# 3500/91 Universal Gateway

## *PROFINET Acceptance Test Plan*

**Prepared For**

PROFINET Acceptance Test Plan
Version 1.0
Aug 24, 2011

| REVISION HISTORY | | | |
|---|---|---|---|
| **Date** | **Version** | **By** | **Description of Change** |
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# Table of Contents

# 1 Applicable Documents

The following documents are referenced within:

| No. | Document | Version | Scope |
|---|---|---|---|
| 1 | EGD System Test Plan | A | 3500/91 EGD TEST PLAN |
| | | | |

# 2 Glossary of Terms

The table below represents an alphabetical list of abbreviations, acronyms, and terminology commonly used in reference to this product.

| Term | Definition |
|---|---|
| ATP | Acceptance Test Plan – this document |
| BSP | Board Support Package |
| CRC | Cyclic redundancy check - a hash function designed to detect accidental changes to raw computer data, and is commonly used in digital networks and storage devices such as hard disk drives. CRCs are so called because the check (data verification) code is a redundancy (it adds zero information to the message) and the algorithm is based on cyclic codes. |
| EGD | Ethernet Global Data |
| OPC | Ole for Process Control |
| Ole | Object Linking and Embedding |
| PPL | Proportional Value |
| RIM | Rack Interface Module |
| TDI | Transient Data Interface |
| GSD | Generic Station Description |

# 3 Introduction

## 3.1 Purpose and Scope

The purpose of this document is to define the acceptance test plan for the PROFINET functionality embedded in the /91 Universal Communications Gateway module

This document focuses on the PROFINET portion of the ATP for the /91 Universal Gateway and assumes that the BSP and EGD application code have passed the EGD System Test Plan

The acceptance test can be broken into three distinct areas with each area focused on a specific goal.

- EGD Integration Tests
- PLC Interoperability Tests
- PROFINET Certification Tests

## 3.2 Overview

Acceptance tasks take place throughout the project life cycle and culminate in acceptance testing.

Acceptance Testing incorporates four phases:

1. Defining the acceptance criteria
2. Developing an acceptance test plan
3. Executing the acceptance test plan
4. Reaching acceptance based on the test results

## 3.3 Acceptance Criteria Definition

### 3.3.1 Overview

This section defines the acceptance criteria and provides a high-level checklist to enter and exit test execution.

#### 3.3.1.1 Entrance Criteria

The entrance criteria detailed below must be completed prior to starting formal acceptance testing:

- G.E. Energy must approve this ATP.
- All software development must be completed (with agreed upon exceptions as outlined in known issues mentioned in this document).
- All software must be under configuration management and frozen prior to the acceptance test.
- All resources (human, hardware, or software) must be assigned and in place.

#### 3.3.1.2 Exit Criteria

The Exit Criteria detailed below must be achieved to complete acceptance testing for the project:

- All acceptance tests have been conducted and a pass rate of 100% (or mutual agreement on tests not passing reached) has been achieved.
- The test report has been reviewed and accepted.

## 3.4 Acceptance

Acceptance happens when all pre-defined exit criteria have been achieved. Upon completion of formal acceptance testing, the test lead and the Project Manager will approve the test results. The test result document will be provided to G.E. Energy for review and acceptance.

# 4 Test Resources

## 4.1 Test Environment

Acceptance testing will be performed at a Wind River facility. GE may run tests that can only be run at GE or those tests requiring special knowledge.

## 4.2 Hardware and Equipment Required

The equipment required for testing is broken into three sections: Baseline Equipment, EGD Integration Equipment, and PLC Interoperability Equipment.

### 4.2.1 Baseline Equipment

This is required for all tests and is a starting point for additional hardware modifications

- 3500 Rack populated with:
  - Slot 0 (Top): AC low-voltage power supply
  - Slot 1 (Full): /22M TDI card (w/ I/O module)
  - Slot 2 (Top/Bottom): two /25 Keyphasor Modules (w/ I/O module)
  - Slot 3 (Full): /42 Proximeter Seismic Monitor Module (w/ I/O module)
  - Slot 4 (Full): /91 Universal Gateway Module
- Function Generator
- Bench Power Supply
- Wind River Probe or ICE
- PROFINET IO Controller PC (loaded with one of the following)
  - Molex PROFINET-IO Controller OEM Engineering Console
    - Order Number: 1121065012
    - Engineering No: SDK-PFN-CON-CNF-U
    - There is a PCI NIC associated with this that
  - ProfinetCommander/Simatic Softnet PROFINET IO
  - Siemens Hardware PLC
    - ET200S CPU: ET200S, IM151-8 PN/DP CPU, 192 KB
    - Step 7 basic V 5.5 for Simatic 300/400, PC Based Controllers.

### 4.2.2 EGD Integration Equipment

For the EGD Integration Tests the following additional hardware is needed with the Baseline Equipment (section 4.2.1):

- Additional 3500 modules
  - /91 Communications Gateway (with Ethernet I/O module)
  - /32 Standard Relay module (with 4 Channel Relay I/O module)

  - /33 16 Channel Relay Module
  - two /34 TMR Relay Module
  - /40/40M Proximitor Monitor (with Proximitor I/O modules)
  - /42/42M Proximitor/Seismic Monitors (with PROX/VELOM I/O module)
  - /44/44M Aeroderivative GT Monitor
  - /45 Position Monitor
  - /46M Hydro Monitor
  - /50 Tachometer Monitor
  - /53 Overspeed Detection Monitor
  - /60 Temperature Monitor (w/no Recs)
  - /61 Temperature Monitor (w/Recs)
  - /62 Process Variable Monitor
  - /63 Gas Detection Monitor
  - /64M Dynamic Pressure Monitor
  - /65 16-Channel Temperature Monitor
  - /70M Impulse/Velocity Monitor
  - /72M Rod Position Monitor
  - /77M Cylinder Pressure Monitor
  - /90 Communication Gateway
  - /91 Communication Gateway
  - /92 Communication Gateway
  - /93 Display interface Module
  - /94 VGA Display Module

### 4.2.3 PLC Interoperability Equipment

For the PLC Interoperability Tests the following additional hardware is needed with the Baseline Equipment (section 4.2.1):

- Additional 3500 modules
  - Slot 01: /22 RIM-TDI Module
  - Slot 02: two /25 Keyphasor Module
  - Slot 03: /42M Proximitor/Seismic Monitor
  - Slot 04: /91 Communication Gateway Module
  - Slot 05: /40M Proximitor Module
  - Slot 06: /42M Proximitor/Seismic Monitor
  - Slot 07: /40M Proximitor Module
  - Slot 08: /42M Proximitor/Seismic Monitor
  - Slot 09: /40M Proximitor Module
  - Slot 10: /42M Proximitor/Seismic Monitor
  - Slot 11: /40M Proximitor Module
  - Slot 12: /42M Proximitor/Seismic Monitor
  - Slot 13: /42M Proximitor/Seismic Monitor
  - Slot 14: /42M Proximitor/Seismic Monitor
  - Slot 15: /42M Proximitor/Seismic Monitor
- PROFINET IO Controller PC
  - Siemens Hardware PLC

- ET200S CPU: ET200S, IM151-8 PN/DP CPU, 192 KB
- Step 7 basic V 5.5 for Simatic 300/400, PC Based Controllers

### 4.2.4 PN Tester Equipment

For the running the PN Tester pre-certification test suite, the following additional hardware is needed with the Baseline Equipment (section 4.2.1):

- PC for running PN Tester and Wireshark

## 4.3 Test Software

The following software is required for acceptance testing

- 3500 Rack Configuration Software - version 3.94.0817 SP1
- WindRiver Workbench with support for OCD (Version 3.2)
- Serial Communications program – PuTTY
- PROFINET IO Controller software (one of the following)
  - Molex PROFINET-IO Controller OEM Engineering Console
  - ProfinetCommander/Simatic Softnet PROFINET IO
  - Step 7 basic V 5.5 for Simatic 300/400, PC Based Controllers.
- Wireshark
- PN IO Tester from PI International website

# 5 Test Configurations

The PROFINET device stack is built as a Downloadable Kernel Module (DKM). This DKM is stored in the compressed ROMFs image with the other protocols (OPC and ModBus). At startup, the configuration specified by the 3500 Rack Configuration Software will dictate which protocols is to be started.

## 5.1 Build and Flash the EGD Compressed Image

From a VxWorks Development Shell, create the project by running makeproj.bat. Change into the project directory and add the WDB component:

```
vxprj component add INCLUDE_WDB
```

Build the project:

```
make BUILD_SPEC=default_romCompress egdcomm_romCompress.bin
```

Flash the newly created image to the board at the start address 0xfff00100.

# 6 Test Procedures and Results

The following test procedures assume a working knowledge of the following required software elements:

- 3500 Rack Configuration Software for adding/removing modules from the rack
- PROFINET IO-Controller for device configuration, operation, and data validation
- PN IO Tester for configuration and running of the certification test suite
- Wireshark to capture IO-Controller/IO-Device traffic during certification tests

## 6.1 EGD Data Integration Tests

These tests use the Baseline Equipment (section 4.2.1) plus additional modules described in EGD Integration Equipment (section 4.2.2).

Tests in this section will verify that the EGD data is being correctly sent to the IO-Controller and is correctly translated from the EGD data structures into the PROFINET IO Data.

### 6.1.1 Verify Device Identification for Modules

The following steps need to be performed for each device type to make sure that it is correctly identified and recognized by the IO-Controller. This will verify that the Generic Station Description file (GSD) is in sync with what is recognized by the device as being configured in the rack.

The following steps should be performed for each module/channel pair in the following table.

- Insert the device into the 3500 rack
- Use the Rack Configuration Software to
  - Select the PROFINET protocol on the /91 Universal Gateway Card
  - Download the configuration
- On the IO-Controller
  - Molex IO-Controller
    - Scan the network for devices.
    - Verify that device is detected
    - Verify that the modules are being accurately detected

| Monitor | Description | PASS/FAIL |
|---|---|---|
| 22 | TDI | PASS |
| 25 | Keyphasor Module –Top | PASS |
| 25 | Keyphasor Module - Bottom | PASS |
| 25 | Both Keyphasor Modules | PASS |
| 32 | Standard Relay Module | |
| 33 | 16 Channel Relay Module | PASS |
| 34 | TMR Relay Module -Top | PASS |

| Monitor | Description | PASS/FAIL |
|---|---|---|
| 34 | TMR Relay Module - Bottom | PASS |
| 34 | Both TMR Modules | PASS |
| 40/40M | Proximeter Monitor | PASS |
| 42/42M | Proximeter/Seismic Monitor | PASS |
| 44/44M | Aeroderivative GT Monitor | PASS |
| 45 | Position Monitor | PASS |
| 50 | Tachometer Monitor | PASS |
| 53 | Overspeed Detection Monitor | PASS |
| 60 | Temperature Monitor (w/no Recs) | PASS |
| 61 | Temperature Monitor (w/Recs) | PASS |
| 62 | Process Variable Monitor | PASS |
| 63 | Gas Detection Monitor | PASS |
| 64M | Dynamic Pressure Monitor | PASS |
| 65 | 16-Channel Temperature Monitor | PASS |
| 70M | Impulse/Velocity Monitor | PASS |
| 72M | Rod Position Monitor | PASS |
| 77M | Cylinder Pressure Monitor | PASS |
| 90 | Communication Gateway | PASS |
| 91 | Communication Gateway | PASS |
| 92 | Communication Gateway | PASS |
| 93 | Display interface Module | PASS |
| 94 | VGA Display Module | PASS |

### 6.1.2 Verify Channel/Data Identification for Sub-modules

This test will verify that a given device's channel and associated data are valid and are populated correctly in the PROFINET IO Data Cyclical frame. This test requires the IO-Controller to select "Canned Data Mode" prior to device connection. With this option, each sub-module will use a known data pattern for each piece of data placed into the cyclical IO Data frame. The expected data is as follows for each sub-module type:

| Sub-module | EGD Data | Size | Expected Value | Equivalent Controller Values |
|---|---|---|---|---|
| Rack Status | Rack Status | Unsigned32 | 0xDEADBEEF (-559038737) | Power Supply 2 OK, RIM Not OK, Configuration Fault LED State, RIM H/W Config Change, Key Lock In Program Mode, H/W Rack Reset Active, H/W Alarm Inhibit Active, S/W Alarm Inhibit Active, Configuration Lock Active |
| Module Status | Module Status | Unsigned 16 | 0x3000 | Not Ok, Inhibited |
| Module Switches | Module Switches | Unsigned8 | Module ID | (1) |
| Channel Status | Channel Status | Unsigned16 | Channel ID | (2) |
| Channel Switches | Channel Switches | Unsigned16 | Channel Number | (3) |

| Sub-module | EGD Data | Size | Expected Value | Equivalent Controller Values |
|---|---|---|---|---|
| RPM | Keyphasor RPM | Unsigned32 | 0xDEADBEEF (-559038737) | 0xDEADBEEF (-559038737) |
| N PPLs (N= 1-8) | PPL Status | Unsigned16 | (4) | PPL #N Alert, PPL #N Danger |
| | PPL #1 | Float | XYY.1 | (5) |
| | … | … | … | … |
| | PPL #N | Float | XYY.N | (5) |
| Set points 8PPL | Type | Unsigned32 | (6) | (6) |
| | Info | Unsigned8 | 0x15 | Enabled, Danger, Under |
| | Value | Float | XYY.01 | (7) |
| | … | … | … | |
| | Type | Unsigned32 | (6) | (6) |
| | Info | Unsigned8 | 0x15 | Enabled, Danger, Under |
| | Value | Float | XYY.20 | (7) |

(1) See expected values from the table titled: **Canned Module Switches Data**
(2) See expected values from the table titled: **Canned Channel Status Data**
(3) See expected values from the table titled: **Canned Channel Switches Data**
(4) See expected values from the table titled: **Canned PPL Status Data**
(5) XYY.Z (X: slot #, Y:chan #, Z: PPL #)
(6) See expected values from the table titled: **Canned Setpoint Types Data**
(7) XYY.ZZ (X: slot #, Y:chan #, Z: Setpoint # )

| Monitor | Description | Module ID | Expected Module Switches |
|---|---|---|---|
| 25 | Keyphasor Module –Top | 0x19 | Manual Keyphasor Threshold Adjust, Config Mode |
| 25 | Keyphasor Module - Bottom | 0x19 | Manual Keyphasor Threshold Adjust, Config Mode |
| 25 | Both Keyphasor Modules | 0x19 | Manual Keyphasor Threshold Adjust, Config Mode |
| 32 | Standard Relay Module | 0x20 | All False |
| 33 | 16 Channel Relay Module | 0x21 | Config Mode |
| 34 | TMR Relay Module -Top | 0x22 | Internal Calibration |
| 34 | TMR Relay Module - Bottom | 0x22 | Internal Calibration |
| 34 | Both TMR Modules | 0x22 | Internal Calibration |
| 40/40M | Proximeter Monitor | 0x28 | Manual Keyphasor Threshold Adjust |
| 42/42M | Proximeter/Seismic Monitor | 0x2A | Internal Calibration, Manual Keyphasor Threshold Adjust |
| 44/44M | Aeroderivative GT Monitor | 0x2C | Manual Keyphasor Threshold Adjust, External Calibration |
| 45 | Position Monitor | 0x2D | Manual Keyphasor Threshold Adjust, External Calibration, Config Mode |
| 50 | Tachometer Monitor | 0x32 | Internal Calibration |
| 53 | Overspeed Detection Monitor | 0x35 | External Calibration, Config Mode |
| 60 | Temperature Monitor (w/no Recs) | 0x3C | Manual Keyphasor Threshold Adjust, External Calibration |
| 61 | Temperature Monitor (w/Recs) | 0x3D | Manual Keyphasor Threshold Adjust, External Calibration, Config Mode |
| 62 | Process Variable Monitor | 0x3E | Manual Keyphasor Threshold Adjust, External Calibration, Internal Calibration |
| 63 | Gas Detection Monitor | 0x3F | Manual Keyphasor Threshold Adjust, External Calibration, Internal Calibration, Config Mode |
| 64M | Dynamic Pressure Monitor | 0x40 | All False |
| 65 | 16-Channel Temperature Monitor | 0x41 | Config Mode |
| 70M | Impulse/Velocity Monitor | 0x46 | External Calibration, Internal Calibration |
| 72M | Rod Position Monitor | 0x48 | Manual Keyphasor Threshold Adjust |
| 77M | Cylinder Pressure Monitor | 0x4D | Manual Keyphasor Threshold Adjust, External Calibration, Config Mode |
| 90 | Communication Gateway | 0x5A | Internal Calibration, Manual Keyphasor Threshold Adjust |
| 91 | Communication Gateway | 0x5B | Manual Keyphasor Threshold Adjust, Internal Calibration, Config Mode |
| 92 | Communication Gateway | 0x5C | Manual Keyphasor Threshold Adjust, External Calibration |
| 93 | Display interface Module | 0x5D | Manual Keyphasor Threshold Adjust, External Calibration, Config Mode |
| 94 | VGA Display Module | 0x5E | Manual Keyphasor Threshold Adjust, External Calibration, Internal Calibration |

**Canned Module Switches Data**

| Channel | Channel ID | Expected Channel Status | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Not Comm. | Special Inhibit | Trip Multiply | OFF | Bypass | Alarm 2 | Alarm 1 | Not OK |
| Radial Vibration | 0x01 | | | | | | | | x |
| Thrust Position | 0x02 | | | | | | | x | |
| Eccentricity | 0x03 | | | | | | | x | x |
| Acceleration | 0x04 | | | | | | x | | |
| Velocity | 0x05 | | | | | | x | | x |
| Aeroderivative | 0x06 | | | | | | x | x | |
| Differential Expansion | 0x07 | | | | | | x | x | x |
| Complementary Input Differential | 0x08 | | | | | x | | | |
| Standard Single Ramp Diff Exp | 0x09 | | | | | x | | | x |
| Non-Standard Single Ramp Diff Exp | 0x0A | | | | | x | | x | |
| Dual Ramp Differential Expansion | 0x0B | | | | | x | | x | x |
| Rotor Accceleration & Speed | 0x0C | | | | | x | x | | |
| Temperature | 0x0D | | | | | x | x | | x |
| Rotor Speed | 0x0F | | | | | x | x | x | x |
| Rotor Accceleration & Speed | 0x10 | | | | x | | | | |
| Zero Speed | 0x11 | | | | x | | | | x |
| Overspeed | 0x12 | | | | x | | | x | |
| Case Expansion - Paired | 0x13 | | | | x | | | x | x |
| Case Expansion - Single | 0x14 | | | | x | | x | | |
| Process Variable | 0x15 | | | | x | | x | | x |
| Shaft Absolute Radial Vibration | 0x16 | | | | x | | x | x | |
| Shaft Absolute Velocity | 0x17 | | | | x | | x | x | x |
| Valve Position | 0x18 | | | | x | x | | | |
| Dynamic Pressure | 0x19 | | | | x | x | | | x |
| Hydro Radial Vibration | 0x1A | | | | x | x | | x | |
| Temperature (Comp or Diff) | 0x1B | | | | x | x | | x | x |
| Acceleration II | 0x1C | | | | x | x | x | | |
| Velocity II | 0x1D | | | | x | x | x | | x |
| Cylinder Pressure | 0x1E | | | | x | x | x | x | |
| Rod Position Single | 0x1F | | | | x | x | x | x | x |
| Rod Position Pair | 0x20 | | | x | | | | | |
| Rod Drop | 0x21 | | | x | | | | | x |
| Hyper | 0x22 | | | x | | | | x | |
| Hydro Air Gap | 0x23 | | | x | | | | x | x |
| Circular Acceptance Regions | 0x24 | | | x | | | x | | |
| REBAM | 0x26 | | | x | | | x | x | |
| Aeroderivative II | 0x28 | | | x | | x | | | |
| Reverse Rotation | 0x29 | | | x | | x | | | x |
| Gas Detection | 0x2C | | | x | | x | x | | |
| Hydro Velocity | 0x2D | | | x | | x | x | | x |
| Recip Velocity | 0x2E | | | x | | x | x | x | |
| Recip Acceleration | 0x2F | | | x | | x | x | x | x |
| Impulse Acceleration | 0x30 | | | x | x | | | | |

| Channel | Channel ID | Expected Channel Status | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Not Comm. | Special Inhibit | Trip Multiply | OFF | Bypass | Alarm 2 | Alarm 1 | Not OK |
| Multimode Hydro Velocity | 0x31 | | | x | x | | | | x |
| Multimode Air Gap | 0x32 | | | x | x | | | x | |
| Multimode Hydro RV | 0x33 | | | x | x | | | x | x |
| Multimode Thrust | 0x34 | | | x | x | | x | | |
| Multimode Acceleration | 0x35 | | | x | x | | x | | x |
| Multimode Aero | 0x36 | | | x | x | | x | x | |
| Stator End Winding (SEW) | 0x38 | | | x | x | x | | | |
| RPM | 0xFD | x | x | x | x | x | x | | x |

**Canned Channel Status Data**

| Channel Number | Value | Expected Channel Switches | | | |
|---|---|---|---|---|---|
| | | Bypass | Special Channel Inhibit | Alarm 2 Bypass | Alarm 1 Bypass |
| 1 | 0x01 | | | | x |
| 2 | 0x02 | | | x | |
| 3 | 0x03 | | | x | x |
| 4 | 0x04 | | x | | |
| 5 | 0x05 | | x | | x |
| 6 | 0x06 | | x | x | |
| 7 | 0x07 | | x | x | x |
| 8 | 0x08 | x | | | |
| 9 | 0x09 | x | | | x |
| 10 | 0x0A | x | | x | |
| 11 | 0x0B | x | | x | x |
| 12 | 0x0C | x | x | | |
| 13 | 0x0D | x | x | | x |
| 14 | 0x0E | x | x | x | |
| 15 | 0x0F | x | x | x | x |
| 16 | 0x10 | | | | |

**Canned Channel Switches Data**

| # of PPLs | Status Value | Expected IO-Controller Status |
|---|---|---|
| 1 | 0x0101 | PPL #1 Alert, PPL #1 Danger |
| 2 | 0x0202 | PPL #2 Alert, PPL #2 Danger |
| 3 | 0x0404 | PPL #3 Alert, PPL #3 Danger |
| 4 | 0x0808 | PPL #4 Alert, PPL #4 Danger |
| 5 | 0x1010 | PPL #5 Alert, PPL #5 Danger |
| 6 | 0x2020 | PPL #6 Alert, PPL #6 Danger |
| 7 | 0x4040 | PPL #7 Alert, PPL #7 Danger |
| 8 | 0x8080 | PPL #8 Alert, PPL #8 Danger |

**Canned PPL Status Data**

| Setpoint Types for | | Chan w/PPL of | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Type | Value | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Direct | 0000_0001 | x | | | x | | x | | x |
| Gap | 0000_0002 | x | | | x | | x | | x |
| Amp 1X | 0000_0004 | x | | | x | | | x | x |
| Phase 1X | 0000_0008 | x | | | | x | | x | x |
| Amp 2X | 0000_0010 | | x | | | x | | x | x |
| Phase 2X | 0000_0020 | | x | | | x | | x | x |
| Max Value | 0000_0040 | | x | | | x | | x | x |
| Min Value | 0000_0080 | | x | | | x | | x | x |
| Peak to Peak | 0000_0100 | | x | | | x | | x | x |
| RPM | 0000_0200 | | x | | | x | | x | |
| Prime Spike | 0000_0400 | | x | | | x | | x | |
| Power | 0000_0800 | | x | | | x | | x | |
| Peak Torque | 0000_1000 | | | x | | x | | x | |
| Peak Speed | 0000_2000 | | | x | | x | | x | |
| Peak Power | 0000_4000 | | | x | | x | | x | |
| Seismic | 0000_8000 | | | x | | x | | x | |
| RPM per Min | 0001_0000 | | | x | | x | | x | |
| Composite | 0002_0000 | | | x | | | x | x | |
| Amp NX | 0004_0000 | | | x | | | x | x | |
| Phase NX | 0008_0000 | | | x | | | x | x | |
| Amp Shift Cntrl | 0010_0000 | | | x | | | x | | x |
| Phase Shift Cntrl | 0020_0000 | | | x | | | x | | x |
| Amp not 1X | 0040_0000 | | | | x | | x | | x |
| Amp SMAX | 0080_0000 | | | | x | | x | | x |
| Filtered Velocity | 0100_0000 | | | | x | | x | | x |
| Filtered Disp Pk to Pk | 0200_0000 | | | | x | | x | | x |
| Num Reverse Rotations | 0400_0000 | | | | x | | x | | x |
| Zero Speed | 0800_0000 | | | | x | | x | | x |
| Speed Band | 1000_0000 | | | | x | | x | | x |
| Position | 2000_0000 | | | | x | | x | | x |
| Generic | 4000_0000 | | | | x | | x | | x |

**Canned Setpoint Types Data**

The following steps should be performed for each module channel/data items in the following table.

- Insert the module(s) into the 3500 rack
- Use the Rack Configuration Software to
    - Configure the inserted module to a specific channel
    - Select the PROFINET protocol on the /91 Universal Gateway Card
- Download the configuration
- On the IO-Controller
    - Molex IO-Controller
        - Scan the network for devices.

- Verify that device is detected
- Add the detected device to the Controller's configuration
- Configure the data modules as described in the **Module and Channel Identification** table
- Set the "Canned Data Mode" Parameter
- Connect to the device
- Verify that the connection is successful and that IO-Data is received by the controller
- Verify that the data is as expected for each applicable module in the **Sparse Expected Data** table

| PROFINET Sub-module | 3500/module | Channel | PASS/FAIL |
|---|---|---|---|
| Rack Status | /22 | - | PASS |
| Module Status | 42/42M | - | PASS |
| Module Switches | 42/42M | - | PASS |
| Channel Status | 42/42M | - | PASS |
| Channel Switches | 42/42M | - | PASS |
| 8 PPLs | 42/42M | Radial Vibration | PASS |
| 7 PPLs | 40/40M | REBAM | PASS |
| 6 PPLs | 42/42M | Velocity II | PASS |
| 5 PPLs | 44/44M | Aeroderivative II | PASS |
| 4 PPLs | 42/42M | Shaft Absolute Radial Vibration | PASS |
| 3 PPLs | 44/44M | Aeroderivative | PASS |
| 2 PPLs | 42/42M | Differential Expansion | PASS |
| 1 PPL | 42/42M | Velocity | PASS |
| Set points 8PPL | 42/42M | Radial Vibration | PASS |
| Set points 7PPLs | 40/40M | REBAM | PASS |
| Set points 6PPLs | 42/42M | Velocity II | PASS |
| Set points 5PPLs | 44/44M | Aeroderivative II | PASS |
| Set points 4PPLs | 42/42M | Shaft Absolute Radial Vibration | PASS |
| Set points 3PPLs | 44/44M | Aeroderivative | PASS |
| Set points 2PPLs | 42/42M | Differential Expansion | PASS |
| Set points 1PPL | 42/42M | Velocity | PASS |
| RPM | /25 | Keyphasor | PASS |

**Sparse Expected Data**

| Monitor | Description | Type | Chan # | Data | Pass/Fail |
|---|---|---|---|---|---|
| 25 | Keyphasor Module (Top) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | N/A | 1 | Chan Status | PASS |
| | | N/A | 1 | Chan Switches | PASS |
| | | N/A | 1 | RPM(Top) | PASS |
| | | N/A | 2 | Chan Status | PASS |
| | | N/A | 2 | Chan Switches | PASS |
| | | N/A | 2 | RPM(Top) | PASS |
| 25 | Keyphasor Module (Bottom) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | N/A | 1 | Chan Status | PASS |
| | | N/A | 1 | Chan Switches | PASS |
| | | N/A | 1 | RPM(Botom) | PASS |
| | | N/A | 2 | Chan Status | PASS |
| | | N/A | 2 | Chan Switches | PASS |
| | | N/A | 2 | RPM(Botom) | PASS |
| 25 | Keyphasor Module (Both) | N/A | N/A | Module Status (Top) | PASS |
| | | N/A | N/A | Module Switches (Top) | PASS |
| | | N/A | N/A | Module Status (Bottom) | PASS |
| | | N/A | N/A | Module Switches (Bottom) | PASS |
| | | N/A | 1 | Chan Status | PASS |
| | | N/A | 1 | Chan Switches | PASS |
| | | N/A | 1 | RPM(Top) | PASS |
| | | N/A | 2 | Chan Status | PASS |
| | | N/A | 2 | Chan Switches | PASS |
| | | N/A | 2 | RPM(Top) | PASS |
| | | N/A | 1 | Chan Status | PASS |
| | | N/A | 1 | Chan Switches | PASS |
| | | N/A | 1 | RPM(Botom) | PASS |
| | | N/A | 2 | Chan Status | PASS |
| | | N/A | 2 | Chan Switches | PASS |
| | | N/A | 2 | RPM(Botom) | PASS |
| 32 | Standard Relay Module | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 33 | 16 Channel Relay Module | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 34 | TMR Relay Module (Top) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 34 | TMR Relay Module (Bottom) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 34 | TMR Relay Module (Both) | N/A | N/A | Module Status (Top) | PASS |
| | | N/A | N/A | Module Switches (Top) | PASS |
| | | N/A | N/A | Module Status (Bottom) | PASS |
| | | N/A | N/A | Module Switches (Bottom) | PASS |
| 40/40M | Proximeter Monitor | N/A | N/A | Module Status | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | N/A | N/A | Module Switches | PASS |
| | | Radial Vibration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Radial Vibration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Radial Vibration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Radial Vibration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Eccentricity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Eccentricity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Eccentricity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Eccentricity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Setpoints | PASS |
| | | Thrust Position | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 42/42M | Proximeter/Seismic Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Differential Expansion | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Differential Expansion | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Differential Expansion | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Differential Expansion | 4 | Chan Status | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Velocity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Eccentricity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-4 | PASS |
| | | | | Setpoints-4 | PASS |
| | | Eccentricity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-4 | PASS |
| | | | | Setpoints-4 | PASS |
| | | Eccentricity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-4 | PASS |
| | | | | Setpoints-4 | PASS |
| | | Eccentricity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-4 | PASS |
| | | | | Setpoints-4 | PASS |
| | | Radial Vibration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-8 | PASS |
| | | | | Setpoints-8 | PASS |
| | | Radial Vibration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-8 | PASS |
| | | | | Setpoints-8 | PASS |
| | | Radial Vibration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-8 | PASS |
| | | | | Setpoints-8 | PASS |
| | | Radial Vibration | 4 | Chan Status | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Acceleration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-1 | PASS |
| | | | | Setpoints-1 | PASS |
| | | Acceleration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-1 | PASS |
| | | | | Setpoints-1 | PASS |
| | | Acceleration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-1 | PASS |
| | | | | Setpoints-1 | PASS |
| | | Acceleration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-1 | PASS |
| | | | | Setpoints-1 | PASS |
| | | Thrust Position | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Thrust Position | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Thrust Position | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Thrust Position | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL-2 | PASS |
| | | | | Setpoints-2 | PASS |
| | | Shaft Absolute Radial Vibration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Shaft Absolute Radial Vibration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Shaft Absolute Radial Vibration | 3 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Shaft Absolute Radial Vibration | 4 | Chan Status | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Shaft Absolute Velocity | 1 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Shaft Absolute Velocity | 2 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Shaft Absolute Velocity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Shaft Absolute Velocity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity II | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity II | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity II | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Velocity II | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Circular Acceptance Regions | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Circular Acceptance Regions | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Circular Acceptance Regions | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Circular Acceptance Regions | 4 | Chan Status | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Acceleration II | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Acceleration II | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Acceleration II | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Acceleration II | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | REBAM | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 44/44M | Aeroderivative GT Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Aeroderivative | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Setpoints | PASS |
| | | Aeroderivative | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative II | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative II | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative II | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Aeroderivative II | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Aero | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Aero | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Aero | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Aero | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 45 | Position Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Thrust Position | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 3 | Chan Status | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Thrust Position | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Differential Expansion | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Standard Single Ramp Diff Exp | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Standard Single Ramp Diff Exp | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Standard Single Ramp Diff Exp | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Standard Single Ramp Diff Exp | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Non-Standard Single Ramp Diff Exp | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Non-Standard Single Ramp Diff Exp | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | Non-Standard Single Ramp Diff Exp | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Non-Standard Single Ramp Diff Exp | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dual Ramp Differential Expansion | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dual Ramp Differential Expansion | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dual Ramp Differential Expansion | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dual Ramp Differential Expansion | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Complementary Input Differential | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Complementary Input Differential | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Complementary Input Differential | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Complementary Input Differential | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Case Expansion - Paired | 1 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |

| | | | | | |
|---|---|---|---|---|---|
| | | Case Expansion - Paired | 2 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Case Expansion - Paired | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Case Expansion - Paired | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Case Expansion - Single | 1 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Case Expansion - Single | 2 | Chan Status | N/A |
| | | | | Chan Switches | N/A |
| | | | | PPL | N/A |
| | | | | Setpoints | N/A |
| | | Case Expansion - Single | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Case Expansion - Single | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Valve Position | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Valve Position | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Valve Position | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Valve Position | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 46M | Hydro Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Hydro Radial Vibration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Radial Vibration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Radial Vibration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Radial Vibration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Air Gap | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Air Gap | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Air Gap | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Air Gap | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Velocity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Velocity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Velocity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hydro Velocity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro RV | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro RV | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro RV | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro RV | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Air Gap | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Air Gap | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Air Gap | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Air Gap | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro Velocity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro Velocity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro Velocity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Hydro Velocity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Thrust | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

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|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Thrust | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Thrust | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Thrust | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Acceleration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Acceleration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Acceleration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Multimode Acceleration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Stator End Winding (SEW) | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Stator End Winding (SEW) | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Stator End Winding (SEW) | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Stator End Winding (SEW) | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 50 | Tachometer Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | Rotor Accceleration & Speed | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rotor Accceleration & Speed | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Zero Speed | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Zero Speed | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rotor Speed | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rotor Speed | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Reverse Rotation | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Reverse Rotation | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 53 | Overspeed | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Overspeed | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 60 | Temperature Monitor (w/no Recs) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Temperature | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | Temperature | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 6 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 6 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 61 | Temperature Monitor (w/Recs) | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Temperature | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

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|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature | 6 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 6 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 62 | Process Variable Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Process Variable | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |

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|---|---|---|---|---|---|
| | | Process Variable | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Process Variable | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Process Variable | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Process Variable | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Process Variable | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 63 | Gas Detection Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Gas Detection | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Gas Detection | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Gas Detection | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Gas Detection | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 64M | Dynamic Pressure Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Dynamic Pressure | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dynamic Pressure | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |

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|---|---|---|---|---|---|
| | | Dynamic Pressure | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Dynamic Pressure | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 65 | 16-Channel Temperature Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Temperature (Comp or Diff) | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 5 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 6 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 7 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 8 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 9 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 10 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

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|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 11 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 12 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 13 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 14 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 15 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Temperature (Comp or Diff) | 16 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 70M | Impulse/Velocity Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Impulse Acceleration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Impulse Acceleration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Impulse Acceleration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Impulse Acceleration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Acceleration | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |

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|---|---|---|---|---|---|
| | | Recip Acceleration | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Acceleration | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Acceleration | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Velocity | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Velocity | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Velocity | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Recip Velocity | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 72M | Rod Position Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| | | Rod Position Pair | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Pair | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Pair | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Pair | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Single | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |

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|---|---|---|---|---|---|
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Single | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Single | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Position Single | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hyper | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hyper | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hyper | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Hyper | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Drop | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Drop | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Drop | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Rod Drop | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 77M | Cylinder Pressure Monitor | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |

| | | | | | |
|---|---|---|---|---|---|
| | | Cylinder Pressure | 1 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Cylinder Pressure | 2 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Cylinder Pressure | 3 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| | | Cylinder Pressure | 4 | Chan Status | PASS |
| | | | | Chan Switches | PASS |
| | | | | PPL | PASS |
| | | | | Setpoints | PASS |
| 90 | Communication Gateway | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 91 | Communication Gateway | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 92 | Communication Gateway | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 93 | Display interface Module | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |
| 94 | VGA Display Module | N/A | N/A | Module Status | PASS |
| | | N/A | N/A | Module Switches | PASS |

### 6.1.3 Verify EGD Data Translation

These tests use the Rack Configuration Software to validate the data translation routines in the IO-Device, which are used to populate the PROFINET cyclical IO Data frame.

#### 6.1.3.1 Verify Status and Switches

- Configure the rack with only the TDI, keyphasor and /91 communications cards.
- Reboot the /91 card selecting the PROFINET protocol.
- On the IO-Controller add Module Status, Module Switches, Channel Status, and Channel Switches sub modules to the Keyphasor configuration
- Connect the IO-Controller to the device
- Verify the current sub-module settings

Result: **PASS**

#### 6.1.3.2 Modify Status and Recheck Values

- Using the Rack Configuration Software set a Keyphasor Channel switch to Channel Bypass.

- Observe that “MODULE-STATUS—IN-BYPASS” and “CHANNEL-STATUS—BYPASS” has changed to TRUE

Result: **PASS**

#### 6.1.3.3 Verify Keyphasor

- Configure one Keyphasor Module to have an Upper RPM Limit of 99999.
- Configure the clamp values for each channel to be various values from the low end of the scale to the upper end of the scale.
- Download the confguration
- The /91 will reboot selecting the PROFINET protocol.
- On the IO-Controller add the RPM sub-module to the Keyphasor configuration
- Connect the IO-Controller to the device
- Input a 60000 RPM Keyphasor signal and verify values

Result: **PASS**

#### 6.1.3.4 Verify Keyphasor with the RIM removed

Perform the test in section 6.1.3.3 Verify Keyphasor. Then perform the following

- Remove the RIM and wait for 20-30 seconds. Verify that the Keyphasor RPM values are clamped to the values set in the Rack Configuration Software.

Result: **PASS**

#### 6.1.3.5 Verify Monitor IO Data

- Configure a /42 Proximitor/Seismic Monitor for the first 2 channels to be Radial Vibration.
- Connect a 250 mV p-p sine wave to the inputs. The signal should have a -10 V offset, and the same frequency as the Keyphasor signal.
- Reboot the /91 card selecting the PROFINET protocol.
- On the IO-Controller add all available sub-modules for the /42 channels
- Connect the IO-Controller to the device
- Compare the values displayed in the IO-Controller with those displayed in Rack Configuration Software.

| PPL | Rack Config Values | IO-Controller Values |
|---|---|---|
| Direct | 2.5 | 2.450945 |
| Gap | -14.9 | -14.934932 |

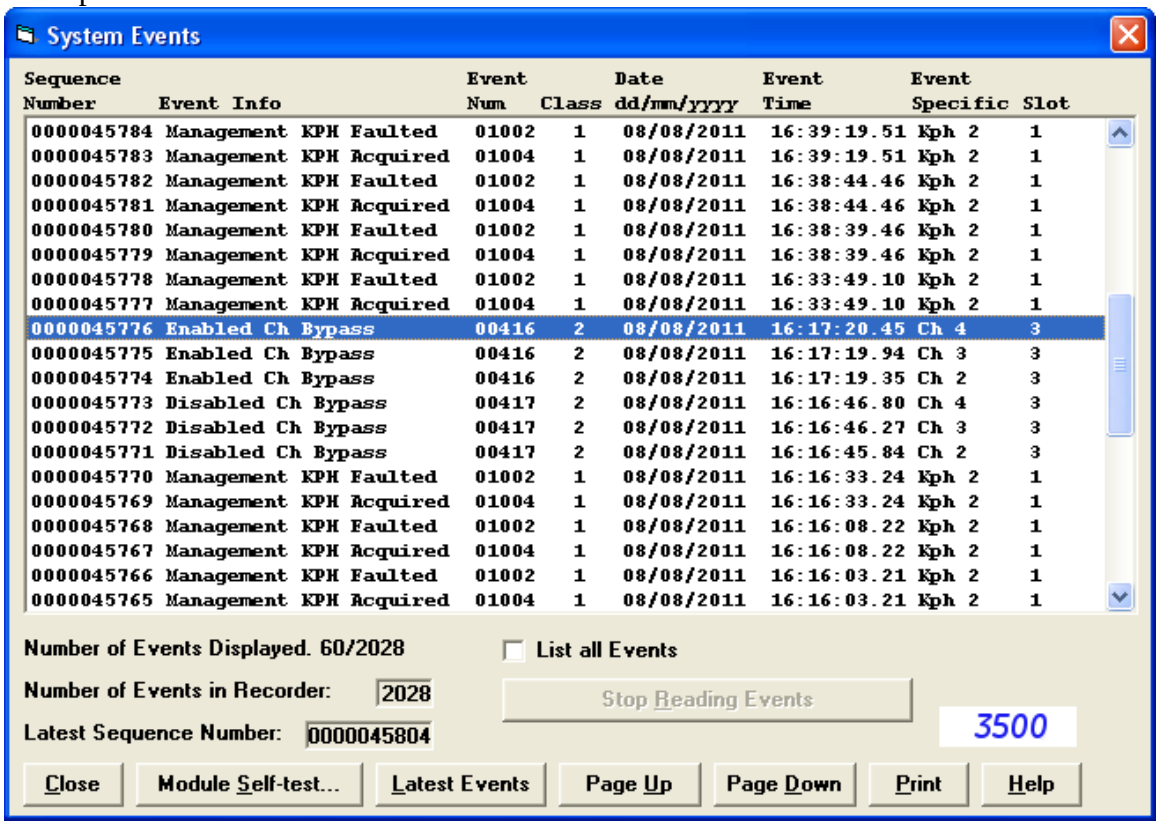
Result: **PASS**

#### 6.1.3.6 Verify System Events are being received

- In the IO-Controller look at the Event Log to see the list of Events that have occurred on the controller. System Events received from the IO-Device should be present.

- Start Wireshark and capture packets.
- Generate some system events
    - For one of the modules in the configuration initiate one or more channel bypass with the channel switches
- Compare the system events displayed in the Rack Configuration Software with those displayed in the Event Log
- Stop Wireshark capture and verify the Event data sent to the controller corresponds with what is present in the Rack Configuration Software

Example:




| Data Field | Data Type | SystemEvent Hex Data from Wireshark | Translated value |
|---|---|---|---|
| Sequence Number | Unsigned 32 | 0000b2d0 | 45776 |
| Source Device | Unsigned8 | 02 | Dev 2 (slot 1) TDI |
| Destination Device | Unsigned8 | 06 | Dev 6 (slot 3) /42M |
| Type/Severity | Bit Field XXYYYYYY<br>X - severity<br>Y - number | 81a0 | X – Typical logged Event<br>Y – 416 Enabled Ch Bypass |
| Course Time | Unsigned16 | 001d | |

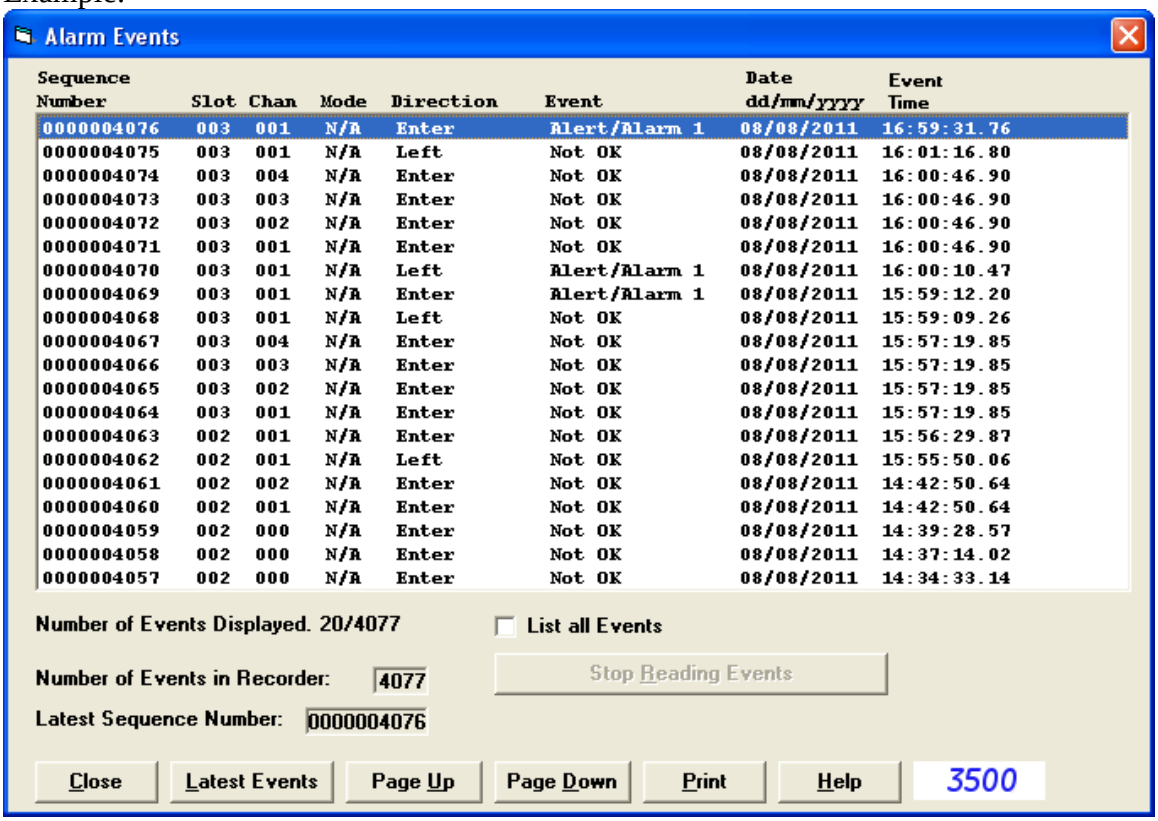
| | | | |
|---|---|---|---|
| FineTime | Unsigned32 | b8b3083a | |
| Data | String | 43 68 20 34 20 20 | Ch 4 |
| Text | String | 45 6e 61 62 6c 65 64 20 43 68 20 42 79 70 61 73 73 20 20 20 20 20 20 20 | Enabled Ch Bypass |

Result: **PASS**

### 6.1.3.7 Verify Alarm Events are being received

- In the IO-Controller look at the Event Log to see the list of Events that have occurred on the controller. Alarm Events received from the IO-Device should be present.
- Start Wireshark and capture packets.
- Generate some Alarm Events by changing voltage inputs to monitor cards
- Compare the Alarm Events displayed in the Rack Configuration software with those displayed in the Event Log.
- Stop Wireshark capture and verify the Event data sent to the controller corresponds with what is present in the Rack Configuration Software

Example:



| Data Field | Data Type | SystemEvent Hex Data from Wireshark | Translated value |
|---|---|---|---|
| Sequence Number | Unsigned 32 | 00000fec | 4076 |
| Device | Unsigned8 | 06 | Dev 6 (slot 3) /42M |
| Channel | Unsigned8 | 00 | Channel 1 |
| Type | Unsigned 8 | 00 | Alert (ALERT_ALARM_TYPE) |
| Direction | Unsigned8 | 00 | Enter Alarm (ENTER_ALARM) |
| Course Time | Unsigned16 | 001d | |
| FineTime | Unsigned32 | b8b7f9e2 | |

Result: **PASS**

### 6.1.4 Verify Redundancy Functionality

This tests in this section will verify that the two /91 Universal Gateway cards will operate in two modes concurrent mode or backup mode.

#### 6.1.4.1 Verify Concurrent operation mode

This is the default operation for multiple /91 Universal Gateway cards in the system.

- Use the PROFINET Engineering tool and the DCP protocol to configure each /91 with a unique IP address, MAC, station ID, etc….
- Add each device to the controller's configuration
- Configure each device to represent the rack configuration
- Connect to each device
- Verify that each device produces the information requested from the rack concurrently

Result: **PASS**

#### 6.1.4.2 Verify backup mode operation

This operation relies on setting the Redundancy mode parameter prior to connecting to the device

- Use the PROFINET Engineering tool and the DCP protocol to configure each /91 with a unique IP address, MAC, station ID, etc….
- Add each device to the controller's configuration
- Configure each device to represent the rack configuration
- Choose one of the /91 modules to be the primary module and the second /91 as a backup module. For the backup module make sure the Redundancy mode parameter is set to "Backup Mode"
- Connect to each device
- Verify that Primary is producing the expected I/O data
- Verify that Backup module is not producing any valid cyclical data
- Pull the /91 module from the rack

- Verify that the Backup module is now producing the same valid data that the Primary was producing.

Result: **PASS**

## 6.2 PLC Interoperability Tests

The tests in this section will verify operation with the PLC and 3500 modules described in section 4.2.3 PLC Interoperability Equipment. The goals of these tests are to make sure that a standard PLC will work with a full rack of modules

Insert modules in the rack as follows:


Using the Rack Configuration S/W, set channels 1-4 for each of the /40's and /42's in the rack to be of type Radial Vibration. When the device starts, it will plug all data types for each module and channel. The following table show that data submodules that will be plugged in by the device:

| Slot | Module | Channel | Data Types |
|---|---|---|---|
| | 1/22 TDI | N/A | N/A |
| | 2/25 Keyphasor (Both) | N/A | Module Status (Top) |
| | | | ModuleSwitches (Top) |
| | | | Channel Status (Top) |
| | | | Channel Switches (Top) |
| | | | Chan 1 RPM (Top) |
| | | | Channel Status (Top) |
| | | | Channel Switches (Top) |

| | | |
|---|---|---|
| | | Chan 2 RPM (Top) |
| | | Module Status (Bottom) |
| | | Module Switches (Bottom) |
| | | Channel Status (Bottom) |
| | | Channel Switches (Bottom) |
| | | Chan 1 RPM (Bottom) |
| | | Channel Status (Bottom) |
| | | Channel Switches (Bottom) |
| | | Chan 2 RPM (Bottom) |
| 3/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | **Chan 4 PPLs (8)** |
| | | Chan 4 Setpoints (8) |
| 4/91 Comm Gateway Module | N/A | Module Status |
| | | Module Switches |
| 5/40M Proximitor Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | **Chan 4 PPLs (8)** |
| | | Chan 4 Setpoints (8) |
| 6/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |

| | | |
|---|---|---|
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | **Chan 4 PPLs (8)** |
| | | Chan 4 Setpoints (8) |
| 7/40M Proximitor Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | **Chan 4 PPLs (8)** |
| | | Chan 4 Setpoints (8) |
| 8/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |

| | | |
|---|---|---|
| | | Chan 4 Setpoints (8) |
| 9/40M Proximitor Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |
| | | Chan 4 Setpoints (8) |
| 10/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |
| | | Chan 4 Setpoints (8) |
| 11/40M Proximitor Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |

| | | |
|---|---|---|
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |
| | | Chan 4 Setpoints (8) |
| 12/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |
| | | Chan 4 Setpoints (8) |
| 13/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |
| | | Chan 2 Setpoints (8) |
| | | Chan 3 Status |
| | | Chan 3 Switches |
| | | **Chan 3 PPLs (8)** |
| | | Chan 3 Setpoints (8) |
| | | Chan 4 Status |
| | | Chan 4 Switches |
| | | Chan 4 PPLs (8) |
| | | Chan 4 Setpoints (8) |
| 14/42M Proximitor Seismic Module | Radial Vibration | Module Status |
| | | Module Switches |
| | | Chan 1 Status |
| | | Chan 1 Switches |
| | | **Chan 1 PPLs (8)** |
| | | Chan 1 Setpoints (8) |
| | | Chan 2 Status |
| | | Chan 2 Switches |
| | | **Chan 2 PPLs (8)** |

| | | |
|---|---|---|
| 15/42M Proximitor Seismic Module | Radial Vibration | Chan 2 Setpoints (8)<br>Chan 3 Status<br>Chan 3 Switches<br>**Chan 3 PPLs (8)**<br>Chan 3 Setpoints (8)<br>Chan 4 Status<br>Chan 4 Switches<br>Chan 4 PPLs (8)<br>Chan 4 Setpoints (8)<br>Module Status<br>Module Switches<br>Chan 1 Status<br>Chan 1 Switches<br>**Chan 1 PPLs (8)**<br>Chan 1 Setpoints (8)<br>Chan 2 Status<br>Chan 2 Switches<br>**Chan 2 PPLs (8)**<br>Chan 2 Setpoints (8)<br>Chan 3 Status<br>Chan 3 Switches<br>**Chan 3 PPLs (8)**<br>Chan 3 Setpoints (8)<br>Chan 4 Status<br>Chan 4 Switches<br>Chan 4 PPLs (8)<br>Chan 4 Setpoints (8) |

Now manually build a configuration on the PLC that fits within the 1440 byte RTC limitation. The configuration should correspond to the rows in the above table marked in **bold**

### 6.2.1 Verify the PLC connects an receives IO Data

This test will make sure that we can feed live inputs to each of the devices and make sure that the expected live data is reported on each of the channels. Connect a 250 mV p-p sine wave to the inputs. The signal should have a -10 V offset, and the same frequency as the Keyphasor signal. See Section 6.2.4 for results.

NOTE: This test was done for the channels that that were in the 1440 byte RTC configuration

### 6.2.2 Verify the PLC receives System Events

From the Rack Configuration software, select a channel on a given device and enable the channel bypass for the channel. This will generate a system event for that device and channel. Verify that a system event is generated for that slot. See Section 6.2.4 for results.

### 6.2.3 Verify the PLC receives Alarm Events

With the live data hooked up to a given device channel, change the input signal voltage to a 450 mV p-p Sine wave and verify that an alarm is generated. See Section 6.2.4 for results.

### 6.2.4 Test Results

This section contains the test results from sections 6.2.1 – 6.2.3

| Slot | Module | Channel | Data Type | Verified | Correctly Generated Alarm | Correctly Generated Event |
|---|---|---|---|---|---|---|
| 2 | /25 Keyphasor (Both) | N/A | Chan 1 RPM (Top) | PASS | N/A | PASS |
| | | | Chan 2 RPM (Top) | PASS | N/A | |
| | | | Chan 1 RPM (Bottom) | PASS | N/A | PASS |
| | | | Chan 2 RPM (Bottom) | PASS | N/A | |
| 3 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | PASS | PASS | |
| 4 | /91 Comm Gateway Module | N/A | Module Status | N/A | N/A | N/A |
| | | | Module Switches | | | |
| 5 | /40M Proximitor Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | PASS | PASS | |
| 6 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | PASS | PASS | |
| 7 | /40M Proximitor Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | PASS | PASS | |
| 8 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 9 | /40M Proximitor Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 10 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 11 | /40M Proximitor Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 12 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | PASS |

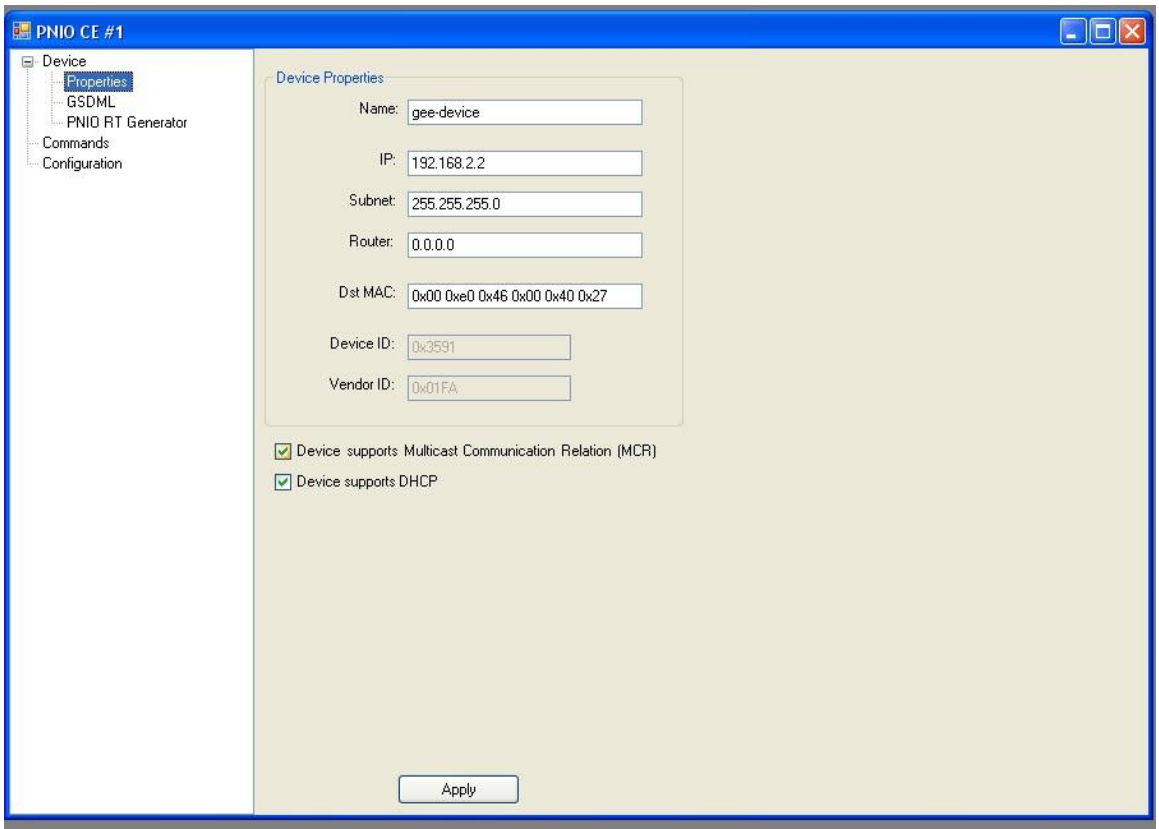
| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Channel 2 | PASS | PASS | |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 13 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | |
| | | | Channel 2 | PASS | PASS | PASS |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 14 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | |
| | | | Channel 2 | PASS | PASS | PASS |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |
| 15 | /42M Proximitor Seismic Module | Radial Vibration | Channel 1 | PASS | PASS | |
| | | | Channel 2 | PASS | PASS | PASS |
| | | | Channel 3 | PASS | PASS | |
| | | | Channel 4 | N/A | N/A | |

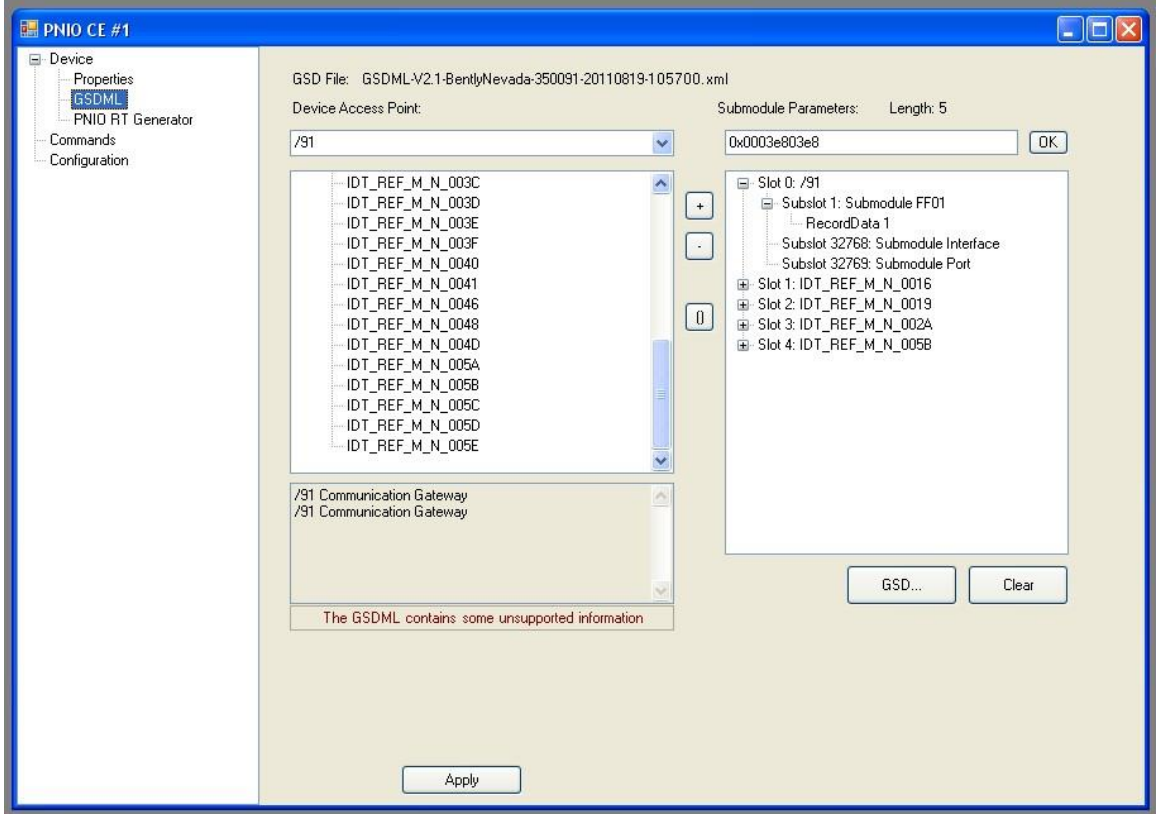
## 6.3 PROFINET Certification Tests

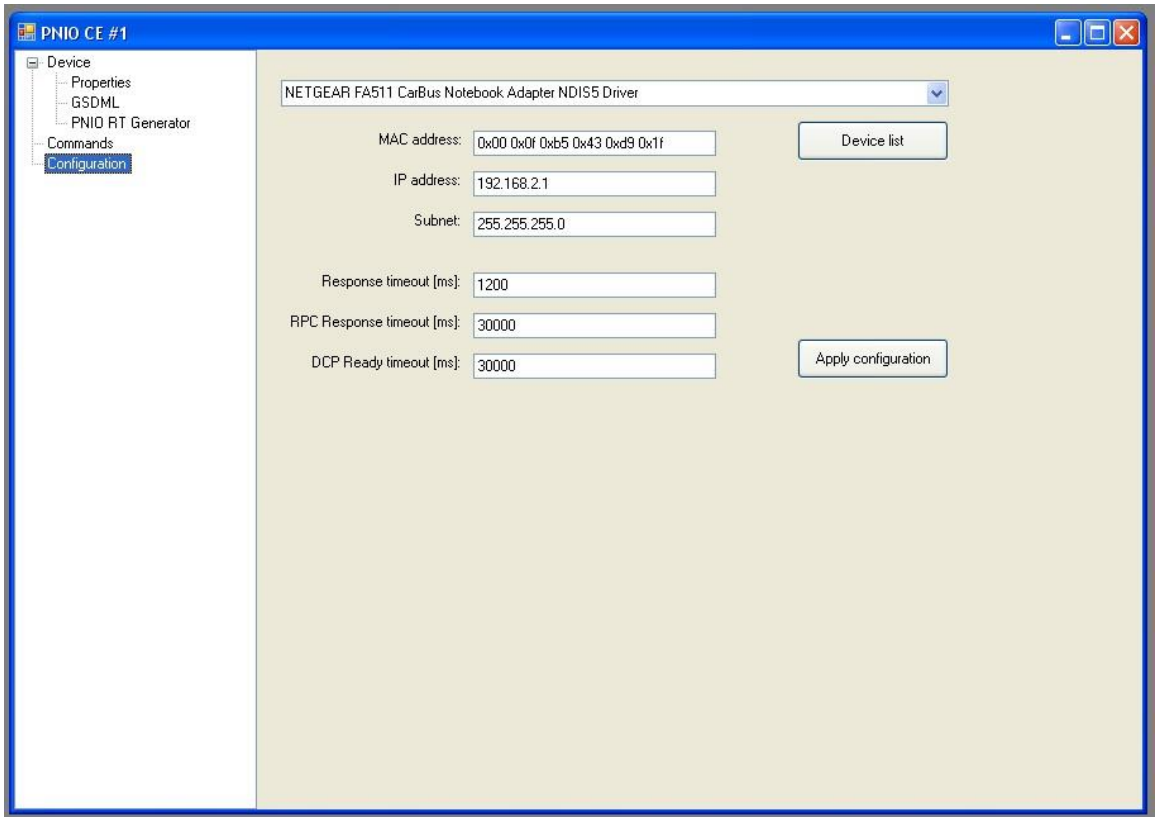
These tests are part of the PN IO Tester software package. The test suite used is PNIO_V2_2_14_18_PUB and is broken down into 7 subsections: Test, Info, Behavior, RM_DCP, Cyclic, Acyclic, and CMDEV.

This test uses the equipment described in Section 4.2.4 PN Tester Equipment.

Follow the instructions provided with the PN Tester to setup the software and Configure the test as show in the following screen shots.


PNIO CE #1
Device
Properties
GSDML
PNIO RT Generator
Commands
Configuration
Device Properties
Name: gee-device
IP: 192.168.2.2
Subnet: 255.255.255.0
Router: 0.0.0.0
Dst MAC: 0x00 0xe0 0x46 0x00 0x40 0x27
Device ID: 0x3591
Vendor ID: 0x01FA
Device supports Multicast Communication Relation (MCR)
Device supports DHCP
Apply


PNIO CE #1
Device
Properties
GSDML
PNIO RT Generator
Commands
Configuration
GSD File: GSDML-V2.1-BentlyNevada-350091-20110819-105700.xml
Device Access Point:
/91
Submodule Parameters: Length: 5
0x0003e803e8
OK
IDT_REF_M_N_003C
IDT_REF_M_N_003D
IDT_REF_M_N_003E
IDT_REF_M_N_003F
IDT_REF_M_N_0040
IDT_REF_M_N_0041
IDT_REF_M_N_0046
IDT_REF_M_N_0048
IDT_REF_M_N_004D
IDT_REF_M_N_005A
IDT_REF_M_N_005B
IDT_REF_M_N_005C
IDT_REF_M_N_005D
IDT_REF_M_N_005E
+
-
[]
Slot 0: /91
Subslot 1: Submodule FF01
RecordData 1
Subslot 32768: Submodule Interface
Subslot 32769: Submodule Port
Slot 1: IDT_REF_M_N_0016
Slot 2: IDT_REF_M_N_0019
Slot 3: IDT_REF_M_N_002A
Slot 4: IDT_REF_M_N_005B
/91 Communication Gateway
/91 Communication Gateway
GSD...
Clear
The GSDML contains some unsupported information
Apply




Each test was run individually. Wireshark traces and test results were captured for each test. In the following sections, the description of each of these tests is provided. This description is pulled directly from the TCL/TK code for each of the tests in the test suite. The results of the test are also shown along with the file names associated with those results. A zip file is provided with all these test results

### 6.3.1 Test

#### 6.3.1.1 __nameipconnparamRTC

- Description: This is a simple test to set the name, ip address, connect to the device, then start the RTC communication.

- Result: **PASS [**see __nameipconn-then__realease.pcap, __nameipconnparamRTC.html**]**

#### 6.3.1.2 __nowait_nameipconnparamRTC

- Description: This is a simple test to set the name, ip address, connect to the device, then start the RTC communication. This test does not have any of the standard delays present. It is a convenience test and not required for passing certification.

- Result: **FAIL**

#### 6.3.1.3 __release

- Description: This sends the release command to the device. It halts RTC communication and ends the connection.

- Result: **PASS [**see __nameipconn-then__realease.pcap, __release.html**]**

### 6.3.2 Info

#### 6.3.2.1 PDEV1

- Description: Tests whether the GSD-File contains SystemDefinedSubSlots and read PDInterfaceDataReal and PDPortDataReal for each Interface and Port and displays for manual checking.

- Result: **INCONCLUSIVE [**see PDEV1.html and PDEV1.pcap**]**. Examining the log file reveals that the values are as expected. This test passes

#### 6.3.2.2 PDEV2

- Description: Read PDDataReal Information and displays it for manual checking.. Within PDDataReal are also to check optional services like MRP, FO.

- Result: **INCONCLUSIVE [**see PDEV2.html and PDEV2.pcap**]**. Examining the log file reveals that the values are as expected. This test passes

#### 6.3.2.3 LLDP

- Description: Test of LLDP support

- Result: **INCONCLUSIVE [**see LLDP.html and LLDP.pcap**]**. Examining the log file does not reveal any problems. This test passes

#### 6.3.2.4 RPC_EPM_TEST

- Description: Test of End Point Mapper Instance for Remote Procedure Call Protocol EPM records are looked up and is searched for a record with Profinet device object description (PN record). The test of the EndPointMapper is part of the RPC testing. Within the standard RPC calls the EndPointMapper shall give an overview about the tested device. The data within the EndPointMapper shall be consistent and shall also be consistent with the data read back with I&M functions. The PNIO-UUID shall be present within the EndPointMapper (EPM) response, the RPC-EPM-UUID may be present.

- Result: **PASS[**see RPC_EPM.pcap and RPC_EPM.html**]**

#### 6.3.2.5 SNMP

- Description: SNMP and MIB-II and LLDP-MIB shall be supported by a device of conformance class B and C. A conformance class A device may support SNMP and the MIBs, but these things are optional for it. The MIBs shall contain the correct information, if supported (see also Table 3 7 -Conformance class behaviors). They are read via SNMP (if supported).Only the following object identifiers "iso(1).org (3).dod(6).internet(1).mgmt(2).mib-2(1).system(1)." sysDescr(1), or sysObjectID(2), or sysUpTime(3), or sysContact(4), or sysName(5), or sysLocation(6), or sysServices(7) are mandatory.

- Result: **FAIL[**see SNMP.pcap and SNMP.html**]**. SNMP is not supported and does not need to be to pass certification

#### 6.3.2.6 LLDP_MIB

- Description: Test of LLDP MIB via SNMP support LLDP MIB shall be exists and MIB records have consistent values. SNMP and MIB-II and LLDP-MIB shall be supported by a device of conformance class B and C. A conformance class A device may support SNMP and the MIBs, but these things are optional for it. The MIBs shall contain the correct information, if supported (see also Table 3 7 - Conformance class behaviors). They are read via SNMP (if supported).

- Result: **FAIL[**see LLDP_MIB.pcap and LLDP_MIB.html**]**. LLDP is not supported and does not need to be to pass certification

#### 6.3.2.7 IM_READ_EXT

- Description: Test of I&M Read function. A read with I&M0FilterData is performed; afterwards also I&M0, I&M1, I&M2, I&M3 and I&M4 shall be read out of the device by "Read_implicit" function. The I&M0 and I&M0FilterData shall be present, all other I&M are checked if present with the entries in the bit field of IM_Supported of I&M0. The meaning of the I&M data is checked according to the description of the device, depending on the tested device itself. The data shall make sense to the device. The testing of the I&M data shall be done according to the following steps. Read the RealIdentificationData of the device and the I&M0FilterData of the device and analyze that data API specific. Com-pare that RealIdentificationData with the I&M0FilterData API specific of all (Sub-)Modules - for all entries in the I&M0FilterData there shall be also an entry in the RealIdentificationData in the same API. For all in I&M0FilterData existing entries of (Sub-)Modules shall be read the I&M0 data with the related API. These (Sub-)Modules shall give back their I&M0 data. Also the further I&M data that are mentioned in I&M0 shall be possible to read and Write in that same API. If the requested API of the (Sub-)Module is not correct or the writing is done to a (Sub-)Module that is not part of the established AR the access may be rejected with an error "INVALID SLOT/SUBSLOT".

- Result: **INCONCLUSIVE [**see IM_READ_EXT.html and IM_READ_EXT.pcap**]**. Examining the log file does not reveal any problems. This test passes

#### 6.3.2.8 IM_WRITE_EXT

- Description: Test of I&M Write function. Write access shall only be possible at I&M1, I&M2, I&M3 and I&M4, if present. When trying to write at I&M0, the device shall react with a negative response to that write (ACCESS DENIED, 0x80B6). The write access shall be done after establishing a connection with the test system to the Device Under Test (DUT) and having data exchange. An access to not existing I&M data blocks (read and/or write) shall be answered by a negative response (INVALID INDEX, 0x80B0). This test is performed only with the used DAP, not with all modules. A module may send back a response to I&M0 where the field BlockLength is set to "0". That indicates that the I&M data of this module are not known (e.g. an old module) to the device. This is acceptable for modules, but not for a DAP. If the module sends back the I&M data, they are also checked. I&M1-4 for SystemDefinedSubmodules if supported shall be defined in GSD as writeable.

- Result: **PASS[**see IM_WRITE_EXT.pcap and IM_WRITE_EXT.html**]**

### 6.3.3 Behavior

#### 6.3.3.1 CONNECT_FULL

- Description: Testing of RPC. The startup of the device is done with different adjustments within the RPC. Once a correct connect is sent with data representation of RPC with byte order "little endian". After the connection is established fully, the data exchange shall work in a proper way. Also a READ.req for I&M0 data of the PROFINET interface is sent with RPC byte order "little endian". The answer of the device shall contain the correct I&M0 data. Then the connection is aborted. Without switching off the device a second startup is done, but this time a correct connect is sent with data representation of RPC with byte order "big endian". After the connection is established fully, the data exchange shall work in a proper way. Also a READ.req for I&M0 data of the PROFINET interface is sent with RPC byte order "big endian". The answer of the device shall contain the correct I&M0 data. The device shall react in the same way without considering the byte order sent by the test system. The AR is shut down again by a RELEASE.req of the test system.

- Expected Result: **PASS[**see CONNECT_FULL.pcap and CONNECT_FULL.html**]**

#### 6.3.3.2 CONNECT_FRAG

- Description: Testing of RPC. A correct segmented CONNECT.req shall be processed correctly. The device and the controller shall be able to establish an AR. DataExchange is working properly. After releasing this AR, a second time a segmented CONNECT.req is sent to the device by the test system. But this time the first segment is sent with data representation "little endian" and the second segment is sent with data representation "big endian". In that case the device may reject the segmented connect, answer with an error and may not establish an AR to the test system. The exact reaction of the device shall be noted in the test records.

- Result: **INCONCLUSIVE [**see CONNECT_FRAG.html and CONNECT_FRAG.pcap**]**. It should be noted that the device does connect for fragments with different endians.

#### 6.3.3.3 IP_UDP

- Description: Testing of IP, UDP. At a running AR the following errors are generated within a READ.req (e.g. with I&M0 or with READ REAL CONFIGURATION):
  - wrong checksum in the IP part of the frame
  - wrong checksum in the UDP part of the frame
  - wrong checksums in IP and in UDP part of the frame
  - data length in the IP part is set too big
  - data length in the UDP part is set to the same value than in IP part
  - data length of the IP part is set too small
  - data length in UDP part is set too small

  The reaction of the device to those errors is to check. The wrong frames shall not be processed and shall be rejected.

- Result: **PASS [**IP_UDP.pcap and IP_UDP.html**]**

#### 6.3.3.4 IOC_READ

- Description: This test case checks the consistency of the data when using different access ways to records of the device and checks also the behavior of the device to some unallowed accesses. The test system opens different ARs and reads different indices of all used slots and subslots according to the following description. The used API set to "0". First a supervisor AR (IOS) is established and the indices mentioned below are read. Afterwards this IOS AR is shut down then a controller AR is established (IOC) and the same indices are read. After closing this IOC AR again a Device Access (DA) AR is opened to the DUT and again the same indices are read. And last via an implicit AR also that indices are read after closing the DA AR. The answers of the marked indices in the list below shall be identical with all ways of read out. In this test case following indices are read within the IOC AR: 0xF80c 0xF820 0xF830 0xF831 0x8000

0x800A 0x800B 0x800C 0x8010 0x8011 0x8012 0x8013 0x8028 0x8029 0xC000 0xC00A 0xC00B 0xC00C 0xC010 0xC011 0xC012 0xC013 0xE000 0xE001 0xE002 0xE00A 0xE00B 0xE00C 0xE010 0xE011 0xE012 0xE013 0xF00A 0xF00B 0xF00C 0xF010 0xF011 0xF012 0xF013 0xF020

- Result: **INCONCLUSIVE [**see IOC_READ.html and IOC_READ.pcap**]**.

#### 6.3.3.5 IMPLICIT_READ

- Description: This test case checks the consistency of the data when using different access ways to records of the device and checks also the behavior of the device to some unallowed accesses. The test system opens different ARs and reads different indices of all used slots and subslots according to the following description. The used API set to "0". First a supervisor AR (IOS) is established and the indices mentioned below are read. Afterwards this IOS AR is shut down then a controller AR is established (IOC) and the same indices are read. After closing this IOC AR again a Device Access (DA) AR is opened to the DUT and again the same indices are read. And last via an implicit AR also that indices are read after closing the DA AR. The answers of the marked indices in the list below shall be identical with all ways of read out. In this test case following indices are implicit read: 0xF80c 0xF820 0xF830 0xF831 0x8000 0x800A 0x800B 0x800C 0x8010 0x8011 0x8012 0x8013 0x8028 0x8029 0xC000 0xC00A 0xC00B 0xC00C 0xC010 0xC011 0xC012 0xC013 0xE000 0xE001 0xE002 0xE00A 0xE00B 0xE00C 0xE010 0xE011 0xE012 0xE013 0xF00A 0xF00B 0xF00C 0xF010 0xF011 0xF012 0xF013 0xF020

- Result: **INCONCLUSIVE [**see IMPLICIT_READ.html and IMPLICIT_READ.pcap**]**.

#### 6.3.3.6 IOS_READ

- Description: This test case checks the consistency of the data when using different access ways to records of the device and checks also the behavior of the device to some unallowed accesses. The test system opens different ARs and reads different indices of all used slots and subslots according to the following description. The used API set to "0". First a supervisor AR (IOS) is established and the indices mentioned below are read. Afterwards this IOS AR is shut down then a controller AR is established (IOC) and the same indices are read. After closing this IOC AR again a Device Access (DA) AR is opened to the DUT and again the same indices are read. And last via an implicit AR also that indices are read after closing the DA AR. The answers of the marked indices in the list below shall be identical with all ways of read out. In this test case following indices are read within the IOS AR: 0xF80c 0xF820 0xF830 0xF831 0x8000 0x800A 0x800B 0x800C 0x8010 0x8011 0x8012 0x8013 0x8028 0x8029 0xC000 0xC00A 0xC00B 0xC00C 0xC010 0xC011 0xC012 0xC013 0xE000

0xE001 0xE002 0xE00A 0xE00B 0xE00C 0xE010 0xE011 0xE012 0xE013 0xF00A 0xF00B 0xF00C 0xF010 0xF011 0xF012 0xF013 0xF020

- Result: **INCONCLUSIVE [**see IOS_READ.html and IOS_READ.pcap**]**.

#### 6.3.3.7 DA_READ

- Description: This test case checks the consistency of the data when using different access ways to records of the device and checks also the behavior of the device to some unallowed accesses. The test system opens different ARs and reads different indices of all used slots and subslots according to the following description. The used API set to "0". First a supervisor AR (IOS) is established and the indices mentioned below are read. Afterwards this IOS AR is shut down then a controller AR is established (IOC) and the same indices are read. After closing this IOC AR again a Device Access (DA) AR is opened to the DUT and again the same indices are read. And last via an implicit AR also that indices are read after closing the DA AR. The answers of the marked indices in the list below shall be identical with all ways of read out. In this test case following indices are read within the IOS Device Access Mode AR: 0xF80c 0xF820 0xF830 0xF831 0x8000 0x800A 0x800B 0x800C 0x8010 0x8011 0x8012 0x8013 0x8028 0x8029 0xC000 0xC00A 0xC00B 0xC00C 0xC010 0xC011 0xC012 0xC013 0xE000 0xE001 0xE002 0xE00A 0xE00B 0xE00C 0xE010 0xE011 0xE012 0xE013 0xF00A 0xF00B 0xF00C 0xF010 0xF011 0xF012 0xF013 0xF020

- Result: **INCONCLUSIVE [**see DA_READ.html and DA_READ.pcap**]**

#### 6.3.3.8 IDENTICAL_RECORDS

- Description: This test case checks the consistency of the data when using different access ways to records of the device and checks also the behavior of the device to some unallowed accesses. The test system opens different ARs and reads different indices of all used slots and subslots according to the following description. The used API set to "0". First a supervisor AR (IOS) is established and the indices mentioned below are read. Afterwards this IOS AR is shut down then a controller AR is established (IOC) and the same indices are read. After closing this IOC AR again a Device Access (DA) AR is opened to the DUT and again the same indices are read. And last via an implicit AR also that indices are read after closing the DA AR. The answers of the marked indices in the list below shall be identical with all ways of read out. In this test case are read following indices: 0xF821 0xF840 0x8001 0x801E 0x802A 0xAFF0 0xAFF1 0xAFF2 0xAFF3 0xAFF4 0xC001 0xF000. For this indices records have to be identical in all ways of read out.

- Additional Details: Respond with 'Yes' when prompted if IOS Supervisor supported. Respond with 'Yes' when prompted if IOS Device Access supported.

- Result: **PASS [**IDENTICAL_RECORDS.pcap and IDENTICAL_RECORDS.html**]**

#### 6.3.3.9 WRONG_ACCESS

- Description: Check of wrong access to RPC write and control. In the second part of this test case send a WRITE and afterwards a CONTROL frame via an Implicit_AR. The device shall answer with an ERROR to that frames and ignore that frames.

- Result: **PASS [**WRONG_ACCESS.pcap and WRONG_ACCESS.html**]**

#### 6.3.3.10 VLAN

- Description: This test case checks the correct behavior of the IP stack regarding VLAN TAG. The test system shall connect to the device and do data exchange one time using the described VLAN TAG and after that it shall do this a second time without using VLAN TAGs. In both tests the device shall do correct data exchange and work properly.

- Result: **PASS [**VLAN.pcap and VLAN.html**]**

#### 6.3.3.11 ROUTER_ADDR

- Description: Check of ROUTER_ADDR. The tests with setting IP addresses shall be performed with the following possibilities of the router addresses:
  - own IP (this shall work well)
  - 0.0.0.0 (this shall work well)
  - another valid address (this shall work well)
  - an invalid address (the DCP_SET shall be refused)

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**ROUTER_ADDR.pcap and ROUTER_ADDR.html**]**

#### 6.3.3.12 STATEFLAGS1

- Description: This test case checks the flags "Primary" and "Backup" of the ARProperties.State within the ARBlockReq of a Connect and the DataStatus.State within the APDU_Status of an IOCR. If an "IOCAR single" or an "IOSAR" is tried to establish within the ARBlockReq of a Connect.req and the ARProperties.State is set to "Backup" then the Connect.req shall be answered by an Error. (Faulty ARBlock.req, parameter value 9: "0xdb, 0x81, 0x01, 9"). Establish a connection with ARType "IOCAR_IODeviceRedundant" and

ARProperties.State "Backup" and send data telegrams with DataStatusFlag "Backup". This is the analogue test case to TC_CPM2 but with "Backup" data state. The connection will not be closed (like in CPM2 transitions #32 and #9) and the only further difference is the transition #28 is exchanged by transition #27.

- Additional Details: Respond with 'No' when prompted if IOCAR_IODeviceRedundant supported.

- Result: **PASS [**STATEFLAGS1.pcap and STATEFLAGS1.html**]**

#### 6.3.3.13 RESERVEDBITS

- Description: Test of BlockHeader and Parts marked as reserved. Within the connect.req of the test system to the device the Version Np. of the blocks are varied: There should be registered Version-No. high = 1 and low = 0. A modification of the Version high to "2" shall be refused by the device. A modification of the Version low-part to "2" shall be refused by the device. In all block headers of the blocks contained in the connect.req first the BlockVersionHigh is set to "1" and the BlockVersionLow is set to "2". With this modification of the connect.req the device shall reject this request and answer with error ErrorCode2=3. Afterwards in a new start up the BlockVersionHigh is set to "2" and the BlockVersionLow is set to "0" in the AR block only. All other blocks of the connect.req are set to the correct version. In that case the device has to reject the connect.req by answering with error.

- Result: **PASS [**RESERVEDBITS.pcap and RESERVEDBITS.html**]**

#### 6.3.3.14 RESTERVEDBITS_RTC

- Description: It shall be tested, that some data parts mentioned as "reserved" are not checked by the device. This is done by some tests with setting some reserved marked bits within the IOxS (bit 1 to 4). The device shall ignore those reserved bits and send them back with value "0". Also tested in this way are the bits marked as "reserved" within the DataStatus (bit 1 and bit 3). There also the device shall ignore that "reserved" marked bits and send them back with value "0".

- Result: **PASS [**RESERVEDBITS_RTC.pcap and RESERVEDBITS_RTC.html**]**

#### 6.3.3.15 CCONTROL_TIMEOUT

- Description: This test case tests the correct behavior of a timeout CControl. The system is started up with the normal startup frames but after the CONNECT and - if needed - all the parameters are written and a correct PARAMETER_END (DControl) is signaled, no answer of the test system is sent to the

"APPLICATION_READY" of the device (CControl). After the timer expires (RPC timeout) the device sends an ERROR (Abort of the connection) and stops cyclical communication. The state transitions of CMDEV are #1, #2, #8, #15, #19, #20, (starts CMI_Timeout), #22 (stops Timer and activates CPM), #37, #43, #23, #43, #25, #56, #73, after that the RM indicates a negative response via RMPM state transition #51, #52, from RPC that is followed by the CMDEV state transitions: #98, #132, #135, #136, #137, #139 (or equivalent).

- Result: **PASS [**CCONTROL_TIMEOUT.pcap and CCONTROL_TIMEOUT.html**]**

#### 6.3.3.16 DHt_STARTING

- Description: This test case tests the timeout immediately after sending the first Parameter_Write (then the DH timer shall be started). A startup is done with the normal startup frames but the test system stops sending frames after the first PARAMETER_WRITE. When expiring the DH timer the device sends an ERROR (Abort of the connection) and stops cyclic communication. The state transitions of CMDEV are #1, #2, #8, #15, #19, #20, (starts CMI_Timeout), #22 (stops Timer and activates CPM), #37, #43 (or equivalent), here the CPM state transitions with the timeout create the further transitions: #32, #132, #135, #136, #137, #139. The state transitions of CPM are #1, #24, #34, (#24 and #34 may occure more than once), #34, #34, #31, then after the second part of CMDEV state transitions #9.

- Result: **PASS [**DHt_STARTING.pcap and DHt_STARTING.html**]**

#### 6.3.3.17 REPEAT_FRAMES

- Description: This test case uses the repeat of RPC_Read and RPC_Write to simulate a problem on the receiver or line. First normal startup is done, so that there is a running system in data exchange. Then a RPC_Read is repeated once. The device sends back the same data in the second READ.res as in the first READ.res. Afterwards a RPC_Write is repeated in the same way. The device shall accept that and run without problems.

- Result: **INCONCLUSIVE [**see REPEAT_FRAMES.html and REPEAT_FRAMES.pcap**]** Based on the bus monitor output this test passes.

#### 6.3.3.18 STRUCT_DATA

- Description: This test case checks consistency of the data between IOCR input/output and expected sub modules and the reaction of the device to failures and inconsistencies. Test if 1 element is mentioned 2 times in different ways, and also test if 1 sub module is mentioned 2 times in the same way. The expected reaction to that failure is an Error with definition of the wrong block and

parameter of the connect.req. For the element mentioned two times in the same way, it would also possible to accept that request and the device may go to data exchange. In the following the tests are done with an input data length of 1440 octets and an output data length of 1440 octets. This data length of 1440 octets for the IO CR is mandatory according to the profile description of PROFINET IO. ICR/OCR: the pointers to data within the telegram are manipulated in the way, that

- Elements are moved to the end of the data telegram (still o.k.)
- Elements would exceed the telegram end (faulty)
- Gaps within the telegram arise (still o.k.)
- Data elements overlap (faulty)
- The smallest possible data length and the highest possible data length is tested
- The maximum number of modules/sub modules is tested
- The maximum cycle time is tested as well as the maximum factor for ReductionRatio (DataExchangeBroadcast).

The tests marked with "faulty" shall return an Error that defines the faulty block and parameter. All other tests shall bring the device to data exchange with the test system without errors.

- Result: **PASS [**STRUCT_DATA.pcap and STRUCT_DATA.html**]**

#### 6.3.3.19 FSU_TEST

- Description: Testing of FastStartUp (FSU). FSU data are written to a FSU device in the first startup phase and read back again in data exchange phase. At a following startup of the device the "Hello.req" shall be sent by the device according to the written parameters. The correct timing, retry and the correct content of the "Hello.req" shall be checked.

- Result: **INCONCLUSIVE [**see FSU_TEST.html and FSU_TEST.pcap**]** Fast Start-up not supported

#### 6.3.3.20 MULTIPLE_WRITE

- Description: Testing of MultipleWrite. If in the GSDML file the element "MultipleWriteSupp" is set, the parameters of the device are also sent to the device by using one MultipleWrite request (Index 0xE040) instead of some single Write requests. The device shall startup correctly and enter state DataExchange. The reaction to a Read request with Index 0xE040 shall be a negative response (0xDE 0x80 0xB0 or 0xDE 0x80 0xB8). This test case is only run, if the device supports MultipleWrite.

- Result: **INCONCLUSIVE [**see MULTIPLE_WRITE.html and MULTIPLE_WRITE.pcap**]** MultipleWriteSup not present in GSD.

#### 6.3.3.21 DCPUCx

- Description: Additional testing of the State Machines DCPUCx. DCPUCS state machine in controller for sending DCP_GET and/or DCP_SET. DCPUCR state machine for responding to DCP_GET and/or DCP_SET, also in devices. The reaction to a DCP_SET.req and DCP_GET.req is tested in the RM test cases and the interoperability test and so the relevant state transitions of DCPUCR are tested already there implicit. The relevant state transitions are for DCP_GET #3 followed by #9 and for DCP_SET #4 followed by #10. State transition #11 could be tested by sending a second DCP_SET.req or a DCP_GET.req before the first req is proceeded by the device. The device has to ignore this second req. Maybe this is not always possible to test. All other transitions are internal and not possible to test. A request from another station within the Client Hold Time (=3s) shall be ignored by the device.

- Result: **INCONCLUSIVE [**see DCPUCx.html and DCPUCx.pcap**]**. The bus monitor trace shows the device responded as expected. This test passes

### 6.3.4 RM_DCP

#### 6.3.4.1 RM1

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Startup of the device with setting of name and IP_parameters by means of DCP and establishing the connection with parameter write. Also tested is the read back of the Name and IP_parameters written to the device. Precondition is a new power up of the device without DHCP enabled and without Name and IP stored in the device.If the device has stored a name and/or an IP address, these things shall be deleted by setting "Factory Reset" by DCP means before executing this test case.

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM1.pcap and RM1.html**]**

#### 6.3.4.2 RM2

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Startup of the device with setting of name and IP_parameters by means of DCP and establishing the connection. A RPC_call RELEASE shall be rejected when no connection is established. Also tested is the read back of the Name and IP_parameters written to the device. Precondition is a new power up of the device without DHCP enabled and without Name and IP stored in the device. If the device has stored a name and/or an IP address, these things shall be deleted by setting "Factory Reset" by DCP means before executing this test case. It is to

check that the FactoryReset is executed (before the next "Power-On" is done to execute the test case).

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM2.pcap and RM2.html**]**

#### 6.3.4.3 RM3

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Startup of the device with setting of name and IP_parameters by means of DCP and establishing the connection. A RPC_call RELEASE shall be rejected when no connection is established. Also tested is the read back of the Name and IP_parameters written to the device. Precondition is a new power up of the device without DHCP enabled and device shall have a name, but no IP address set yet. If the device has stored an IP address, this address shall be deleted by setting "Factory Reset" by DCP means before executing this test case afterwards set the name by DCP means permanent.

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM3.pcap and RM3.html**]**

#### 6.3.4.4 RM4

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Startup of the device without setting of name and IP_parameters; these things shall be stored in the device already. A RPC_Read at first shall be rejected. Precondition is a new power up of the device with Name and IP stored in the device. If no name and/or IP address is stored in the device, both shall be set permanently by DCP means before executing this test case.

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM4.pcap and RM4.html**]**

#### 6.3.4.5 RM5

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). The device has got name and IP address and is running in state data exchange with a standard controller (running AR). The test system sends a DCP_SET_NAME command to the device with a name length of "0" to delete the existing name. The expected reaction of the device is to leave state data

exchange with the standard controller and to delete its name. Tested is here the state transistion #41 of the state machine RMPM. Afterwards a DCP_Identify with selector "ALL" is responded by the device, showing no name. After a DCP_SET_NAME with the projected name, the standard controller takes control of the device again and brings it to state data exchange again.

- Additional Details: When prompted to connect with a standard IO-Controller, use the Molex Engineering tool to scan the network and locate the device. Then use the resulting configuration and connect to the device. Once the RTC data exchange starts the icon on the Engineering workstation will turn green. Click "Yes" in the tester once the icon is green and notice that it turns red indicating that it has left the connection. When prompted " Click "Yes" that the controller has left the connection. Notice that the icon again turns green. Click "Yes" that the controller has re-established the connection. Once the test is completed disconnect the Molex tool from the device.

- Result: **PASS [**RM5.pcap and RM5.html**]**

#### 6.3.4.6 RM61

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine) The device is only run with the test system. The test system sends a DCP_SET_NAME with a correct name and the BlockQualifier is set to "save the value permanent". Afterwards the test system sends a DCP_SET_IP with correct IP address, correct subnet mask and correct router information and the BlockQualifier is set to "save the value permanent". The device reacts correctly to a "ping" sent from the test system to its IP address and also responds with its name and IP to a DCP_IDENTIFY_ALL sent from the test system. After that a new IP address is set to the device by means of DCP_SET_IP and the BlockQualifier is set to "use IP temporary". The device reacts correctly to a "ping" sent from the test system to its new IP address and also responds with its name and IP to a DCP_IDENTIFY_ALL sent from the test system. Then the device is powered off and on again. A "ping" sent from the test system to the IP address that was set temporary and also a "ping" sent from the test system to the IP address that was stored in the beginning is not responded. A DCP_IDENTIFY_ALL from the test system is responded by the device with its name and the IP parameter (IP address, subnet mask, router address) set to "0.0.0.0".

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM61.pcap and RM61.html**]**

#### 6.3.4.7 RM62

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Test RM61 is done a second time by using the same IP parameter for the

DCP_SET_IP with BlockQualifier "use IP temporary" as for the stored parameter before.

- Additional Details: When prompted to reboot, remove and re-insert the /91 or type reboot() from the target shell if a terminal session is connected.

- Result: **PASS [**RM62.pcap and RM62.html**]**

#### 6.3.4.8 RM63

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). Afterwards correct device name and IP parameters are set permanently. Also I&M1 to I&M4, if supported, are set to correct values. After a DCP_SET command "RESET_TO_FACTORYSETTINGS" the device shall answer to DCP_IDENTIFY_ALL with a name length of "0", the IP parameter shall be set to "0.0.0.0" and when reading the supported I&M data of I&M1 to I&M4 they shall be reset.

- Result: **PASS [**RM63.pcap and RM63.html**]**

#### 6.3.4.9 RM8

- Description: Test of State machine RMPM (ResourceManagerProtocolMachine). The maximum and the minimum length of the name shall be checked with DCP. First a DCP_SET_NAME with a name "z" is sent to the device. The device has to accept it and set the name to "z" and run with that name. A DCP_IDENTIFY_ALL is answered by the device with the set name and its correct set IP parameters. Afterwards a name with 63 signs "a" to "z" and "-" and "0" to "9" is tested the same way. The device name for example may be set to: "abcdefghijklmnopqrstuvwxyz-abcdefghijklmnopqrstuvwxyz1234567890". Afterwards a name is tested with 63 signs and "." and another 55 signs and "." and another 56 signs and "." and another 63 signs (total 240 signs). The device has to accept that name and run in a proper way with that name.

- Result: **PASS [**RM8.pcap and RM8.html**]**

### 6.3.5 Cyclical

#### 6.3.5.1 PPM1

- Description: Test of State machine PPM (ProducerProtocolMachine). Test of sending new Input data and new Provider_Status. Precondition is that the device started and a connection is established.

- Additional Details: When prompted with if the device can change inputs, respond with “Yes”. When prompted with can the device trigger an alarm, respond with

"Yes". To change inputs, you need to use the backdoor from the target shell by setting **rs_bitmask = 1**, and **rs_bitmask = 0,** and wait approximately 15 seconds. To trigger an alarm, turning the TDI key.

- Result: **PASS [**PPM1.pcap and PPM1.html**]**

#### 6.3.5.2 CPM1

- Description: Test of State machine CPM (ConsumerProtocolMachine). New and valid data are sent to the device first for four times (cycle counter increases); afterwards older data (cycle counter decreases) are sent to the device. As long as the cycle counter increases, the data are sent to the application (and can be checked at the outputs of the device, if possible). When the cycle counter decreases, these output data are not sent to the application, so the outputs don't change. After the DataHoldTimer and the WatchdogTimer expires the connection will be closed. Precondition is that the device is started and the connection is established and the Timers are activated.

- Result: **PASS [**CPM1.pcap and CPM1.html**]**

#### 6.3.5.3 CPM2

- Description: Test of State machine CPM (ConsumerProtocolMachine). New data (increasing cycle counter) are sent to the device that have no valid data status. Then the default values are sent to the application. The WatchdogTimer is triggered but the DataHoldTimer expires and the connection will be closed. Precondition is that the device is started and the connection is established and the Timers are activated.

- Result: **PASS [**CPM2.pcap and CPM2.html**]**

### 6.3.6 Acyclical

#### 6.3.6.1 ALPMI1-APMS1

- Description: Test of Alarm-State machine ALPMI (AlarmProtocolMachinelitiator). The correct startup of the AlarmProtocolMachinelnitiator (runs with the startup) of CMDEV under condition that a correct Connect with Alarms activated is received) and the correct shutdown of it - by sending a Release (ControlCommand Release) - is tested.

- Result: **PASS [**ALPMI1-APMS1.pcap and ALPMI1-APMS1.html**]**

#### 6.3.6.2 ALPMI2

- Description: Test of Alarm-State machine ALPMI (AlarmProtocolMachinelitiator). Precondition is the correct startup of the Alarm-SM. An Alarm is triggered and acknowledged, afterwards two alarms are triggered, but only the first of the alarms is sent. When the sent Alarm is acknowledged, a triggered alarm is sent. A wrong "Ack" - here a telegram with Alarm_Ack Frame ID but read_data - indicates an Error to the User; the following correct Alarm_Ack is ignored. A further triggered alarm is sent on the bus again. To stop the test, a Release (ControlCommand Release) is sent by the test system.

- Additional Details: When prompted “Outputs set to '1'” respond with “Yes”. Turn the TDI key - for each alarm.

- Result: **PASS [**ALPMI2.pcap and ALPMI2.html**]**

#### 6.3.6.3 ALPMR1

- Description: Test of Alarm-State machine ALPMR (AlarmProtocolMachineResponder). The correct startup of the AlarmProtocolMachineResponder (runs with the startup of CMDEV under condition that a correct Connect with Alarms activated is received) and the correct shutdown of it - by sending a Release (ControlCommand Release) - is tested.

- Result: **PASS [**ALPMR1.pcap and ALPMR1.html**]**

#### 6.3.6.4 ALPMR2

- Description: Test of Alarm-State machine ALPMR (AlarmProtocolMachineResponder). Precondition is the correct startup of the Alarm-SM. A "Read" is sent by the test system with an Alarm_FrameID. The User gets an Error_Indication. This part of the test is stopped by a Release (ControlCommand Release).

- Result: **PASS [**ALPMR2.pcap and ALPMR2.html**]**

#### 6.3.6.5 ALPMR3

- Description: Test of Alarm-State machine ALPMR (AlarmProtocolMachineResponder). Precondition is the correct startup of the Alarm-SM. An Alarm is sent to the device and immediately after that a second Alarm is sent to the device. An Alarm-ACK to the fist Alarm is seen on the bus, the second Alarm is ignored. After that a sent alarm is acknowledged by the device again. This part of the test is stopped by a Release (ControlCommand Release).

- Result: **PASS [**ALPMR3.pcap and ALPMR3.html**]**

#### 6.3.6.6 ALPMR4

- Description: Test of Alarm-State machine ALPMR (AlarmProtocolMachineResponder). Precondition is the correct startup of the Alarm-SM. If the device can trigger an Alarm_Ack by the User, this is tested; if no Alarm to that Ack was received before, the Ack shall not be sent on the bus and the User gets back a .cnf(-). This part of the test is stopped by a Release (ControlCommand Release).

- Additional Details: When prompted if there is an acknowledge button, respond with "No"

- Result: **PASS [**ALPMR4.pcap and ALPMR4.html**]**

#### 6.3.6.7 APMR1

- Description: Test of Alarm-State machine APMR (AcyclicProtocolMachineReceiver). The correct startup of the AcyclicProtocolMachineReceiver (runs with the startup of CMDEV/ALPMR/ALPMS under condition that a correct Connect with Alarms activated is received) and the correct shutdown of it - by sending a Release (ControlCommand Release) - is tested.

- Result: **PASS [**APMR1.pcap and APMR1.html**]**

#### 6.3.6.8 APMR2

- Description: Test of Alarm-State machine APMR (AcyclicProtocolMachineReceiver). Precondition is the correct startup of the Alarm-SM. A correct Alarm (with Start SendSeqNum=0xffff) is received and immediately after that the connection is closed by a Release (ControlCommand Release).

- Result: **PASS [**APMR2.pcap and APMR2.html**]**

#### 6.3.6.9 APMR3

- Description: Test of Alarm-State machine APMR (AcyclicProtocolMachineReceiver). Precondition is the correct startup of the Alarm-SM. If the User can trigger immediate Resp_Ack, the User gets back a .cnf(-), if no Alarm was received before; the Ack is not sent on the bus. To a correct Alarm, an immediate_response is sent. To a repeated Alarm, the Ack is also repeated. Afterwards a new Alarm is sent by the test system that is

acknowledged correct by the device. An Alarm with wrong SendSeqNum is responded with a "NACK". A following Alarm with correct SendSeqNum is acknowledged correct again. A telegram that is not of type "Data" is ignored. A following Alarm with correct SendSeqNum is acknowledged correct again. This part of the test is stopped by a Release (ControlCommand Release).

- Additional Details: When prompted if there is an acknowledge button, respond with “No”

- Result: **PASS [**APMR3.pcap and APMR3.html**]**

#### 6.3.6.10 APMS2

- Description: Test of Alarm-State machine APMS (AcyclicProtocolMachineSender). Precondition is the correct startup of the Alarm-SM. An Alarm is triggered; the Alarm can be seen on the bus; the SendSeqNum is checked. This part of the test is stopped by a Release (ControlCommand Release).

- Result: **PASS [**APMS2.pcap and APMS2.html**]**

#### 6.3.6.11 APMS3

- Description: Test of Alarm-State machine APMS (AcyclicProtocolMachineSender). Precondtion is the correct startup of the Alarm_SM. First there is tested that ACK and NACK of the last Alarm is ignored; afterwards ACK and NACK of SeqNum that are incorrect are tested, so Error.ind and with NACK at incorrect SeqNum also an Error PDU shall be sent on the bus. Then an Alarm is triggered and the Time_out expires; here the Alarm shall be repeated for "M_Retry" times and if not acknowledged until then the User gets an Error. An Alarm that is triggered is sent on the bus and the Ack from the test system enables the device for sending another Alarm. If this Alarm is not acknowledged, no new Alarm can be sent. Only an Alarm_Ack enables the device for sending a new Alarm. If there is sent ACK and/or NACK with the SeqNum of the Alarm before the last sent, when waiting for an Alarm_Ack, these telegrams are ignored; ACK and/or NACK with incorrect SeqNum is handled the same as when not waiting for an Alarm_Ack. After these tests the correct function is tested with a new Alarm and correct Alarm_Ack. This part of the test is stopped by a Release (ControlCommand Release). In this version of APMS3 more as one alarm can be triggered at each step.

- Additional Details: When prompted “Outputs set to '1'” respond with “Yes”. Turn the TDI key - for each alarm and for last alarm select 'OK prior to sending

- Result: **PASS [**ALPMS3.pcap and ALPMS3.html**]**

#### 6.3.6.12 ALARMNUM_CHECK

- Description: Test of Alarm-State machine APMS (AcyclicProtocolMachineSender). Number of alarm retries have to be checked.

- Additional Details: Turn the key on the TDI to trigger an alarm

- Result: **PASS [**ALARMNUM_CHECK.pcap and ALARMNUM_CHECK.html**]**

### 6.3.7 CMDEV

#### 6.3.7.1 CMDEV1

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). First a wrong connect is sent to the device; that is rejected. Second a connect is sent to the device with Muticast_communtication enabled and with more resources needed than available; that is also rejected by the device. Then a correct Unicast_communication is established but no further communication is done, so a timeout occurs and the connection is shut down by the device again.

- Result: **PASS [**CMDEV1.pcap and CMDEV1.html**]**

#### 6.3.7.2 CMDEV4

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). An Unicast_communication is tried to be established and the same connection is tried to be established a second time immediately. The connection is shut down again by the device.

- Result: **PASS [**CMDEV4.pcap and CMDEV4.html**]**

#### 6.3.7.3 CMDEV5

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). An Unicast_communication is tried to be established and the same connection is tried to be established after getting back the confirmation of the first connect. The connection is shut down again by the device.

- Result: **PASS [**CMDEV5.pcap and CMDEV5.html**]**

#### 6.3.7.4 CMDEV6

- Description: Test of State machine CMDEV (ContextManager of the DEVICE) Startup and connect with Unicast_communication but wrong DControl (wrong ParameterEnd). The connection is shut down by the device.

- Result: **PASS [**CMDEV6.pcap and CMDEV6.html**]**

#### 6.3.7.5 CMDEV7

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). Startup and connect with Unicast_communication but wrong DControl (wrong ParameterEnd) and additional Write (Parameter_Write) in the startup phase. The connection is shut down by the device.

- Result: **PASS [**CMDEV7.pcap and CMDEV7.html**]**

#### 6.3.7.6 CMDEV8a

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). Correct Startup of the connection with Parameter_Write and the correct ParameterEnd. A Write between ParameterEnd of the controller and ApplicationReady of the device is rejected. A Read between ParameterEnd of the controller and ApplicationReady of the device is handled correctly. A Write and also a Read after the device's signaling ApplicationReady is handled correctly. A Release (ControlCommand Release) sent by the controller shuts down the connection.

- Result: **INCONCLUSIVE [**CMDEV8a.pcap and CMDEV8a.html**]** The bus monitor trace confirms the expected operation.

#### 6.3.7.7 CMDEV8b

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). Correct Startup of the connection with Parameter_Write and the correct ParameterEnd. A Write between ParameterEnd of the controller and ApplicationReady of the device is rejected. A Read between ParameterEnd of the controller and ApplicationReady of the device is handled correctly. A Write and also a Read after the device's signaling ApplicationReady is handled correctly. A Release (ControlCommand Release) sent by the controller shuts down the connection.

- Result: **INCONCLUSIVE [**CMDEV8b.pcap and CMDEV8b.html**]** The bus monitor trace confirms the expected operation.

#### 6.3.7.8 CMDEV8c

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). Correct Startup of the connection with Parameter_Write and the correct ParameterEnd. A Write between ParameterEnd of the controller and ApplicationReady of the device is rejected. A Read between ParameterEnd of the controller and ApplicationReady of the device is handled correctly. A Write and also a Read after the device's signaling ApplicationReady is handled

correctly. A Release (ControlCommand Release) sent by the controller shuts down the connection.

- Result: **PASS [**CMDEV8c.pcap and CMDEV8c.html**]**

#### 6.3.7.9 CMDEV9

- Description: Test of State machine CMDEV (ContextManager of the DEVICE). After a correct Connect by the controller and the Connect_Response by the device but not yet sent ParameterEnd a Read is handled correctly. A Release (ControlCommand Release) sent by the controller shuts down the connection.

- Result: **PASS [**CMDEV9.pcap and CMDEV9.html**]**