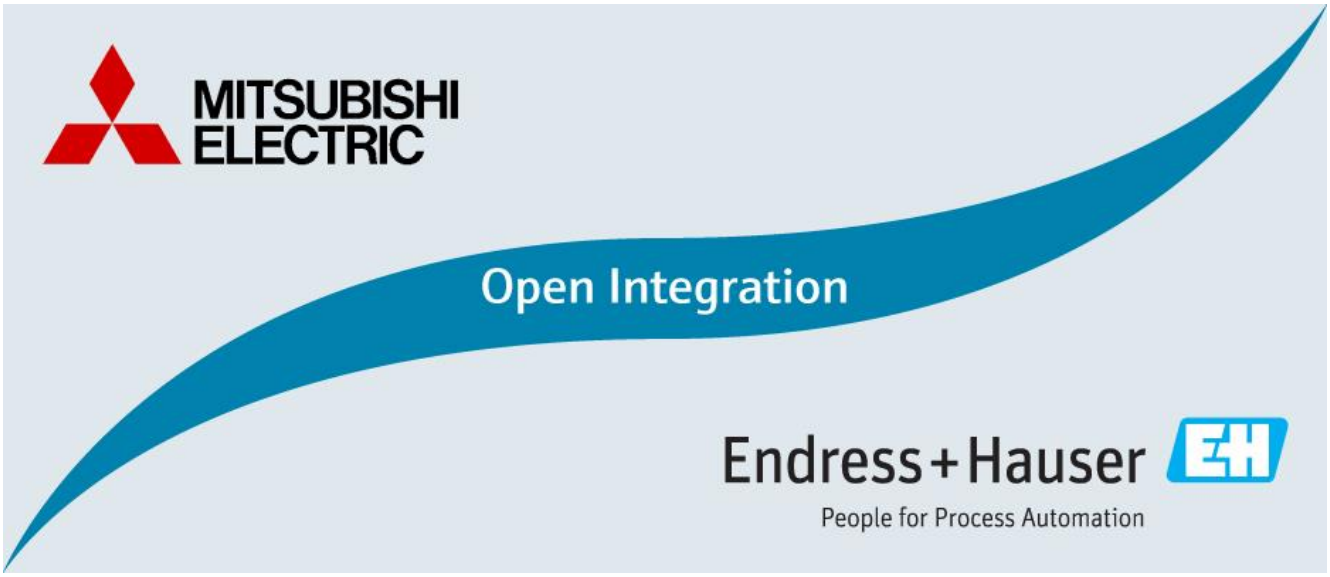
Integration Test Summary ME02

Mitsubishi Electric MELSEC System Q - Redundant PLC System and HART over PROFIBUS for Power & Energy Industry



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1 Document Information

1.1 Purpose and Scope

This document provides a brief summary of Open Integration tests for Reference Topology ME02. All content of this document is jointly developed, reviewed and approved by Mitsubishi Electric and Endress+Hauser as a common deliverable of Open Integration.

1.2 Document History

This is version 1.00.00 of this document. Version history:

Version	Released	Description
1.00.00	2016-12	Initial version

1.3 Related Documents

Please refer to related documents as listed below:

Document	Description
SD017065S/04/EN/01.16	Reference Topology ME02
SD017066S/04/EN/01.16	Integration Tutorial ME02
SD017068S/04/EN/01.16	List of Tested Devices and Versions ME02

2 Preface

Open Integration focuses on complementary system tests to verify integration and interoperability using practical test conditions. This is done by testing the system versus a reference test network with a relevant variety of components and field devices for defined target applications, and asking questions like this:

Is the system prepared to handle a necessary variety of compliant device implementations?
How does it deal with multiple device revisions and device replacements?
Does it apply reasonable bus settings to share access with other masters?
How can field devices be accessed for configuration or asset health monitoring?
Is this path stable and performing? ...

Open Integration does not test field devices, field network components or systems as such. All parts of a reference topology under test are released and have passed mandatory integration and interoperability tests as defined by technology foundations upfront.

3 General Introduction

This chapter provides a short introduction to Open Integration testing in general:

3.1 Reference Test Network

Open Integration verifies systems versus a reference test network: Figure 1 shows the principle as applied for HART direct and HART over PROFIBUS DP:

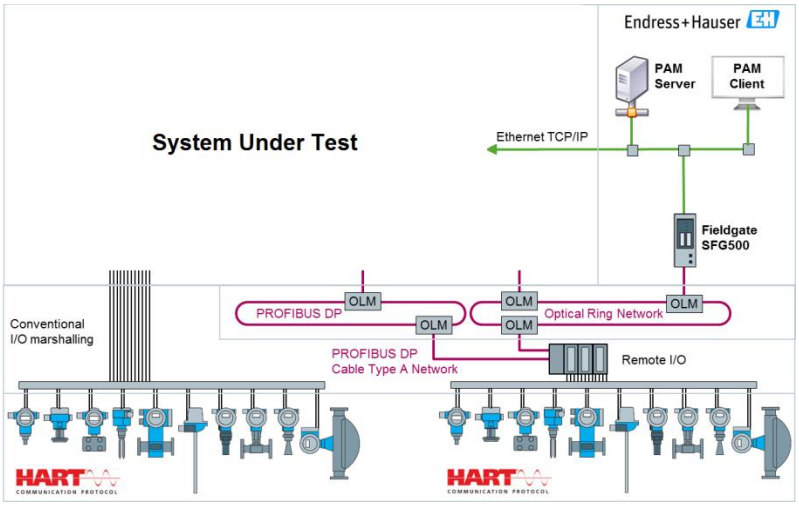

Figure 1: Open Integration Reference Test Network for HART and HART over PROFIBUS DP

3.2 Integration Test Scenarios

Open Integration verifies supported means for integration into the system and interoperability with other tools. Figure 2 shows the main test scenarios as considered:

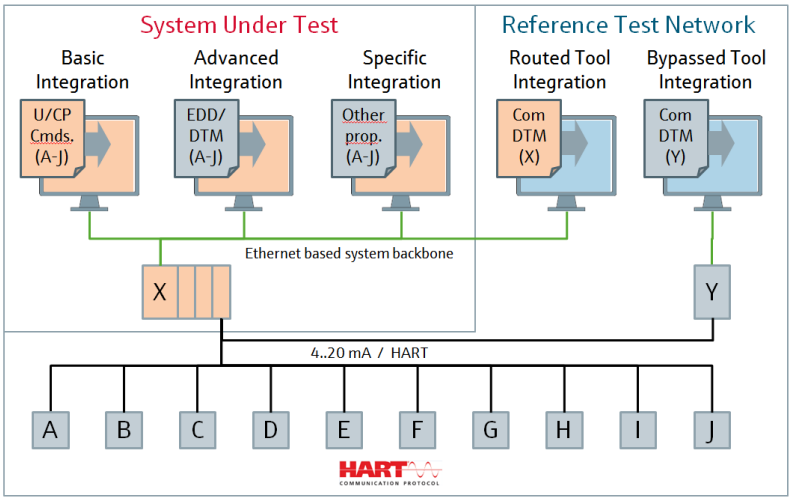

Figure 2: Open Integration Test Scenarios

3.2.1 Basic Integration

This scenario deals with integration of field devices by means of conventional I/O and HART Universal and Common Practice Commands. If HART devices are connected via PROFIBUS DP and Remote I/O, the commissioning of the PROFIBUS network by means of GSDs must be considered as well. As a result, the necessary cyclic communication is up and running, all process values and if supported also the standard HART Request/Response Data Bytes are available for further processing within the control strategy of the system. Test cases related to this scenario are mandatory.

3.2.2 Advanced Integration

This scenario deals with device type specific integration of field devices by means of EDD, DTM or FDI. As a result, the system is enabled to access additional information from field devices, e.g. for an integrated asset management solution. Test cases related to this scenario are mandatory, if the system under test supports such means.

3.2.3 Specific Integration

This scenario considers proprietary means for integration which may be supported by a specific system, e.g. to simplify commissioning or to provide preconfigured elements for visualization. This is optional and not supported by standard test cases. If relevant, a specific set of additional test cases must be defined.

3.2.4 Routed Tool Integration

Vice versa, this scenario deals with integration of system components under test as access path for plant asset management software provided by Endress+Hauser. Test cases related to this scenario are mandatory, if the system under test supports such means.

3.2.5 Bypassed Tool Integration

This scenario focuses on interoperability of the system under test with other masters, which may be used to access field devices independently from routing support by the system itself.

If HART devices are directly connected to Analog Inputs or Analog Outputs of the system under test, such secondary master could be a HART modem or HART multiplexer connected to the conventional 4..20 mA/HART loops. If HART devices are connected via Remote I/O, a PROFIBUS gateway may be used to access HART devices via the intermediate field network and the Remote I/O.

Test results may serve to complement a missing routing support, or as performance reference for routing support provided by a system under test.

4 Relevant Test Scenarios

Mitsubishi Electric redundant MELSEC System Q utilizes Basic Integration by means of GSDs for PROFIBUS DP. This is relevant for communication via Remote I/O and must be tested. Further on shall be validated if and how HART commands may be used within the control strategy. Advanced Integration by means of EDD or DTM is not relevant. Specific Integration is not required.

Mitsubishi Electric redundant MELSEC System Q supports Routed Tool Integration by means of Communication DTMs. This has to be tested.

Mitsubishi Electric redundant MELSEC System Q shall also be tested whether to share access with other PROFIBUS master devices for Bypassed Tool Integration.

5 Summary of Test Results

5.1 Basic Integration

The basic integration workflow for integration of the Pepperl+Fuchs Remote IO by means of GSD with the Mitsubishi Electric redundant MELSEC System Q has been successfully tested for a variety of devices at different baud rates as follows: (read baud rate ✔ = supported, ✗ = not supported by device, greyed = not applicable)

PROFIBUS devices		Baud rates (Baud)									
		9.6k	19.2k	31.25k	45.45k	93.75k	187.5k	500k	1.5M	3M	6M	12M
Master	QJ71PB92V	✔	✔	✗	✗	✔	✔	✔	✔	✔	✔	✔
DP Slave	LB8109	✔	✔	✗	✗	✔	✔	✔	✔	✗	✗	✗

Device Type Library

- The Pepperl+Fuchs Remote IO GSD file can be successfully imported into the GX Works2 PROFIBUS library.
- The Pepperl+Fuchs Remote IO GSD file is per default imported in the GX Works2 PROFIBUS library folder “I/O” with the name “LB/FB 8x09 Remote IO 2”.

Field Network Configuration

- The PROFIBUS slave "LB/FB 8x09 Remote IO 2" can be successfully integrated into the GX Configurator DP PROFIBUS network, under the PROFIBUS Master QJ71PB92V.
- All IO modules of the "LB/FB 8x09 Remote IO 2" slave can be configured according to slot definitions as specified in GSD. However, the GX Configurator DP does not check for valid module assignments. Invalid assignments will not allow cyclic communication with that slave.
- HART devices can be connected with different Pepperl+Fuchs input and output modules. If connected via LB3102, the analog value and up to four HART values are directly available for using in the Control Strategy. If connected via LB3106 or LB4106, only the analog value is available by default. If required, HART values must be collected separately via CMD3.
- Bus parameters settings are updated automatically according to configured slaves and the defined baud rate.
- The calculated timing parameters allowed access also with a secondary master. In case the target rotation time needs to be adjusted, manually overwrite the calculated "min slave interval".
- The PROFIBUS DP optical ring network installed between the Mitsubishi Electric redundant MELSEC System Q and the Pepperl+Fuchs Remote IO has no impact on the PROFIBUS communication with the tested Baud rates.

Control Strategy

- As the Mitsubishi Electric redundant MELSEC System Q is based on 16 bit data format, all received PROFIBUS telegrams from the Pepperl+Fuchs Remote IO need to be converted in order to read the correct data from the HART devices. To achieve this, a GX Works2 function block library "Profibus_LB_serie" is provided with eight function blocks:
    - "LB3102" used to convert analog input 4/20mA telegram.
    - "LB3102_1HART" used to convert analog input 4/20mA and one HART variable telegram.
    - "LB3102_2HART" used to convert analog input 4/20mA and two HART variables telegram.
    - "LB3102_3HART" used to convert analog input 4/20mA and three HART variables telegram.
    - "LB3102_4HART" used to convert analog input 4/20mA and four HART variables telegram.
    - "LB3106" used to convert analog input 4/20mA telegram.
    - "LB4106" used to convert analog output 4/20mA telegram.
    - "StatusCheck_PF" used to read LB8109 Com Unit status.
- Data exchange between PLC, Remote IO and HART devices by using these function blocks has been successfully tested.
- Diagnosis messages coming from the GSD file are displayed in the menu "Diagnosis Messages".

Redundancy System Tests

- Mitsubishi Electric Melsec Q redundant PLC System switchover between Control and Standby PLC is realized successfully as soon as the power supply of the Control PLC is switched down or any other error occurs in the active CPU. In this case, Pepperl+Fuchs redundant LB8109 Com Unit is switching successfully too.
- A defect PROFIBUS line on the Control PLC side is detected as an error by the system but doesn't automatically produce the switchover to the redundant PROFIBUS line of the Standby PLC. If required, this must be programmed explicitly.

AUMA Actuator Integration

- The AUMA Actuator SA07.2/AC01.2 has been connected to the HART analog output card LB4106 of the Pepperl+Fuchs Remote IO System and configured in Actuator mode in order to receive an analog Set point signal from the control system.
- The set point, sent from the Mitsubishi Electric redundant MELSEC System Q has been successfully received by the AUMA Actuator.
- Since the LB4106 doesn't provide the HART values by default, a read back of the Set Point and Actual Position must be collected separately via CMD3. This has been successfully tested.

5.2 Specific Integration

Control Strategy

- The handling of HART Commands from the Control Strategy requires an acyclic PROFIBUS DPV1 Class2 communication with the Remote IO System. Four additional function blocks have been implemented and tested:
  - "InitiateClass2" used to establish a line connection with the Remote IO System.
  - "WriteClass2" used to write the HART requests to the Remote IO System.
  - "ReadClass2" used to read the HART response data from the Remote IO System.
  - "AbortClass2" used to disconnect the line with the Remote IO System.
- The workflow has been successfully tested with two additional function blocks for CMD0 and CMD3:
  - "HARTCommand0" executes Command 0 Read Unique Identifier.
  - "HARTCommand3" executes Command 3 Read Dynamic Variables and Loop current.
- All new function blocks can be found in the GX Works2 library "Profibus_LB_serie".
- Further HART commands may be implemented based on this concept.

General Findings

- The Mitsubishi Electric PROFIBUS Master card can handle up to eight different PROFIBUS DPV1 Class2 connections. As one connection is needed for the PROFIBUS DPV1 Class2 Initiate/Abort services, seven connections are available for execution of HART Commands.
- Parallel access to the same slot of the Remote IO System is not supported by Pepperl+Fuchs. As a consequence, if a HART Command is sent on a certain Slot and Index from the Control Strategy, the same cannot be accessed at the same time by the SFG500 and FieldCare.

Device Specific Findings

- Minor issues were found with CMD0 requests on Micropilot (0x0028) and Levelflex (0x0022). Both device types did not respond correctly to all requested data. Issues are fixed with latest firmware updates:
    - Micropilot FMR5x requires FW 01.02.00 or higher for corrected response to CMD0.
    - Levelflex FMP5x requires FW 01.03.00 or higher for corrected response to CMD0.

5.3 Routed Tool Integration

- The Pepperl+Fuchs Remote IO system can successfully be configured by using FieldCare and the Mitsubishi Electric MX CommDTM-PBDP commDTM in combination with the Pepperl+Fuchs LB8109 LB-DPV1/UNICOM Interface commDTM.
- The function “Create Network” doesn’t work from the Mitsubishi Electric MX CommDTM-PBDP level. The Pepperl+Fuchs LB8109 LB-DPV1/UNICOM Interface commDTM must be added manually.
- The function “Create Network” is finding all Endress+Hauser devices with exception of the necessary iDTM for the AUMA actuator. FieldCare 2.10 is assigning automatically the generic HART DTM when scanning the HART module LB4106. The iDTM AUTOMATIC AC 01.2/ACEx 01 Rev 1 must be added manually.
- The Mitsubishi Electric MX CommDTM-PBDP commDTM in combination with the Pepperl+Fuchs LB8109 LB-DPV1/UNICOM Interface commDTM allows establishing connection in FieldCare with all HART devices of the ME02 topology.
- The Mitsubishi Electric MX CommDTM-PBDP commDTM cannot be successfully connected if the GX Works2 Online Monitoring via Ethernet is enabled.
- Routed Tool Integration can be recommended for temporary use only, e.g. for device configuration.

5.4 Bypassed Tool Integration

- The Pepperl+Fuchs Remote IO system can successfully be configured by using FieldCare and the SFG500 commDTM in combination with the Pepperl+Fuchs LB8109 LB-DPV1/UNICOM Interface commDTM.
- The function "Create Network" is finding all Endress+Hauser devices except the iDTM for the AUMA actuator. FieldCare 2.10 is assigning automatically the generic HART DTM when scanning the HART module LB4106. The iDTM AUTOMATIC AC 01.2/ACEx 01 Rev 1 must be added manually.
- The PROFIBUS master of the Mitsubishi Electric redundant MELSEC System Q and Fieldgate SFG500 showed no issues in sharing access to the same PROFIBUS network. The default bus timing parameters as calculated by GX Configurator DP are adequate to allow access also for SFG500. Increase of target rotation time via manually increase of calculated "min slave interval" may be used to further improve the performance for device configuration.
- It must be considered that the SFG500 adapts to the current bus parameters only at time when connected. If the network configuration is changed e.g. by adding or removing slaves via GX Configurator DP, the SFG500 needs to be disconnected from the PROFIBUS or rebooted to adapt accordingly.
- Bypassed Tool Integration can be recommended for device configuration and asset health monitoring.

6 Open Integration Result

Reference Topology ME02	Recommended	Not Recommended	Not Applicable
Basic Integration (process values)	X		
Advanced Integration			X
Specific Integration (HART commands)	X		
Routed Tool Integration (temporary device configuration)	X		
Routed Tool Integration (permanent device status monitoring)		X	
Bypassed Tool Integration (temporary device configuration)	X		
Routed Tool Integration (permanent device status monitoring)	X		

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