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**Conformance test report of the DNP3
protocol implementation in the Siemens
SIPROTEC 4 7SC80 Device**

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1. INTRODUCTION

1.1 Background

Protocols define the rules by which devices talk with each other, and DNP3 is a protocol for transmission of data from point A to point B using serial or TCP/IP communications. It has been used primarily by utilities like the electric companies, but it operates suitably in other areas. DNP3 provides the rules for slave station computers (servers) and master station computers (Clients) to communicate data and control commands. The Siemens SIPROTEC 4 7SC80 Device acts as the slave station.

The information exchange between the master station and the slave station typically consists of binary input data, analog input data, count input data, and commands. DNP3 was designed to optimize the transmission of data acquisition information and control commands from one system to another. It is not a general-purpose protocol for transmitting hypertext, multimedia or large files.

The Master Station usually consists of one or multiple EMS systems and Communication Front End (CFE) systems. A Local Area Network (LAN) connects the EMS system with the Front End processors. DNP3 is only used for the communication between the Front End's and the substation (Slave Station). Communication between the EMS and CFE over a LAN is considered internal to the Control Centre and therefore not subject of this test.

An overview and description of the actual test environment is given in Chapter 3.

DNV KEMA's assignment was to answer the following question:

***“Does the DNP3 protocol implementation version 01.00.05 in the Siemens SIPROTEC 4 7SC80 Device conform to DNP3 Subset Level 2.*”**

To answer this question, DNV KEMA has performed a **conformance test** of the DNP3 protocol implementation.

1.1.1 Testing viewpoints

There are two viewpoints for testing: Conformance testing and Interoperability testing.

The first testing viewpoint, conformance testing, is the process of verifying that an implementation performs in accordance with a particular standard. A manufacturer may claim: “my equipment is conformant to standard xxx-x”. Conformance testing enables such a claim to be investigated and assessed by an objective and independent institute, like DNV KEMA, to establish its validity. The conformance test may result in certification by means of a Certificate, guaranteed by DNV KEMA, for the tested implementation version in

that equipment. This certificate also confirms that the device has successfully complied with the requirements outlined by the DNP3 Technical Committee, and entitles the bearer to promote the device as having fully passed the corresponding DNP3 Subset Definition. The DNP Users Group maintains a list of conformance-tested and approved equipment (see www.dnp.org).

The second viewpoint, Interoperability testing (IOP), shows whether or not a protocol implementation, installed in one product, can be used to exchange information with another product which has implemented the same protocol. No direct attention is paid to the implementation of the protocol itself. After completion of the tests, there is no guarantee that the protocol implementation is in accordance with that particular standard. It is clear, however, whether or not the protocol functions required in order to exchange information can work together to accomplish the required task.

1.2 Purpose of this document

The purpose of this document is to describe the results of the conformance test of the DNP3 implementation in the System Under Test [further SUT]. As such, the audience for this report consists of product development departments and customers that are interested in detailed features. The conformance test was executed at DNV KEMA, Arnhem, The Netherlands from September 3 till September 5, 2012. The results will form the basis of an (eventual) Certificate. This certificate is primarily of interest to product marketers and customers, as a proof of independent verification of minimized interoperability risks.

This test is performed on basis of the relevant DNP3 standards.

1.3 Contents of this document

Chapter 2 shows the list of relevant normative and other references, used to provide input for the conformance test.

Chapter 3 describes the various relevant components for the conformance test and their configuration as used in the conformance test, including the SUT. This chapter also gives an overview and introduction to the various test groups that together constitute the conformance-test.

Chapter 4 and 5 give an overview and summary of the test results, the conclusion(s) and recommendations based on the conclusions. The summary contains two **defect** categories for defects found during the conformance test: a **Major** category and a **Minor** category. Also a **Remarks** category is introduced. These categories are further explained in this chapter.

Appendix A specifies the detailed test cases and their outcome.

2. REFERENCES

1.4 Normative

The tests defined in this document are based on the following DNP3 documents as specified by the DNP Users Group:

1. DNP3 Volume 1, DNP3 Introduction, version 2.02, 15-12-2007
2. DNP3 Volume 2, DNP3 Application layer, Part 1, Basics, version 2.11, 15-3-2009
3. DNP3 Volume 2, DNP3 Application layer, Part 2, Annex, version 2.11, 15-3-2009
4. DNP3 Volume 2, DNP3 Application layer, Part 3, State Tables and Diagrams, version 2.10, 15-12-2007
5. DNP3 Volume 3, DNP3 Transport Function, version 2.01, 3-2-2007
6. DNP3 Volume 4, DNP3 Data Link Layer, version 2.01, 3-2-2007
7. DNP3 Volume 5, DNP3 Layer-independent Topics, version 2.03, 15-12-2007
8. DNP3 Volume 6, DNP3 Object Library, Part 1, Basics, version 2.02, 15-12-2007
9. DNP3 Volume 6, DNP3 Object Library, Part 2, Objects, version 2.04, 15-3-2009
10. DNP3 Volume 6, DNP3 Object Library, Part 3, Parsing codes, version 1.05, 20-4-2009
11. DNP3 Volume 7, DNP3 IP Networking, version 2.20, 11-7-2007
12. DNP3 Volume 8, DNP3 Interoperability, version 2.05, 11-6-2009
13. DNP3 Volume 8, appendix 1, Device Profile, version 2.07, 23-2-2010
14. DNP3 Intelligent Electronic Device (IED) Certification Procedure, Subset Level 2, Version 2.6 rev 1.

1.5 Other

15. The DNP3 Device Profile Document in the Siemens document: " SIPROTEC, Feeder Automation Controller 7SC80 Communication module DNP3 TCP, Bus Mapping/Point Lists", for SIPROTEC 4 7SC80, Edition 12.2012, Document Release: C53000-L2040-C353-2.01.

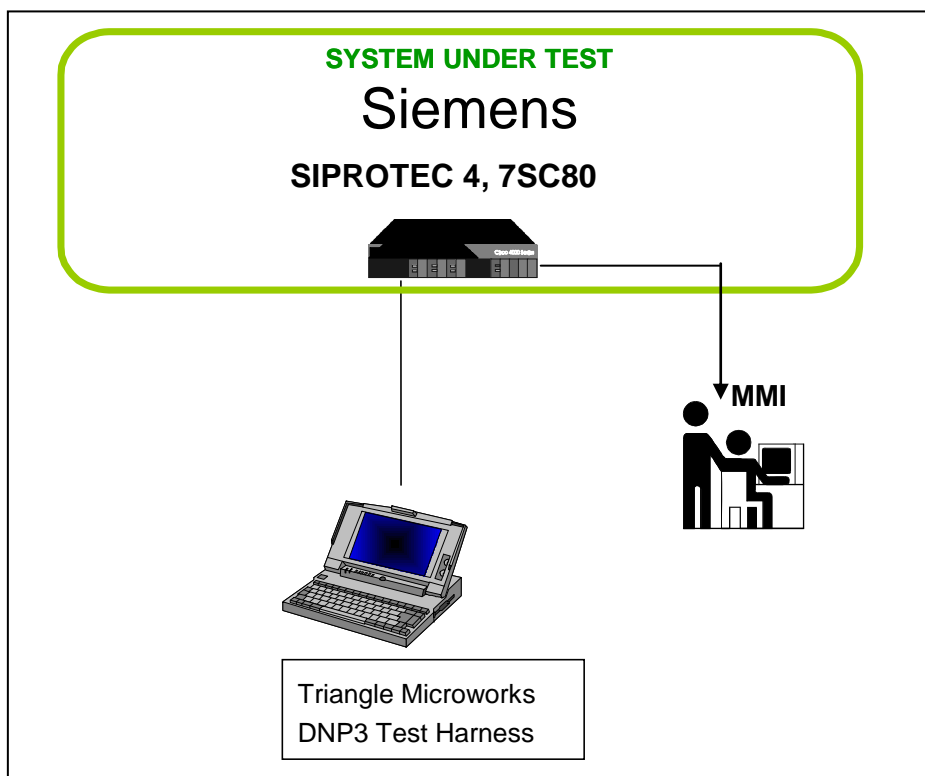
3. THE CONFORMANCE TEST

1.6 Components in the test environment

The test environment consists of the following components:

- The Triangle Microworks DNP3 test Harness **version 3.13**, which runs the DNP3 Conformance Test Scripts **Version 3.13.0.0** and acting as a single-node Master Station
- The System Under Test (SUT): SIPROTEC 4, 7SC80 Device with implemented DNP3 protocol acting as the slave station. The used firmware version is:
 - **01.00.05**
- Ethernet wire.

Figure 3.1 shows the (simple) layout of the connected test components.



1.6.1 SUT requirements

Next to the DNP3 communication capability as specified in the DNP3 Configuration / Interoperability Guide (See section 6), the System Under Test must support the following requirements for control and simulation purposes during testing, e.g. via additional test equipment attached to the SUT or one or more configured and running operator MMI stations:

- Display the current values of the Data Points described in I/O list, mapped to visible MMI-elements
- Manually pause/freeze (or equivalent, e.g. extending timers) of the communication to verify displayed or analysed data
- Manually shut down and restart or equivalent
- Manually cut-off of the connection to the communication link
- Manually activate the supported Application Layer Functions
- Direct physical connection to the communication link.

1.6.2 SUT configuration

The configuration of the SUT is as follows:

- The communication mode is Master-Slave capable of using fixed (point-to-point) communication lines. The Triangle Microworks DNP test Harness and the SUT are respectively acting as the (simulated) Master and Slave
- Highest DNP Level Supported: Level 2
- Further details of the implemented protocol subset can be found in section 6, DNP3 Configuration/Interoperability Guide. The DNP3 Configuration/Interoperability Guide forms the basis for the applicable test cases in the test plan in Appendix A.

1.6.3 DNP3 test system requirements

The Triangle Microworks DNP3 Test Harness is used by DNV KEMA for testing DNP3 protocol implementations. The Triangle Microworks DNP3 Test Harness supports real-time data capturing, analysis and decoding, combined with construction of frames and real-time script execution for simulation of conforming (positive) as well as non-conforming (negative) communication functions. The Triangle Microworks DNP3 Test Harness automatically executes all test cases in the conformance test scripts.

The Triangle Microworks DNP3 Test Harness is the test tool for testing slave implementations based on the DNP3 protocol standard.

In this conformance test, the Triangle Microworks DNP3 Test Harness is used in active mode and acts like a Master.

1.6.4 Communication link requirements

The communication link must support the following requirements for testing:

The SUT supports the following communication links:

- Ethernet.

1.7 Overview of the Conformance Test Scripts

1.7.1 Tests on physical level

For signal transmission between both end systems the V24/V28 (the well-known EIA232 standard) interface with interface connector (EIA DB9) is used. The Triangle Microworks DNP3 Test Harness checks constantly physical level failures. The SUT can send and receive octets after both systems are connected. All tests in appendix A have to pass the tests, the tests are passed if the physical connection doesn't fail permanently.

1.7.2 Tests on link level

The tests on link level are automatically performed by the Triangle Microworks DNP3 Test Harness on each transmitted frame. The tests are passed if no error is reported during a test session.

1.7.3 Tests on application level

The tests on application level as defined in the tables of Appendix A are performed by a combination of automatic verification and manual expert analysis for each test case if applicable. The tests have passed if no defects are found during a test session.

1.7.4 Negative tests

The Negative tests defined in Appendix A are performed by a combination of automatic verification and manual expert analysis for each test case if applicable. The tests have passed if the SUT continues correct operation. This means it does not sent corrupted frames and reacts in a correct and sensible manner.

The SUT may not fail permanently when receiving:

- Corrupted frames
- Illegal functions
- Not supported functions
- Not supported features.

4. TEST RESULTS

Table 4.1 in this Chapter gives a summary of the conformance test results. Numbers shown in the table columns refer to test numbers of individual test cases in appendix A.

Major defects are a **certain** cause for operational risks: these **MUST** be corrected before going into an operational situation! They imply the test is **failed**.

A **minor** defect is non-conformant behaviour, and can have a negative influence on the use of the product *in specific configurations*. Minor defects are a potential cause for operational problems. Therefore in a conformance test they also imply the test is **failed**.

In interoperability tests a minor defect **could pass** the test, depending on the severity of the defect. In configurations with different products and/or different manufacturers these minor defects in the implementation are a potential risk for the interoperability when not taken into account before going into an operational situation.

Finally, **remarks** introduce additional observations about the test case results, like limitations in the implementation.

The DNP3 Configuration/Interoperability Guide in paragraph 6 is the basis for the applicable test cases in Appendix A. The DNP3 Configuration/Interoperability Guide gives an overview of the tested protocol implementation, but this isn't a guarantee that the complete function is tested and supported. Partial testing is possible and the completeness of the tests for the specific function must be consulted in Appendix A.

Table 4.1 Summary of test results for the System Under Test

Test Group	Major	Minor	Remarks on test case:	Verdict Ethernet
6.1 Reset Link and Passive Confirm support			6.1: See remark	Passed
6.3 Request Link Status				Passed
6.4 Test Retries				Passed
6.5 § DIR and FCV Bits				Passed
6.6 Data Link Rejects Invalid Frames			6.6.3: See remark	Passed
6.7 Self-Address Support				N.S.
7 Transport Layer				Passed
8.1 Binary Output Status				Passed
8.2 Binary Outputs			8.2.1.2.10, 8.2.2.2.3, 8.2.3.2.3: N.S. 8.2.4: See remark	Passed
8.3 Analog Output Status				Passed
8.4 Analog Outputs				N.S.
8.5 Class Data Test Procedure				Passed
8.6 Indications			8.6.4.3: N.S. 8.6.6.2.2, 8.6.6.2.3, 8.6.6.2.4: N.S.	Passed
8.7 Time			8.7.1.2, 8.7.2.2: See remarks	Passed
8.8 Cold Restart				Passed
8.9 Application Layer Fragmentation				N.S.
8.10 Multi-Drop Support				N.S.
8.11 Unsolicited Responses				Passed
8.12 § Collision Avoidance				N.S.
8.13 Binary Inputs			8.13.2.3: N.S.	Passed
8.14 Binary Input Change			8.14.2.6-8.14.2.8: N.S. 8.14.2.13-8.14.2.15: N.S.	Passed
8.15 Common Time of Occurrence				N.S.
8.16 Binary Counters			8.16.1.2.3: N.S. 8.16.2.2.2-8.16.2.2.5: N.S.	Passed
8.17 Binary Counters, Event				Passed
8.18 Analog Input				Passed
8.19 Analog Change Event				Passed
8.20 Multiple Read Requests				Passed
8.21 Double-bit Inputs				N.S.
8.22 Double-bit Input Change				N.S.
8.23 Device attributes				N.S.
TOTALS	0	0		Passed

N.S.= Not supported

5. CONCLUSION AND RECOMMENDATIONS

The assignment was to give a well-founded answer on the question

“Does the DNP3 protocol implementation version 01.00.05 in the Siemens SIPROTEC 4 7SC80 Device conform to DNP3 Subset Level 2?”

Based on the test results described in this report, DNV KEMA declares the tested DNP3 implementation version **01.00.05** in the Siemens SIPROTEC 4, 7SC80 Device, *In Conformance* with Subset level 2 of the DNP3 standard.

1.8 **Remarks & Recommendations following from the test**

The following remarks and recommendations apply for the tested system configuration:

There are no remarks or recommendations.

6. DNP3 CONFIGURATION/INTEROPERABILITY GUIDE

The DNP3 communication capabilities of the SUT are as specified in the Device Profile Document [14].

This section contains a selection of the items in that document.

Device function	Outstation
DNP Level supported	Level 2
Connections supported	Ethernet
Collision avoidance	Not Supported
Self address	Not Supported
Multi-drop	Not Supported
Maximum number of objects allowed in a single control request for CROB or Analog outputs	1
Multi-Fragment Responses:	Not Supported
Unsolicited Responses	Configurable On or Off
Master Data Link address	Configurable
Number of events (for each class 1, 2 or 3)	Configurable
Maximum Delay Measurement error	10 ms

Supported DNP3 objects:

Binary Input	Supported Note: Binary Input Change Without Time and Binary Input Change With Relative Time are not supported
Double-bit input	Not Supported
Binary Output	Supported
Counter	Supported
Frozen counter	Not Supported
Analog Input	Supported
Analog Output	Not Supported

APPENDIX A – DETAILED TEST PLAN AND RESULTS

It is the purpose of this appendix to describe a set of tests that will determine an Intelligent Electronic Devices' (IED) compliance with the Distributed Network Protocol (formally known as DNP V3.00). This certification procedure is designed specifically to determine an IED's compliance to Level 2 of the Subset Definitions. A device must pass all of the tests to be considered compliant to this procedure. A summary of the tests and the results for each: Pass, Fail, Skipped (due to an unsupported feature or configuration) is given in underlying tables.

For a further description of the test procedures and test cases please refer to DNP3 Intelligent Electronic Device (IED) Certification Procedure, Subset Level 2, Version 2.5.

APPENDIX B – DNP3 INTELLIGENT ELECTRONIC DEVICE (IED) CERTIFICATION PROCEDURE SUBSET LEVEL 2

Table 6: DNP3 Link Layer Conformance Tests

Test No.	Test	Pass	Fail	Skipped	Remarks
6.1	Reset Link and Passive Confirm support	Pass			SUT can't be configured to request Data link layer confirmations
6.1.1	Desired Behaviour	Pass			
6.1.2	Test Procedure	Pass			
6.2	Test Link			Skipped	Test is deprecated in DNP3 test procedures.
6.2.1	Desired Behaviour			Skipped	
6.2.2	Test Procedure			Skipped	
6.3	Request Link Status	Pass			
6.3.1	Desired Behaviour	Pass			
6.3.2	Test Procedure	Pass			
6.4	Test Retries	Pass			
6.4.1	Desired Behaviour	Pass			
6.4.2	Test Procedure	Pass			
6.5	§ DIR and FCV Bits	Pass			
6.5.1	Desired Behaviour	Pass			
6.5.2	Test Procedure	Pass			
6.6	Data Link Rejects Invalid Frames	Pass			
6.6.1	Desired Behaviour	Pass			
6.6.2	Test Procedure – Primary Frames	Pass			
6.6.2.1	Invalid Start Octets	Pass			
6.6.2.2	Invalid Primary Function Code	Pass			
6.6.2.3	Invalid Destination Address	Pass			
6.6.2.4	Invalid CRC	Pass			
6.6.2.5	§ Invalid FCV	Pass			
6.6.3	Test Procedure – Secondary Frames			Skipped	SUT can't be configured to request Data link layer confirmations
6.6.3.1	Invalid Start Octets			Skipped	
6.6.3.2	Invalid Secondary Function Code			Skipped	
6.6.3.3	Invalid Destination Address			Skipped	
6.6.3.4	Invalid CRC			Skipped	
6.7	Self-Address Support			Skipped	Self-Address is not supported by SUT
6.7.1	Desired Behaviour			Skipped	
6.7.2	Test Procedure			Skipped	

Table 7: DNP3 Transport Layer Conformance Tests

Test No.	Test	Pass	Fail	Skipped	Remarks
7.1	Desired Behaviour	Pass			
7.2	Test Procedure	Pass			

Table 8: DNP3 Application Layer Conformance Tests

Test No.	Test	Pass	Fail	Skipped	Remarks
8.1	Binary Output Status	Pass			
8.1.1	Desired Behaviour	Pass			
8.1.2	Test Procedure	Pass			
8.2	Binary Outputs	Pass			
8.2.1	Select Before Operate	Pass			
8.2.1.1	Desired Behaviour	Pass			
8.2.1.2	Test procedure	Pass			
8.2.1.2.1	Binary Output, SBO, 0x28	Pass			
8.2.1.2.2	Binary Output, SBO, 0x17	Pass			
8.2.1.2.3	Binary Output, SBO, To Uninstalled Point	Pass			
8.2.1.2.4	Binary Output, SBO, Execute Issued After Timeout	Pass			
8.2.1.2.5	Binary Output, SBO, Execute to Different Point Than Select	Pass			
8.2.1.2.6	Binary Output, SBO, Execute On Time does not match Select On Time	Pass			
8.2.1.2.7	Binary Output, SBO, Execute Off Time does not match Select Off Time	Pass			
8.2.1.2.8	Binary Output, SBO, Select with supported Code, Execute with different Code	Pass			
8.2.1.2.9	Binary Output, SBO, Select 0x28, Execute 0x17	Pass			
8.2.1.2.10	Binary Output, SBO, Configurable Device			Skipped	Not supported by the SUT.
8.2.1.2.11	Binary Output, SBO, Same Sequence Number Select Retries	Pass			
8.2.1.2.12	Binary Output, SBO, Incrementing Sequence Number Select Retries	Pass			
8.2.1.2.13	Binary Output, SBO, Same Sequence Number Operate Retries	Pass			
8.2.1.2.14	Binary Output, SBO, Incrementing Sequence Number Operate Retries	Pass			
8.2.1.2.15	Binary Output, SBO, Sequence number checking	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.2.2	Direct Operate with Acknowledge	Pass			
8.2.2.1	Desired Behaviour	Pass			
8.2.2.2	Test Procedure	Pass			
8.2.2.2.1	Binary Output, Direct Operate	Pass			
8.2.2.2.2	Binary Output, Direct Operate to Uninstalled Point	Pass			
8.2.2.2.3	Binary Output, Direct Operate, Configurable Device			Skipped	Not supported by the SUT.
8.2.3	Direct Operate, No Acknowledge	Pass			
8.2.3.1	Desired Behaviour	Pass			
8.2.3.2	Test Procedure	Pass			
8.2.3.2.1	Binary Output, Direct Operate, No Acknowledge	Pass			
8.2.3.2.2	Binary Output, Direct Operate, No Acknowledge, to an Uninstalled Point	Pass			
8.2.3.2.3	Binary Output, Direct Operate, No Acknowledge, Configurable Device			Skipped	Not supported by the SUT.
8.2.4	Multiple Object Requests	Pass			SUT only allows 1 object
8.2.4.1	Desired Behaviour	Pass			
8.2.4.2	Test Procedure	Pass			
8.2.5	Control Code Support	Pass			
8.2.5.1	Desired Behaviour	Pass			
8.2.5.2	Test Procedure	Pass			
8.2.5.2.1	Binary Output, Complementary Function Support	Pass			
8.2.5.2.2	Binary Output, Single Function Support	Pass			
8.3	Analog Output Status	Pass			
8.3.1	Desired Behaviour	Pass			
8.3.2	Test Procedure	Pass			
8.4	Analog Outputs	Pass			
8.4.1	Select Before Operate	Pass			
8.4.1.1	Desired Behaviour	Pass			
8.4.1.2	Test Procedure	Pass			
8.4.1.2.1	Analog Output, SBO, 0x28	Pass			
8.4.1.2.2	Analog Output, SBO, 0x17			Skipped	Not supported by the SUT.
8.4.1.2.3	Analog Output, SBO, to Uninstalled Point			Skipped	Not supported by the SUT.
8.4.1.2.4	Analog Output, SBO, Execute Issued After Time-out			Skipped	Not supported by the SUT.
8.4.1.2.5	Analog Output, SBO, Execute Value does not match Select Value			Skipped	Not supported by the SUT.
8.4.1.2.6	Analog Output, SBO, Select 0x28, Execute 0x17			Skipped	Not supported by the SUT.

Test No.	Test	Pass	Fail	Skipped	Remarks
8.4.1.2.7	Analog Output, SBO, Configurable Device			Skipped	Not supported by the SUT.
8.4.1.2.8	Analog Output, SBO, Same Sequence Number Select Retries			Skipped	Not supported by the SUT.
8.4.1.2.9	Analog Output, SBO, Incrementing Sequence Number Select Retries			Skipped	Not supported by the SUT.
8.4.1.2.10	Analog Output, SBO, Same Sequence Number Operate Retries			Skipped	Not supported by the SUT.
8.4.1.2.11	Analog Output, SBO, Incrementing Sequence Number Operate Retries			Skipped	Not supported by the SUT.
8.4.1.2.12	Analog Output, SBO, Sequence number checking			Skipped	Not supported by the SUT.
8.4.2	Direct Operate with Acknowledge	Pass			
8.4.2.1	Desired Behaviour	Pass			
8.4.2.2	Test Procedure	Pass			
8.4.2.2.1	Analog Output, Direct Operate	Pass			
8.4.2.2.2	Analog Output, Direct Operate, to Uninstalled Point			Skipped	Not supported by the SUT.
8.4.2.2.3	Analog Output, Direct Operate, Configurable Device			Skipped	Not supported by the SUT.
8.4.3	Direct Operate, No Acknowledge			Skipped	Not supported by the SUT.
8.4.3.1	Desired Behaviour			Skipped	Not supported by the SUT.
8.4.3.2	Test Procedure			Skipped	Not supported by the SUT.
8.4.3.2.1	Analog Output, Direct Operate, No Acknowledge			Skipped	Not supported by the SUT.
8.4.3.2.2	Analog Output, Direct Operate, No Acknowledge, to an Uninstalled Point			Skipped	Not supported by the SUT.
8.4.3.2.3	Analog Output, Direct Operate, No Acknowledge, Configurable Device			Skipped	Not supported by the SUT.
8.4.4	Multiple Object Requests			Skipped	Not supported by the SUT.
8.4.4.1	Desired Behaviour			Skipped	Not supported by the SUT.
8.4.4.2	Test Procedure			Skipped	Not supported by the SUT.
8.5	Class Data	Pass			
8.5.1	Class 0	Pass			
8.5.1.1	Desired Behaviour	Pass			
8.5.1.2	Test Procedure	Pass			
8.5.2	Class 1	Pass			
8.5.2.1	Desired Behaviour	Pass			
8.5.2.2	Test Procedure	Pass			
8.5.2.2.1	Class 1 Data, 0x06	Pass			
8.5.2.2.2	Class 1 Data, 0x07	Pass			
8.5.2.2.3	Class 1 Data, 0x08	Pass			
8.5.2.2.4	Class 1 Data Without Confirm	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.5.3	Class 2	Pass			
8.5.3.1	Desired Behaviour	Pass			
8.5.3.2	Test Procedure	Pass			
8.5.3.2.1	Class 2 Data, 0x06	Pass			
8.5.3.2.2	Class 2 Data, 0x07	Pass			
8.5.3.2.3	Class 2 Data, 0x08	Pass			
8.5.3.2.4	Class 2 Data Without Confirm	Pass			
8.5.4	Class 3	Pass			
8.5.4.1	Desired Behaviour	Pass			
8.5.4.2	Test Procedure	Pass			
8.5.4.2.1	Class 3 Data, 0x06	Pass			
8.5.4.2.2	Class 3 Data, 0x07	Pass			
8.5.4.2.3	Class 3 Data, 0x08	Pass			
8.5.4.2.4	Class 3 Data Without Confirm	Pass			
8.5.5	Multiple Object Request	Pass			
8.5.5.1	Desired Behaviour	Pass			
8.5.5.2	Test Procedure	Pass			
8.5.5.2.1	Multiple Object Request, Class 1, 2, and 3	Pass			
8.5.5.2.2	Multiple Object Request, Class 1, 2, 3, and 0	Pass			
8.5.6	Class Assignment Verification	Pass			
8.5.6.1	Desired Behaviour	Pass			
8.5.6.2	Test Procedure	Pass			
8.6	Indications	Pass			
8.6.1	Restart	Pass			
8.6.1.1	Desired Behaviour	Pass			
8.6.1.2	Test Procedure	Pass			
8.6.2	Bad Function	Pass			
8.6.2.1	Desired Behaviour	Pass			
8.6.2.2	Test Procedure	Pass			
8.6.3	Object Unknown	Pass			
8.6.3.1	Desired Behaviour	Pass			
8.6.3.2	Test Procedure	Pass			
8.6.4	Local	Pass			
8.6.4.1	Desired Behaviour	Pass			
8.6.4.2	Test Procedure for Devices with Global Remote Supervisory Control	Pass			
8.6.4.3	Test Procedure for Devices with Individual Remote Supervisory Control			Skipped	Not supported by the SUT.
8.6.5	Broadcast Address and All Stations Indication	Pass			
8.6.5.1	Desired Behaviour	Pass			
8.6.5.2	§ Test Procedure	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.6.5.3	Test Procedure	Pass			
8.6.5.4	Test Procedure, Confirmed Response Options	Pass			
8.6.6	Buffer Overflow	Pass			
8.6.6.1	Desired Behaviour	Pass			
8.6.6.2	Test Procedure	Pass			
8.6.6.2.1	Buffer Overflow, Binary Input Change Event Buffers	Pass			
8.6.6.2.2	Buffer Overflow, Analog Input Change Event Buffers			Skipped	SUT does not queue multiple events for the same point
8.6.6.2.3	Buffer Overflow, Binary Counter Change Event Buffers			Skipped	SUT does not queue multiple events for the same point
8.6.6.2.4	Buffer Overflow, Double-bit Input Change Event Buffers			Skipped	Double-bit Inputs are not supported by SUT
8.7	Time	Pass			
8.7.1	Delay Measurement	Pass			
8.7.1.1	Desired Behaviour	Pass			
8.7.1.2	Test Procedure	Pass			The test procedure requires measuring the accuracy of the delay measurement. During the tests it was not possible to measure the delay with high accuracy, however the reported delay times were plausible.
8.7.2	Synchronization	Pass			
8.7.2.1	Desired Behaviour	Pass			
8.7.2.2	Test Procedure	Pass			The test procedure requires measuring the accuracy of the timestamp of an event. During the tests it was not possible to measure the time with high accuracy, however the reported timestamps were plausible.
8.8	Cold Restart	Pass			
8.8.1	Desired Behaviour	Pass			
8.8.2	Test Procedure	Pass			
8.9	Application Layer Fragmentation			Skipped	Because of fixed buffer size (100) and fixed frame length (2048) it is not possible to cause a multi fragment message.
8.9.1	Use of FIR, FIN and SEQUENCE in Fragmentation			Skipped	
8.9.1.1	Desired Behaviour			Skipped	
8.9.1.2	Test Procedure			Skipped	
8.9.2	Use of Confirmation in Fragmentation			Skipped	
8.9.2.1	Desired Behaviour			Skipped	
8.9.2.2	Test Procedure			Skipped	
8.10	Multi-Drop Support			Skipped	Not supported by the SUT.
8.10.1	Desired Behaviour			Skipped	
8.10.2	Test Procedure			Skipped	
8.11	Unsolicited Responses	Pass			
8.11.1	Desired Behaviour	Pass			
8.11.1.1	Configuration	Pass			
8.11.1.2	Sequence Numbers and Confirmation	Pass			
8.11.1.3	Restart Behaviour	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.11.1.4	Runtime Behaviour	Pass			
8.11.1.5	Unsolicited and Polled Responses	Pass			
8.11.2	Test Procedure	Pass			
8.11.2.1	Unsolicited Response Configuration/Startup	Pass			
8.11.2.2	Unsolicited Response - Class 1 Data	Pass			
8.11.2.3	Unsolicited Response - Class 2 Data	Pass			
8.11.2.4	Unsolicited Response - Class 3 Data	Pass			
8.11.2.5	Unsolicited and Polled Responses	Pass			
8.11.2.5.1	Transmits data-filled unsolicited responses	Pass			
8.11.2.5.2	Clears transmitted data upon confirmation	Pass			
8.11.2.5.3	Processes non-READ requests immediately	Pass			
8.11.2.5.4	Defers READ requests until after confirmation received	Pass			
8.11.2.5.5	Defers READ requests until after confirmation timeout	Pass			
8.11.2.5.6	Abandons READ requests upon subsequent non-READ requests	Pass			
8.11.2.5.7	Abandons READ requests upon subsequent READ requests	Pass			
8.11.2.5.8	Inhibits Unsolicited responses until after polled confirmation	Pass			
8.11.2.5.9	Retries unsolicited responses configurable number of times	Pass			
8.11.2.6	Unsolicited Responses Off	Pass			
8.12	Collision Avoidance			Skipped	Not supported by the SUT.
8.12.1	Desired Behaviour			Skipped	
8.12.2	Test Procedure			Skipped	
8.13	Binary Inputs	Pass			
8.13.1	Desired Behaviour	Pass			
8.13.2	Test Procedure	Pass			
8.13.2.1	Device does not have Binary Inputs	Pass			
8.13.2.2	Device has Binary Inputs	Pass			
8.13.2.3	Device supports Binary Inputs, Configurable Device			Skipped	Not supported by the SUT.
8.14	Binary Input Change	Pass			
8.14.1	Desired Behaviour	Pass			
8.14.2	Test Procedure	Pass			
8.14.2.1	Device does not support Binary Input Changes	Pass			
8.14.2.2	Binary Input Change, 0x06	Pass			
8.14.2.3	Binary Input Change, 0x07	Pass			
8.14.2.4	Binary Input Change, 0x08	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.14.2.5	Binary Input Change Without Confirm	Pass			
8.14.2.6	Binary Input Change Without Time, 0x06			Skipped	Binary Input change without time is not supported
8.14.2.7	Binary Input Change Without Time, 0x07			Skipped	
8.14.2.8	Binary Input Change Without Time, 0x08			Skipped	
8.14.2.9	Binary Input Change With Time, 0x06	Pass			
8.14.2.10	Binary Input Change With Time, 0x07	Pass			
8.14.2.11	Binary Input Change With Time, 0x08	Pass			
8.14.2.12	Binary Input Change With Relative Time, 0x06			Skipped	Not supported by the SUT.
8.14.2.13	Binary Input Change With Relative Time, 0x07			Skipped	
8.14.2.14	Binary Input Change With Relative Time, 0x08			Skipped	
8.14.2.15	Binary Input Change with Relative Time, Long Interval			Skipped	
8.15	Common Time of Occurrence			Skipped	Not supported by the SUT.
8.15.1	Desired Behaviour			Skipped	
8.15.2	Test Procedure			Skipped	
8.16	Binary Counters	Pass			
8.16.1	Binary Counters, Running	Pass			
8.16.1.1	Desired Behaviour	Pass			
8.16.1.2	Test Procedure	Pass			
8.16.1.2.1	Device does not have Binary Counters	Pass			
8.16.1.2.2	Device responds with Binary Counters	Pass			
8.16.1.2.3	Device supports Binary Counters, Configurable Device			Skipped	Not supported by the SUT.
8.16.2	Binary Counters, Frozen	Pass			
8.16.2.1	Desired Behaviour	Pass			
8.16.2.2	Test Procedure	Pass			
8.16.2.2.1	Device does not have Frozen Counters	Pass			
8.16.2.2.2	Binary Counter, Freeze			Skipped	Frozen counters are not supported by the SUT.
8.16.2.2.3	Binary Counter, Freeze And Clear			Skipped	
8.16.2.2.4	Binary Counter, Freeze, No Acknowledge			Skipped	
8.16.2.2.5	Binary Counter, Freeze And Clear, No Acknowledge			Skipped	
8.17	Binary Counters, Event	Pass			
8.17.1	Desired Behaviour	Pass			
8.17.2	Test Procedure	Pass			
8.17.2.1	Device does not support Binary Counter Events	Pass			
8.17.2.2	Binary Counters, Event, 0x06	Pass			
8.17.2.3	Binary Counters, Event, 0x07	Pass			
8.17.2.4	Binary Counters, Event, 0x08	Pass			
8.17.2.5	Binary Counters, Event Without Confirm	Pass			
8.18	Analog Input	Pass			

Test No.	Test	Pass	Fail	Skipped	Remarks
8.18.1	Desired Behaviour	Pass			
8.18.2	Test Procedure	Pass			
8.18.2.1	Device does not have Analog Inputs	Pass			
8.18.2.2	Device has Analog Inputs	Pass			
8.19	Analog Change Event	Pass			
8.19.1	Desired Behaviour	Pass			
8.19.2	Test Procedure	Pass			
8.19.2.1	Analog Input Change	Pass			
8.19.2.2	Analog Input Change, Without Confirm	Pass			
8.20	Multiple Read Requests	Pass			
8.20.1	Desired Behaviour	Pass			
8.20.2	Test Procedure	Pass			
8.21	Double-bit Inputs			Skipped	Double-bit Inputs are not supported by SUT.
8.21.1	Desired Behaviour			Skipped	
8.21.2	Test Procedure			Skipped	
8.21.2.1	Device has Double-bit Inputs			Skipped	
8.21.2.2	Device supports Double-bit Inputs, Configurable Device			Skipped	
8.22	Double-bit Input Change			Skipped	
8.22.1	Desired Behaviour			Skipped	
8.22.2	Test Procedure			Skipped	
8.22.2.1	Device does not support Double-bit Input Changes			Skipped	
8.22.2.2	Double-bit Input Change, 0x06			Skipped	
8.22.2.3	Double-bit Input Change, 0x07			Skipped	
8.22.2.4	Double-bit Input Change, 0x08			Skipped	
8.22.2.5	Double-bit Input Change Without Confirm			Skipped	
8.22.2.6	Double-bit Input Change Without Time, 0x06			Skipped	
8.22.2.7	Double-bit Input Change Without Time, 0x07			Skipped	
8.22.2.8	Double-bit Input Change Without Time, 0x08			Skipped	
8.22.2.9	Double-bit Input Change With Time, 0x06			Skipped	
8.22.2.10	Double-bit Input Change With Time, 0x07			Skipped	
8.22.2.11	Double-bit Input Change With Time, 0x08			Skipped	
8.22.2.12	Double-bit Input Change With Relative Time, 0x06			Skipped	
8.22.2.13	Double-bit Input Change With Relative Time, 0x07			Skipped	
8.22.2.14	Double-bit Input Change With Relative Time, 0x08			Skipped	
8.22.2.15	Double-bit Input Change with Relative Time, Long Interval			Skipped	



Test No.	Test	Pass	Fail	Skipped	Remarks
8.23	Device Attributes			Skipped	Not supported by the SUT.
8.23.1	Desired Behaviour			Skipped	Not supported by the SUT.
8.23.2	Test Procedure			Skipped	Not supported by the SUT.
8.23.2.1	Variation 255 – list of attribute variation			Skipped	Not supported by the SUT.
8.23.2.2	Variation 254 – non-specific all attribute request			Skipped	Not supported by the SUT.
8.23.2.3	Variation nnn – specific attribute read request			Skipped	Not supported by the SUT.
8.23.2.4	Variation nnn – specific attribute write request			Skipped	Not supported by the SUT.