Workshop #16 review.	Sep 27, 2005	Perry Green	
1.0d8a	Various	Further suggestions for change	Sep 29, 2005	Viktor Schiffer	
1.0d8b	6	Reworded participation requirements	Sep 30, 2005	Viktor Schiffer	
1.1	Various	Updates after Plug Fest Planning Committee review	Oct 7, 2005	Perry Green	
1.2		Updates after Plug Fest #4 and Workshop #18	Mar 24, 2006	Perry Green	
1.3	Various	– Updated Normative References. – Updated Figures 1 thru 3. – Removed references to Test Plan document. – Add several clarifications/new criteria/new tests to: P6, P7, P11, P12& P13. – Modified System Interoperability test. – Update Table 1, associated text and added Table 2. – Misc. typos & misspellings	Apr 24, 2007	Ray Romito	
1.4		– Mods to Network Interop. Test to clarify methods and expected results. – Change hierarchy of P8 tests.	Mar 19, 2008	Ray Romito	
2.0		– Make multiport device changes – Add address conflict detection tests – A few typo corrections	Aug 18, 2008	Ray Romito	
2.0WD2		Added unicast T→O tests	Sep 23, 2008	Viktor Schiffer	
2.0WD3		Minor edits	Sep 24, 2008	Viktor Schiffer	
2.0WD4	Perform.	– Added Performance Testing Procedures – Formatting & typos fixed	Oct 7, 2008	Jim Gilsinn	
2.0WD5	4, 7.5 13.3	More details for the ACD tests	Oct 14, 2008	Viktor Schiffer	
2.0WD6	4 8.5	– Added new chapter: Software and Tool Revisions – More details for the ACD tests – Various other edits	Oct 31, 2008	Viktor Schiffer	
2.0final		Accepted all edits, removed all comments	Nov 10, 2008	Viktor Schiffer	
2.1WD1	8, 8, 12 & 13	Fixed some inconsistencies (incorrect references) in the document	Dec 18, 2008	Viktor Schiffer	

Rev.	Section	Remarks	Date	Editor	RT Appr
2.1 WD2	6 & 12 12	• Add test steps at several places to assure that: ▪ EDS values for connection points, size &RPI are used in the adapter and interoperability tests ▪ If EDS values do not work properly in the adapter and/or interoperability tests, that the corrected EDS and the device return to the EDS test station for retesting. • Remove Test P12.1.2	Jan 19, 2010	Ray Romito	
2.1 WD3	4 13 All 5 6	• Changes to software tools required for testing. • Remove Unidirectional test from scanner test • Added section for software requirements to each test • Added Figure 7 • Added new test steps to EDS test	Feb 26, 2010	Ray Romito	
2.1 WD4	1 2 5 6 12 13	• Added cross reference to Normative Reference Documents for document number and revision • Add pub revision to pub number 70 • Changes to Figure 7, Scanner test configuration o Issues to resolve • Added a missing clause to EDS test • Added remarks to adapter test o Issues to resolve • Added remarks to scanner test o Issues to resolve	Mar 22, 2010	Schiffer, Romito, VanGompel	
2.1 WD5	5 8 12 13	• Changed Figure 7, Scanner test configuration to resolve issue with Example Code PC • Added note on devices with optical interface • Added note on connection with no keying segment o Issue to resolve • Added detail concerning Example Code to scanner test to resolve issue with Example Code PC	Jul 28, 2010	Viktor Schiffer	
2.1 WD6	12	Added clarification concerning unicast/multicast testing of Class 1 connections	Aug 12, 2010	Viktor Schiffer	

Rev.	Section	Remarks	Date	Editor	RT Appr
2.1	Front page, footer, general	• Removed "WD6" and cleaned up all edits for publication • Referenced the latest editions of CIP Specs Volumes 1 & 2	Aug 17, 2010	Viktor Schiffer	
2.2	14	• Corrected system test reference in tests 14.4 through 14.7	Sept 13, 2010	Viktor Schiffer	
2.3 PR001	12 1 2 7 P8.5 P9.2.1 P9.5 11 P12.2.2 P12.3.2	• Updated tests in 12.7 (updated against version 2.1 of the Recommended Functionality document) • Updated ACD requirement (Appendix F preferred). • Updated spec and Recommended Functionality for EtherNet/IP Devices document revisions • Clarified that CIP Spec is source of minimum requirements for EtherNet/IP devices • Updated ACD Test Procedure for devices that support Appendix F (draft) • Grammar correction • Clarified spec reference • Grammar correction • Clarification to sync with Input Only possibility in PF12.2.1 • Clarified Null Electronic Key	Mar 1, 2011	Joakim Wiberg/Darren Klug	
2.3 PR002	P8.5	• Integrated updated ACD Test Configurations and Procedure from Joakim Wiberg • Added EO/EO Rejection verification to P12.5.3	Apr 12, 2011	Darren Klug	
2.3 PR003	P9 P12	• Added preliminary test cases • Removed "informational" from LED test case • Broke out input-only test logic so that it's clearer how input-only devices should be tested. • Added more Run/Idle testing to P12.1.1 – this recommendation wasn't really being tested • Added test for non-matching key to P12.3.1 • Removed "not tested" note from P12.3.3 • Added tests to P12.4.1 to verify configuration data handling for Input Only connections • Clarified how input only devices should be handled in the tables in P12.5	May 4, 2011	Perry Green	

Rev.	Section	Remarks	Date	Editor	RT Appr
2.3 PR004	P12	• Added clarification that configuration data should be included in the fwd_open unless Null or No data segment is required.	Jul 13, 2011	Perry Green	
2.3 PR005	various	• Cleaned up document in a couple of areas (typos, formatting) • Updated CIP spec dates • Added one normative reference • Added explanation of heartbeat use in IO and LO connections • Added definition of IP frame • Added one more test step in IP Address Configuration test • Added several details to ACD test to make it easier to understand for a newbie	Aug 18, 2011	Viktor Schiffer	
2.3 PR006	P6.2.3	• Modified details with respect to the Molex scanner tool	Aug 26, 2011	Viktor Schiffer	
2.3 PR007	Section 5 pp. 4-5	• Corrected formatting of paragraph containing Figure 3 so it doesn't show up in Table of Contents • Updated all "Table of …" fields	Sept 9, 2011	Darren Klug	
2.3 PR008		• Workshop 33 feedback	Sept 13, 2011	Darren Klug	
2.3 PR009	All Section 1 Section 4 Section 8.5	• Accepted all changes; removed reviewed comments • Updated 2nd paragraph to better reflect current mode of operation, noting that a device that has not been officially conformance tested may still receive the interoperability mark provided the same version is conformance tested within 6 months. • Added entry for ACD Test Tool • Updated intro to ACD test. • Updates to P8.5.7 and P8.5.8	Sept 19, 2011	Darren Klug	
2.3 PR010	Section 3	Addressed comments received from Schneider: • Added abbreviations • Carried forward a couple of comments re: ACD (P8.5.4.1 and P8.5.9) • Corrected APR typos in P8.5.11-P8.5.13 • Made Null (P12.4.2) and No (P12.4.3) config tests Informational (pending further discussion)	Sept 26. 2011	Darren Klug	

Rev.	Section	Remarks	Date	Editor	RT Appr
2.3 PR011		Updates based on feedback from Viktor Schiffer: • Updated text in P8.5 to make it clear that ACD is not optional. • Added some suggested improvements re: ongoing SCD probe time (P8.5.4) requirement and corrected typo from PR010 • Made Null (P12.4.2) and No (P12.4.3) config tests Informational only for products that require config with each fwd_open • Clarified that config path must be specified in fwd_open with null data segment (P12.4.2) • Clarified that config path is optional in fwd_open with no data segment (P12.4.3)	Sept 26. 2011	Darren Klug	
2.3	Section 4 P8.5.4 P8.5.9 P8.5.11.1	Incorporated Joakim's comments: • Added source/rev re: ACD Test Tool • Added note recommending skip of ongoing ACD probe timing test in first pass • Updated sequence for LastConflictDetected test • Corrected step in Verification of ACD Defend	Sept 27, 2011	Darren Klug	
2.4 PR001	Section P8.5	Updates to make the ACD test sequence easier to automate	Oct 19, 2011	Joakim Wiberg	
2.4 PR002	Section P8.5	Clarify IP Conflict Detection with NS and MS LEDs test cases	Oct 21, 2011	Emmanuel Lude	
2.4 PR003	Section 8.4	Added text that a 10% variance in timing measurements is allowed.	Oct 21, 2011	Joakim Wiberg	
2.4 PR004	All	Removed comments and accepted all changes to create document for PlugFest #14	Oct 21, 2011	Viktor Schiffer	
2.4 PR005	Section P8.5	Corrections to ACD Test section to reflect the actual behavior of the ACD Test Tool	Apr 10, 2012	Joakim Wiberg	
2.4	Various	Added in Low-Cost Performance Test Suite changes. • Added test suite to Section 4, Software and Tool Versions. • Replaced figure in Section 5, Proposed Test Configurations. • Updated Section 15, Device Performance Test to reflect all the changes necessary for the low-cost performance testing system	Apr 10, 2012	Jim Gilsinn	
3.0 PR001	P12.1.2 P12.2	Updates based on Recommendations v3: • Made COS connections required • Expanded two connection tests to include all combinations of multicast and unicast connections.	Aug 31, 2012	Perry Green	

Rev.	Section	Remarks	Date	Editor	RT Appr
3.0 PR002	P12.2	• Added wording for consistency • Modified footer to read "3.0"	Sept 6, 2012	Viktor Schiffer	
3.0 PR003	P6.2.2	Updates based on latest EIP-CT (version 3.1)	Sept 14, 2012	Emmanuel LUDE	
3.0 PR004	2, 4	Normative References, Software and Tools Versions	Sept 21, 2012	Viktor Schiffer	
3.0		Accepted all edits, changed to rev. 3.0 for PDF creation	Sept 26 2012	Viktor Schiffer	
3.0.1 PR001	4, P8.5	• Updated version for ACD Test Tool • Corrected timings related to DEFEND_INTERVALL as this value has changes from 10s to 2s in EtherNet/IP Adaptation of CIP, Edition 1.13 • Added text to make it clear that the DUT shall have an static IP assigned for all ACD tests	Sept 27 2012	Joakim Wiberg	
3.0.1		Accepted all edits and set the revision to 3.0.1	Sept 27 2012	Viktor Schiffer	
3.0.2 PR001	4, P8.5	• Updated version for ACD Test Tool • Tightened span for OngoingProbe in P8.5.4 from 80s between 165s to 90s between 150s • Added tests to P8.5.9 to allow for the test to be run standalone and not be dependent on P8.5.8 • Extended P8.5.12 to verify that the DUT returns to OngoingDetection state	Sept 28 2012	Joakim Wiberg	
3.0.2		Accepted all edits and set the revision to 3.0.2	Sept 28 2012	Viktor Schiffer	
4.0 PR001		Clean-up based on PF#16 and added suggestions for extensions P6.1.3 – Clarified definition of Format P6.1.4 – Clarified that CM section of EDS shall have appropriate ConnectionN entries for Adapters and Scanners that support Class 1 connections P8.3, P8.4, P8.5.5 – Updated ACD tests to be tested on two ports of multiport devices. P8.5.9.3 – Clarify that device should be allowed up to 60 secs to recover from set of TCP LastConflictDetected attribute (5) P12.6 – Clarified that P12.6 is informational for devices that do not support Config Params. P14.8.2 – Corrected which test procedures need to be repeated after regrouping. P15.1.8, P15.6.2 – Removed notes indicating that results are not official until finalized with PlugFest Completion.	Jan 31 2013	Viktor Schiffer	
4.0 PR002		Editorial clean up.	Feb 1, 2013	Darren Klug	
4.0 PR003		Editorial clean up	Feb 6, 2013	Viktor Schiffer	

Rev.	Section	Remarks	Date	Editor	RT Appr
4 PR004	2 P6.1.3 2, 8.5	Updated normative references. Clarified that rule 6.1.3 does not apply to technology enabler devices. Clarified that device must support Vol 2, Appdx F ACD.	Feb 18, 2013	Darren Klug	
4 PR005	 P6.1.3 - P8.5.9.3 P12.6 P12.7.3, P12.7.5.1, P12.7.7.1 P14.6	Updates made during WS#37 review: 1. Clarified requirements for specifying EDS I/O details. 2. Clarified instructions to repeat multiport tests (P8.3.14, P8.4.18, P8.5.5.6, P8.5.6.7). 3. Changed requirement to note regarding device recovery time. 4. Clarified requirements regarding explicit messaging access to configuration data. 5. Clarified that explicit requests can be either connected or unconnected (device must support both). 6. Added requirement to conduct ad hoc cable break testing to system test.	Feb 19, 2013	Darren Klug	
4 PR006	-	Reconstructed from 4 PR005. As approved at WS#37; all changes accepted.	Feb 19, 2013	Darren Klug	
4 PR007	 P8.3.2 P8.5 P14.3.4 Header 13	Updates per feedback from Viktor on PR006: 1. Corrected cross reference. 2. Corrected some missing space characters. 3. Removed “Note:” from last statement. 4. Corrected text. 5. Updated comment re: use of example code.	Feb 21, 2013	Darren Klug	
4	-	Accepted all changes. As approved at WS#37.	Feb 22, 2013	Darren Klug	
4.1 PR001	8.2 and 8.3	Added power up test case to Network tests.	Aug 30, 2013	Darren Klug	
4.1 PR002	Figure 8	Changed PC icons in Figure 8 to resolve pdf conversion issue	Oct 7, 2013	Darren Klug	
5	 1.1 8.5.1 13	Pre Workshop 40 Cleanup Aligned version with Recommendations Doc Added future work items section (1.1). Updated ACD test per ESE-090-015 ACD Clarification II. Removed reference to EtherNet/IP Example Code.	Mar 10. 2014	Darren Klug	X
6 PR001	4	Added URL for as many tools as I could find on the web.	Apr 30, 2014	Jamin Wendorf	
6 PR002	4	Added URL to ACD Test Tool. Updated version for ACD Test Tool.	May 14, 2014	Joakim Wiberg	
6 PR003	4	Changed RSLinx URL to point to the free downloads link, also changed the version to the latest.	May 27, 2014	Ray Romito	

Rev.	Section	Remarks	Date	Editor	RT Appr
6	9, 12 P9.4, P9.5 P12.2.4 P12.6 P12.8 P12.9 7 P7.1 4	Added DHCP server to software list Specified non-CIP connection details Added Unicast-Multicast connection combination Clarification that config parameters should be in the EDS Removed TBD – it was handled by P12.2.4 Added note about filling in EDS test results from adapter test station Changed passing of conformance test to recommended. Removed clause on relationship and timing of Interop and conformance testing. Made test informational Changed 'Windows XP' requirement to just 'Windows'	Oct 22, 2014	Perry Green	X
7	P12.4.2, 3 P6.1.5 P12.7.4	Remove informational clause allowing device to require configuration data with every Fwd_Open Added EDS check for configuration assembly format Clarified data consistency check between explicit and I/O connection data.	Feb 17, 2016	Perry Green	X
7.1	4	Corrected web address for ACD Test Tool software.	Nov 16, 2016	Perry Green	
8	P8.5 P9.2 P9.7 P12.1.1 P12.2.6 P12.2.2 P12.2.3 P12.2.4 P12.2.5 P12 P9 This table	Added tests to ACD test to match test tool operation Added tests for support of class 3 priorities in class 3 server tests Added test for support of class 1 priorities in Adapter tests Added Listen Only as an option for Unicast connections Added test for simultaneous class 3 and class 1 connections Added default connection parameter specification to be used for all class 1 and class 3 connections in each section unless specified Moved to end of document	Mar 30, 2017	Perry Green	X

Rev.	Section	Remarks	Date	Editor	RT Appr
8.1	4	Updated link to EZ EDS Corrected name of RSLinx Classic Lite	April 10, 2017	Ray Romito	X
	14	Added system test steps to introductory material			
	P14.1.3	Added enable IGMP Snooping			
	P14.3.1	Removed (Multicast I/O) from heading because test is now entered multiple times during the course of testing, not all are multicast			
	P14.3.1.1.1	Changes to the RPI specified for this test			
	P14.3.2	Removed (Multicast I/O) from heading because test is now entered multiple times during the course of testing, not all are multicast			
	P14.3.2.2.1	Changes to the RPI specified for this test			
	P14.3.4	Moved to P14.9			
	P14.4 P14.5 P14.6	Changed section references since this test is now entered multiple times during the course of testing			
	P14.6.4	Removed section			
	P14.7	Changed section reference since this test is now entered multiple times during the course of testing			
	P14.8 P14.8.1	Added this for the “Multicast with IGMP off” test Added disturbance testing step			
	P14.9 P14.9.1	Material relocated from P14.3.4 Added disturbance testing step			
	P14.10.2	Changed which tests are included in this test step			
	P14.11	Removed tests that are either part of earlier tests or no longer tested			
	-	Added table caption to Document Revision Log so it shows up in the list of tables at the front of the document			
	P12.1.2	Added note that COS is optional for non-discrete	June 14, 2017	Perry Green	
	14 P14.1 P14.8	Changed system test to disable IGMP snooping on first configuration, then only run with it enabled if any devices failed.			
	4	Updated required software versions	Sept 12, 2017	Perry Green	
	1.1	Removed ‘Future’ section as it has been handled			

Rev.	Section	Remarks	Date	Editor	RT Appr
9	P8.2 P8.4	Removed half duplex requirements from Network Test	April 10, 2018	Perry Green	x
	P8.5.16	New ACD test for ARP probe during probe phase.			
	P12.10	New Adapter test for handling of Ethernet link loss.			