FOUNDATION FIELDBUS INTEROPERABILITY TESTING ON YOKOGAWA CENTUM CS3000 SYSTEM

By

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FINAL PROJECT REPORT

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CERTIFICATION OF APPROVAL

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CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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Nur Amnanie Binti Zulkifli

ABSTRACT

Since Fieldbus was introduced in 1980s, leading process control suppliers started to implement their own proprietary protocols and none of them could talk together. The Foundation Fieldbus was implemented in 1994 to achieve an internationally fieldbus standard. A test need to be conducted to proved the interoperability of Foundation Fieldbus. This report will discuss about the Fieldbus and the work that done during the Foundation Fieldbus Interoperability Testing. The main objective of this project is to perform technical verification and interoperability of Foundation Fieldbus host and devices from various manufacturers. For the industry to adapt to the Fieldbus system, a comprehensive understanding on the operability of the system is required. This project aims to provide a familiarization to the Fieldbus system for scientific researchers and engineers for further development intended for laboratory or industrial application and testing. The laboratory testing will cover three main tests which are basic interoperability test, stress test and diagnostics capability test. For the first phase, the test is focused on basic test. The test will be conduct using the Yokogawa Centum CS3000 system as hosts. The outcome of this test will be implemented in PETRONAS Groupwide in the form of guidelines, procedures and standards on Foundation Fieldbus.

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LIST OF ABBREVIATIONS

AI	Analog Input
AS-I	Actuator Sensor Interface
CIM	Computer Integrated Manufacturing
CNF	Connection Failure
DCS	Distributed Control System
DD	Device Description
DDC	Direct Digital Control
DP	Decentralized Philosopy
EWS	Engineering Work Station
FCS	Field Control System
FF	Foundation Fieldbus
FFIT	Foundation Fieldbus Interoperability Testing
FMS	Factory Management System
HMI	Human Machine Interface
HART	Highway Addressable Remote Transmitter
HSE	High Speed Ethernet
IEC	International Electrotechnical Commission
IOP	Input open
ISA	Instrument Society of America
ISO	International Standard Organization
ISP	Interoperable System Project
LAN	Local Area network
LAS	Link Active Scheduler
LM	Link Master
OOS	Out of services
OSI	Open System Interconnection
PA	Process Automation
PGTS	PETRONAS Group of Technology Solution
PLC	Programmable Logic Controller
PRM	Plant Resource Manager
TCP	Transmission Control Protocol
IP	Internet Protocol

CHAPTER 1
INTRODUCTION

1.1 Background of Study

Fieldbus is a digital communication network that will be used in industry to replace the existing 4-20mA analogue signal. The network is **digital, bi-directional, multidrop, serial bus** communications that interconnect isolated field devices such as sensors, actuators, controllers and transducers. [10] The digital bus serving as the communication backbone for the field devices and controllers. Instead of transferring data in digital mode, it is also designed to resolve process control applications [7].

Chairman of Foundation Fieldbus, John Berra points in his article, that Fieldbus is not a “digital 4-20mA”. It is not a file transfer protocol. It is nothing short of a total change in the architecture of process automation. It cannot be analyzed on any conventional basic. A narrow focus on things like cheap cost and speed result in a perspective that misses the whole point. The only way to analyze Fieldbus is from the perspective of automation an end user’s plant. How does Fieldbus improve plant performance, plant safety and plant availability? How does it lower installation and operating costs? This is the only perspective from which to judge a Fieldbus. [8]

For this project, FFIT is the collaboration between the PGTS, UTP and vendors which is the main owner of this technology facility. UTP will provide the installation and commission testing facilities for the Foundation Fieldbus system and the testing will be carried out in the UTP. All FFIT equipment conforms to IEC 801, EN 50081-2 and EN 50083-2 requirements for Electromagnetic Compatibility (EMC).UTP will be the owner of the testing facilities, including the equipment.

1.2 Problem Statement

1.2.1 Problem Identification

Fieldbus has open since 1980 and this technology is not widely used in industry. Fieldbus is not so simple. The biggest problem about Fieldbus is people are not so familiar with Fieldbus system. Understanding the Fieldbus system is not easy as understanding the 4-20mA analogue signal. For the industry to adopt the Fieldbus system, a comprehensive understanding on the interoperability of the system is required.

When digital communications first began to appear, every vendor invented their own protocol independently of others. Soon, many different proprietary protocols were in the markets and products could only work with other products from the same vendor. One of the goals of standardization committees is to define a standard protocol that all devices can follow, thus making it possible from different manufacturers to interoperate and work with each others. So, a test needs to be done to verify the interoperable of different hosts and field devices.

1.2.2 Significant of the Project

After complete the research and testing for FFIT, the final results shall be implemented in PETRONAS Group-wide. The testing and calculation will determine the performance of the Foundation Fieldbus system. The FFIT SKG 14th team projects from PETRONAS will also involve in the testing process and share their knowledge base on the FFIT. The outcome of this project is a comprehensive technical report on the FFIT in the form of guidelines, procedures and standards to be implemented in PETRONAS Groupwide.

1.3 Objective and Scope of Study

1.3.1 Objectives

The objectives of FFIT project are:

1. To perform the interoperability testing of Foundation Fieldbus system namely the basic test, stress test and diagnostics test by using the Yokogawa system as a host. For this phase, the focus is to repeat the basic test.
2. To provide familiarization on the Fieldbus system for scientific researchers and engineers, for further development of either laboratory or industrial applications.
3. To perform technical verification and interoperability of Foundation Fieldbus host and devices.
4. To test for the Fieldbus devices limitations by using the Pepper Fuchs segment checker.

1.3.2 Scope of Study

The FFIT scopes of project activity consist of:

1. To detail the approach in designing, configuring and implementing a Fieldbus test rig from various loose field devices, controllers and actuators, and the software development tool.
2. Build understanding on Fieldbus and its technology.
3. Basic interoperability test including operability and ease of maintenance.
4. To come out with a comprehensive report on FFIT that will be the reference for Foundation Filedbus system in PETRONAS.
5. Ensure the entire testing meet PETRONAS Technical Standard on Foundation Fieldbus system.
6. Familiar with vendor (Yokogawa) system configuration.

CHAPTER 2
LITERATURE REVIEW

2.1 Origin of the Technology

2.1.1 The Evolution of Control System

Control systems were mainly located right at the process under control in the early of 1900's. At that time, controllers were mainly manual-based in nature and the field devices that completing the control loop were mechanical gadgets, that transmitting process measurements to the operator and receiving commands from the operators through cam and lever mechanisms.[11] This resulting a huge number and great coordination effort of human to operate a large scale process. At that time, there were no centralized control possibilities and therefore only a little scope for any system wide optimization.

Through year's development of in analogue transmission methods and standard, automatic control systems become possible. In 1940's process instrumentation relied on 3-15psi pneumatic standard, which will work naturally for the mechanically instrumented process [12]. In 1960's, the 4-20mA electrical standard was introduced for instrumentation. This standard can serve the same purpose with a higher level of efficiency in transmission and intrinsic safety and it is also widely accepted as international standard and still being used today [11]. In spite of this standard, several of signal levels were used to suit many instruments which were not designed to the standards specifications. The development of digital processors in 1970's sparked the use of computers to monitor and control system of instruments from a central point. [12]

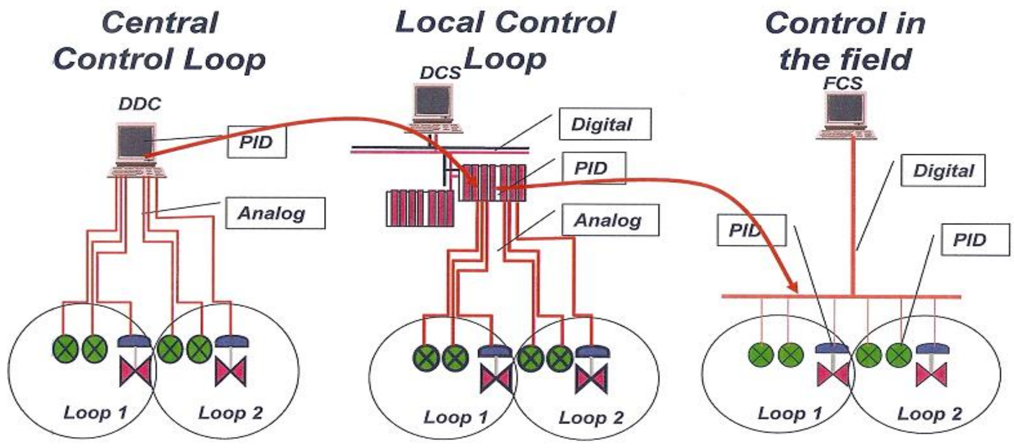

Figure 1 Migration of Control System

The concept of DDC, consist of computer control system in the central room that linked direct to the field devices through analog signals. DDC replace lots of analogue components with a digital computer running a real time operating system. Each control loop, which is each device, will connect on the same digital computer. The maximum number of loops would be function of computer processing speed, A/D conversion time and the complexity of control equations. The analogue systems that are not required in this DDC system are: [13]

- Analogue Controller
  The digital computer performs the programmed to simulate the required control action. Moreover, the single digital computer could be programmed to perform more complex control actions compare to many analogue controllers

- Display Instrument
  All information displayed on digital computer

- Set Point Dial
  Could be defined in the program and modified from operator console

- Comparator
  Comparison between set point and actual valve could be done on digital computer

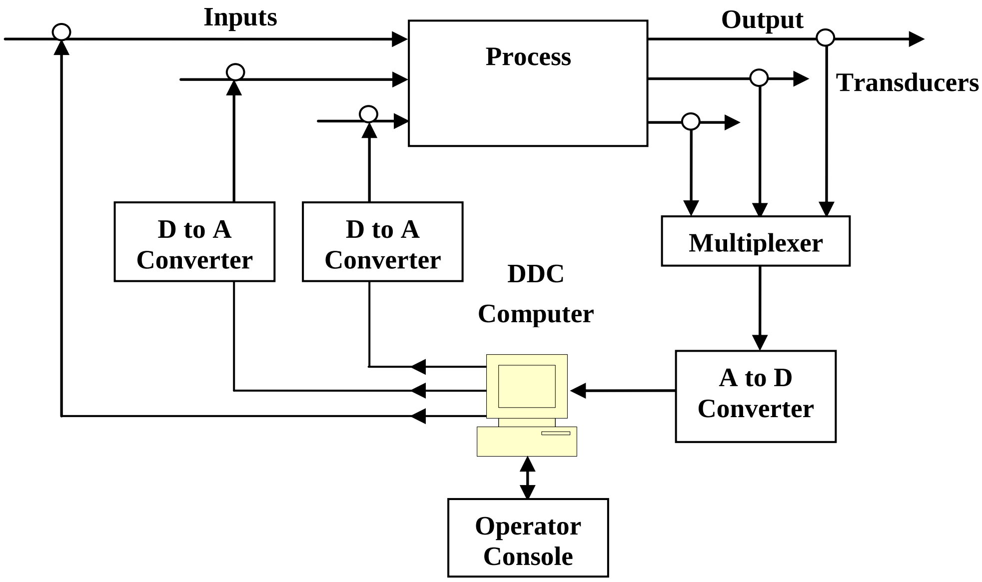

Figure 2 Typical DDC Systems

Figure 2 show the typical DDC system. The multiplexer receive the signal from the transducers and scan it. Then the analogue signal from the transducer is converted to digital that will be process in the DDC computer. Then, from the DDC computer output, the digital signal to open or close valve, are send straight to the device meanwhile for analogue signal to control variable flow, digital signal from DDC computer need to convert to analogue signal.

The advantages of DDC are it is easy to program and modified a complex control strategy than the analogue hardwired elements. DDC also save the cost for analogue controllers its more reliable compare to analogue. DDC is also faster and easy to do diagnostics. The disadvantages of DDC are it is required backup system. Because all the functions were concentrated into one computer, the entire system with all of its fail if there were even a single fault occurs. Moreover, the programming cost for complex DDC also costly.

After the DDC system, the new evolution system called DCS being implemented. DCS is a control system that the controller elements are not central in location but distributed throughout the system. DCS is a complete system that consists of HMI, control modules and remote I/O. Distributed means to perform control functions over a series standalone control modules, distributed physically and linked via a communication highway [11]. Figure 3 is a system architecture of DCS.

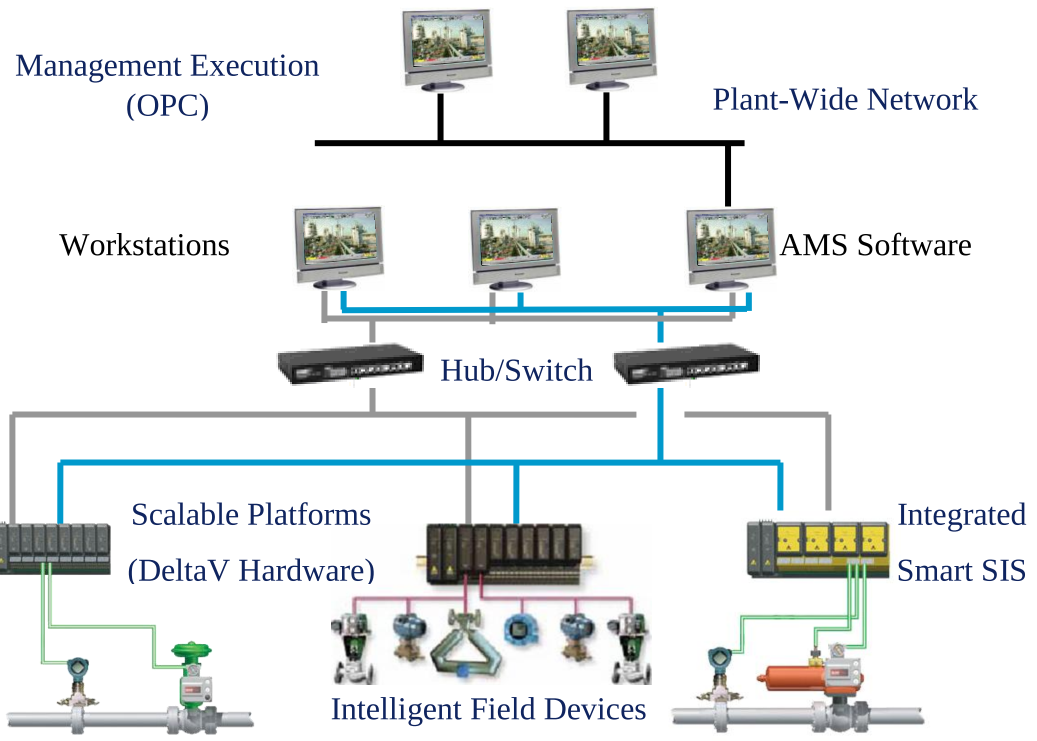

Figure 3 Distributed Control Systems

DCS was a great improvement over DDC which is a single fault would only affect part of the plant, not all of it as compare with DDC. The higher level of distribution increases the availability of the system. Not all of the smart instrument protocols allowed simultaneously 4-20 mA and communication a as result, many system were unable to use the communication features. Most of the DCS models did not provide the HART interface because of the system manufacturers had their own proprietary protocols standard. So, plants were needs to buy the field instruments from the system supplier rather than field instruments from other companies.[18]

An improved architecture of DCS is the FCS. In the 1980's smart sensors began to be developed and implemented in a digital control, microprocessor environment. This prompted the need to integrate the various types of digital instrumentation into field networks to optimize system performance. While the "if it works then use it" mentality progressed, it became obvious that a Fieldbus standard was required to formalize the control of smart instruments.[12] The main difference from DCS are the FCS use less wiring, fewer intrinsic safety barriers and marshalling cabinets and less exposed to faults due to use of smart devices.

2.1.2 Fieldbus History

In early 1970s the idea of the Fieldbus technology has developed with the first attempts to distribute control functionality to the field level. With the introduction of DCS, processing plants were able to distribute intelligent control throughout the process facilities.

At that time, field devices are limited and the data that sent to DCS are very minimal. The devices communicated to the controller with pneumatics or 4-20mA analog signals. The real process information were limited and often obtained through interpolation, inference or expensive gateways and proprietary data acquisition implementations. The process to obtain the data was too complex and costly.

In 1980s, members of ISA's SP50 committee have developed the digital communication standard for field devices. They spend years to define the technical requirements and building consensus for a digital Fieldbus.

In late 1994, two parallel consortiums, the ISP and WorldFIP North America merged to form the Foundation Fieldbus. Their effort achieve in an internationally acceptable Fieldbus standard. The organized development programs, free trials and established the industry's most exact program for testing and registration of Fieldbus devices. The advanced digital communication result in proper transfer and handle of data is essential. User gain the power to implement tightly digital control based in unified system architecture and high speed backbone. The Foundation Fieldbus replace the incompatible networks and based with an open, fully integrated architecture for information integration and distributed real time control across the enterprise. [3]

2.2 Fieldbus Overview

Foundation Fieldbus is a digital, two ways, multi-drop communication link among intelligent field devices and automations [7]. Fieldbus provides digital communications at 31.25kbps over existing wiring and also meets intrinsic safety requirements of the process industry.

Fieldbus is the communication link that addressing the specific needs of the field devices for the process control system. Fieldbus meet the needs of any CIM application where smart sensors are applied. Fieldbus provides an open international communication standard for connecting field devices to computer based controller such as Workstations and PLC [1].

The term of "Fieldbus" is generic and it does not refer to any specific technology, protocol or product brand. Fieldbus allow true distributed control system where control can be located at host or filed or both. Fieldbus differs from others communications technologies in the fact that they have been specifically designed for automation and process control. Although usually based on technologies known and used across various fields, Fieldbus do have specific provisions to suit the intended areas of application. Figure 4 shows the Fieldbus network overview:

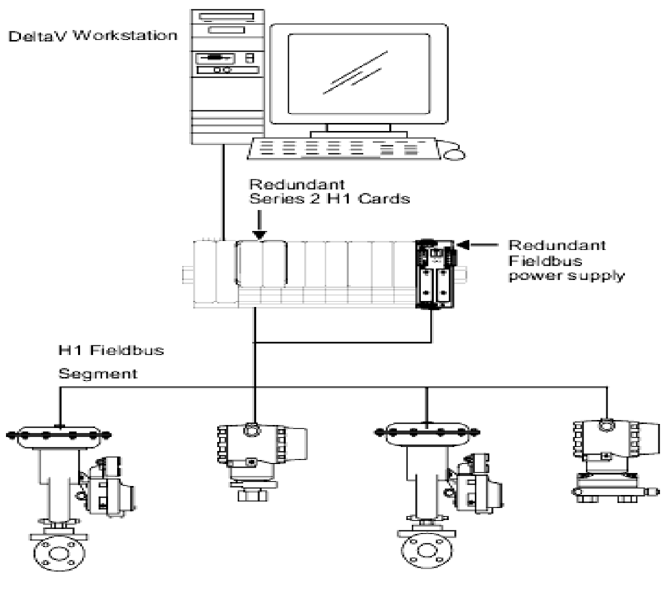

Figure 4 Fieldbus Network Overview

Fieldbus is not only communications protocol but also a programming language for building control strategies. Fieldbus has the ability to perform control that is distributed into the field devices rather than central controller. It is common for the valve positioner to act as a controller for the loop which part of it. It executes the PID function block but only for its own loop but not for other loops. In the FCS architecture the instruments on the field level networks are connected to the workstations via a linking device to the host level network.

2.3 Fieldbus Topology

Topology describes the shape of network. Basically there are four types of topology which are Point to Point, Brach, Daisy Chain and Tree Topology. Some of the topology more reliable than others depends on situation and condition. Figure 5 shows the typical network topology.

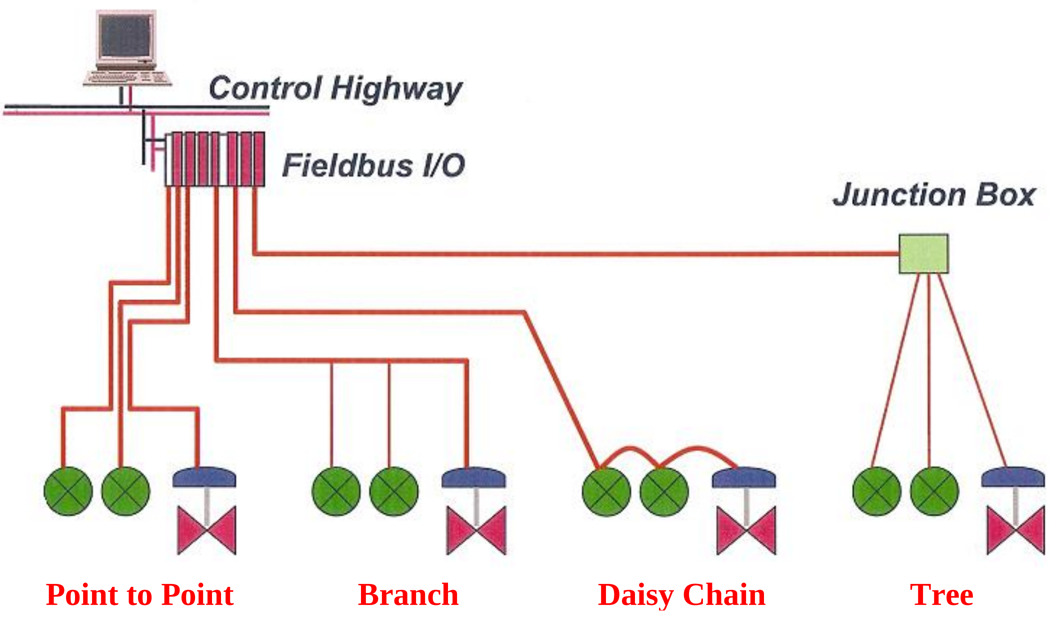

Figure 5 Typical Network Topology

2.3.1 Daisy Chain Topology

Figure 6 Daisy Chain Topology

All the devices are used to connect in serial connection. The Fieldbus trunk is routed from one device to another next device and being interconnect to the terminals of each Fieldbus devices.

2.3.2 Point to Point Topology

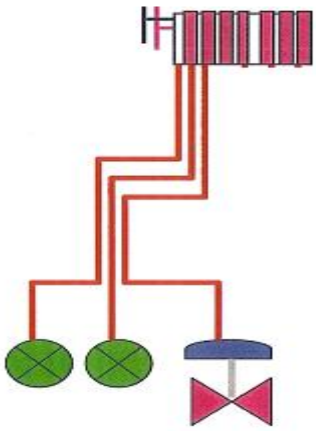

Figure 7 Point to Point Topology

In the point to point topology, only a single field device slave is connected on each pair of wires. Point to Point topology connects two devices directly. The two connections maybe located at the field which is between a transmitter and a valve, or connect between the field devices to the Host Device.

2.3.3 Branch Topology

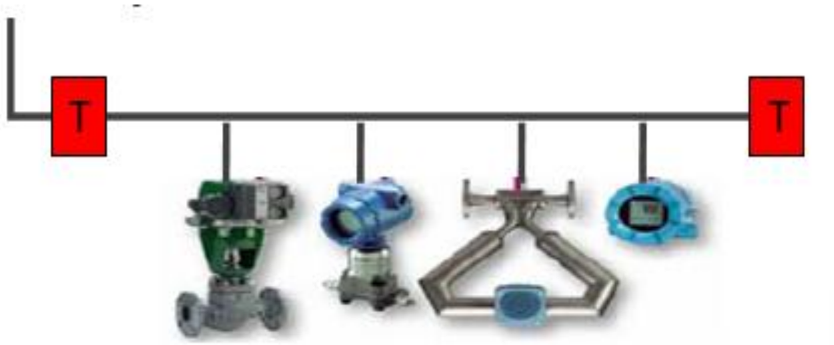

Figure 8 Branch Topology

Branch topology use a single bus and several spur are connecting directly to the bus. The spurs then connect to the devices. One spur can connect to several devices.

2.3.4 Tree Topology

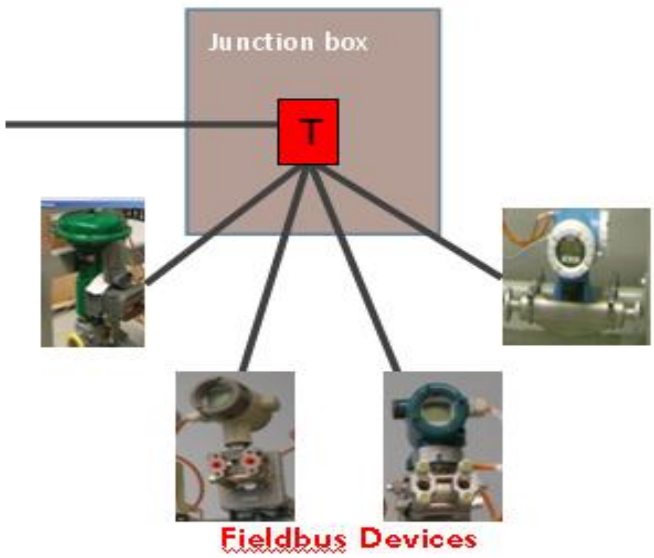

Figure 9 Tree Topology

Tree topology concentrated on connecting several field devices to the junction box. All of the devices on the segments are at the end of the Trunk cable. This tree topology is also known as "chicken-foot" topology. Tree topology is so popular because it is more reliable as it minimizes the number of wire transmissions.

For this FFIT project, it used the tree topology in the Fieldbus system as the only topology that being allowed by PTS is tree topology. Tree topology is the standard practice and applied in most of PETRONAS plants. If many devices are connected on a single pair of wires, then the voltage drop over the resistor will be high, and consequently the power dissipation as well. The power supply output voltage and the resistor power rating must therefore be calculated. Typically, no more that fifteen devices are connected on network.

2.4 Fieldbus Standard

Fieldbus protocols and systems have been developed in line with the ISO/OSI seven model layer as shown in Figure 10. It divides the features of any communication protocols into seven distinct layers from the physical layer to the application layer. A number of Fieldbus concepts have been chosen to form only 3 layers shown in Figure 11 which is consist of physical layer, link layer and application layer. [9]

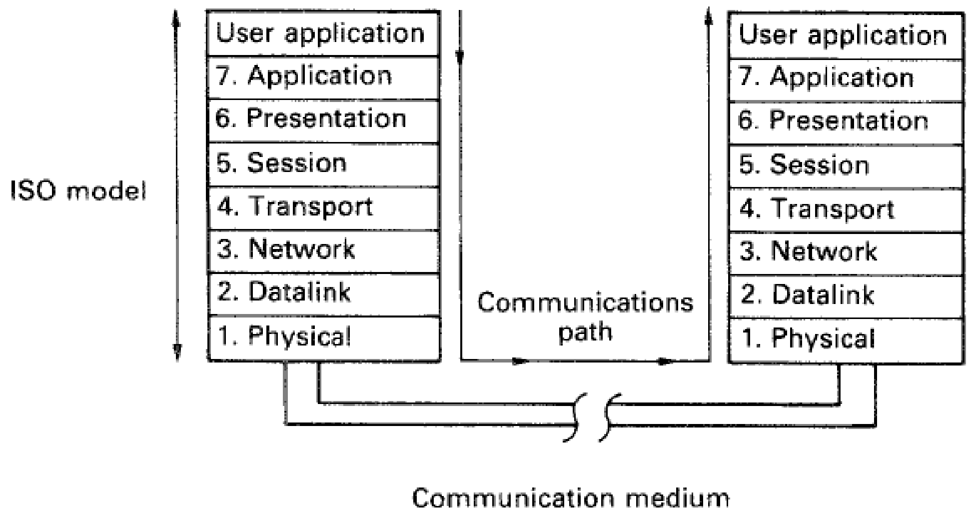

Figure 10 ISO/OSI Seven Layers

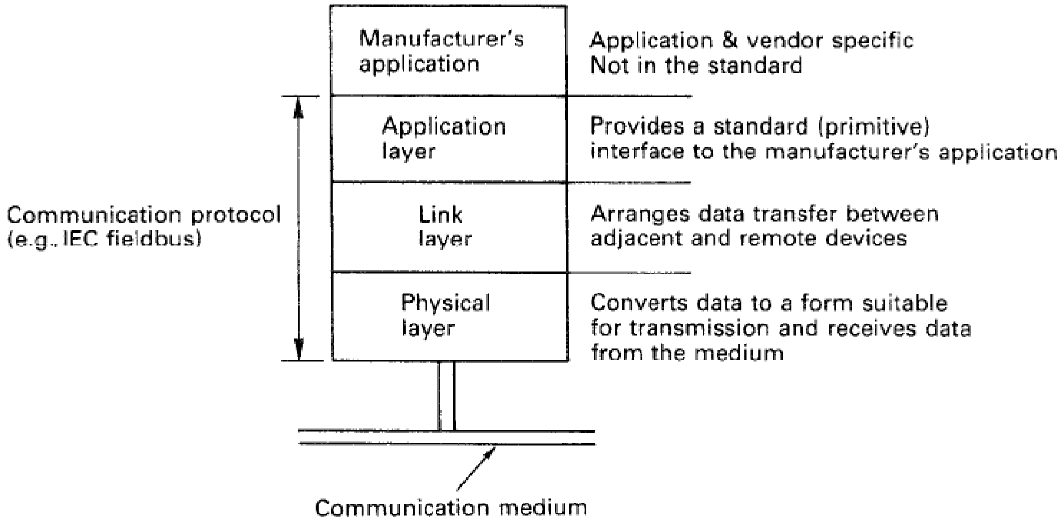

Figure 11 Three Layer Implementation of Fieldbus Concept

Table 1 Layer and its Function

Layer	**Function**
Physical Layer	Specifies the connection medium
Data link Layer	Specifies the Interface between the protocols
Application Layer	Specifies the Interface between the protocol and application running it

The physical layer can take many forms such as twisted pair, coaxial cable, radio link, infrared and optical cable. Each medium then have different specifications to allow for variations in performance requirements such as different data transmission speed.

Typically, each layer in the transmitting device adds a piece of information to the original message, which is then stripped off in the corresponding layer of the receiving device. For example, the data link layer may add a destination address that is then removed in the data link layer of the receiving device.

2.4.1 IEC 61158

IEC established a working group to define a bus standard for field instrument in 1985. In January, IEC approved IEC 61158, "A Fieldbus standard for use in industrial systems".

IEC 61158 consist of seven parts. Part 1-2 is for introduction and management part. Part 3-6 is the data link to application layers in ISO/OSI model. IEC 61158 is to ensure reliable inter device communication for the user layer which is a vital but basic requirement. The IEC 61158 standardizes eight different Fieldbus types:

- IEC 61158, Type 1 Foundation Fieldbus H1
- IEC 61158, Type 2 ControlNet
- IEC 61158, Type 3 Profibus DP/PA
- IEC 61158, Type 4 P-Net
- IEC 61158, Type 5 Foundation Fieldbus HSE
- IEC 61158, Type 6 SwiftNet (withdrawn)
- IEC 61158, Type 7 WorldFIP
- IEC 61158, Type 8 Interbus

Other Standards:

- IEC 62026-2 AS-i

2.5 Foundation Fieldbus

Foundation Fieldbus is a starndard that have been developed by foundation Fieldbus in 1994. Foundation Fieldbus is just one of many types of Fieldbus. It is formed to complete development of a Single Open, International, Interoperable Fieldbus Technology. Foundation Fieldbus has its own communication points at the controller level. It require only one communication point at the controller and allow multiple (100's) of analog and digital points to be connected at the same time. This will reduce the usage of cables. Figure 12 shows the Foundation Fieldbus architecture:

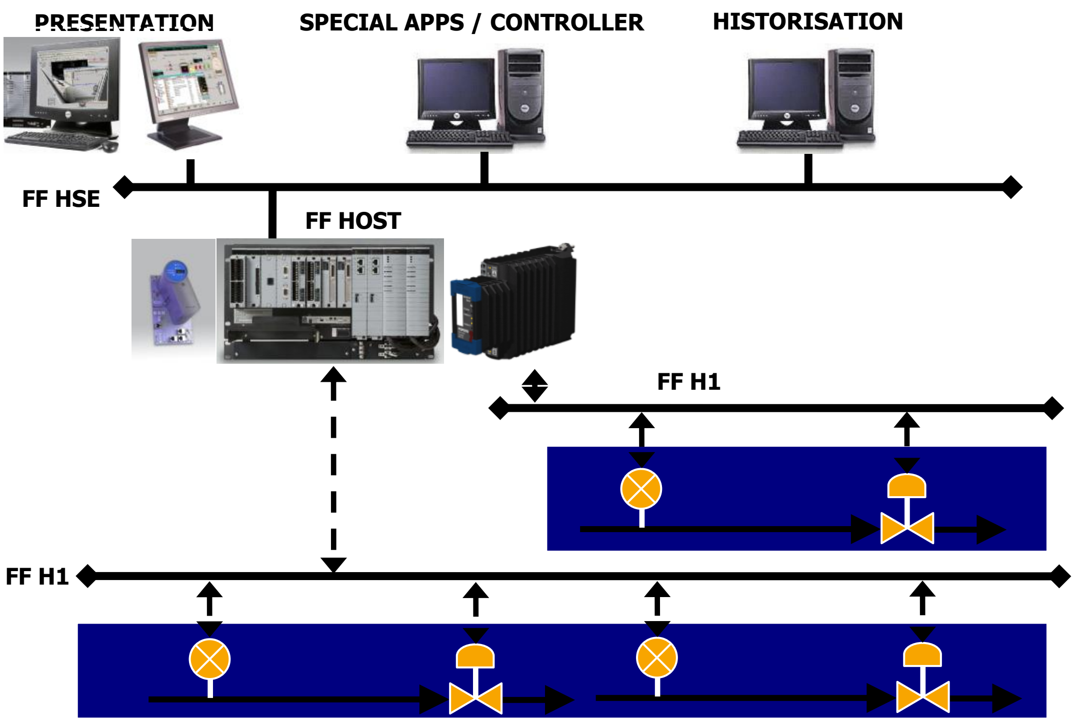

Figure 12 Foundation Fieldbus Architecture

2.5.1 Foundation H1 and Foundation HSE

` The Foundation system is a systematic technology that comprised of a bi-directional communication protocol that will be used for communication among the field devices to the control system. There are two implementations use different physical media and communication speeds which are **H1** and **HSE** (High Speed Ethernet). [3]

- **H1**
  - Transmission rate of 31.25kbps
  - Interconnects device such as actuators and transmitters on a field network
  - Foundation HI is intended primarily for process control, field level, and interface and device integration.
  - Cable length up to 1900m
  - Intrinsic safety
  - Use standard Twisted Pair Cable
  - Each segment support up to 32 devices

- **HSE**
  - High Speed Internet with transmission rate of 100Mbps
  - Control Network technology specifically to connect higher-level devices such as controllers and remote I/O
  - Connect input/Output subsystems, host systems, linking the devices gateways and field devices using standard Ethernet cabling
  - Length of cable for 100BaseTX-copper pair up to 100m while for 100BaseFX-fiber optics up to 2km

2.5.2 Segment Design

Theoretically, each segment can support up to 32 devices. In real plant, the average number of devices per segment is around 12-16 devices only. When designing segment, several requirement need to be consider. First, the current draw by each Fieldbus device. Second, the length of segment because the voltage drops occurs along the cable. We also need to take note that the maximum voltage of 9V must be available at the field device terminals to operate properly. Many users specify a margin on top of 9V minimum operating voltage to allow for unexpected current loads and adding additional devices in the future. [17]

2.5.3 Cable Specification and Wiring Rule

Fieldbus, an emerging instrument standard, promises data communication among low-power field instruments. The standard specifies a low-speed data rate under 100 kbits/second using single- and multiple-twisted-pair cables at distances up to 1900 meter. The cable parameters of importance to data communication are attenuation and phase constants, characteristic impedance, and crosstalk; which are generally not available for the existing installed cable. Knowledge of these parameters is helpful in determining acceptable lengths and topologies of proposed networks, and is essential in simulation of signaling on proposed networks. [6] The most importing thing when determine cable length is the maximum voltage of 9V must be available at the field device terminals to operate properly.

The IEC/ISA standards have specified the minimum amplitude and worst waveform signal for the received signal from the Fieldbus device from the field. The ISA SP50 committee has created a set of wiring rule to simplify the network design. Recommended rules by IE/ISA standard:

Table 2 Wiring Rule

Rule 1	The number of devices on a Fieldbus is between 2 to 32
Rule 2	Cable need to be individually shielded twisted pair (type A) 18 AWG wires
Rule 3	The total cable length must not exceed 1900m (including total spur length)
Rule 4	The maximum total spur length shall not exceed 120m
Rule 5	When overall shielded twisted pair (type B) 22 AWG wires are used, the total length shall not exceed 1200m

Table 3 Fieldbus Cable and Maximum Transmission Length

Cable Type	Gauge No.	Max Length (meter)
A: Twisted Pair with Shield	18 AWG	1900
B: Multi-twisted pair with Shied	22 AWG	1200
C: Twisted Pair without Shield	22 AWG	400
D: Multi Core with Shield	16 AWG	200

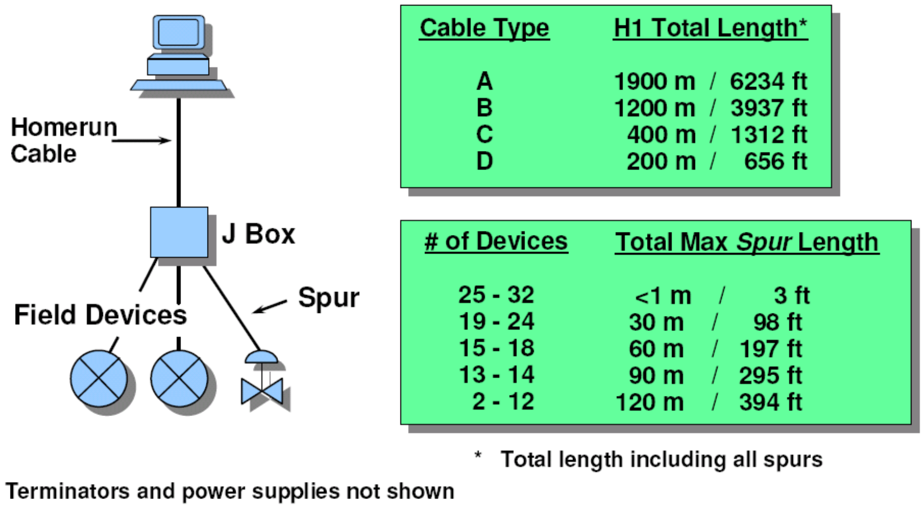

Figure 13 Cable length Recommendations

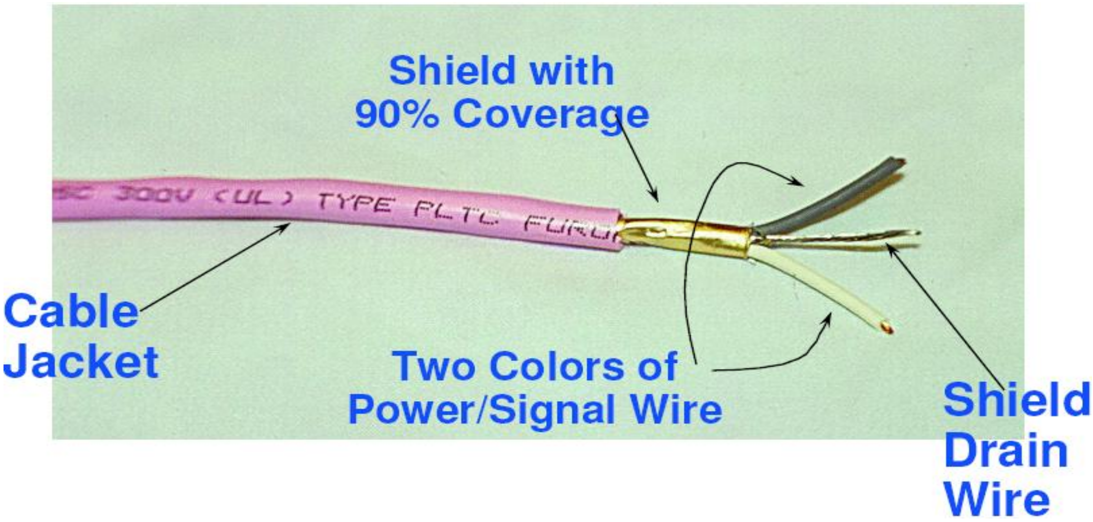

Figure 14 Shielded Twisted Pair

2.5.4 Device Descriptor (DD)

DD is a driver for the Fieldbus devices. New devices are added to the Fieldbus by simply connecting the device to the Fieldbus segment and providing the control system of host with the DD. DD allows achieving interoperability. It allows operation of devices from different vendor on the same Fieldbus network with only one version of the host human interface.

DD contains standard device descriptions from the Fieldbus foundation which are universal parameters, function block parameters and transducer block parameters. DD also can be downloading from Fieldbus foundation website.

2.5.5 Link Active Scheduler (LAS)

Foundation Filedbus use a single cable from the devices. How this cable bring all the devices information without collide? It is by using LAS system. Digital Communication signals on a link (Fieldbus segment) are synchronized by LAS. LAS separate time critical process data from background MMI messages and download. Only one LAS at a time control the traffic on the bus. The device sends out transmission frames on the bus only when instructed by the LAS. LAS maintain the list of all devices on the bus.

When LAS fails, LM will be the LAS back up. The LM can be DCS or other device such as valve, transmitter and power conditioner. In a segment there can be more than LM but only one LM at one time. When LAS fails, the primary LM with the lowest address will be the backup LAS. Normally, in a plant, LM is the non-critical device and power conditioner can be LM.

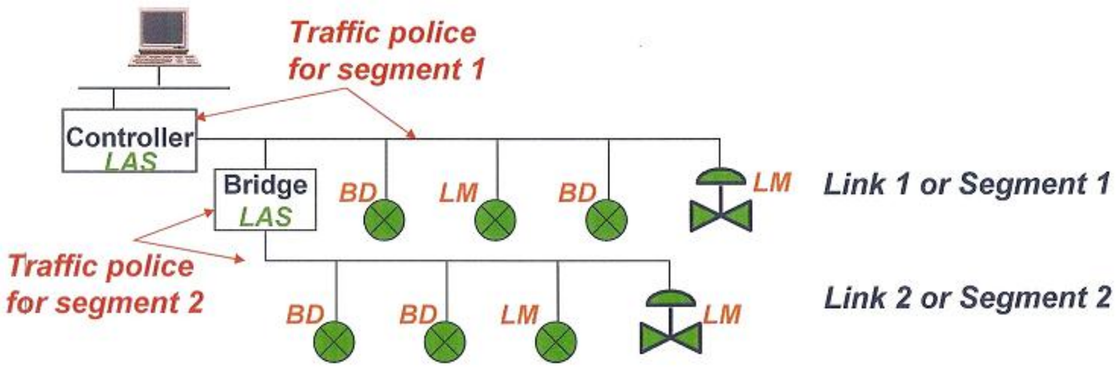

Figure 15 LAS and LM in the Fieldbus

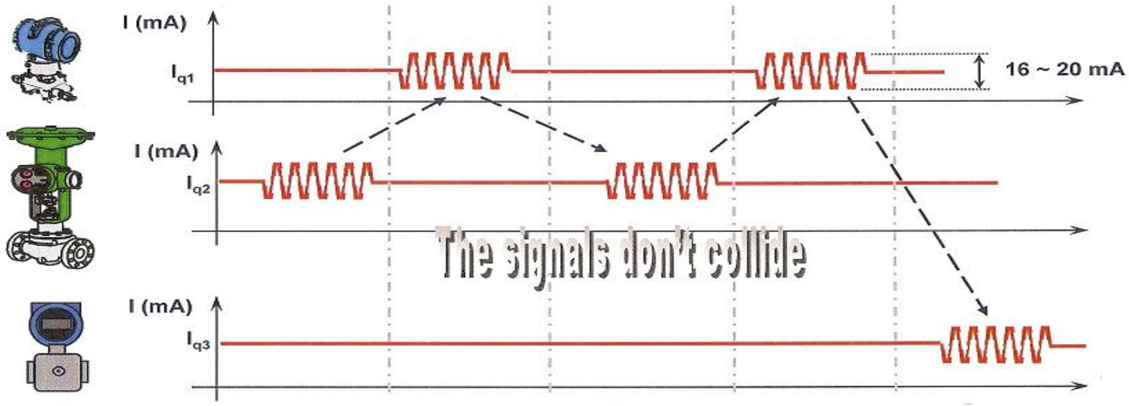

Figure 16 Non Collision Based Communication Protocols

2.6 Others Fieldbus

2.6.1 Profibus

Profibas stand Process Fieldbus. Profibus is a serial Fieldbus system that supports the networking of intelligent field devices and support both master and slave devices. Master device can send a message without external request when it hold bus access right while for slave device, it do not have bus access rights and can only acknowledge receiving or sending message to the master device upon request. It designed for wide range of the application includes the discrete manufacturing, process control and building automation. Figure 17 shows the Profibus architecture.

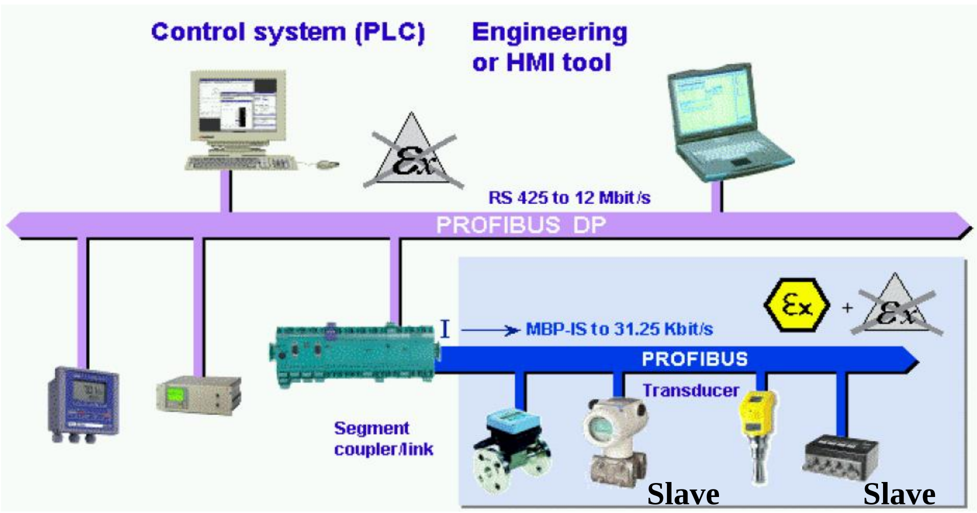

Figure 17 Profibus Architecture

Profibus has 3 families which is Profibus-FMS, Profibus-DP, Profibus-AP. Below are the type of Profibus family:

- PROFIBUS-FMS
    - Optimized for universal, object oriented communication of intelligent master devices at the cell level
    - Profibus-FMS are the transmission of large amount of data
    - Integration of several decentralized process components to one common process and Communication of Profibus-FMS is between intelligent stations

- PROFIBUS-DP
    - Designed to replace expensive wiring between PLC/PC and I/O
    - Very fast, transmit 1 kbit of I/O data in less than 2 ms
    - Reduce configuration and maintenance efforts
    - Supported by all major PLC vendors
    - Wide product range available: PLC,PC, I/O, Drives, Valves, Encoders
    - Cyclic and acyclic data transfer permitted
    - Mono- and multi-master networks
    - Up to 244 byte input & output data per station

- PROFIBUS-PA
    - Based on extended Profibus-DP protocol and IEC 1158-2 transmission
    - Suitable to replace 4-20mA technology
    - Only two wires for data and power
    - Connects instruments to the control system via a serial bus
    - Suitable for EEx-Application with Intrinsic Safety
    - Reliable serial digital transmission
    - Control, regulation & monitor via a simple twisted pair cable
    - A single engineering tool for all devices
    - Interoperability & Interchangeability due to Profibus-PA profile
    - Maintenance & diagnostic information from the instruments

2.6.2 AS-i

As-i stands for Actuator Sensor Interface. It used to network the sensors and actuators. [15] Below are the specifications for As-i:

- Two wire interface for power and data communication
- Based around ProfiSafe (developed from Profibus-DP
- Developed by Siemens Automation
- Unshielded 2-wire(Yellow Cable), Undetermined, Ungrounded Sensor Bus
- Power provided by 24V floating DC supply, supply min 8A over network
- Open standard based on IEC 62026-2 and EN 50295
- Cable length 100 meters per AS-I master (300 m with repeaters)
- Number of Slaves : 31maximum
- Number of nodes : Up to 4 sensors and 4 actuators per slave (maximum 248 binary elements)
- Message format: 4 bits (net) per slave per message
- Cycle Time: With 31 slaves: 5 milliseconds. Real-time performance can be achieved within this his latency and faster times are possible with less slaves
- Device Interface: 4 configurable data ports (as inputs or outputs or bi-directional) plus 4 parameter outputs

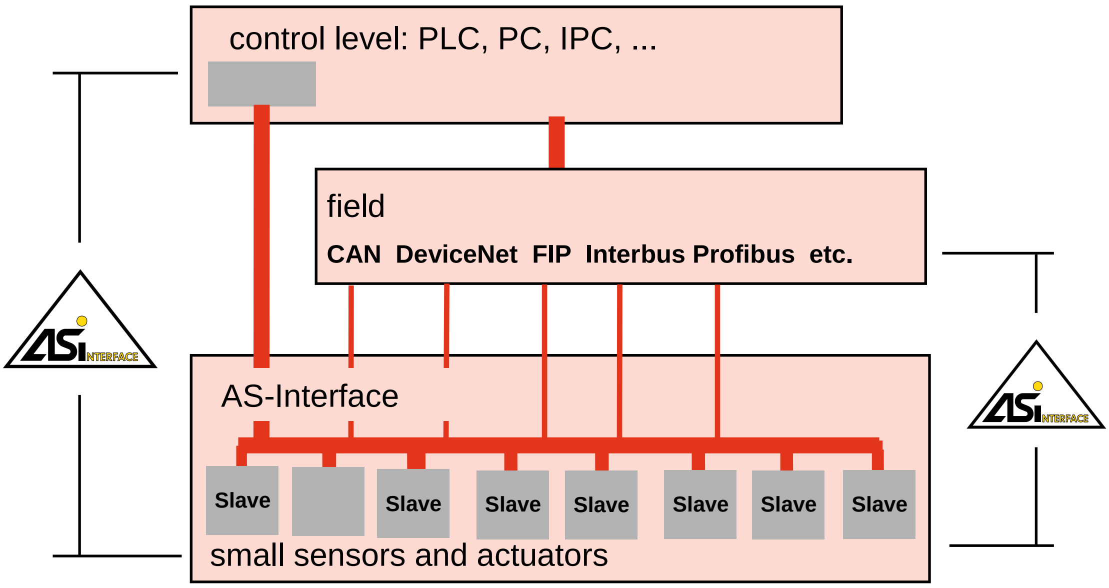

Figure 18 AS-I Architecture

2.6.3 ControlNet

ControlNet is the high level, Mission Critical Fieldbus, plant-wide networking between multiple Workstation, PLC's and sub-networks (DeviceNet, Foundation Fieldbus H1) and process controls. ControlNet used when the situation that required high speed transport of both time critical I/O and messaging data, including upload/download of programming and configuration data and peer to peer messaging.[16] Below are the specifications for ControlNet:

- Origin by Allen-Bradley
- Maximum of nodes can support up to 99
- Use twin redundant BNC connectors
- Maximum distance is 250 but can up to 5000M by using repeaters
- Transmission rate 5Mbit/s
- Message size is 0-510 bytes, based on Product/Consumer model, multi-master, pear to peer, fragmented, prioritized and deterministically schedule repeatable messages, dual transmission paths for build-in redundancy

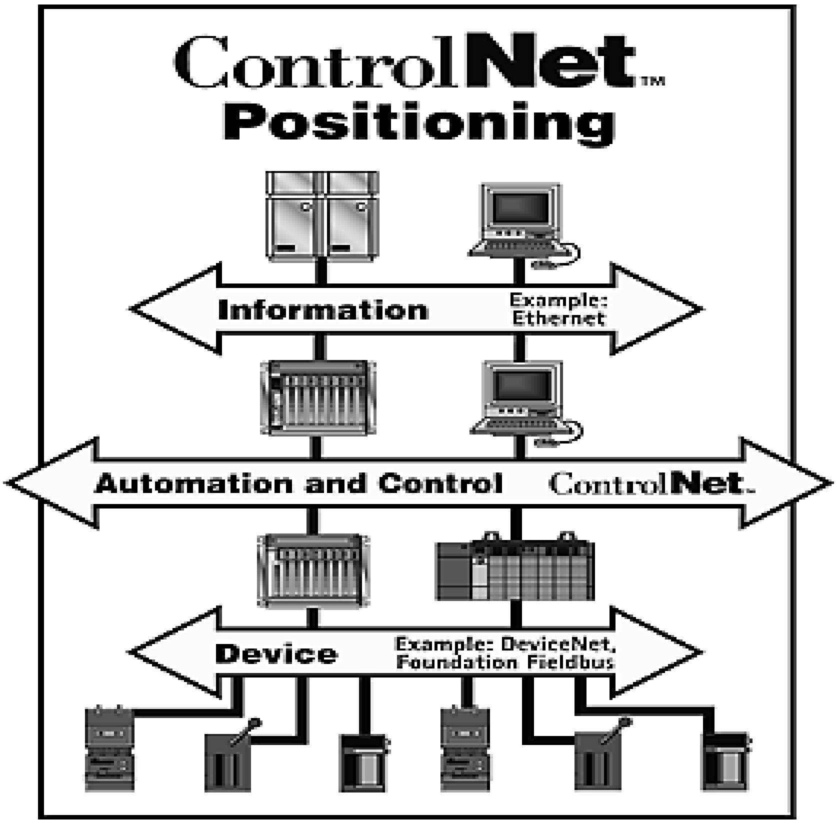

Figure 19 ControlNet Architecture

2.6.4 P-Net

P-Net was developed by PROCESS-DATA A/S. P-net is based the EIA485 standard. Below are the specifications for P-Net

- Similar to Profibus and Foundation Fieldbus
- Maximum 1200m cable length, shielded
- Support up to 125 field devices
- Only allows one data rate 76,8000bps
- Data send as an asynchronous transmission
- The bit encoding used is Non Return to Zero (NRZ) encoding
- Bus structure is physical ring without termination

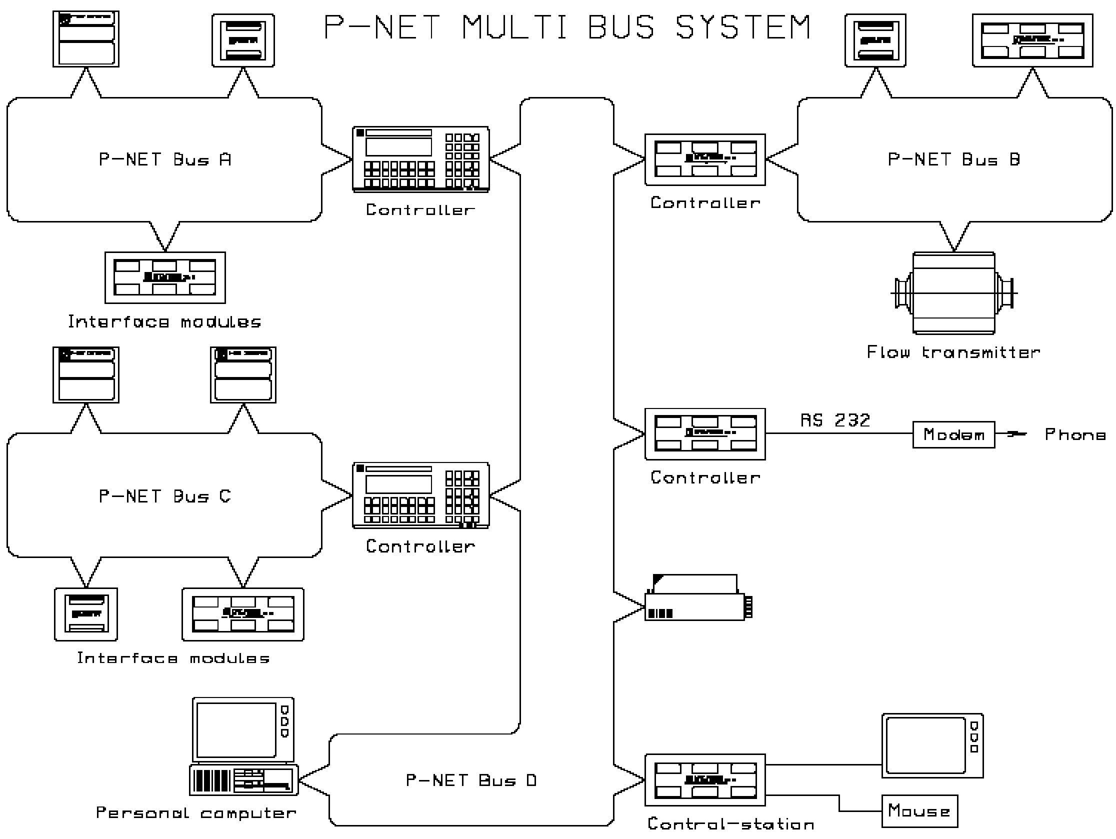

Figure 20 P-Net Architecture

Refer to Appendix A for details about Fieldbus types.

2.7 Interoperability

Interoperability is the central theme of Fieldbus. Interoperability authorizes users to “mix and match” field devices and host system from the various vendors and manufacturers on the same Fieldbus at the same time maintaining specific operations. Without host company revisions, field devices can be added or replaced on a Fieldbus network. Fieldbus device can be replaced by similar device from different supplier and the system able to work with the device. [4]

With interoperability, designing, building and maintaining the Fieldbus system are more easier by transferring data in standard format among the system builder, device vendor and user sites. Various tools are needed for Fieldbus can communicate through value file. DD (Device Description) is a technology that achieves interoperability of the Fieldbus devices. The interoperability of various tools that is used for Fieldbus engineering will be accomplished by using the value file. For example, if there is an off-line configuration tool and downloader or an uploader that can understand the value file, any such tools can be used. Interoperability will be realized by keeping the external interface provided as the value file, even if the tools are developed by separated vendors. [5] These are the benefits of interoperability:-[4]

i. Implementing control strategy over Fieldbus, which allows control capabilities to be migrated to and executed in field devices. All device must be synchronized in their operation with the bus and with other devices on the network without intervention by host
ii. Monitoring control variables and status periodically, then string the information in a database for subsequent analysis and reporting. Typically a single host system will perform data acquisition from a large number of Fieldbus devices from multiple suppliers
iii. Configuring and maintaining Fieldbus devices, which required that devices have the capability to be configured and have diagnostics executed remotely by the maintenance console of a different vendors over the Fieldbus.

2.8 Advantages and Disadvantages

2.8.1 Advantages

This is the comparison between the conventional instrument system and Fieldbus instrument system. [7]

Table 4 Comparison between Conventional and Fieldbus

SI No	Conventional Instrument System	Fieldbus Instrument System
Cable Requirement	Huge	Around 1/10th for analog signal
Hardware (PID Controller)	Depending on no. of loops	Not required. Soft PID Functional Block available
Interoperability	Not there	Available
I/P Converters	Required for valve control	Not required
Cable Tray	The size is more	Small Size
Configuration	More steps	Easy

The advantages of Fieldbus are:-

- More information available foe operations
- Increased accuracy of measurements
- Easier evolution due to standardized function blocks
- Increase flexibility of instrument

The implementation of Fieldbus based instrument system will minimize the overall cost and maintenance, make the system interoperable and reduce hazards in accelerators and will make the operators life easy. This will result the better productivity hence will improve the organization profit. The safe operation of facility will not affect environment and general public within and outside the operating facilities. [7]

2.8.2 *Disadvantages*

This are the disadvantages of using Fieldbus compared to the 4-20mA analog signals standard: [2]

- Fieldbus system more complex, so users need to be more extensively trained or more highly qualified
- The price of Fieldbus components is higher
- Fieldbus test devices are more complex compared to a (high-spec) multimeter that can be used to read and simulate analog 4-20 mA signals
- Slightly longer reaction times with Fieldbus, depending on the system
- Device manufacturers have to offer different versions of their devices (e.g. sensors, actuators) due to the number of different (incompatible) Fieldbus standards. This can add to the cost of the devices and to the difficulty of device selection and availability.
- One or more Fieldbus standards may predominate in future and others may become obsolete. This increases the investment risk when implementing Fieldbus.

CHAPTER 3

METHODOLOGY

3.1 Project Process Flow

Figure 21 shows the flowchart for the overall project which will be applied throughout the project.

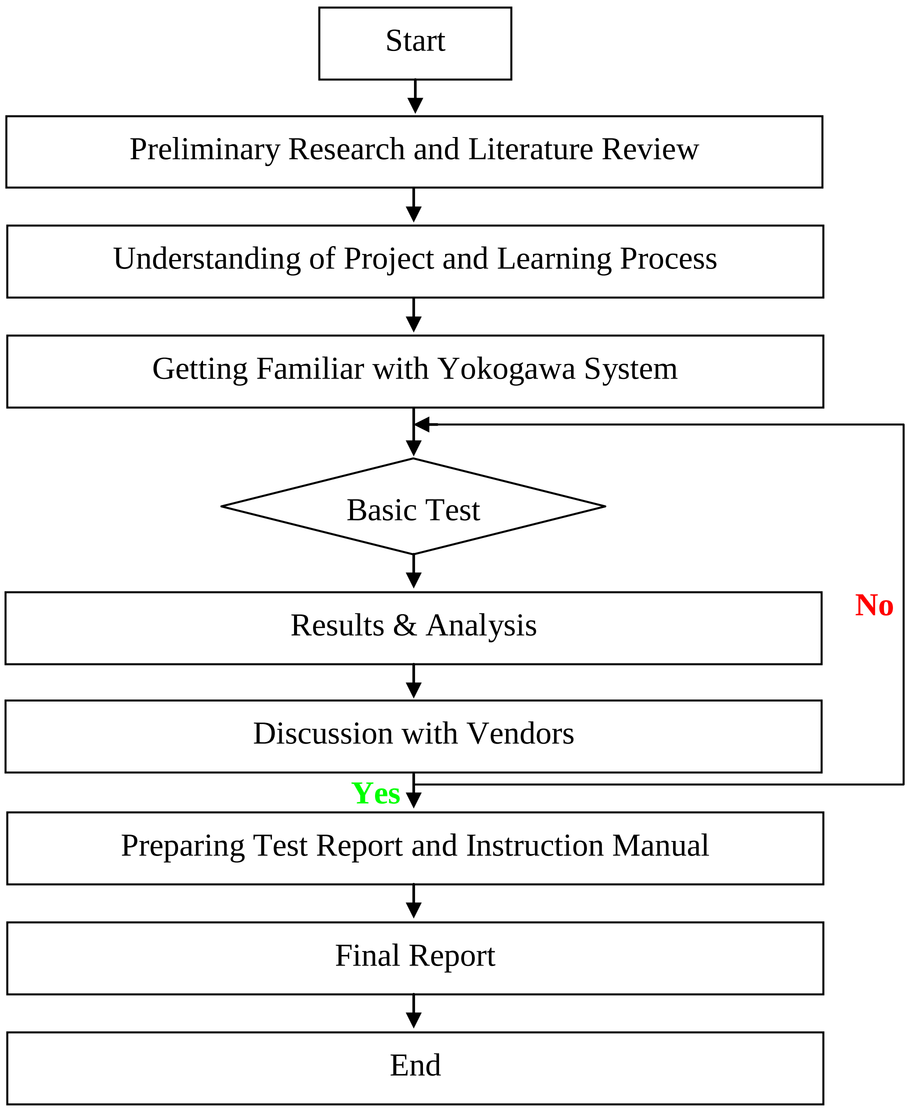

Figure 21 Flows for the Testing

3.1.1 Preliminary Research and Literature review

At the early state of this project, the preliminary researches and literature review on the chosen topic need to be done. The literature review is done by researching the available resources which is journals, articles, conferences papers, books and internet. Emerson also comes to UTP to give training and familiarization regarding what is the Foundation Fieldbus.

3.1.2 Understanding of Project and Learning Process

The understanding of the project details is done by meeting with the SKG 14 group project members. They share their ideas regarding the projects and it is very useful in building up a good perspective and gives a clear idea what is this project about and how to meet their standards.

3.1.3 Getting Familiar with Yokogawa System

Familiarization with Yokogawa system needs to be performing before involve in any test. There are 2 workstations on Yokogawa system, one is EWS and the other one is PRM. EWS is a workstation that with engineering capabilities used for system configuration and system maintenance. Meanwhile, PRM is a Plant Asset Management (PAM) solution. It is an online and centralized automation asset management system that strives to reduce downtime and maintenance costs.

3.1.4 Basic Test

Basic test is one of the interoperability test procedures. Basic test consists of several steps which is decommissioning and commissioning, online device replacement, drop out test and calibration function check. This entire test is to prove the interoperability and functionality of Foundation Fieldbus.

3.1.5 Results and Analysis

After completing the basic test, analysis need to be done to the receive result.

3.1.6 Discussion with Vendors

We need to present to the vendor, Yokogawa people regarding the result that do not meet with the standards. If there is any problem regarding the system host and devices we need to seek for the vendor's explanation and ask them to fix the problems. During the testing, there were few devices that are not up to date with the DD files and problem occurs during the equalization process.

3.1.7 Preparing Test Report and Instruction Manual

The testing report need to be done on what we got and study during the testing was conducted as a reference to the Petronas SKG 14 group. The instruction manual that had been prepared by the Petronas also needs to update. This is to ensure the step to do the test is easily understood for the future researches.

3.1.8 Final Report

Prepare the final report for the Final Year Project based on what I have learned about this project.

Refer to Appendix A for Project Gantt chart

3.2 Basic Test Interoperability Testing Flow

Figure 22 shows the flowchart for the basic test procedure which is one of the Foundation Fieldbus Interoperability Testing procedures.

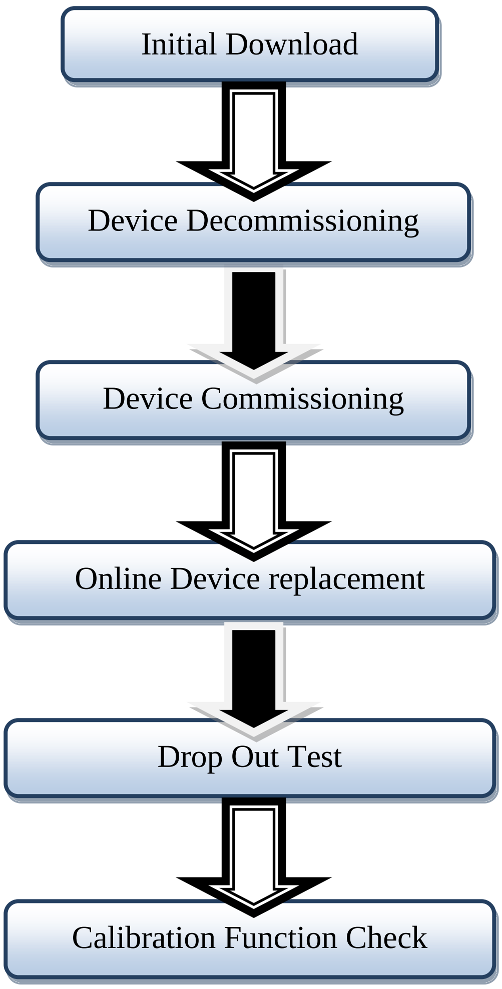

Figure 22 Flows for the Basic Test

3.2.1 Initial Download

Initial download is to ensure that the device information is being uploaded to the host and the host will download to the entire system. Initial download need to be performed each time the system changing the host.

3.2.2 Device Decommissioning

This test shows a proper method to put the system in offline mode if the devices need to be replaces or for maintenance work. The process must make sure that host does not scan the detached device as error. Generally, in Foundation Fieldbus, there were only 4 temporary addresses that available for decommissioning purpose.

3.2.3 Device Commissioning

This test aim is to come out with proper procedure to commission devices and come out with guidelines on device commissioning. The commissioning process must not interrupt the system or affect other devices on the segment. For Basic Test, the commission covers only the preregister devices and the other new device will cover for in the extended test.

3.2.4 Online Device Replacement

This test is done to verify that system can acquire the device ID automatically when any new devices attached to the Fieldbus system.

3.2.5 Drop Out Test

This test is to ascertain that device failure will not affect the overall segment or any other healthy devices in a segment. This test also checks whether signal is automatically recovered once the device is online.

3.2.6 Calibration Function Check

This test aim is to come out with a procedure to calibrate the device by using 3 different procedures which is from EWS, PRM and 375 Field Communicator.

3.3 Tools

The testing will be using the following tools

- Yokogawa system, Centum CS3000
- Foundation Fieldbus Interoperability Test Facilities.
- 375 Field Communicator

Figure 23 Foundation Fieldbus Interoperability Testing Facilities

Table 5 and table 6 show the field device details in the lab that consists of segment 1 and segment 2.

Table 5 Segment 1 Devices

	DEVICE NAME	LOGIC NAME	DI / DO / AI / AO NAME	ADD	VENDOR
1	TT201	TI201	TT201AI1/ TT201AI3	22	ROSEMOUNT
2	PT202	PI202	PT202AI1	23	ROSEMOUNT
3	TT203	TI203	TT203AI1	24	ROSEMOUNT
4	PDT204	PDI204	PDT204AI1	25	ROSEMOUNT
5	FV205	FY205	FV205AO1	26	FISHER
6	FT206	FI206	FT206AI1	27	MICRO MOTION
7	AT207	AI207	AT207AI1	28	ROSEMOUNT
8	AT208	AI208	AT208AI1	29	ROSEMOUNT
9	PDT501	PDI501	PDT501AI1	30	YOKOGAWA
10	PT502	PI502	PT502AI1	31	YOKOGAWA
11	TT503	TI503	TT503AI1	32	YOKOGAWA
12	TT901	TI901	TT901AI1	34	P+F
13	VC902	VCDO902	VC902DO1	35	P+F
14	FT504	FI504	FT504AI1	33	YOKOGAWA

Table 6 Segment 2 Devices

	DEVICE NAME	LOGIC NAME	DI / DO / AI / AO NAME	ADD	VENDOR
1	LT301	LI301	LT301AI1	22	E+H
2	LT302	LI302	LT302AI1	23	E+H
3	PT303	PI303	PT303AI1	24	E+H
4	PDT304	PDI304	PDT304AI1	25	E+H
5	AT305	AI305	AT305AI1	26	E+H
6	FT306	FI306	FT306AI1	27	E+H
7	FT307	FI307	FT307AI1	28	E+H
9	TT308	TI308	TT308AI1	29	E+H
8	TT401	TI401	TT401AI1	30	HONEYWELL
10	PT402	PI402	PT402AI1	31	HONEYWELL
11	PDT403	PDI403	PDT403AI1	32	HONEYWELL
12	FT101	FI101	FT101AI1	33	FOXBORO
13	FV102	FY102	FV102AO1	34	FOXBORO
14	MTLADM1			35	MTL

CHAPTER 4
RESULT AND DISCUSSION

The testing for the Interoperability test will be using Yokogawa Centum CS3000, Vigilance system. Besides doing the Foundation Fieldbus Interoperability Testing, the author has to implement a simple plant using the Yokogawa system. Therefore, for the progress the author has started getting familiar with the Centum CS3000.

4.1 Getting Familiar with Yokogawa System

The author started to design a simple plant with a Tank and a Flow Transmitter using the software. Below are the step taken during the implementation of a simple plant:-

i. Create a new project
   Start>>All Program>>YOKOGAWA CENTUM>>System View
ii. Create New FCS Folder – To design Function Block (Logic)
iii. Create new HIS Folder – To design graphics
iv. Go to FCS>>Pick one Control Drawing for example DR0001.
v. At the Control Drawing Builder, the author designed a simple function block for FT-306 (Flow Transmitter).
vi. After done the Function Block, the author need to save and download the Control Drawing Builder. Figure 4.1.1 shows the Control Drawing Block window.

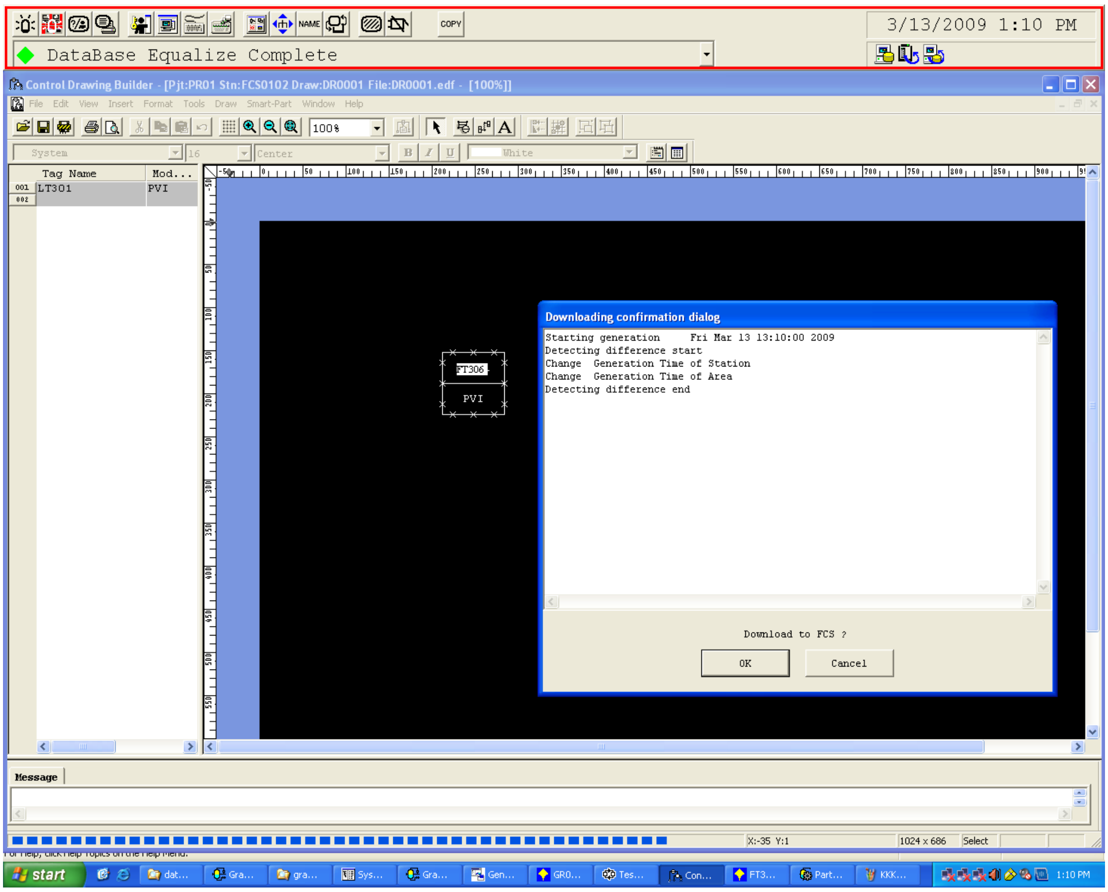

Figure 24 Control Drawing Builder

vii. From the System View, go to HIS>>Window>>Pick one graphic for example GR0001.

viii. The author designs a simple plant on the graphic which s consists of Tank, Flow Transmitter and Valve.

ix. For the Flow Transmitter, the author link the Process Data Character to the Function Block that has been designed earlier (FT306).

x. Save.

xi. Finally the author tests the functionality of the simple plant on the online mode.

xii. Figure 4.1.2 shows how to open the graphic.

Figure 25 opens the graphic

xiii. Call up the faceplate

Figure 26 Call up the faceplate

xiv. Figure 4.1.4 show the simple plant design

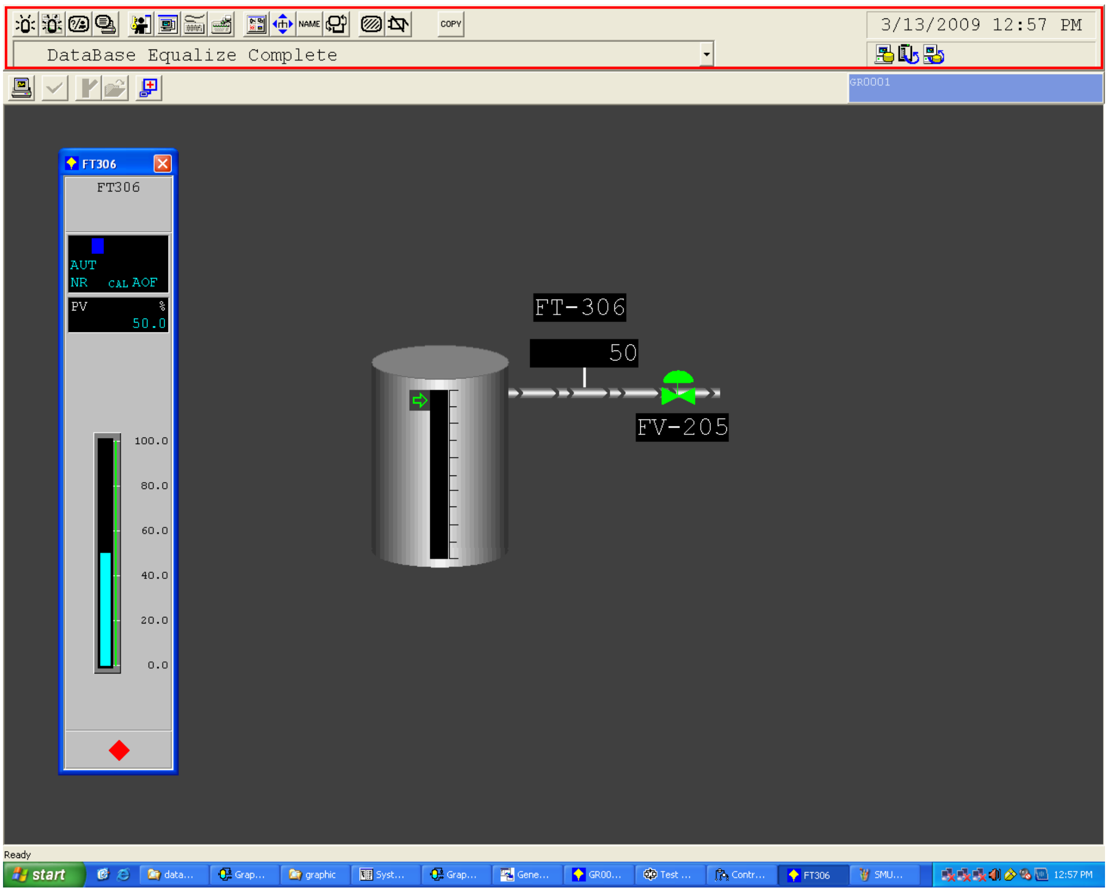

Figure 27 Simple Plant

xv. Using Centrum CS3000, the author calibrates the value for FT306. Figure 4.1.5 show how to calibrate the value.

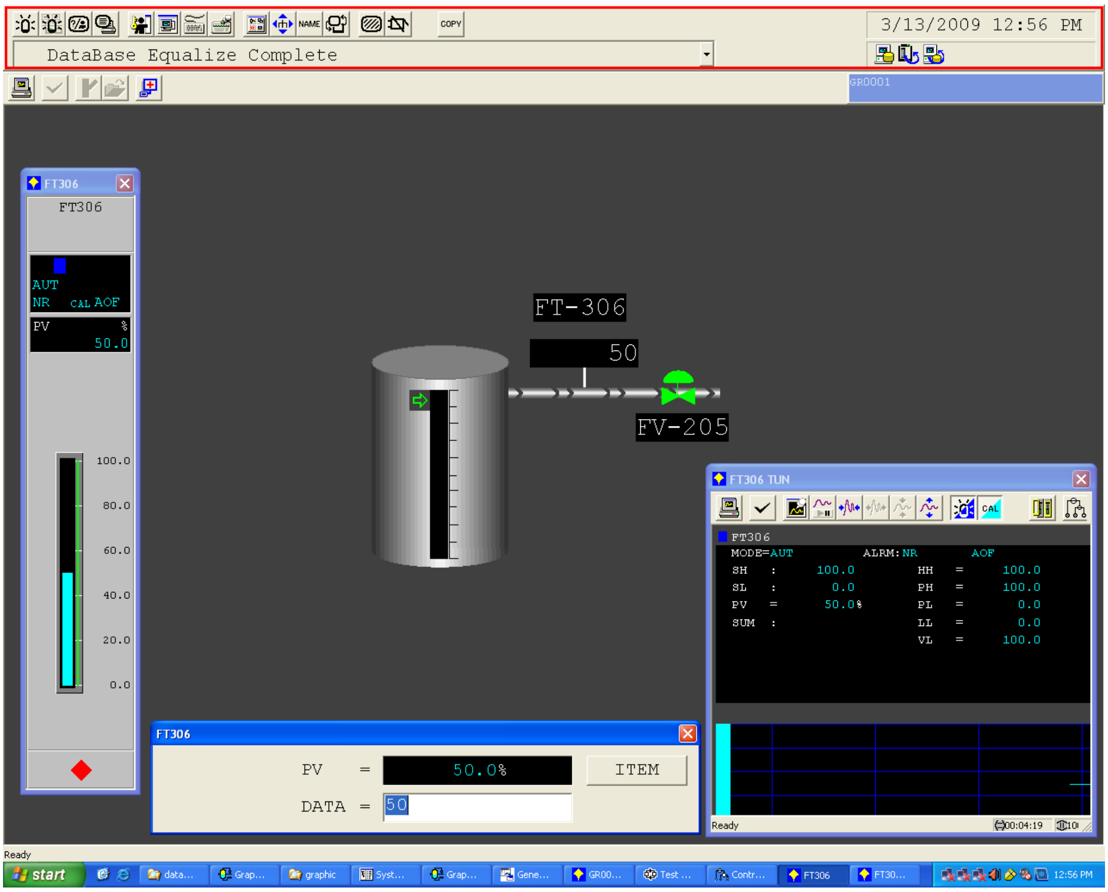

Figure 28 Calibrate the value for FT306

4.2 Emerson training

The author has attended the Fieldbus training that conducted by Emerson for 3 days. The Fieldbus training consist of:-

- Basic Foundation Fieldbus
- Operation and Maintenance Training (using 375 communicator)
- Basic Troubleshooting
- Basics of Wireless, Operation and Maintenance and Basic Troubleshooting
- Asset Management System
- Liquid Analyzer, Theory and Technology
- Flow Best Practice, Coriolis, Vortex and Magnetic Theory and its application

4.3 Basic Test

The author has completed one of the test which is basic test that covers initial download, device decommissioning, device decommissioning, online device replacement, drop out test and calibration function check/online parameter download.

4.3.1 Initial Download

Initial download need to be performed each time changed the host to ensure that all device recognized by the new host, loaded with identified host configuration and updated with current data. Both segment 1 and segment 2 are switched to YOKOGAWA host at selection switch. The segment 1 initial download took 50 minutes while segment 2 took 45 minutes. The time taken for initial download depends on how many devices in each segment. Appendix C shows the result status after the initial download and equalization on each device.

Some of the devices still got the equalization symbol even after the equalization process already done. This is because there is mismatch in the block structure.

4.3.2 Device Decommissioning

Decommission is make the device in offline mode which is detach the device from the segment. The author did the device decommissioning in 2 different ways which is clear the address and clears the tag name. First 5 of the device on each segment are decommissioning by clearing the address. When the “address clear” option was chosen, the original address will be cleared and temporary address will be assigned to the device. The time taken for each device decommission is 10s. The device status changed to offline, AI block to CNF and PVI block to IOP. There is host limitation for the numbers of device decommissioned to occupy the temporary address. The decommissioned devices must not exceed 4 units due to limited temporary address. The fifth decommissioned device will not be detected from the device panel.

After commissioning the devices, others 5 devices are then decommission by clearing the tag name. By using this method, both the address and tag is deleted. The temporary address will be assigned to the device. The device status change to offline, AI block status to CNF and PVI block status to IOP. The time taken for each device decommission is 30s. Temporary address also limit to 4 devices only. It follows the Foundation Fieldbus standard that reserves 4 addresses as the temporary address. Refer to appendix D for the result.

4.3.3 Device Commissioning

Commissioning is to make the device in online mode which is attach the device to the segment. The commissioning process must not interrupt he system or affect other device other devices on the segment. The commissioning involves 3 steps which is commissioning from device panel, followed by assigning the tag name and address and lastly equalization.

Firstly, the device is commission at device panel and the time taken is 1s. The device status at live list change from decommission to commission. The graphic status, AI block status and PVI block status still remain unchanged. The device still use the temporary address and after assign a new address, the device temporary address changed to a new address assigned. The graphic status, AI block status and PVI block status still remain unchanged. Lastly, after equalize the device, the graphic change from offline to online, AI block status from CNF to NR and PVI block status from IOP to NR. Equalization is an operation that matches the information devices in the project database and the information of devices on the FF-H1 bus. There are few device that cannot be equalize due to mismatch in block structure. So the device fail to create instantiation information error and the graphic status, AI block status and PVI block status failed to commission and remain unchanged. Refer to Appendix D for decommissioning and commissioning result.

4.3.4 Online Device Replacement

This test aims is to develop steps required to perform the online device replacement. The device is replaced with the same device used before. The device ID is permanently removed from the Fieldbus Builder. Then, new device ID an acquisition is performed to obtain the new device ID. It will appear in green color and after download, it will appear in black color indicate that the replacement is successfully performed. Both segment 1 and segment 2 got the same device ID before deleted the device ID. This indicated that the online device replacement had successfully occurs. Refer to Appendix E for online device replacement result.

4.3.5 Drop out Test

This test is to ensure that the device failure will not affect the overall segment or any healthy devices in the segment. This test is also to see whether signal is automatically recovered once the device is online. The device cable is taken out from the segment and the response is checked from the host HMI. When the device is taken out, the device should appear offline while other devices should not affect.

The device turn offline when the author take out the wire and automatically return online when reconnect back the wire. During device take out, the AI block status changed from NR to CNF while for PVI block status changed from NR to IOP. Alarm is raised after 10s of device drop out. Device is normalized after 30s reconnection and the AI block status changed from CNF to NR while for PVI block status changed from IOP to NR. No downloading is required when reconnecting the device. All alarms related to the failed device are cleared once the device is reconnected. Refer to Appendix F for drop out test result.

4.3.6 Calibration Function Check / Online Parameter Download

This test is to test how online parameter download is performed on the device. The device range is changed using EWS, 375 Field Communicator and host (PRM). When rescaling device from EWS, changes are made to XD_SCALE and OUT_SCALE from the Functional Block Detail Builder. When rescaling device via 375 Field Communicator and PRM, set AI block to OOS mode and make changes to XD_SCALE and OUT_SCALE.

The device is rescaling using EWS and the changes were observed by 375 Field Communicator and PRM. After rescaling and download, the changes were updated within AI block of the device as well as PRM. From HMI graphics, OUT_SCALE was updated at AI block faceplate while high and low limit values were updated at PVI faceplate.

The device is rescaling using 375 Field Communicator and the changes were observed by EWS and PRM. After rescaling from 375, the device needs to update and equalize at Function Block Detail Builder. Then, the new rescaling value will changed at EWS. The device is rescaling using PRM and the changes were observed by 375 Field Communicator and EWS. The device also needs to update and equalize at Function Block Detail Builder after rescaling from PRM. Refer to appendix G for calibration function check/online parameter download.

4.4 Segment Checker

Pepperl + Fuchs segment checker software is a Fieldbus design tool that is used to design and analyze the required values for each segment that need to be constructed. By using the software, we can check the operational parameters to validate fieldbus segment architecture evaluate potential problems with a fieldbus segment configuration and design Foundation Fieldbus and PROFIBUS PA networks. The author has conducted the segment design by taking segment 1 as reference and the result is shown in Appendix H.

4.5 Discussion

4.5.1 Basic Test

From the result, we noted that the maximum devices that can be decommissioning and get temporary address are 4. The range of temporary address is from 148 until 151. Each time the device is decommissioned, the original address is changed to the temporary address until it reach the maximum number of temporary address which is 4. If we decommissioned the fifth device, the devices still can be decommissioned but it do not have any temporary address and it would not appear in the live list. When we commissioned one of the decommissioned devices, the fifth device with no temporary address will take the temporary address from the commissioned device and will appear in the live list.

When we decommissioned the device, the device will appear OFFLINE with red color in the graphics and the AI block indicated the device is CNF (Connection Fail). The process alarm also generated with the CNF status. After commissioned the device back, the device will appear ONLINE with green color. The process for commissioned takes time because the device needs to be equalizing before it totally commissioned.

Fieldbus system was able to detect the device ID even though we deleted the original device ID. It is proved from the online device replacement test. From the drop out test, we noted that when a device is failed, it is not affected all the devices at that segment.

From the calibration function check, we noticed mismatch problem of capabilities and DD files occurred. 375 Field Communicator is unable to extract information from all devices, thus preventing output range trim to these devices using the communicator. Mostly, this affects a number of Endress+Hauser transmitters. The problems are due to unavailability of 375 DD files of these transmitters. This problem had been discussed with Emerson and Endress+Hauser and this issue is being resolve by their principle in Switzerland. The list of DD files required against the list of available files in the communicator is summarized in table below:-

Table 7 List of DD Files

Tag	Device Type	Files in device	Filed in 375	Match	Error Message
LT301	LevelFlixM	Dev Rev 4 DD Rev 1	Dev Rev 3 DD Rev 3	Mismatch	Communicator can scan the device but unable to view more information in it.
LT302	Micropilot M	Dev Rev 5 DD Rev 1	Dev Rev 3 DD Rev 3	Mismatch	Communicator can scan the device but unable to view more information in it.
PT303	Cerebar	Dev Rev 5 DD Rev 1	Dev Rev 5 DD Rev 2	Match	Able to view all the function blocks and other information but unable to change any parameter.
PDT304	Deltabar S	Dev Rev 5 DD Rev 1	Dev Rev 5 DD Rev 2	Match	Able to view all the function blocks and other information but unable to change any parameter.
AT305	Liquilline	Dev Rev 1 DD Rev 1	N/A		Ok although there are no matched DD files but able to view all parameters and make changes.
FT306	Prowill 73	Dev Rev 1 DD Rev 1	Dev Rev 1 DD Rev 1	Match	OK
FT307	Promass 83	Dev Rev 3 DD Rev 1	Dev Rev 2 DD Rev 1	Mismatch	Communicator can scan the device but unable to view more information in it.
TT308	TMT 162	Dev Rev 1	N/A		Device offline. Unable to test. (Not available in Fieldbus Builder database)

4.5.2 Segment Analysis

By using segment checker, we can observe the limitation of Foundation Fieldbus by checking the cable length and number of devices in one segment. The current consumption for typical devices is 12mA each devices, the spur length is fixed to be 0.5 m. The result for the segment design is success and the result shows in appendix H under normal design.

4.5.2.1 Cable Length

The length of cable is increased until reach the limit of the cable length. From the result 2 at appendix H, when the cable length is 800m and above, error on the short circuit check occur which is the calculated voltage is too low. It shows that a segment that used type A cable, with 14 devices on a segment and draws 10mA for each devices can only work with cable less than 800 m.

4.5.2.2 Number of Field Barriers

When another field barrier is added in one segment, an error occurs at the segment design tool which on a segment cannot have more that 4 field barrier. Appendix H result 3 shows the result when 5 barriers put in a segment.

4.5.2.3 Number of Terminator

Generally, in one segment, only two terminators are required. Terminator is to prevent distortion and signal loss due to reflection at the end of fieldbus cable. The terminator testing is conducted using the FFIT Facilities Testing and below are the result.

Table 8 Terminator Testing Result

Segment	Details	No of Terminator			
		2	3	4	5
1	FF Signal (mV)	>600	>450	>290	>220
	Noise Signal(mV)	<6	<4	<4	<4
	Affect on other device	none	none	none	none
2	FF Signal (mV)	>600	>450	>290	-
	Noise Signal(mV)	<6	<4	<4	-
	Affect on other device	none	none	none	-

From the result, having more than 2 terminators does not affect the other device on that segment. The signal level will drop but not to unsafe level due to the short distance between the device. If the device distance is too long, having more than 2 terminators might affect the signal level and bring it to the unsafe level.

CHAPTER 5
CONCLUSION & RECOMMENDATION

5.1 Conclusion

The author managed to complete the basic test for the interoperability testing and segment checker using p+F software. The result has been submitted to PTS and they already discussed the result along with the results for other 3 hosts. From the basic test result, the result shows that the device is interoperable within the host system and field devices from different manufacturer. All field devices able to talk to each other's and if an error occurs on a device, it will not affect the other devices on that segment. All test reports have been submitted to Petronas GTS team and they will come out with a comprehensive technical report on the Foundation Fieldbus Interoperability Testing.

5.2 Recommendation

Most of the DD files are not up to date and this will affect the outcome from the test. Therefore, vendors need to take this into consideration to update new DD files to the field instruments. A pilot plant on a fieldbus system also need to be constructed, means the field devices is connected to the real simple plant. Performance of the Foundation Fieldbus can be observed and understand when dealing with real plant. For the next batch, stress test need to be conducted and below is the procedure for the next interoperability testing:

1) How many logical device can a segment handle if given a short trunk
2) How many devices can 300m trunk handle? (repeat for 600, 900 and 1300)
3) Study the effect of macrocycle

4) Will constant/rapid on and off device cause host system to breakdown
5) Will noise affect the quality of signal
6) Proof the LAS is true
7) Try using the different cable others than type A cable
8) Proof segment calculator and real set up

For this Foundation Fieldbus Interoperability Testing project, we need to follow the instructions and procedure on the testing from Petronas GTS. So, Petronas GTS should have come out with a proper schedule on the testing for the FFIT team.

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APPENDICES

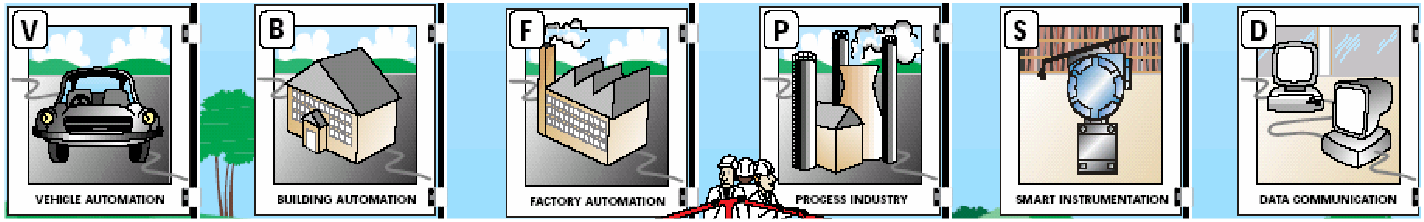
APPENDIX A

PROJECT GANTT CHART

No.	Detail/ Month	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	Selection of Project Topic						Mid Semester Break						
2	Preliminary Research Work												
3	Training with Emerson Process Management												
5	Basic Interoperability Test (Basic Test)												
6	Segment Checker Analysis												
7	Final Report												
8	Preparation for Final Oral Presentation												

APPENDIX B

FIELDBUS TYPES AND SPECIFICATIONS



* Notes

1. H1 and H2 are FOUNDATION Fieldbus terms not used by the IEC.

2. Profibus - DP also has an extended command set called DPV1, Extensions to EN 50170, Version 1.0, November 1996.

3. DEVICENET and SDS are application layer utilities that use CAN for the physical layer.

4. Profibus (excluding PA) and WorldFIP, together with P-Net, are formalised into European Standard EN 50170.

5. CSMA/CD: Carrier Sense Multiple Access with Collision Detection, (NDA: Non-Destructive Bitwise Arbitration)

6. Deterministic: The ability to perform predefined tasks at precise times.

7. ASIC: Application Specific Integrated Circuit

8. Various interfaces and modes of communication:
   a) Node-to-line transformer isolation, with differential Manchester encoding
   b) RS-485 Twisted Pair
   c) Single ended for Radio & Fibre operation
   d) Power line (i.e. local 'mains') interface

9. CTDMA: Concurrent Time Domain, Multiple Access.

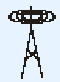
10. This is the number of addressable nodes - the number of physical nodes may be significantly smaller.

Symbols


Twisted Pair

Optical Fibre


Co-axial Cable


Radio Propagation

See key above	FOUNDATION™ Fieldbus				PROFIBUS *4			ControlNET	Modbus ®	INTERBUS	Ethernet ®	WorldFIP *4	LONWORKS ®	CAN	HART ®	AS - Interface
	H1 *1	H2 *1	H2 *1 bus powered	H2 *1	DP *2	FMS	PA				10Base-5			(DEVICENET) (SDS) *3		
Typical Applications	P S F	P F	P	P F	P F	P F	P S	P F	P B F	P F	P D	P S B F	P B F	P V B F	S	P B F
Data Rates bits/s	31.25k	1.0M	1.0M	2.5M	To 1.5M & 12M	500k	31.25k	5M	Not specified (1.2k -115.2k typ.)	500k	10M	31.25k, 1M & 2.5M	300 to 1.25M	To 1M	1200	167k
Comms. technique	Single/ Multi-Master	Single/ Multi-Master	Single/ Multi-Master	Single/ Multi-Master	Master /Slave, Peer to Peer	Master /Slave, Peer to Peer	Master /Slave, Peer to Peer	Producer/ Consumer	Master /Slave	Master /Slave	Master /Slave, Peer to Peer	Producer/ Consumer	Master /Slave, Peer to Peer	Producer/ Consumer, Peer to Peer	Master /Slave	Master /Slave
Media access algorithm	Token Passing	Token Passing	Token Passing	Token Passing	Token Passing	Token Passing	Token Passing	CTDMA *9	Token Passing	None	CSMA/CD *5	Bus Arbiter Access	Predictive Media	CSMA/CD /NDA *5	None	Cyclic polling
Media supported	opto Planned	opto Planned		opto Planned				opto		opto		opto	opto	opto		
*10 **Max. No. of nodes**	240 per segment, or 2^{16} per system	240 per segment, or 2^{16} per system	240 per segment, or 2^{16} per system	240 per segment, or 2^{16} per system	127 per network	127 per network	256 per network	99 per link	247 per network	256 stations	400 per segment	256 per network	32,768 per domain	2^{11}, or 2^{29} in extended address mode	15 per loop	31 per network
*6 **Deterministic?**	✓	✓	✓	✓	-	-	-	✓	-	✓	-	✓	-	-	-	✓
Intrinsic Safety?	✓	-	✓	-	-	-	✓	-	-	-	-	✓	✓	-	✓	-
Bus powered?	✓	-	✓	-	-	-	✓	-	-	-	-	✓	✓	-	✓	✓
*7 **ASICs available?**	Planned	Planned	Planned	Planned	✓	✓	✓	✓	-	✓	✓	✓	✓	✓	Partial	✓
Physical layer standard	IEC 1158	IEC 1158	IEC 1158	IEC 1158	RS485	RS485	IEC/ISA/FF IEC 1158-2	See * 8 a)	Not Specified	RS485	Unbalanced voltage	IEC/ISA/FF IEC 1158-2	See * 8 a), b), c) & d)	Balanced differential voltage	4-20mA pair (f.s.k. current modulation)	Balanced differential voltage
Applicable Standards	IEC 1158 ISA S50	IEC 1158 ISA S50	IEC 1158 ISA S50	IEC 1158 ISA S50	EN 50170 (Part 2) DIN 19245	EN 50170 (Part 2) DIN 19245	DIN 19245	BSI draft standard pr(EN 50254)	Modicon Protocol PI-MBUS-300 Rev.E	DIN E 19258 pr(EN 50254)	IEE802.3 ISO8802.3 (10Base-5)	EN 50170 (Part 3)	LonMark Interoperability Association Guidelines	ISO 11898	HART Protocol Specification Rev. 5.1 Physical layer Rev. 8.0	IEC947-5-2/D EN 60 947 DIN VDE 0660/208

APPENDIX C

INITIAL DOWNLOAD RESULT

Segment	Device	Status			Remarks
		Live List	Graphic	Device	
1	TT 201	Decommission	ONLINE	ONLINE	-
	PT 202	Commission	ONLINE	ONLINE	-
	TT 203	Commission	ONLINE	ONLINE	-
	PDT 204	Commission	ONLINE	ONLINE	-
	FV 205	Commission	ONLINE	ONLINE	-
	FT 206	Not found	OFFLINE	OFFLINE	Not Powered
	AT 207	Commission	OFFLINE	ONLINE	Graphic and device status not tally because mismatch in range of pH
	AT 208	Not found	OFFLINE	OFFLINE	Not Powered
	PDT 501	Commission	ONLINE	ONLINE	-
	PT 502	Commission	ONLINE	ONLINE	-
	TT 503	Commission	ONLINE	ONLINE	-
	TT 901	Commission	ONLINE	ONLINE	-
	VC 902	Commission	OFFLINE	OFFLINE	Not Powered
	FT 504	Commission (not equalize)	ONLINE	ONLINE	Cannot be equalized because mismatch in block structure
2	LT 301	Commission	ONLINE	ONLINE	-
	LT 302	Commission	ONLINE	ONLINE	-
	PT 303	Commission	ONLINE	ONLINE	Cannot Equalized
	PDT 304	Commission	ONLINE	ONLINE	Cannot Equalized
	AT 305	Commission	ONLINE	ONLINE	-
	FT 306	Commission	ONLINE	ONLINE	-
	FT 307	Not found	OFFLINE	OFFLINE	Not Powered
	TT 308	(not found in project)	ONLINE	ONLINE	Not in Database
	TT 401	Not found	ONLINE	ONLINE	Not Powered
	PT 402	Commission	ONLINE	ONLINE	-
	PDT 403	Commission	ONLINE	ONLINE	-
	FT 101	Commission	ONLINE	ONLINE	-
	FV 102	Commission	ONLINE	ONLINE	-
	MTLADM 1	Not found	UNHEALTHY	-	MTL diagnostics tools.

APPENDIX D

DEVICE DECOMMISSIONING AND COMMISSIONING RESULT

Decommissioning by using address clear

Segment	Device	Decommission Sequence	Time Taken(s)	Address		Status		Block status		Remarks
				Device	Temporary	Live List	Graphic Status	AI	PVI	
1	PDT204	1	15	25	251	Decommission	**OFFLINE**	CNF	IOP	Address is cleared after decommission and the device is assigned to new address (temporary address)
	TT503	2	22	32	248	Decommission	**OFFLINE**	CNF	IOP	
	AT207	3	12	28	249	Decommission	**OFFLINE**	CNF	IOP	
	TT201	4	12	22	250	Decommission	**OFFLINE**	CNF	IOP	
	PT202	5	12	23	248	Decommission	**OFFLINE**	CNF	IOP	System only provide 4 temporary address.After decommission the device disappear from Live List even though it is in decommission state - because not enough temporary address to assigned to PT202. PT202 is assigned to temporarty address after commissionin 1 of the decommissioned devuce earlier (TT503). PT202 take the temporary address of TT503.
2	LT301	1	13	22	248	Decommission	**OFFLINE**	CNF	IOP	Address is cleared after decommission and the device is assigned to new address (temporary address)
	LT302	2	12	23	251	Decommission	**OFFLINE**	CNF	IOP	
	PT303	3	10	24	250	Decommission	**OFFLINE**	LL	IOP	
	PDT304	4	12	25	249	Decommission	**OFFLINE**	LL	IOP	
	AT305	5	11	26	248	Decommission	**OFFLINE**	CNF	IOP	System only provide 4 temporary address.After decommission the device disappear from Live List even though it is in decommission state - because not enough temporary address to assigned to AT305. AT305 is assigned to temporarty address after commissionin 1 of the decommissioned devuce earlier (LT301). AT305 take the temporary address of LT301.

Commissioning by using address clear

Segment	Device	Commissioning					Assigning Address				Equalize				Remarks
		Time Taken (s)	Status		Block Status		Time Taken (s)	Status	Block Status		Time Taken (s)	Status	Block Status		
			Live List	Graphic	AI	PVI		Graphic	AI	PVI		Graphic	AI	PVI	
1	TT503	1	Commission	**OFFLINE**	CNF	IOP	106	**OFFLINE**	CNF	IOP	97	**ONLINE**	NR	NR	The device only change it status from OFFLINE to ONLINE after it is commission and equalize.
	TT201	2	Commission	**OFFLINE**	CNF	IOP	99	**OFFLINE**	NR	IOP	145	**ONLINE**	NR	NR	
	PDT204	2	Commission	**OFFLINE**	CNF	IOP	104	**OFFLINE**	CNF	IOP	103	**ONLINE**	NR	NR	
	AT207	2	Commission	**OFFLINE**	OOP	IOP	99	**OFFLINE**	OOP	IOP	98	**OFFLINE**	OOP	IOP	The status will not change to ONLINE even though it is already commission - because the device is not equalize
	PT202	2	Commission	**OFFLINE**	CNF	IOP	93	**OFFLINE**	CNF	IOP	107	**ONLINE**	NR	NR	The device only change it status from OFFLINE to ONLINE after it is commission and equalize.
2	LT301	1	Commission	**OFFLINE**	CNF	IOP	123	**OFFLINE**	CNF	IOP	82	**ONLINE**	NR	NR	
	LT302	1	Commission	**OFFLINE**	CNF	IOP	89	**OFFLINE**	CNF	IOP	111	**ONLINE**	NR	NR	
	PT303	1	Commission	**OFFLINE**	LL	IOP	118	**OFFLINE**	LL	IOP	47	**OFFLINE**	LL	IOP	The status will not change to ONLINE even though it is already commission - because the device is not equalize
	PDT304	1	Commission	**OFFLINE**	LL	IOP	122	**OFFLINE**	LL	IOP	47	**OFFLINE**	LL	IOP	
	AT305	1	Commission	**OFFLINE**	CNF	IOP	88	**OFFLINE**	CNF	IOP	220	**ONLINE**	NR	NR	The device only change it status from OFFLINE to ONLINE after it is commission and equalize.

Decommissioning by using tag clear

<table>
<tr><th rowspan="2">Segment</th><th rowspan="2">Device</th><th rowspan="2">Decommission Sequence</th><th rowspan="2">Time Taken(s)</th><th colspan="2">Address</th><th colspan="2">Status</th><th colspan="3">Status</th><th rowspan="2">Remarks</th></tr>
<tr><th>Device</th><th>Temporary</th><th>Live List</th><th>Graphic Status</th><th>AI</th><th>AO</th><th>PVI</th></tr>
<tr><td rowspan="5">1</td><td>FV205</td><td>1</td><td>29</td><td>26</td><td>248</td><td>Decommission & not found in the project</td><td>OFFLINE</td><td>-</td><td>CNF</td><td>OOP</td><td rowspan="4">Address and tagname of the device is cleared after decommission and the device is assigned to new address (temporary address). Clear tag method will delete the tagname of the device and also will automatically delete the device address without selecting the address clear option.The status "not found in the project" appear in Live List because the tagname of the device is deleted.</td></tr>
<tr><td>PT202</td><td>2</td><td>28</td><td>23</td><td>249</td><td>Decommission & not found in the project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>PDT501</td><td>3</td><td>22</td><td>30</td><td>250</td><td>Decommission & not found in the project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>TT901</td><td>4</td><td>45</td><td>34</td><td>251</td><td>Decommission & not found in the project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>TT203</td><td>5</td><td>171</td><td>24</td><td>248</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td><td>System only provide 4 temporary address. After decommission the device disappear from Live List even though it is in decommission state because not enough temporary address to assigned to TT203. TT305 assigned to temporary address after commission 1 of the decommissioned device earlier (FV205). TT203take the temporary address of FV205</td></tr>
<tr><td rowspan="5">2</td><td>FT306</td><td>1</td><td>18</td><td>27</td><td>248</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>OOP</td><td rowspan="4">Address and tagname of the device is cleared after decommission and the device is assigned to new address (temporary address). Clear tag method will delete the tagname of the device and also will automatically delete the device address without selecting the address clear option.The status "not found in the project" appear in Live List because the tagname of the device is deleted.</td></tr>
<tr><td>PT402</td><td>2</td><td>25</td><td>31</td><td>251</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>PDT403</td><td>3</td><td>23</td><td>32</td><td>249</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>FT101</td><td>4</td><td>73</td><td>33</td><td>250</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>CNF</td><td>-</td><td>IOP</td></tr>
<tr><td>FV102</td><td>5</td><td>182</td><td>34</td><td>248</td><td>Decommission & not found in project</td><td>OFFLINE</td><td>-</td><td>CNF</td><td>IOP</td><td>System only provide 4 temporary address. After decommission the device disappear from Live List even though it is in decommission state because not enough temporary address to assigned to FV102. FV102 is assigned to temporary address after commission 1 of the decommissioned device earlier (FT306). FV102 take the temporary address of FT306</td></tr>
</table>

Commissioning by using tag clear

Segment	Device	Commissioning						Assigning Address and Tag					Equalize					Remarks
		Time taken(s)	Status		Block Status			Time taken(s)	Status	Block Status			Time taken(s)	Status	Block Status			
			Live List	Graphic	AI	AO	PVI		Graphic	AI	AO	PVI		Graphic	AI	AO	PVI	
1	FV205	1	Commission	OFFLINE	-	CNF	OOP	97	OFFLINE	-	CNF	OOP	109	ONLINE	-	NR	NR	The device only change it status from OFFLINE to ONLINE after it is commission and equalize. The status will not change to ONLINE even though it is already commission because the device is not equalize. Both tag and address can be assigned using tag assignment.
	PDT501	1	Commission	OFFLINE	CNF	-	IOP	103	OFFLINE	CNF	-	IOP	105	ONLINE	NR	-	NR	
	TT901	1	Commission	OFFLINE	CNF	-	IOP	93	OFFLINE	CNF	-	IOP	93	ONLINE	NR	-	NR	
	PT202	1	Commission	OFFLINE	CNF	-	IOP	93	OFFLINE	CNF	-	IOP	91	ONLINE	NR	-	NR	
	TT203	1	Commission	OFFLINE	CNF	-	IOP	94	OFFLINE	CNF	-	IOP	93	ONLINE	NR	-	NR	
2	FT306	1	Commission	OFFLINE	LL	-	IOP	127	OFFLINE	LL	-	IOP	170	ONLINE	NR	-	NR	
	PT402	1	Commission	OFFLINE	LL	-	IOP	88	OFFLINE	LL	-	IOP	88	ONLINE	LL	-	NR	
	PDT403	1	Commission	OFFLINE	LL	-	IOP	97	OFFLINE	LL	-	IOP	93	ONLINE	NR	-	NR	
	FT101	1	Commission	OFFLINE	CNF	-	IOP	92	OFFLINE	CNF	-	IOP	86	ONLINE	NR	-	NR	
	FV102	1	Commission	OFFLINE	-	CNF	OOP	91	OFFLINE	-	CNF	OOP	91	ONLINE		NR	NR	

APPENDIX E
ONLINE DEVICE REPLACEMENT RESULT

Segment	Device	Acquisition Time(s)	Devie ID		Graphic Status		Download Time(s)	Remarks
			Before	After	Before	After		
1	TT201	22	0011510848-FR-TEMP-0x214E6C27	0011510848-FR-TEMP-0x214E6C27	ONLINE	ONLINE	550	-
	PT202	10	0011513051032208120613-020060507	0011513051032208120613-020060507	ONLINE	OFFLINE	306	Lack of system update.. Devide ONLINE in several days
	TT203	9	0011513144-TMP-0x23511C27	0011513144-TMP-0x23511C27	ONLINE	OFFLINE	274	
	PDT204	10	0011513051032208074316-020060493	0011513051032208074316-020060493	ONLINE	OFFLINE	387	
	FV205	10	0051006000FisherDVC0070208100218	0051006000FisherDVC0070208100218	ONLINE	ONLINE	237	-
	FT206	-	-	-	-	-	-	Not Powered
	AT207	27	5241494085-5081pH/ORP-Ox8548C431	5241494085-5081pH/ORP-Ox8548C431	OFFLINE	OFFLINE	199	Cannot Equalized
	AT208	-	-	-	-	-	-	Not Powered
	PDT501	10	594543000CJ0017515	594543000CJ0017515	ONLINE	ONLINE	239	-
	PT502	10	594543000CJ0017516	594543000CJ0017516	ONLINE	ONLINE	340	-
	TT503	9	5945430005S1003598	5945430005S1003598	ONLINE	ONLINE	252	-
	TT901	9	502B460003-01517169585037	502B460003-01517169585037	ONLINE	OFFLINE	321	Lack of system update.
	VC902	9	502B460001-01108172711042	502B460001-01108172711042	ONLINE	ONLINE	190	
	FT504	10	5945430006D0002728	5945430006D0002728	ONLINE	ONLINE	191	-
2	LT301	9	452B481012-9B01750104E	452B481012-9B01750104E	ONLINE	ONLINE	225	-
	LT302	8	452B48100F-9B00930108D	452B48100F-9B00930108D	ONLINE	ONLINE	205	-
	PT303	9	452B481007-9518D801BCC	452B481007-9518D801BCC	OFFLINE	OFFLINE	372	Cannot Equalized
	PDT304	8	452B481009-9518F501BCC	452B481009-9518F501BCC	OFFLINE	OFFLINE	429	Cannot Equalized
	AT305	8	452B48108F-9A109705G00	452B48108F-9A109705G00	ONLINE	ONLINE	356	-
	FT306	8	452B481057-9B00D302000	452B481057-9B00D302000	ONLINE	ONLINE	615	-
	FT307	-	-	-	OFFLINE	-	-	Not Powered
	TT308	-	-	-	ONLINE	-	-	Not in Database
	TT401	-	-	-	ONLINE	-	-	Not powered
	PT402	7	48574C0002-HWL-ST3000-4269154912	48574C0002-HWL-ST3000-4269154912	ONLINE	ONLINE	122	-
	PDT403	8	48574C0002-HWL-ST3000-4903423400	48574C0002-HWL-ST3000-4903423400	ONLINE	ONLINE	120	-
	FT101	9	385884_FOX-IASVT-NC04D0419B	385884_FOX-IASVT-NC04D0419B	ONLINE	ONLINE	123	-
	FV102	9	385884240183/031884	385884240183/031884	ONLINE	ONLINE	206	-
	MTLADM1	-	-	-	UNHEALTHY	-	-	MTL Diagnostics Tools

APPENDIX F

DROP OUT TEST RESULT

Segment 1

Device	Disconnect the Cable								Connect the Cable								Remarks
	Block Status				Status		Alarm	Time taken(s)	Block Status				Status		Alarm	Time taken(s)	
	AI	AO	PVI	DO	Graphic	Live List			AI	AO	PVI	DO	Graphic	Live List			
TT201	CNF	-	IOP	-	OFFLINE	Not exist	TT201AI1 - CNF TT201AI3 - CNF	3.3	NR	-	NR	-	ONLINE	Not exist	TT201AI1 - NR TT201AI3 - NR	47.9	
PT202	CNF	-	IOP	-	OFFLINE	Not exist	PT202AI1 - CNF	15.1	NR	-	IOP	-	OFFLINE	Not exist	PT202AI1 - CNF	26.4	
TT203	CNF	-	IOP	-	OFFLINE	Not exist	TT203AI1 - CNF TI203 - IOP	4.5	NR	-	NR	-	ONLINE	Not exist	TT203AI1 - NR TI203 - NR	28.8	
PDT204	CNF	-	IOP	-	OFFLINE	Not exist	PDT204AI1 - CNF	12.4	NR	-	IOP	-	OFFLINE	Not exist	PDT204AI1 - NR	13.6	
FV205	-	CNF	OOP	-	OFFLINE	Not exist	FY205 - OOP FV205AO1 - CNF	4.2	-	NR	-	-	ONLINE	Not exist	FY205 - NR FV205AO1 - NR	39.2	
FT206	-	-	-	-	-	Not exist	-	-	-	-	-	-	-	Not exist	-	-	Not Powered
AT207	OOP	-	IOP	-	OFFLINE	Not exist	AT207AI1 - CNF	13.8	NR	-	NR	-	ONLINE	Not exist	AT207AI1 - NR	25.8	
AT208	-	-	-	-	-	Not exist	-	-	-	-	-	-	-	Not exist	-	-	Not Powered
PDT501	LL	-	IOP	-	OFFLINE	Not exist	PDT205AI1 - CNF PDI501 - IOP	4.7	LL	-	NR	-	ONLINE	Not exist	PDI501 - NR	11.3	
PT502	CNF	-	IOP	-	OFFLINE	Not exist	PT502AI1 - CNF PI502 - IOP	9	NR	-	NR	-	ONLINE	Not exist	PT502AI1 - NR PI502 - NR	22.7	
FT504	CNF	-	IOP	-	OFFLINE	Not exist	FT504AI1 - CNF FI504 - IOP	5.2	NR	-	NR	-	ONLINE	Not exist	FT504AI1 - NR FI504 - NR	18.8	
TT901	IOP	-	IOP	-	OFFLINE	Not exist	TT901AI1 - CNF TI901 - IOP	16.1	IOP	-	NR	-	ONLINE	Not exist	TI901 - NR	23.9	
VC902	-	CNF	-	CNF	OFFLINE	Not exist	VC902DO1 - CNF	13.4	-	-	-	NR	OFFLINE	Not exist	VC902DO1 - NR	10.6	
TT503	CNF	-	IOP	-	OFFLINE	Not exist	TT503AI1 - CNF TI503 - IOP	3.6	NR	-	NR	-	ONLINE	Not exist	TT503AI1 - NR TI503 - NR	22.8	

Segment 2

Device	Disconnect the Cable								Connect the Cable								Remarks
	Block Status				Status		Alarm	Time taken(s)	Block Status				Status		Alarm	Time taken(s)	
	AI	AO	PVI	DO	Graphic	Live List			AI	AO	PVI	DO	Graphic	Live List			
LT301	CNF	-	IOP	-	OFFLINE	Not exist	LT301AI1 CNF LI301 IOP	6.26	NR	-	NR	-	ONLINE	Exist	LT301AI1 NR LI301 NR	49.5	-
LT302	CNF	-	IOP	-	OFFLINE	Not exist	LT302AI1 CNF LI302 IOP	5.55	NR	-	NR	-	ONLINE	Exist	LT302AI1 NR LI302 NR	48.2	-
PT303	CNF	-	IOP	-	OFFLINE	Not exist	PT303AI1 CNF	16	LL	-	IOP	-	OFFLINE	Exist	-	39.3	Cannot be equalized
PDT304	LL	-	IOP	-	OFFLINE	Not exist	PDT304AI1 CNF	13.75	LL	-	IOP	-	OFFLINE	Exist	-	47.2	Cannot be equalized
AT305	CNF	-	IOP	-	OFFLINE	Not exist	AT305AI1 CNF AI305 IOP	6.85	NR	-	NR	-	ONLINE	Exist	AT305AI1 NR AI305 NR	66	-
FT306	LL	-	IOP	-	OFFLINE	Not exist	FT306AI1 CNF FI306 IOP	8.65	LL	-	NR	-	ONLINE	Exist	FI306 NR	44.6	-
FT307	-	-	-	-	-	Not exist	-	-	-	-	-	-	-	Exist	-	-	Not Powered
TT308	-	-	-	-	-	Not exist	-	-	-	-	-	-	-	Exist	-	-	Not in Database
TT401	-	-	-	-	-	Not exist	-	-	-	-	-	-	-	Exist	-	-	Not powered
PT402	CNF	-	IOP	-	OFFLINE	Not exist	PT-402 CNF PI402 IOP	11.3	NR	-	NR	-	ONLINE	Exist	PT-402 NR PI402 NR	22.8	-
PDT403	LL	-	IOP	-	OFFLINE	Not exist	PDT403AI1 CNF PDI403 IOP	3.8	LL	-	NR	-	ONLINE	Exist	PDI403 NR	26.5	-
FT101	CNF	-	IOP	-	OFFLINE	Not exist	FT101AI1 CNF FI101 IOP	6.6	LL	-	NR	-	ONLINE	Exist	FT101AI1 NR FI101 NR	32.3	-
FV102	-	CNF	OOP	-	OFFLINE	Not exist	FV102AO1 CNF FY102 OOP	11.7	-	NR	NR	-	ONLINE	Exist	FV102AO1 NR FY102 NR	29.7	-
MTLADM1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	MTL Diagnostics Tools

APPENDIX G

CALIBRATION FUNCTION CHECK RESULT

Segment 1

Segment	Device	EWS																Time Taken(s)	Faceplate		
		FF-AI												PVI							
		XD_SCALE				OUT_SCALE				PV_SCALE											
		Original		Change		Original		Change		Original		Change		Original		Change			AI Block Range	AO Block Range	PVI Block Range
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H				
1	TT201 (AI1)	-180	760	-120	701	-200	780	-104	702	-	-	-	-	-180	700	-160	703	60	-104 to -702	-	-160 to 703
	TT201 (AI3)	-180	760	-120	710	-180	760	-130	720	-	-	-	-	-180	760	-170	700	60	-130 to 720	-	-170 to 700
	PT202	0	100	20	75	-15	4000	-10	3000	-	-	-	-	-15	4000	-12	3500	60	-10 to 3000	-	-12 to 3500
	TT203	-200	850	-100	800	-200	200	-100	100	-	-	-	-	0	500	10	400	60	-100 to 100	-	10 to 400
	PDT204	-1000	1000	-900	900	-1500	1500	-1000	1000	-	-	-	-	-1500	1500	-1300	1300	60	-1000 to 1000	-	-1300 to 1300
	FV205	0	100	15	90	-	-	-	-	0	100	10	95	-	-	-	-	60	-	15 to 90	0 to 100
	AT208	0	20000	10	15000	0	20000	20	17000	-	-	-	-	0	20000	30	15000	60	20 to 17000	-	30 to 15000
	PDT501	-100	2000	-90	1000	-500	5000	-400	4000	-	-	-	-	-500	5000	-450	4500	60	-400 to 4000	-	-450 to 4500
	PT502	-100	100	-90	90	-1000	1000	-950	950	-	-	-	-	-100	100	-95	95	60	-950 to 950	-	-95 to 95
	TT503	-200	850	-100	800	-200	850	-150	830	-	-	-	-	-200	850	-50	700	60	-150 to 830	-	-50 to 700
	FT504	0	19	5	17	0	25	10	20	-	-	-	-	0	25	7	23	60	10 to 20	-	7 to 23
	AT207	0	14	3	13	0	14	5	10	-	-	-	-	0	30	10	20	60	5 to 10	-	10 to 20
	FT206	0	100	10	90	0	100	20	80	-	-	-	-	0	100	30	70	60	20 to 80	-	30 to 70
	TT901	0	100	10	90	-5	105	-3	100	-	-	-	-	0	100	20	80	60	-3 to 100	-	20 to 80

Continue

375						PRM						FIELDBUS BUILDER						Remark
XD_SCALE		OUT_SCALE		PV_SCALE		XD_SCALE		OUT_SCALE		PV_SCALE		XD_SCALE		OUT_SCALE		PV_SCALE		
L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	
-120	701	-104	702	-	-	-120	701	-104	702	-	-	-120	701	-104	702	-	-	-
-120	710	-130	720	-	-	-120	710	-130	720	-	-	-120	710	-130	720	-	-	-
-15	4000	-10	3000	-	-	-15	4000	-10	3000	-	-	20	75	-10	3000	-	-	XD_scale in 375 and PRM does not changed to the rescaled value in EWS
-100	800	-100	100	-	-	-100	800	-100	100	-	-	-100	800	-100	100	-	-	-
-1000	1000	-1000	1000	-	-	-1000	1000	-1000	1000	-	-	-900	900	-1000	1000	-	-	XD_scale in 375 and PRM does not changed to the rescaled value in EWS
15	90	-	-	10	95	15	90	-	-	10	95	15	90	-	-	10	95	-
-	-	-	-	-	-	-	-	-	-	-	-	10	1500	20	17000	-	-	Not powered
-90	1000	-400	4000	-	-	-90	1000	-400	4000	-	-	-90	1000	-400	4000	-	-	-
-90	90	-950	950	-	-	CONNECTION FAIL				-	-	-90	90	-950	950	-	-	Connection Fail in PRM - ? Symbol in PRM. Therefore the XD and OUT scale does not update.
-100	800	-150	830	-	-	-100	800	-150	830	-	-	-100	800	-150	830	-	-	-
5	17	10	20	-	-	5	17	10	20	-	-	5	17	10	20	-	-	-
3	13	5	10	-	-	NO AI1 BLOCK				-	-	3	13	5	10	-	-	No AI1 block in PRM, but have AI1 block in 375
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not powered
10	90	-3	100	-	-	10	90	-3	100	-	-	10	90	-3	100	-	-	-

Segment 2

Segment	Device	EWS																Time Taken(s)	Faceplate		
		FF-AI												PVI							
		XD_SCALE				OUT_SCALE				PV_SCALE											
		Original		Change		Original		Change		Original		Change		Original		Change			AI Block Range	AO Block Range	PVI Block Range
		L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H				
2	LT301	0	100	10	90	0	100	15	80	-	-	-	-	0	100	20	70	1 min	15 to 80	-	20 to 70
	LT302	0	100	10	90	0	100	15	80	-	-	-	-	0	100	20	70	1 min	15 to 80	-	20 to 70
	PT303	0	2	0.5	1.5	0	2	1	1.5	-	-	-	-	0	3	0.9	2.9	1 min	1 to 1.5	-	0.9 to 2.9
	PDT304	0	3	1	2	0	3	0.5	2.5	-	-	-	-	0	3	0.9	2.9	1 min	0.5 to 2.5	-	0.9 to 2.9
	AT305	0	100	10	90	0	100	20	80	-	-	-	-	0	100	30	70	1 min	20 to 80	-	30 to 70
	FT306	0	100	10	90	0	100	20	80	-	-	-	-	0	100	30	70	1 min	20 to 80	-	30 to 70
	FT307	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	TT308	0	100	10	90	10	70	20	60	-	-	-	-	10	70	30	50	1 min	20 to 60	-	30 to 50
	TT401	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	PT402	0	125	10	120	0	125	20	120	-	-	-	-	0	125	30	100	1 min	20 to 120	-	30 to 100
	PDT403	0	10160	50	10000	0	10160	30	9000	-	-	-	-	0	10160	10	10100	1 min	30 to 9000	-	10 to 10100
	FT101	0	100	10	90	0	30	10	20	-	-	-	-	0	30	5	25	1 min	10 to 20	-	5 to 25
	FV102	0	100	10	90	-	-	-	-	20	50	25	40	20	50	25	40	1 min	10 to 90	-	0 to 100
	MTLADM1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Continue

375						PRM						FIELDBUS BUILDER						Remark
XD_SCALE		OUT_SCALE		PV_SCALE		XD_SCALE		OUT_SCALE		PV_SCALE		XD_SCALE		OUT_SCALE		PV_SCALE		
L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	L	H	
Unable to load DD						10	90	15	80	-	-	10	90	15	80	-	-	On PRM the limit change according to the limit change in EWS. We cannot abbserve the changing in the 375 because the device unable to load DD.
Unable to load DD						-	-	-	-	-	-	10	90	15	80	-	-	Cannot observe the changing on the limit because:- 1.375- Device unable to load DD 2.PRM- Unable to connect to device
375 cannot access to device						-	-	-	-	-	-	0.5	1.5	1	1.5	-	-	Cannot observe the changing on the limit because:- 1.375- Device Upload Aborted 2.PRM- Communication Error to device
376 cannot access to device						-	-	-	-	-	-	1	2	0.5	2.5	-	-	
Aborted						-	-	-	-	-	-	10	90	20	80	-	-	
Aborted						-	-	-	-	-	-	10	90	20	80	-	-	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	The device is not found in the live list
-200	850	-200	850	-	-	-	-	-	-	-	-	not in project database						Cannot observe at PRM because communication error to the device
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Not Powered
10	120	20	120	-	-	10	120	20	120	-	-	10	120	20	120	-	-	The limit change in EWS effect the limit change on that device and that is approve using the 375 and PRM
50	10000	30	9000	-	-	50	10000	30	9000	-	-	50	10000	30	9000	-	-	
0	30	0	30	-	-	0	30	0	30	-	-	10	90	10	20	-	-	The limit do not change according to EWS
10	90	-	-	24	40	10	90	-	-	25	40	10	90	-	-	25	40	The limit change in EWS effect the limit change on that device and that is approve using the 375 and PRM
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	The device is not found in the live list

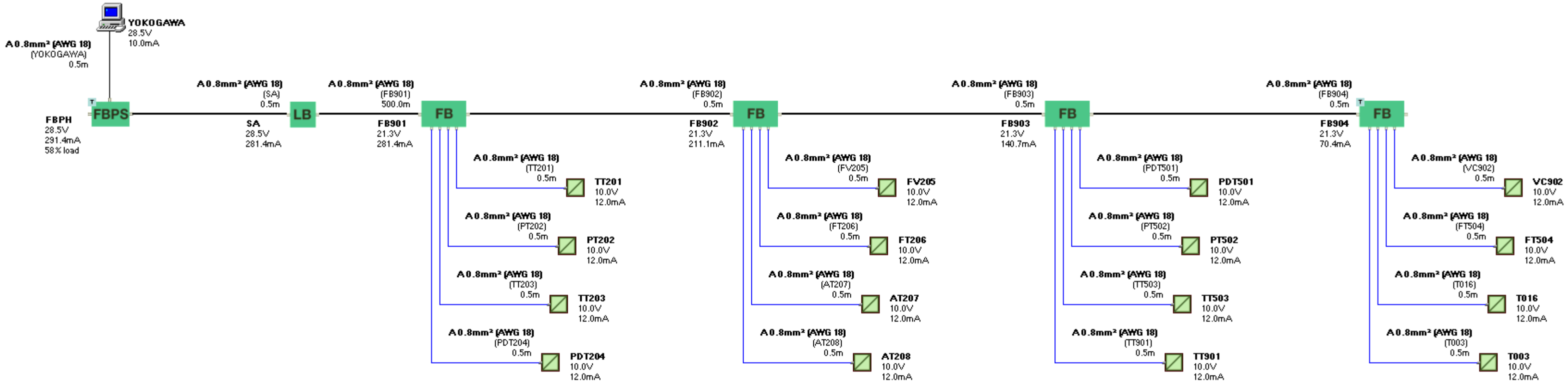
APPENDIX H

SEGMENT CHECKER RESULT

The Segment1 Design on P+F Segment Checker Software

Result 1: Normal Design

	11/2/2009
Segment Type	Fieldbus Foundation: not specified
Cable Type	A 0.8mm² (AWG 18)
Env. Temp.	21°C
Default Field Device Current	10mA
Default Spur Length	0.5m
Short Circuit Checking	On



Project Parameters

Segment Type	= Fieldbus Foundation: not specified
Cable Type	= A 0.8mm² (AWG 18)
Env. Temp.	= 21°C
Default Field Device Current	= 10mA
Default Spur Length	= 0.5m
Short Circuit Checking	= On

Checker Results

Checker Summary	
Topology Check	success
Power Distribution Check	success
Short Circuit Check	success

Device Summary

Devices	
DP-LBF-1.34	1
Gen. Field Device	16
Gen. Host	1
HD2-FBPS-1.500	1
RD0-FB-EX4.xx	4

Cables	
A 0.8mm² (AWG 18)	510.5m

Device List

Tag: YOKOGAWA	**Device Type:** Gen. Host

Device Parameters

Input Current	= 10mA
Min. Input Voltage	= 9V

Connections

Input	⇒FBPH

Tag: FBPH	**Device Type:** HD2-FBPS-1.500

Device Parameters

Open-circuit Voltage	= 29.3V
Rated current	= 500mA
Terminator	= On
Integrated Master/Host	= Off

Connections

Output	⇒SA
Master Con.	⇒YOKOGAWA

Tag: SA	**Device Type:** DP-LBF-1.34

Device Parameters

Series Resistance	= 3.6Ohm

Connections

Input	⇒FBPH
Output	⇒FB901

Tag: FB901	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒SA
Output	⇒FB902
Spur 1	⇒PDT204
Spur 2	⇒TT203
Spur 3	⇒PT202
Spur 4	⇒TT201

Tag: PDT204	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT203	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: PT202	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT201	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: FB902	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4

Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB901
Output	⇒FB903
Spur 1	⇒AT208
Spur 2	⇒AT207
Spur 3	⇒FT206
Spur 4	⇒FV205

Tag: AT208	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: AT207	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FT206	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FV205	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FB903	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB902

Output	⇒FB904
Spur 1	⇒TT901
Spur 2	⇒TT503
Spur 3	⇒PT502
Spur 4	⇒PDT501

Tag: TT901	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: TT503	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: PT502	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: PDT501	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: FB904	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= On

Connections

Input	⇒FB903
Spur 1	⇒T003
Spur 2	⇒T016
Spur 3	⇒FT504
Spur 4	⇒VC902

Tag: T003	**Device Type:** Gen. Field Device

Device Parameters

Input Current = 12mA
Min. Input Voltage = 9V

Connections

Input ⇒FB904

Tag: T016	**Device Type:** Gen. Field Device

Device Parameters

Input Current = 12mA
Min. Input Voltage = 9V

Connections

Input ⇒FB904

Tag: FT504	**Device Type:** Gen. Field Device

Device Parameters

Input Current = 12mA
Min. Input Voltage = 9V

Connections

Input ⇒FB904

Tag: VC902	**Device Type:** Gen. Field Device

Device Parameters

Input Current = 12mA
Min. Input Voltage = 9V

Connections

Input ⇒FB904

Connection List

Cable Parameters: FBPH-YOKOGAWA

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FBPH-SA

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: SA-FB901

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 500.0m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-PDT204

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m

Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT203

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-PT202

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT201

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-FB902

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT208

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT207

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FT206

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FV205

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FB903

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-TT901

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB903-TT503

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB903-PT502

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB903-PDT501

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB903-FB904

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB904-T003

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB904-T016

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB904-FT504

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB904-VC902

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Checker Details

Power Distribution Check					
	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.543	success
FBPH	192.0	291.4	20.942	29.300	success
FBPH:Output	192.0	281.4	20.942	28.543	
FBPH:Master Con.	10.0	10.0	9.000	28.543	
SA	192.0	281.4	20.938	28.537	success
SA:Output	192.0	281.4	20.247	27.526	
FB901	192.0	281.4	16.006	21.320	success
FB901:Output	144.0	211.1	16.006	21.320	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	211.1	16.003	21.315	success
FB902:Output	96.0	140.7	16.003	21.315	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	140.7	16.001	21.312	success
FB903:Output	48.0	70.4	16.001	21.312	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	70.4	16.000	21.310	success
FB904:Spur 1	12.0	12.0	9.000	10.000	
FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 4 iterations with an accuracy of 0.400mA.

Summary:
Minimum applied voltage level for a device: 10.000V

Short Circuit Check					
FB901 - Short Circuit Check:					
	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.450	success
FBPH	192.0	327.0	20.942	29.300	success
FBPH:Output	192.0	317.0	20.942	28.451	
FBPH:Master Con.	10.0	10.0	9.000	28.451	
SA	192.0	317.0	20.938	28.444	success
SA:Output	192.0	317.0	20.247	27.303	
FB901	192.0	317.0	16.006	20.308	success
FB901:Output	144.0	216.1	16.006	20.308	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	216.1	16.003	20.303	success
FB902:Output	96.0	144.1	16.003	20.303	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	144.1	16.001	20.300	success
FB903:Output	48.0	72.1	16.001	20.300	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	72.1	16.000	20.299	success
FB904:Spur 1	12.0	12.0	9.000	10.000	
FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 5 iterations with an accuracy of 0.261mA.

Short Circuit Check

FB902 - Short Circuit Check:

	Current [mA]		Voltage [V]		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.449	success
FBPH	192.0	327.1	20.942	29.300	success
FBPH:Output	192.0	317.1	20.942	28.450	
FBPH:Master Con.	10.0	10.0	9.000	28.450	
SA	192.0	317.1	20.938	28.443	success
SA:Output	192.0	317.1	20.247	27.301	
FB901	192.0	317.1	16.006	20.299	success
FB901:Output	144.0	245.0	16.006	20.299	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	245.0	16.003	20.293	success
FB902:Output	96.0	144.1	16.003	20.293	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	144.1	16.001	20.290	success
FB903:Output	48.0	72.1	16.001	20.290	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	72.1	16.000	20.289	success
FB904:Spur 1	12.0	12.0	9.000	10.000	
FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 2 iterations with an accuracy of 0.021mA.

Short Circuit Check

FB903 - Short Circuit Check:					
	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.449	success
FBPH	192.0	327.1	20.942	29.300	success
FBPH:Output	192.0	317.1	20.942	28.450	
FBPH:Master Con.	10.0	10.0	9.000	28.450	
SA	192.0	317.1	20.938	28.443	success
SA:Output	192.0	317.1	20.247	27.301	
FB901	192.0	317.1	16.006	20.298	success
FB901:Output	144.0	245.0	16.006	20.298	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	245.0	16.003	20.293	success
FB902:Output	96.0	173.0	16.003	20.293	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	173.0	16.001	20.289	success
FB903:Output	48.0	72.1	16.001	20.289	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	72.1	16.000	20.287	success
FB904:Spur 1	12.0	12.0	9.000	10.000	
FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 2 iterations with an accuracy of 0.006mA.

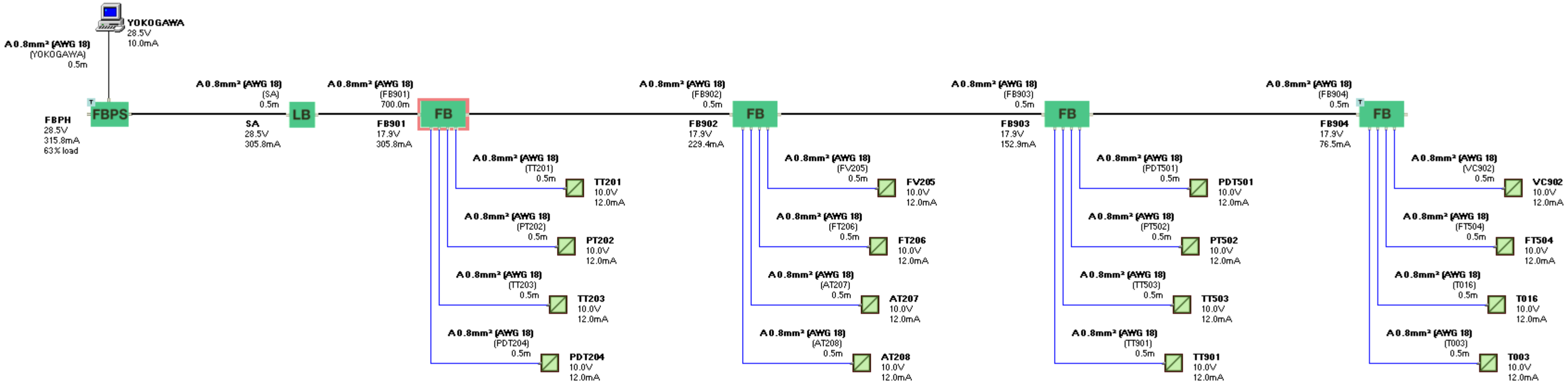
Short Circuit Check					
FB904 - Short Circuit Check:					
	Current [mA]		**Voltage [V]**		

Tag	must	is	must	is	Result
YOKOGAWA	10.0	10.0	9.000	28.449	success
FBPH	192.0	327.1	20.942	29.300	success
FBPH:Output	192.0	317.1	20.942	28.450	
FBPH:Master Con.	10.0	10.0	9.000	28.450	
SA	192.0	317.1	20.938	28.443	success
SA:Output	192.0	317.1	20.247	27.301	
FB901	192.0	317.1	16.006	20.298	success
FB901:Output	144.0	245.0	16.006	20.298	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	245.0	16.003	20.292	success
FB902:Output	96.0	173.0	16.003	20.292	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	173.0	16.001	20.288	success
FB903:Output	48.0	100.9	16.001	20.288	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	100.9	16.000	20.286	success
FB904:Spur 1	12.0	12.0	9.000	10.000	
FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 2 iterations with an accuracy of 0.003mA.

Result 2: Cable Length Test
Length of Cable =700+10.5=710.5m

	11/2/2009
Segment Type	Fieldbus Foundation: not specified
Cable Type	A 0.8mm² (AWG 18)
Env. Temp.	21°C
Default Field Device Current	10mA
Default Spur Length	0.5m
Short Circuit Checking	On



Project Parameters

Segment Type = Fieldbus Foundation: not specified
Cable Type = A 0.8mm² (AWG 18)
Env. Temp. = 21°C
Default Field Device Current = 10mA
Default Spur Length = 0.5m
Short Circuit Checking = On

Checker Results

Checker Summary	
Topology Check	success
Power Distribution Check	success
Short Circuit Check	failed

Device Summary

Devices	
DP-LBF-1.34	1
Gen. Field Device	16
Gen. Host	1
HD2-FBPS-1.500	1
RD0-FB-EX4.xx	4

Cables	
A 0.8mm² (AWG 18)	710.5m

Device List

Tag: YOKOGAWA	**Device Type:** Gen. Host

Device Parameters

Input Current = 10mA
Min. Input Voltage = 9V

Connections

Input ⇒FBPH

Tag: FBPH	**Device Type:** HD2-FBPS-1.500

Device Parameters

Open-circuit Voltage = 29.3V
Rated current = 500mA
Terminator = On
Integrated Master/Host = Off

Connections

Output ⇒SA
Master Con. ⇒YOKOGAWA

Tag: SA	**Device Type:** DP-LBF-1.34

Device Parameters

Series Resistance = 3.6Ohm

Connections

Input	⇒FBPH
Output	⇒FB901

Tag: FB901	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Device Errors

FB902 - Short Circuit Check: Calculated voltage is too low.

FB903 - Short Circuit Check: Calculated voltage is too low.

FB901 - Short Circuit Check: Calculated voltage is too low.

FB904 - Short Circuit Check: Calculated voltage is too low.

Connections

Input	⇒SA
Output	⇒FB902
Spur 1	⇒PDT204
Spur 2	⇒TT203
Spur 3	⇒PT202
Spur 4	⇒TT201

Tag: PDT204	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT203	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: PT202	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT201	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: FB902	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB901
Output	⇒FB903
Spur 1	⇒AT208
Spur 2	⇒AT207
Spur 3	⇒FT206
Spur 4	⇒FV205

Tag: AT208	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: AT207	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FT206	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FV205	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FB903	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB902
Output	⇒FB904
Spur 1	⇒TT901
Spur 2	⇒TT503
Spur 3	⇒PT502
Spur 4	⇒PDT501

Tag: TT901	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: TT503	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: PT502	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: PDT501	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB903

Tag: FB904	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= On

Connections

Input	⇒FB903
Spur 1	⇒T003
Spur 2	⇒T016
Spur 3	⇒FT504
Spur 4	⇒VC902

Tag: T003	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB904

Tag: T016	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB904

Tag: FT504	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB904

Tag: VC902	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB904

Connection List

Cable Parameters: FBPH-YOKOGAWA

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FBPH-SA

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: SA-FB901

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 700.0m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-PDT204

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT203

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-PT202

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT201

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-FB902

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT208

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT207

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FT206

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FV205

Cable Type = A 0.8mm² (AWG 18)

Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FB903

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-TT901

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-TT503

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-PT502

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-PDT501

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB903-FB904

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB904-T003

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB904-T016

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB904-FT504

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²

Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB904-VC902

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Checker Details

Power Distribution Check					
	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.480	success
FBPH	192.0	315.8	22.638	29.300	success
FBPH:Output	192.0	305.8	22.638	28.480	
FBPH:Master Con.	10.0	10.0	9.000	28.480	
SA	192.0	305.8	22.634	28.473	success
SA:Output	192.0	305.8	21.943	27.374	
FB901	192.0	305.8	16.006	17.934	success
FB901:Output	144.0	229.4	16.006	17.934	
FB901:Spur 1	12.0	12.0	9.000	10.000	
FB901:Spur 2	12.0	12.0	9.000	10.000	
FB901:Spur 3	12.0	12.0	9.000	10.000	
FB901:Spur 4	12.0	12.0	9.000	10.000	
PDT204	12.0	12.0	9.000	10.000	success
TT203	12.0	12.0	9.000	10.000	success
PT202	12.0	12.0	9.000	10.000	success
TT201	12.0	12.0	9.000	10.000	success
FB902	144.0	229.4	16.003	17.929	success
FB902:Output	96.0	152.9	16.003	17.929	
FB902:Spur 1	12.0	12.0	9.000	10.000	
FB902:Spur 2	12.0	12.0	9.000	10.000	
FB902:Spur 3	12.0	12.0	9.000	10.000	
FB902:Spur 4	12.0	12.0	9.000	10.000	
AT208	12.0	12.0	9.000	10.000	success
AT207	12.0	12.0	9.000	10.000	success
FT206	12.0	12.0	9.000	10.000	success
FV205	12.0	12.0	9.000	10.000	success
FB903	96.0	152.9	16.001	17.925	success
FB903:Output	48.0	76.5	16.001	17.925	
FB903:Spur 1	12.0	12.0	9.000	10.000	
FB903:Spur 2	12.0	12.0	9.000	10.000	
FB903:Spur 3	12.0	12.0	9.000	10.000	
FB903:Spur 4	12.0	12.0	9.000	10.000	
TT901	12.0	12.0	9.000	10.000	success
TT503	12.0	12.0	9.000	10.000	success
PT502	12.0	12.0	9.000	10.000	success
PDT501	12.0	12.0	9.000	10.000	success
FB904	48.0	76.5	16.000	17.924	success
FB904:Spur 1	12.0	12.0	9.000	10.000	

FB904:Spur 2	12.0	12.0	9.000	10.000	
FB904:Spur 3	12.0	12.0	9.000	10.000	
FB904:Spur 4	12.0	12.0	9.000	10.000	
T003	12.0	12.0	9.000	10.000	success
T016	12.0	12.0	9.000	10.000	success
FT504	12.0	12.0	9.000	10.000	success
VC902	12.0	12.0	9.000	10.000	success

Result reached after 5 iterations with an accuracy of 0.516mA.

Summary:
Minimum applied voltage level for a device: 10.000V

Short Circuit Check

FB901 - Short Circuit Check:

	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.341	success
FBPH	192.0	369.7	22.638	29.300	success
FBPH:Output	192.0	359.7	22.638	28.341	
FBPH:Master Con.	10.0	10.0	9.000	28.341	
SA	192.0	359.7	22.634	28.333	success
SA:Output	192.0	359.7	21.943	27.042	
FB901	192.0	359.7	16.006	15.949	failed
FB901:Output	144.0	-	16.006	-	skipped
FB901:Spur 1	12.0	-	9.000	-	skipped
FB901:Spur 2	12.0	-	9.000	-	skipped
FB901:Spur 3	12.0	-	9.000	-	skipped
FB901:Spur 4	12.0	-	9.000	-	skipped
PDT204	12.0	-	9.000	-	skipped
TT203	12.0	-	9.000	-	skipped
PT202	12.0	-	9.000	-	skipped
TT201	12.0	-	9.000	-	skipped
FB902	144.0	-	16.003	-	skipped
FB902:Output	96.0	-	16.003	-	skipped
FB902:Spur 1	12.0	-	9.000	-	skipped
FB902:Spur 2	12.0	-	9.000	-	skipped
FB902:Spur 3	12.0	-	9.000	-	skipped
FB902:Spur 4	12.0	-	9.000	-	skipped
AT208	12.0	-	9.000	-	skipped
AT207	12.0	-	9.000	-	skipped
FT206	12.0	-	9.000	-	skipped
FV205	12.0	-	9.000	-	skipped
FB903	96.0	-	16.001	-	skipped
FB903:Output	48.0	-	16.001	-	skipped
FB903:Spur 1	12.0	-	9.000	-	skipped
FB903:Spur 2	12.0	-	9.000	-	skipped
FB903:Spur 3	12.0	-	9.000	-	skipped
FB903:Spur 4	12.0	-	9.000	-	skipped
TT901	12.0	-	9.000	-	skipped
TT503	12.0	-	9.000	-	skipped
PT502	12.0	-	9.000	-	skipped
PDT501	12.0	-	9.000	-	skipped

FB904	48.0	-	16.000	-	skipped
FB904:Spur 1	12.0	-	9.000	-	skipped
FB904:Spur 2	12.0	-	9.000	-	skipped
FB904:Spur 3	12.0	-	9.000	-	skipped
FB904:Spur 4	12.0	-	9.000	-	skipped
T003	12.0	-	9.000	-	skipped
T016	12.0	-	9.000	-	skipped
FT504	12.0	-	9.000	-	skipped
VC902	12.0	-	9.000	-	skipped

FB901 = FB901 - Short Circuit Check: Calculated voltage is too low.
Result reached after 6 iterations with an accuracy of 0.908mA.

Short Circuit Check

FB902 - Short Circuit Check:

	Current [mA]		Voltage [V]		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.338	success
FBPH	192.0	370.2	22.638	29.300	success
FBPH:Output	192.0	360.2	22.638	28.338	
FBPH:Master Con.	10.0	10.0	9.000	28.338	
SA	192.0	360.2	22.634	28.330	success
SA:Output	192.0	360.2	21.943	27.034	
FB901	192.0	360.2	16.006	15.901	failed
FB901:Output	144.0	-	16.006	-	skipped
FB901:Spur 1	12.0	-	9.000	-	skipped
FB901:Spur 2	12.0	-	9.000	-	skipped
FB901:Spur 3	12.0	-	9.000	-	skipped
FB901:Spur 4	12.0	-	9.000	-	skipped
PDT204	12.0	-	9.000	-	skipped
TT203	12.0	-	9.000	-	skipped
PT202	12.0	-	9.000	-	skipped
TT201	12.0	-	9.000	-	skipped
FB902	144.0	-	16.003	-	skipped
FB902:Output	96.0	-	16.003	-	skipped
FB902:Spur 1	12.0	-	9.000	-	skipped
FB902:Spur 2	12.0	-	9.000	-	skipped
FB902:Spur 3	12.0	-	9.000	-	skipped
FB902:Spur 4	12.0	-	9.000	-	skipped
AT208	12.0	-	9.000	-	skipped
AT207	12.0	-	9.000	-	skipped
FT206	12.0	-	9.000	-	skipped
FV205	12.0	-	9.000	-	skipped
FB903	96.0	-	16.001	-	skipped
FB903:Output	48.0	-	16.001	-	skipped
FB903:Spur 1	12.0	-	9.000	-	skipped
FB903:Spur 2	12.0	-	9.000	-	skipped
FB903:Spur 3	12.0	-	9.000	-	skipped
FB903:Spur 4	12.0	-	9.000	-	skipped
TT901	12.0	-	9.000	-	skipped
TT503	12.0	-	9.000	-	skipped
PT502	12.0	-	9.000	-	skipped
PDT501	12.0	-	9.000	-	skipped
FB904	48.0	-	16.000	-	skipped

FB904:Spur 1	12.0	-	9.000	-	skipped
FB904:Spur 2	12.0	-	9.000	-	skipped
FB904:Spur 3	12.0	-	9.000	-	skipped
FB904:Spur 4	12.0	-	9.000	-	skipped
T003	12.0	-	9.000	-	skipped
T016	12.0	-	9.000	-	skipped
FT504	12.0	-	9.000	-	skipped
VC902	12.0	-	9.000	-	skipped

FB901 = FB902 - Short Circuit Check: Calculated voltage is too low.

Result reached after 2 iterations with an accuracy of 0.169mA.

Short Circuit Check

FB903 - Short Circuit Check:

	Current [mA]		**Voltage [V]**		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.337	success
FBPH	192.0	370.3	22.638	29.300	success
FBPH:Output	192.0	360.3	22.638	28.337	
FBPH:Master Con.	10.0	10.0	9.000	28.337	
SA	192.0	360.3	22.634	28.329	success
SA:Output	192.0	360.3	21.943	27.032	
FB901	192.0	360.3	16.006	15.891	failed
FB901:Output	144.0	-	16.006	-	skipped
FB901:Spur 1	12.0	-	9.000	-	skipped
FB901:Spur 2	12.0	-	9.000	-	skipped
FB901:Spur 3	12.0	-	9.000	-	skipped
FB901:Spur 4	12.0	-	9.000	-	skipped
PDT204	12.0	-	9.000	-	skipped
TT203	12.0	-	9.000	-	skipped
PT202	12.0	-	9.000	-	skipped
TT201	12.0	-	9.000	-	skipped
FB902	144.0	-	16.003	-	skipped
FB902:Output	96.0	-	16.003	-	skipped
FB902:Spur 1	12.0	-	9.000	-	skipped
FB902:Spur 2	12.0	-	9.000	-	skipped
FB902:Spur 3	12.0	-	9.000	-	skipped
FB902:Spur 4	12.0	-	9.000	-	skipped
AT208	12.0	-	9.000	-	skipped
AT207	12.0	-	9.000	-	skipped
FT206	12.0	-	9.000	-	skipped
FV205	12.0	-	9.000	-	skipped
FB903	96.0	-	16.001	-	skipped
FB903:Output	48.0	-	16.001	-	skipped
FB903:Spur 1	12.0	-	9.000	-	skipped
FB903:Spur 2	12.0	-	9.000	-	skipped
FB903:Spur 3	12.0	-	9.000	-	skipped
FB903:Spur 4	12.0	-	9.000	-	skipped
TT901	12.0	-	9.000	-	skipped
TT503	12.0	-	9.000	-	skipped
PT502	12.0	-	9.000	-	skipped
PDT501	12.0	-	9.000	-	skipped
FB904	48.0	-	16.000	-	skipped
FB904:Spur 1	12.0	-	9.000	-	skipped

FB904:Spur 2	12.0	-	9.000	-	skipped
FB904:Spur 3	12.0	-	9.000	-	skipped
FB904:Spur 4	12.0	-	9.000	-	skipped
T003	12.0	-	9.000	-	skipped
T016	12.0	-	9.000	-	skipped
FT504	12.0	-	9.000	-	skipped
VC902	12.0	-	9.000	-	skipped

FB901 = FB903 - Short Circuit Check: Calculated voltage is too low.

Result reached after 2 iterations with an accuracy of 0.039mA.

Short Circuit Check

FB904 - Short Circuit Check:

	Current [mA]		Voltage [V]		
Tag	**must**	**is**	**must**	**is**	**Result**
YOKOGAWA	10.0	10.0	9.000	28.337	success
FBPH	192.0	370.4	22.638	29.300	success
FBPH:Output	192.0	360.4	22.638	28.337	
FBPH:Master Con.	10.0	10.0	9.000	28.337	
SA	192.0	360.4	22.634	28.329	success
SA:Output	192.0	360.4	21.943	27.032	
FB901	192.0	360.4	16.006	15.889	failed
FB901:Output	144.0	-	16.006	-	skipped
FB901:Spur 1	12.0	-	9.000	-	skipped
FB901:Spur 2	12.0	-	9.000	-	skipped
FB901:Spur 3	12.0	-	9.000	-	skipped
FB901:Spur 4	12.0	-	9.000	-	skipped
PDT204	12.0	-	9.000	-	skipped
TT203	12.0	-	9.000	-	skipped
PT202	12.0	-	9.000	-	skipped
TT201	12.0	-	9.000	-	skipped
FB902	144.0	-	16.003	-	skipped
FB902:Output	96.0	-	16.003	-	skipped
FB902:Spur 1	12.0	-	9.000	-	skipped
FB902:Spur 2	12.0	-	9.000	-	skipped
FB902:Spur 3	12.0	-	9.000	-	skipped
FB902:Spur 4	12.0	-	9.000	-	skipped
AT208	12.0	-	9.000	-	skipped
AT207	12.0	-	9.000	-	skipped
FT206	12.0	-	9.000	-	skipped
FV205	12.0	-	9.000	-	skipped
FB903	96.0	-	16.001	-	skipped
FB903:Output	48.0	-	16.001	-	skipped
FB903:Spur 1	12.0	-	9.000	-	skipped
FB903:Spur 2	12.0	-	9.000	-	skipped
FB903:Spur 3	12.0	-	9.000	-	skipped
FB903:Spur 4	12.0	-	9.000	-	skipped
TT901	12.0	-	9.000	-	skipped
TT503	12.0	-	9.000	-	skipped
PT502	12.0	-	9.000	-	skipped
PDT501	12.0	-	9.000	-	skipped
FB904	48.0	-	16.000	-	skipped
FB904:Spur 1	12.0	-	9.000	-	skipped
FB904:Spur 2	12.0	-	9.000	-	skipped

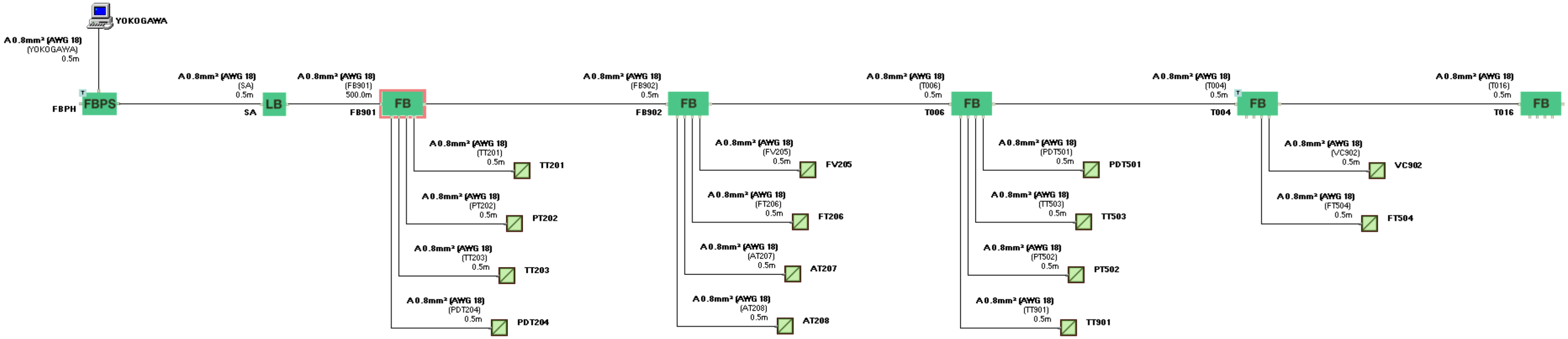
FB904:Spur 3	12.0	-	9.000	-	skipped
FB904:Spur 4	12.0	-	9.000	-	skipped
T003	12.0	-	9.000	-	skipped
T016	12.0	-	9.000	-	skipped
FT504	12.0	-	9.000	-	skipped
VC902	12.0	-	9.000	-	skipped

FB901 = FB904 - Short Circuit Check: Calculated voltage is too low.

Result reached after 2 iterations with an accuracy of 0.012mA.

3: 5 Field Barriers

	11/2/2009
Segment Type	Fieldbus Foundation: not specified
Cable Type	A 0.8mm² (AWG 18)
Env. Temp.	21°C
Default Field Device Current	10mA
Default Spur Length	0.5m
Short Circuit Checking	On



Project Parameters

Segment Type	= Fieldbus Foundation: not specified
Cable Type	= A 0.8mm² (AWG 18)
Env. Temp.	= 21°C
Default Field Device Current	= 10mA
Default Spur Length	= 0.5m
Short Circuit Checking	= On

Checker Results

Checker Summary	
Topology Check	failed
Power Distribution Check	skipped
Short Circuit Check	skipped

Device Summary

Devices	
DP-LBF-1.34	1
Gen. Field Device	14
Gen. Host	1
HD2-FBPS-1.500	1
RD0-FB-EX4.xx	5

Cables	
A 0.8mm² (AWG 18)	510m

Device List

Tag: YOKOGAWA	**Device Type:** Gen. Host

Device Parameters

Input Current	= 10mA
Min. Input Voltage	= 9V

Connections

Input	⇒FBPH

Tag: FBPH	**Device Type:** HD2-FBPS-1.500

Device Parameters

Open-circuit Voltage	= 29.3V
Rated current	= 500mA
Terminator	= On
Integrated Master/Host	= Off

Connections

Output	⇒SA
Master Con.	⇒YOKOGAWA

Tag: SA	**Device Type:** DP-LBF-1.34

Device Parameters

Series Resistance	= 3.6Ohm

Connections

Input	⇒FBPH
Output	⇒FB901

Tag: FB901	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Device Errors

Too many Fieldbarriers.

Connections

Input	⇒SA
Output	⇒FB902
Spur 1	⇒PDT204
Spur 2	⇒TT203
Spur 3	⇒PT202
Spur 4	⇒TT201

Tag: PDT204	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT203	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: PT202	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: TT201	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB901

Tag: FB902	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB901
Output	⇒T006
Spur 1	⇒AT208
Spur 2	⇒AT207
Spur 3	⇒FT206
Spur 4	⇒FV205

Tag: AT208	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: AT207	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FT206	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: FV205	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒FB902

Tag: T006	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V

Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒FB902
Output	⇒T004
Spur 1	⇒TT901
Spur 2	⇒PT502
Spur 3	⇒TT503
Spur 4	⇒PDT501

Tag: TT901	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T006

Tag: PT502	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T006

Tag: TT503	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T006

Tag: PDT501	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T006

Tag: T004	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= On

Connections

Input	⇒T006
Output	⇒T016

Spur 3	⇒FT504
Spur 4	⇒VC902

Tag: FT504	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T004

Tag: VC902	**Device Type:** Gen. Field Device

Device Parameters

Input Current	= 12mA
Min. Input Voltage	= 9V

Connections

Input	⇒T004

Tag: T016	**Device Type:** RD0-FB-EX4.xx

Device Parameters

Number of Spurs	= 4
Min. Input Voltage	= 16V
Max. Voltage/Spur	= 10V
Max. Current/Spur	= 40mA
Short circuit current limit per Spur	= 47mA
Terminator	= Off

Connections

Input	⇒T004

Connection List

Cable Parameters: FBPH-YOKOGAWA

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FBPH-SA

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 0.5m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: SA-FB901

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²
Wire Resistance	= 44Ohm/km
Wire Length	= 500.0m
Temp. Coefficient	= 0.0039Ohm/mK

Cable Parameters: FB901-PDT204

Cable Type	= A 0.8mm² (AWG 18)
Cross Wire Section	= 0.8mm²

Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT203

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-PT202

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-TT201

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB901-FB902

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT208

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-AT207

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FT206

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-FV205

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: FB902-T006

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²

Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T006-TT901

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T006-PT502

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T006-TT503

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T006-PDT501

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T006-T004

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T004-FT504

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T004-VC902

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Cable Parameters: T004-T016

Cable Type = A 0.8mm² (AWG 18)
Cross Wire Section = 0.8mm²
Wire Resistance = 44Ohm/km
Wire Length = 0.5m
Temp. Coefficient = 0.0039Ohm/mK

Checker Details