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Test report of the functional IEC 61850 tests in KYLAND Technology CO., LTD SICOM3024P

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By order of KYLAND Technology CO.,LTD

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CONTENT

SUMMARY

By the order of KYLAND Technology CO., LTD, located in Beijing, China, IEC 61850 Functional Tests were performed on Ethernet Switch type Magnum 6k for use in substation and industrial environments.

Manufacturer : KYLAND Technology CO.,LTD
Type : SICOM3024P Ethernet Switch
Firmware version : 1.2.10
Hardware version : 1.4

The SICOM3024P Ethernet Switch is tested for use in substations according IEC 61850, IEEE 802.1D - Media Access Control (MAC) bridges, IEEE 802.1W - Rapid Spanning Tree (RSTP), IEEE 802.1Q - Virtual Local Area Networks (VLANs).
KYLAND Technology CO.,LTD has implemented the Dt-Ring protocol for the Rapid Spanning Tree functionality.

The following tests are performed with positive test results:

Test Group	**Description**	**Comment**
VLAN handling	The goal of the functional VLAN tests is to verify the multicasting of VLAN tagged IEC 61850 GOOSE messages.	PASSED
Priority tagging	The goal of the functional priority tagging tests is to verify that higher priority messages will prevail lower priority messages. We expect on a network with mixed priority packages that no high priority packages will be dropped.	PASSED
Rapid Spanning Tree	The goal of the Rapid Spanning Tree tests is to verify the recovery of a single communication failure and to measure the recovery time and the number of packet drops.	PASSED Recovery time: **3 – 10** ms. No packet loss.

The report of performance is based on tests performed on four specimens of the product as referred above, performed by KEMA. The test results show that the specimens meet the requirements as listed above.

This document does not imply that KEMA has certified or approved any products other than the specimen tested. The manufacturer’s production facility has not been assessed.

1 INTRODUCTION

1.1 Identifications

The following table gives the exact identification of tested equipment and test environment used for this conformance test.

SUT	SICOM3024P Ethernet Switch Firmware version 1.2.10 Hardware version v.1.4
MANUFACTURER	KYLAND Technology CO.,LTD
TEST INITIATOR	Manufacturer
TEST FACILITY	KEMA Consulting Utrechtseweg 310 6812 AR Arnhem, The Netherlands
TEST ENGINEER	S.J.T. Mulder
TEST SESSION	October 2008 at TEST FACILITY
SIMULATOR	UniCAsim GOOSE 2.14.01 with 61850 switch 0.1.uct
ANALYZER	UniCA 61850 Analyzer 4.18.00

1.2 Background

The KYLAND Technology CO.,LTD SICOM3024P Ethernet Switch will be used in industrial- and substation-environments where IEC 61850 is used for data communication.

1.3 Purpose of this document

The purpose of this document is to describe the test procedure and results of the *TEST SESSION* concerning the functional IEC 61850 communication in the *DUT*.

1.4 Contents of this document

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

Chapter 3 describes the various relevant components for the functional test and their configuration as used in the test, including the DUT. This chapter also gives an overview and introduction to the various test groups.

Chapter 4 and 5 give an overview and summary of the test results, the conclusion(s) and recommendations.

Appendix A specifies the detailed test procedures and their outcome.

1.5 Glossary

DUT	DEVICE UNDER TEST
LAN	Local Area Network
MAC	Media Access Control
VLAN	Virtual LAN
VID	Virtual LAN Identifier

2 REFERENCES

2.1 Normative

The tests defined in this document are based on the following documents.

- IEEE 802.1D, Media Access Control (MAC) bridges
- IEEE 802.1W, Rapid Spanning Tree (RSTP)
- IEEE 802.1Q, Virtual Local Area Networks (VLANs)
- IEC 61850-8-1, Communication networks and systems in substations – Part 8-1: Specific communication service mapping (SCSM) – Mappings to MMS (ISO/IEC 9506-1 and ISO/IEC 9506-2) and to ISO/IEC 8802-3; First edition 2004-05.

2.2 Other

- Installation- and user-documentation guides

3 THE TEST

3.1 Components in the test environment

The physical test environment consists of the following components:

- 4 Ethernet switches in a ring
- IEC 61850 GOOSE Publisher
- IEC 61850 GOOSE Subscriber
- IEC 61850 Analyzer
- Background traffic generator
- Standard Fiber optic / unshielded twisted pair cables.

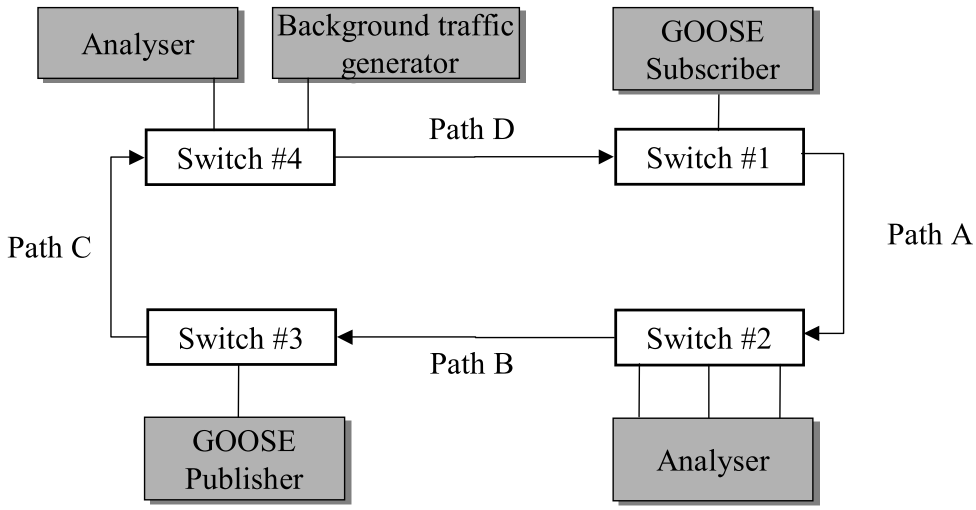

Figure 3.1 The test environment

3.2 Configuration of the test environment

After unpacking the switches have been configured as follows.

Port configuration per SICOM3024P:

Port #	Description	Type(*)	VID
1	Background Traffic	Edge	200
2	Background Traffic	Edge	200
9	GOOSE	Edge	100
10	GOOSE	Edge	100
5	Management	Edge	1
Gig1	Ring Up	Trunk	1
Gig2	Ring Down	Trunk	1

(*):

Edge ports: If a port is assigned a VLAN function of edge, this port belongs to one VLAN (VID). All tagged Ethernet frames that enter the edge port need to belong to the port VID, otherwise they will be dropped. All untagged Ethernet frames entering an edge port will be assigned the default VID. Egressing Ethernet frames will be untagged by default.

Trunk ports: When an Ethernet port is configured as a trunk port it means that this port will accept traffic of all exising VLANs. All tagged/untagged Ethernet frames will egress the port with the standard VID. All untagged frames will be assigned the default VID for this port.

Connect 4 switches in a ring structure with a trunk backbone. The following tables show which equipment is connected:

SICOM3024P Switch 1 Port #	**Equipment description**
1	Background traffic
9	GOOSE Subscriber
Gig2	Ring Down to Switch4
Gig1	Ring Up to Switch2

SICOM3024P Switch 2 Port #	**Equipment description**
2	Background traffic
Gig2	Ring Down to Switch1
Gig1	Ring Up to Switch3

SICOM3024P Switch 3 Port #	**Equipment description**
1	Background traffic
10	GOOSE Publisher
Gig2	Ring Down to Switch2
Gig1	Ring Up to Switch4

SICOM3024P Switch 4 Port #	**Equipment description**
1	Background traffic
9	GOOSE Subscriber
Gig2	Ring Down to Switch3
Gig1	Ring Up to Switch1

The analyzer has no fixed port and is connected to several switches during the test to verify the RSTP traffic and to check if a frame contains the correct VLAN tags.

Quality of Service parameters is configurable and set to the following values:

CoS Value	**Quality of Service**
0, 1	Low priority
2, 3	Normal priority
4, 5	Medium priority
6, 7	High priority

4 TEST RESULTS

Table 4.1 in this Chapter gives a summary of the functional test results. References shown in the table columns refer to references of individual test procedures in appendix A.

The **Failed** column indicates the test cases with test result failed. For details refer to the applicable test procedure in Appendix A.

The **Comment** column indicates the test cases with additional observations about the test case results. Some test procedures maybe partially tested and some may not be tested at all due to limitations of the DUT or test environment. For details refer to the applicable test procedure in Appendix A.

The **Verdict** columns indicate the test result of all applicable test procedures in the test group. When one or more test procedures have test result Failed the test group receives verdict Failed.

Table 4.1 Summary of test results for *DUT*

Test Group	**Failed**	**Comment**	**Verdict**
VLAN handling			PASSED
Priority tagging			PASSED
Rapid Spanning Tree			PASSED Recovery time **3 – 10** ms. No packet loss.
TOTALS	**0**	**0**	**PASSED**

5 CONCLUSION AND RECOMMENDATIONS

Based on the test results described in this report, *TEST FACILITY* declares the tested SICOM3024P has **PASSED** the functional IEC 61850 test.

5.1 Recommendations following from the test

The following recommendations apply for the *DUT*:

None.

5.2 Observations following from the test

The following observations apply for the tested *DUT*:

Use of VLANs in conjunction with GOOSE requires integrators to configure the SICOM3024P to specify backbone (trunk) ports versus equipment (edge) ports.

APPENDIX A – DETAILED TEST PROCEDURES AND RESULTS

A1. VLAN handling

The goal of the functional VLAN tests is to verify the multicasting of VLAN tagged IEC 61850 GOOSE messages.

Id	Test procedure	Verdict
VLAN1	Check if the VLAN tag in the GOOSE message is correct after passing at least two switches	PASSED
VLAN2	Check if a VLAN tagged message only appears on the corresponding port.	PASSED
VLAN3	Check if a VLAN tagged message with VID 0 is rewritten to the default VID of the corresponding VLAN[1]	PASSED

[1] IEEE Std 802.1Q-1998 states "… a VLAN-aware Bridge can never transmit priority-tagged frames; all frames transmitted are either untagged or carry a non-null VID in their tag header.

A2. Priority tagging

The goal of the functional priority tagging tests is to verify that higher priority messages will prevail lower priority messages. We expect on a network with mixed priority packages that no high priority packages will be dropped.

Id	Test procedure	Verdict
Prio1	GOOSE simulator sends 1000 messages within 1 second with priority=LOW, with no or less than 5% network traffic	PASSED
Prio2	GOOSE simulator sends 1000 messages within 1 second with priority=MEDIUM, with no or less than 5% network traffic	PASSED
Prio3	GOOSE simulator sends 1000 messages within 1 second with priority=HIGH, with no or less than 5% network traffic	PASSED
Prio4	GOOSE simulator sends 1000 messages within 1 second with priority=LOW, with about 95% network traffic on a separate VLAN	PASSED
Prio5	GOOSE simulator sends 1000 messages within 1 second with priority=MEDIUM, with about 95% network traffic on a separate VLAN	PASSED
Prio6	GOOSE simulator sends 1000 messages within 1 second with priority=HIGH, with about 95% network traffic on a separate VLAN	PASSED
Prio7	GOOSE simulator sends 1000 messages within 1 second with priority=LOW, with about 95% network traffic on the same VLAN	PASSED
Prio8	GOOSE simulator sends 1000 messages within 1 second with priority=MEDIUM, with about 95% network traffic on the same VLAN	PASSED
Prio9	GOOSE simulator sends 1000 messages within 1 second with priority=HIGH, with about 95% network traffic on the same VLAN	PASSED

A3. Rapid Spanning Tree performance

The goal of the Rapid Spanning Tree tests is to verify the recovery of a single communication failure and to measure the recovery time and the number of packet drops. This may depend on:

- Packet size;
- Network load;
- Connecting / disconnecting the backbone ring.

During the test GOOSE messages are sent on a 1 millisecond period. The measured recovery time is the difference between the timestamp of the last received message before the failure and the timestamp of the first received message after the failure. The packet drop is the difference in sequence number of the last and first received GOOSE message. See figure 3 for the used test setup. The backbone ring is disconnected / connected on 4 different places.

GOOSE Packet size	Test cases	Average recovery for path A,B,C,D	Effect
Large	Rsp 1,3,5,7	5,06 ms	0,13 ms
Small	Rsp 2,4,6,8	4,93 ms	No

Network load	Test cases	Average recovery for path A,B,C,D	Effect
5%	Rsp 3,4,7,8	5,37 ms	0,75 ms
95%	Rsp 1,2,5,6	4,62 ms	No

Connection	Test cases	Average recovery for path A,B,C,D	Effect
Connect	Rsp 5,6,7,8	5,25 ms	0,50 ms
Disconnect	Rsp 1,2,3,4	4,75 Ms	Low

Path	Test cases	Average recovery	
A	All	4,75 ms	
B	All	4,87 ms	
C	All	5 ms	
D	All	5,37 ms	

Based on the test results we conclude that:

- the packet size has no effect on the recovery time
- the network load has no effect on the recovery time
- disconnecting or connecting a backbone cable has no effect on recovery time.

PATH A

Id	Test procedure	Verdict	Measurements
Rsp1	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 5 ms recovery time**
Rsp2	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp3	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 5 ms recovery time**
Rsp4	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 8 ms recovery time**
Rsp5	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp6	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 4 ms recovery time**
Rsp7	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 6 ms recovery time**
Rsp8	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 4 ms recovery time**

PATH B

Id	Test procedure	Verdict	Measurements
Rsp1	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 4 ms recovery time**
Rsp2	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp3	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 3 ms recovery time**
Rsp4	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 8 ms recovery time**
Rsp5	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp6	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 10 ms recovery time**
Rsp7	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 5 ms recovery time**
Rsp8	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 3 ms recovery time**

PATH C

Id	Test procedure	Verdict	Measurements
Rsp1	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 8 ms recovery time**
Rsp2	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 4 ms recovery time**
Rsp3	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 10 ms recovery time**
Rsp4	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 5 ms recovery time**
Rsp5	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 4 ms recovery time**
Rsp6	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp7	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 3 ms recovery time**
Rsp8	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 3 ms recovery time**

PATH D

Id	Test procedure	Verdict	Measurements
Rsp1	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp2	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 4 ms recovery time**
Rsp3	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 5 ms recovery time**
Rsp4	Check if Spanning Tree Protocol recovery mechanism works on a backbone **disconnect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 6 ms recovery time**
Rsp5	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 10 ms recovery time**
Rsp6	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with about 95% network traffic on the backbone.	PASSED	**0 lost messages 3 ms recovery time**
Rsp7	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **large** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 4 ms recovery time**
Rsp8	Check if Spanning Tree Protocol recovery mechanism works on a backbone **connect** when sending 1000 **small** GOOSE messages per second in a network with **no traffic**	PASSED	**0 lost messages 8 ms recovery time**