Quality Assurance Program
Addendum
for
IEC 61850 Specific Product Testing

July 15, 2008

Version 1.3

Prepared

for the

UCA® International Users Group

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REVISION RECORD

Revision	Description	Date
0.1	Separated out the general QAP from specific device testing. Addendums created for testing to specific standards: This addendum covers IEC 61850 testing	June 19, 2006
0.2	Updated the addendum based on input from the Testing Subcommittee on platform testing,	August 22, 2006
0.9	Draft Version to complete open items and add comments from August through November reviews	December 19, 2006
1.0	Updated version based on comments received on version 0.9	March 8, 2007
1.1	Updated with several changes, corrected migration time to mandatory use of new test procedures	May 30, 2008
1.2	References updates	June 27, 2008
1.3	Updated header and footer, format and minor text corrections	July 15, 2008

REFERENCES

a) UCA® International Users Group Charter Revision 3.1, Users Group Secretary, 5 October 2005

b) UCA® Test Plan, called the “Technical Test Plan”, (prepared by KCA, Tamarack, EPRI, SISCO and the UCA® International Users Group), Revision 0.7, May 2, 2001

c) IEC 61850 Part 10 – Conformance Testing

d) Accreditation and Recognition Procedure for IEC 61850 Device Testing Revision 1.1

e) Conformance Test Procedures for Server Devices with IEC 61850-8-1 interface, Revision 2.2

f) Conformance Test Procedures for Client System with IEC 61850-8-1 interface, Revision 1.0

g) IEC 61850 Part 2 – Glossary

h) UCA International Users Group Quality Assurance Program for IEC Product Testing and Test System Accreditation and Recognition Revision 2.6 (The Master QAP Document)

Documents, except the IEC standards, are available for download from the UCA® International Users Group Web site, www.ucaiug.org, in the Forum Area Testing. References from Part 10 on Testing of IEC 61850 shall be considered included in this QAP document. Users are reminded to check for the latest revisions of the above references.

1 Scope

This addendum provides specific details of the Quality Assurance Program aspects for IEC 61850 product testing and support. This document is an addendum to the UCA International Users Group Quality Assurance Program for IEC Product Testing and Test System Accreditation and Recognition also called the Master QAP (see Reference H). This document therefore only defines the sections that are specific to IEC 61850 Product Testing and/or provide additional information and should therefore not be read separately from the Master QAP.

2 Realization of IEC 61850 Product Tests

2.1 Planning

The procedures for the planning of tests are given in the Master QAP document (see Reference H).

2.2 Test Definitions and Set up

The definition of the test definitions and the test setup are given in the Master QAP document (see Reference H).

2.3 Procurement Steps

The definition of the different procurement steps are given in the Master QAP document (see Reference H).

2.4 IEC 61850 Test Architecture/ System Configuration

2.4.1 Test Architecture for Conformance

In this, and the next few subsections, the possible configurations and approaches for Conformance testing are given. As noted in the scope sections of this test plan, there is no guarantee that a device that passes the conformance tests will meet all the requirements of IEC 61850. In addition, the Test Procedure for the Conformance Test defines a virtual test “concept” that may be implemented in any number of actual test devices. The execution of the Test Procedure, not the actual test devices used, is what determines pass/fail (the test devices will be qualified in a PIXIT statement to identify any special constraints or testing limitations of the test devices and configuration).

Clause 7.5 of ISO 9646-1 prescribes four (4) different abstract test methodologies. One possible method identifies an external Remote Test Methods architecture.

The choice of this method implies the following constraints: An IUT shall not be forced to perform a function for which it was not designed to perform. This means that some of the test cases may not be able to be executed against an IUT since the IUT was not designed to respond in the expected manner. In these circumstances, the failure to generate the expected response shall be marked as a “NOT TESTED”. The IUT may need to be configured/programmed to respond to pre-determined Test Coordination Procedures (such coordination requirements shall be set forth within this document). If the IUT cannot implement the coordination procedure, then the IUT shall be viewed as not being designed to perform this particular test. In these circumstances, the failure to generate the expected response shall be marked as a “NOT TESTED”.

A vendor of an IUT will be required to supply PICS/MICS/PIXIT information in order to allow the conformance test software to be appropriately configured.

2.4.2 What is to be Conformance Tested?

It is the philosophy of the conformance tests, set forth within this subsection, to test an IUT in the following areas:
- Normal Behavior
- Abnormal Behavior
- Object Conformance
- Vendor Specific object conformance tests

These tests shall only verify the underlying communication protocols through the manipulation of MMS Protocol Data Units (PDUs) and application level objects. OSI, TCP/IP, and Event (Short Stack) communication profiles will be tested.

2.4.3 Test Configurations

This subsection identifies test structures and architectures that may be used to conformance test an actual IEC 61850 implementation or device.

LAN/WAN Test Configurations: Examples of the test configurations anticipated to be used are shown in Figure 1 and Figure 2. Other than the use of the router, both test architectures are the same.

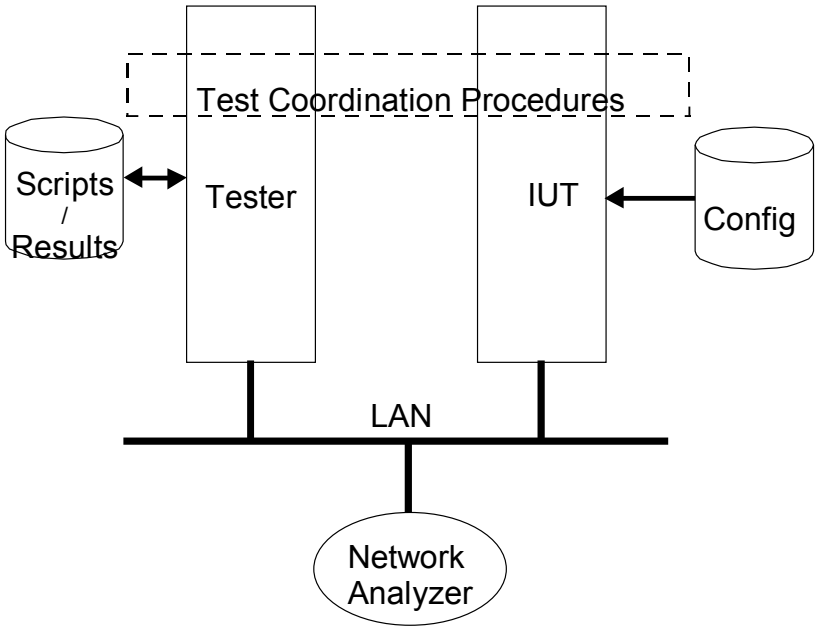


Figure 1: LAN Based Test Architecture

The configuration (Config) of the Implementation Under Test (IUT) is required in order to implement communication connectivity and some of the Test Procedures.

Note: Script based testing, will provide flexibility and extensibility for testing of IEC 61850. Testers could readily add new tests or change tests by changing scripts and definition files.

The general flow of the testing is the following:

1. Test scripts may be executed to control and monitor the test steps.
2. The test scripts will parse the test information file in order to determine the number of repetitions, test topology (LAN/WAN), and other information.
3. The test scripts will invoke an IEC 61850/Stack in order to communicate with the Implementation Under Test (IUT). (The assumption is that the IEC 61850/Stack Package can be provided by any qualified IEC 61850/Communications Supplier.)
4. The test scripts (result monitoring) will determine the status (e.g. PASS or FAIL) of each test case.
5. Upon the determination of PASS/FAIL, the scripts will update file that holds the test results. Some of the test cases require manual execution or observation, therefore, a manual update of the file may be required.

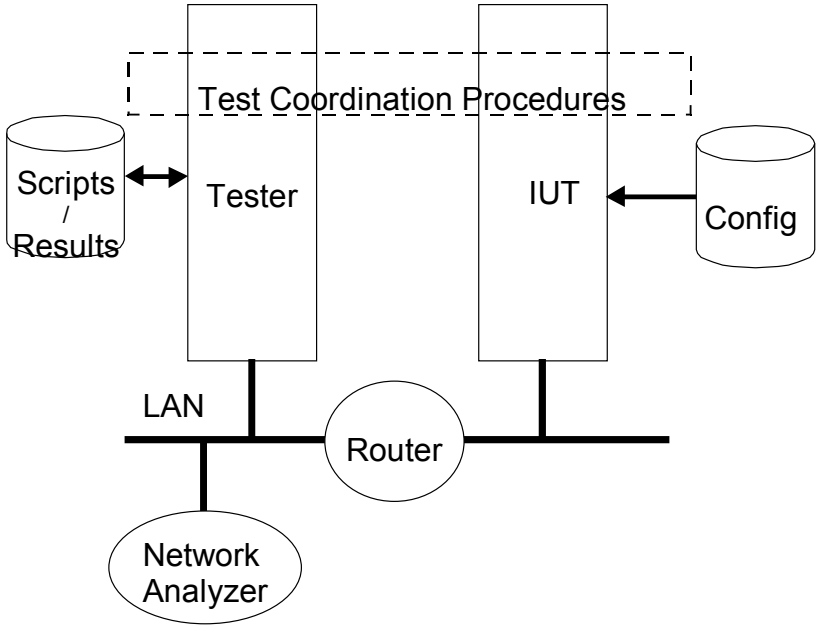


Figure 2: WAN Based Test Architecture

2.5 Conformance Test Procedures/ Steps/ Results

This section contains a high level definition of the procedures for testing device conformance with the controlling documents.

2.5.1 The Conformance Test Process

The conformance test process, based on Part 10, and related steps are illustrated in Figure 3.

The conclusion, and designation of a successful test, always requires a persons review. Thus, the test results are only approved when the customer (or individual ordering the test) signs-off and agrees with the results.

2.5.2 Standard Test Procedure Groups

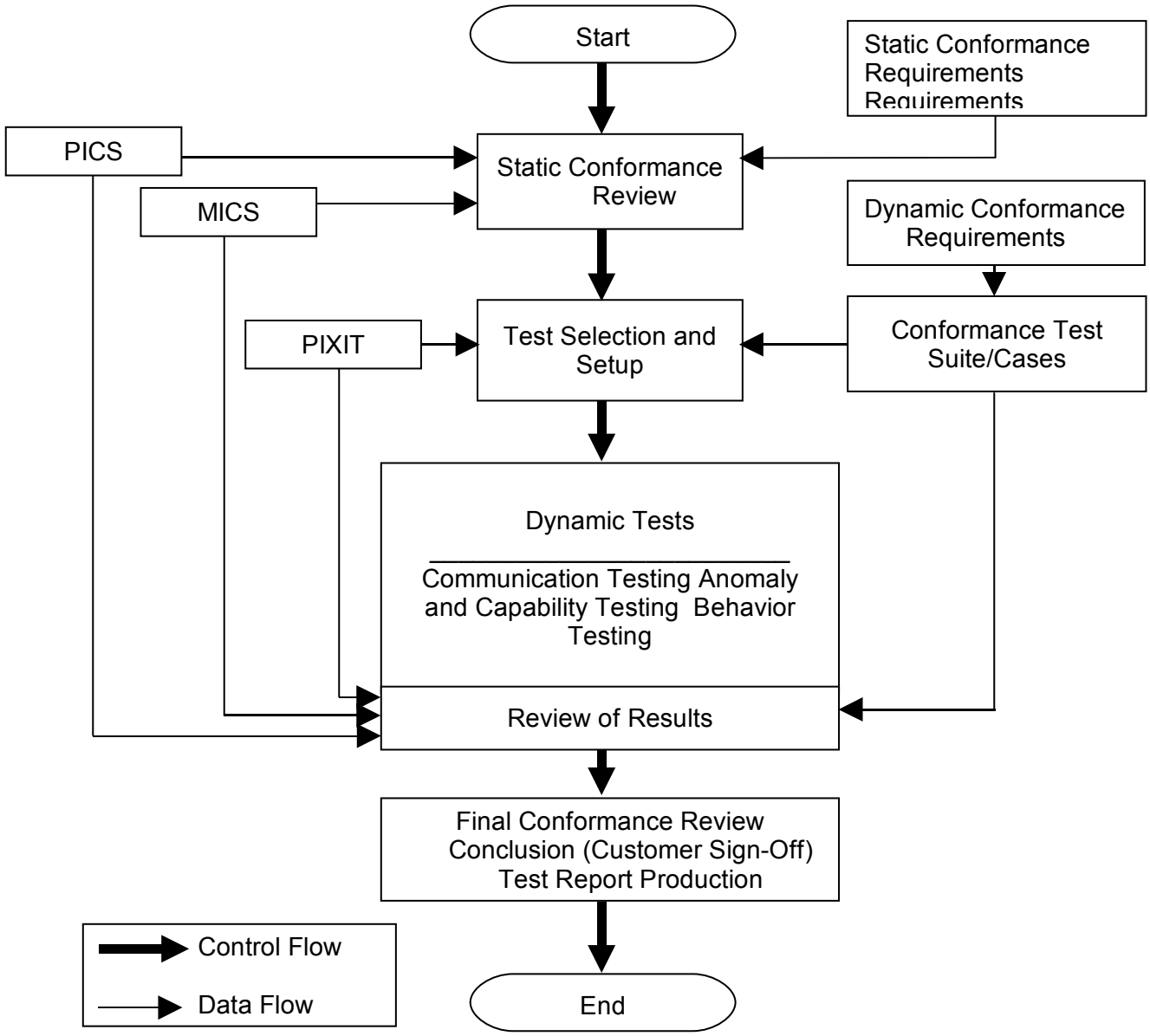
Part 10 of IEC 61850 defines test cases for both normal functions and anomaly testing, or negative, tests. The test cases are broken down into groups depending on function. The main groups are shown in Table 1.

Table 1: Standard Test Procedure Groups (According to IEC 61850 Part 10)

Test Procedure Group	Reference	Notes
Documentation and version control	IEC 61850-4	Visual Inspection
Device configuration and standardized syntax	IEC 61850-6	Formats and device set up
Device configuration and device objects	IEC 61850-7-3, -7-4	Verify correct objects and data structure
Stack implementation specific mapping	IEC 61850-8, -9	To MMS/Ethernet or IEC Serial Links
Implemented abstract services	IEC 61850-7-2	The communication services
Communication functions		Performance issues
Device specific extensions	IEC 61850	Vendor additions must follow IEC rules

The test cases, for the services and objects listed above, are broken down into simple steps and each case and step is given an identifier. This facilitates reporting of test results. Part 10 contains a set of recommended test cases and includes both normal and abnormal tests.

Figure 3: The conformance test process



2.5.3 IEC 61850 Conformance Blocks

The tables below provide the list of IEC 61850 Conformance Blocks and associated test cases. Detailed procedures shall be provided for each test case, see References E and F.

Table 2:IEC 61850 Conformance Blocks

ID	Block Name	Function	Notes
1	Basic Exchange	Association, Basic Definitions, and Data Access	
2	Data Sets	Accessing Groups of Information	
2+	Data Set Definition	Provides Dynamic (online) Data Set definition capability	
3	Substitution	Data Substitution	
4	Setting Group selection	Setting Group Selection	
4+	Setting Group definition	Setting Group definition	
5	Unbuffered Reporting	Unbuffered Periodic or Event Driven Reports	With or without online definition
6	Buffered Reporting	Buffered Periodic or Event Driven Reports	With or without online definition
7	Logging	Storing and Accessing Historical Data	With or without online definition
8a	Generic Substation Status Events	GSSE publish	
8b	Generic Substation Status Events	GSSE subscribe	
8c	GSSE management	GSSE management services	Sub/Pub
9a	Generic Object Oriented Substation Events	GOOSE publish	
9b	Generic Object Oriented Substation Events	GOOSE subscribe	
9c	GOOSE management	GOOSE management services	Sub/Pub
10	Sampled Values	Sampled Analogue Values according to 9-1	Sub/Pub
11	Sampled Values	Sampled Analogue Values according to 9-2	Sub/Pub
12a	Direct Control	Direct Operate with normal security	
12b	SBO Control	Select Before Operate with normal security	
12c	Enhanced direct Control	Direct Operate with enhanced security	
12d	Enhanced SBO control	Select Before Operate with enhanced security	
13	Time Synchronization	Coordinated Synchronization of Devices	Client, Server
14	File Transfer	Exchanging File Oriented Data	Upload, download

Note: Association Services, to establish and release connections, along with mandatory definition services and objects are included in Block 1.

2.5.4 Test Case List

IEC 61850 provides definitions of test cases. Much of the work has been completed for testing conformance definition and users may use Part 10 to specify the tests they require for acceptance by referencing the Test Case ID. The Test Case (ID) identifiers have the form: “ABC”Nn. The “ABC” is short for the service group. The “N” identifies negative tests and the “n” is the number of the test case subset.

The detailed test cases are described in the Conformance test report of the IEC 61850 communication interface in <DUT> (see References E and F)

2.5.5 Test Report

Part 10 provides guidelines for reporting test results as summarized below. The conformance test report shall contain at least the information according to Table 3.

Table 3: Test Report Contents

Section	Content
Report ID	Include Date
References	List all relevant documents including: Test procedures version number, Requirements, PICS, MICS, PIXIT
Test Configuration	Include test system, set up parameters, simulation, input: this is a summary and may point to the references.
Test Vendor	Who conducts the test
Test Owner	Who orders the test and controls the results (typical a vendor gaining certification or a user)
Test Facility	Location of test and support
Device Tested	Definition of device under test, PICS, PIXIT, constraints, hardware and software release information: this is a summary and may point to references.
Tests Conducted	List by IEC Test Cases ID
Tests Result	List by IEC Test Case ID and indicate Pass/Fail/Incomplete. Include designation of mandatory, Conditional, Optional requirements. Include any important observations to help with result and/or correction determination.
Signature Block	Approval signatures for all key parties

Test reports shall, where necessary for the interpretation of the test results, include the following:

a) Deviations from, additions to, or exclusions from the test method, and information on specific test conditions;
b) A statement of compliance/non-compliance with requirements and/or specifications;
c) Where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results or when the uncertainty affects compliance to a specification limit;
d) Where appropriate and needed, opinions and interpretations;
e) Additional information, which may be required by specific methods, clients or groups of clients.

For further information see the Conformance test report of the IEC 61850 communication interface in <DUT> (References E and F). Every test report must be formatted as described in these procedures.

2.5.6 Test Procedures

In order to assure the quality of the test procedures and the references made to them the following shall be applicable.

1) Each approved test procedures gets a unambiguous version number, format x.y, and these procedures will be made available on the UCA web site for members
2) The test procedures version x.y are based on the IEC 61850 series (edition X and Amendments) plus the solved (green) technical issues (TISSUES)
3) The UCA® International Users Group Testing Subcommittee shall be given an agreed time to review and approve any new draft version of the test procedures. Test plans to be used shall incorporate all solved tissues at the time the draft test procedures are ready for review and approval. After review and approval the UCA® International Users Group Testing Subcommittee issues a new formal version of the test procedures.
4) Within 12 Months after the release of a new version of the test procedures it becomes mandatory for conformance tests. This provides a grace period for vendors to upgrade their products to meet the most recent updates to the standards and the approved Tissues.

5) All certificates shall reference the IEC 61850 series and the specific version of the test procedures (version x.y) on which the certificate is based
6) Any TISSUE not correctly implemented conform to the referenced test procedures will result in a failed test
7) The test procedures specify exactly which resolved TISSUES are applicable for a test (for example by indicating the applicable test procedure(s) per TISSUE)
8) More resolved TISSUES may be implemented in the device then demanded by the used test procedures. In case these additional TISSUES are tested the test report must clearly specify the extra TISSUES, the followed test procedure and the test result
9) The PICS shall define the implemented resolved TISSUES in a device

For this procedure, it is assumed that the Technical (TISSUE) Committee of the UCA® International Users Group has considered backward compatibility issues during the resolution process.

If the above described procedures are followed:
- The manufacturers, the users, the test houses have a common and clear basis what is mandatory to test for the equipment to be delivered, used, tested
- Version control of equipment is possible by the users; e.g. they can standardize on IEC 61850 equipment tested according to test procedures version x.y and at a certain moment decide to migrate and update device software tested based on newer test procedures
- The manufacturers, test houses, test system developers and developers of test tools will have time to implement TISSUES in their device(s) from the current test plan and can start to implement TISSUES to be described in newer versions of the test procedures and associated test plans
- All parties will have a clear view what will be and has been tested as specified in the referenced version of the test procedures.

It will be relative easy to investigate changes between different versions of the test procedures

2.5.7 Platform Testing

The UCA Users Group states that only individual devices can be tested and certified. Therefore a product platform certificate does not exist.

However, vendors are free to submit for testing 'products' which represent the superset of a platform family. This IED will be tested just as if it were a 'real' IED and the certificate can be marked to clearly identify that the submitted item is not offered commercially as a product. For example, a vendor could market products named 'red' and 'green' and 'blue' whereas the submitted product is a superset, which is code-named 'white'. The conformance certificate could not mention 'red' or 'green' or 'blue' but could only mention 'white'. Now it is up the vendor to convince their customers that 'red' is actually a subset of 'white'. Supporting documents for this subset assertion can include the ICD file used for testing 'white' compared to the ICD file for 'red', photographs of the circuit boards 'white' and 'red', firmware version numbers, and the reputation of the claiming vendor.

It is up to the customer to decide if this explanation is sufficient or if he would require a certificate per device.

2.5.8 IEC 61850 Device Certificate

The IEC 61850 Product Certificate is an official document that certifies that a given product or device has been tested by a qualified organization against a Published Standard in accordance with the Users Group approved procedures. The Product Certificate is a short summary of 2 pages that identifies the product, the tester, and briefly covers the tests that were completed. Additional details on the Product would be available by contacting the testing organization and the Product supplier listed in the Certificate. Certificates are public documents that are published on the Users Group Web Site.

IEC 61850 Product Certificate Contents

Certificate Identification/ Dates	Title, "IEC 61850 Test Certificate", with unique identification and serial number, date of certificate
Product Information	Identifies the product, and the vendor: the devices and item(s) tested by IEC 61850 Conformance Blocks
Tester Information	Name of testing organization, location and address
Standard	Identifies the standard the device was tested against: Reference to the IEC 61850 and other standards and procedures (including version number) used by the test center or other bodies where these are relevant to the validity or application of the results.
Test Specification	Identifies the tests that were conducted: A description of, the condition of, and unambiguous identification of the test system (hardware, firmware, software level), a second page provides a summary of the actual tests completed by IEC 61850 Conformance Block.
Signature Block	Name and Signature of the authorized individual at the Tester certifying the test results: The name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the certificate.

Detailed definitions of the IEC 61850 Certificates along with examples are given in the approved Tester Qualification Procedures (see Reference D).