# CHAPTER 1

# INTRODUCTION

## 1.1 Background of Study

In a process control system, 4-20 mA technology is widely used which needs each device connects to computer control via its own cable and communication point at the controller level. In this recent year, Fieldbus technology has emerged and will be replacing the previous 4-20 mA technology. Fieldbus is an industrial network system for real-time distributed control which used microprocessor based control. It is two ways multi-drop communication among the intelligent and control devices and automation and display system. The idea of fieldbus was proposed to solve problems such as proprietary protocols, slow transmission rate and different data formats. With Fieldbus technology, various devices from different manufacturers and vendors can communicate via the same language.

Thus, the need of Interoperability Testing is to ensure that the end used will not faced any difficulties or problem regarding to communication between devices from various manufacturer/ vendor such as Emerson, Yokogawa, Honeywell or Foxboro. This project also aims to provide a simple loop design using EMERSON configuration for brief familiarization to the fieldbus system for scientific researchers and engineers, as foundation for further development for either laboratory or industrial applications and testing. Because of several tests need to be carried out, Foundation Fieldbus system have been installed in Universiti Teknologi Petronas (UTP) process lab. All testing and maintenance of the system will be performed in UTP (together with vendors, contractors and SKG 14 team projects). All FFTF equipment confirms to IEC 801, EN 50081-2 and EN 50083-2 requirements for Electromagnetic Compatibility (EMC) [1] [2] [3].

## 1.2 Problem Statement

The interoperability of FOUNDATION Fieldbus is a communication between different devices to host from several manufacturers or vendors. Fieldbus technology is claimed to be interoperability and can replaced the recent 4-20 mA technology [8]. Furthermore since the main objective of fieldbus technology is to overcome the problem in current computer connection in term of the slow speed of transmission rate, propriety protocol and data format, several testing need to be done to ensure the real performance of this system. The design loop will be introduced in this project that might be beneficial to author to understand the whole system and also beneficial for further research.

The outcome of the tests will become the reference to the production of a PETRONAS approved list for FOUNDATION Fieldbus system and field devices. This will involve verification of open standard using several tests

## 1.3 Significance of Project

Upon completion of the research and testing, the final results would be used as reference in formulating test procedures and standard for implementation in PETRONAS Group-wide. The testing and calculation will determine the performance of the Foundation Fieldbus system.

This project is a continuation of previous testing and performance evaluation on the Fieldbus Interoperability Test (FFIT). However, for this project, new design loop will be introduced and tried. A comprehensive technical report on the FFIT will be the outcome of this project.

## 1.4 Objective and Scope of Study

**Objective**

1. To assist the SKG 14 in developing the test methodology (on Stress Test- the second testing). The scope of testing will cover the interoperability test using the EMERSON's host.

2. To design a new loop system for better understanding of the project and might be beneficial for further research.

3. To monitor and discuss the system performance and issues especially the communication between devices and host.

**Scope of Study**

The seeking of understanding on FOUNDATION Fieldbus must first be achieved in completing this project. The scope of study consists of:

1. The detail approach in designing, configuring and implementing a fieldbus test rig from the various loose field devices, controllers and actuators, and the software development tool.

2. The familiarization with vendor Distributed Control System (DCS) especially on EMERSON Delta V System.

3. The study on Basic Interoperability Testing and its methodology which consist of Stress test and Diagnostic test.

# CHAPTER 2

# LITERATURE REVIEW

## 2.1 What is Fieldbus?

Fieldbus is an industrial network system for real-time distributed control which used microprocessor based control. It is digital, bi-directional, multi-drop, serial-bus, communications to link isolated field devices, such as controllers, transducers, actuators and sensors. The Fieldbus technology is a data resource that can provide maintenance information for field instruments on-line [7]. This information capability can assist the maintenance work and reduce the costs.

Fieldbus is actually a technique to connect instruments in a manufacturing plant and replacing the previous computer connection by which only 2 devices could communicate at a certain time. This would be equivalent to a current widely used 4-20 mA communication scheme that needs each device connects to computer control via its own cable and communication point at the controller level. However, the Fieldbus connection is equivalent to current Local Area Network (LAN) connections, which mean it requires only one communication path for hundreds of analogue and digital devices. Thus, all devices can be connected at the same time via the same port connection which means fieldbus connection reduces both the length of the cable required and the number of cables required[6][8].

Each field device has low cost computing power installed in it, making each device a 'smart' device. Each device will be able to execute simple functions on its own such as diagnostic, control, and maintenance functions as well as providing bi-directional communication capabilities. With these devices not only will the engineer be able to access the field devices, but they are also able to communicate with other field devices [5].

## 2.2 FOUNDATION Fieldbus

Unlike proprietary network protocols, FOUNDATION fieldbus is neither owned by any individual company, nor regulated by a single nation or standards body. The technology is controlled by the Fieldbus Foundation, a not-for-profit organization consisting of more than 100 of the world's leading controls and instrumentation suppliers and end users. [5]

FOUNDATION fieldbus retains many of the desirable features of the 4-20 mA analog system, such as a standardized physical interface to the wire, bus-powered devices on a single wire, and intrinsic safety options, it offers a host of additional benefits to users.

In FOUNDATION Fieldbus, there are two related implementations of have been introduced. These two implementations use different physical media and communication speeds to meets with the process control environment needs.

- **H1** works at 31.25 Kbps and generally connects to field devices. It provides communication and power over standard twisted-pair wiring. H1 is currently the most common implementation [5].
- **Ethernet** works at 100 Mbps and generally connects input/output subsystems, host systems, linking devices, gateways, and field devices using standard Ethernet cabling. It doesn't currently provide power over the cable, although work is under way to address this [5].

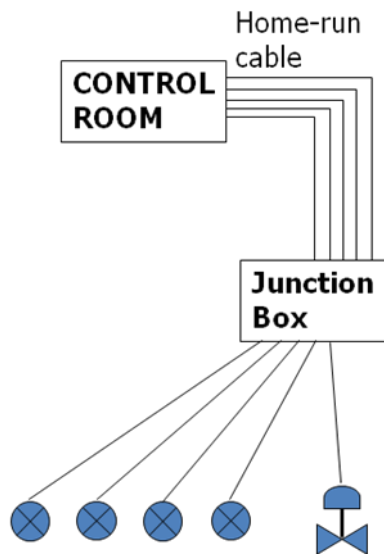Figures below show the difference between home run cables (usually 4-20 mA) to Fieldbus.
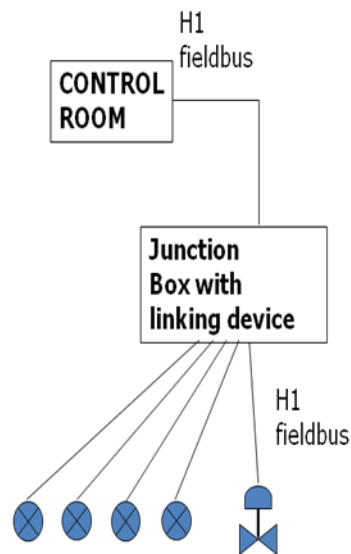


Figure 1: Home Run Cable [5]          Figure 2: Fieldbus Cable [5]

The above figures show the different of the length and amount of cable used by current system and fieldbus system. FOUNDATION Fieldbus' use of existing wiring and multi-drop connections provides significant savings in network installation costs. This includes reductions in intrinsic safety barrier termination and cable costs, particularly in areas where wiring is already in place.

Figure below shows the FOUNDATION Fieldbus topology. On top of the hierarchy, there is Human Machine Interface (HMI) where an operator can monitor or operate the system. Hubs and switches provide a means to connect multiple nodes. Hubs serve as a connection point and rejuvenate the electrical signal as messages are forwarded on the control network.

HMI is typically linked to a middle layer of programmable logic controllers (PLC) via a non time critical communications system (e.g. Ethernet). At the bottom of the control chain is the fieldbus which links the PLCs to the components which actually do the work such as sensors, actuators, electric motors, console lights, switches, valves and contactors.
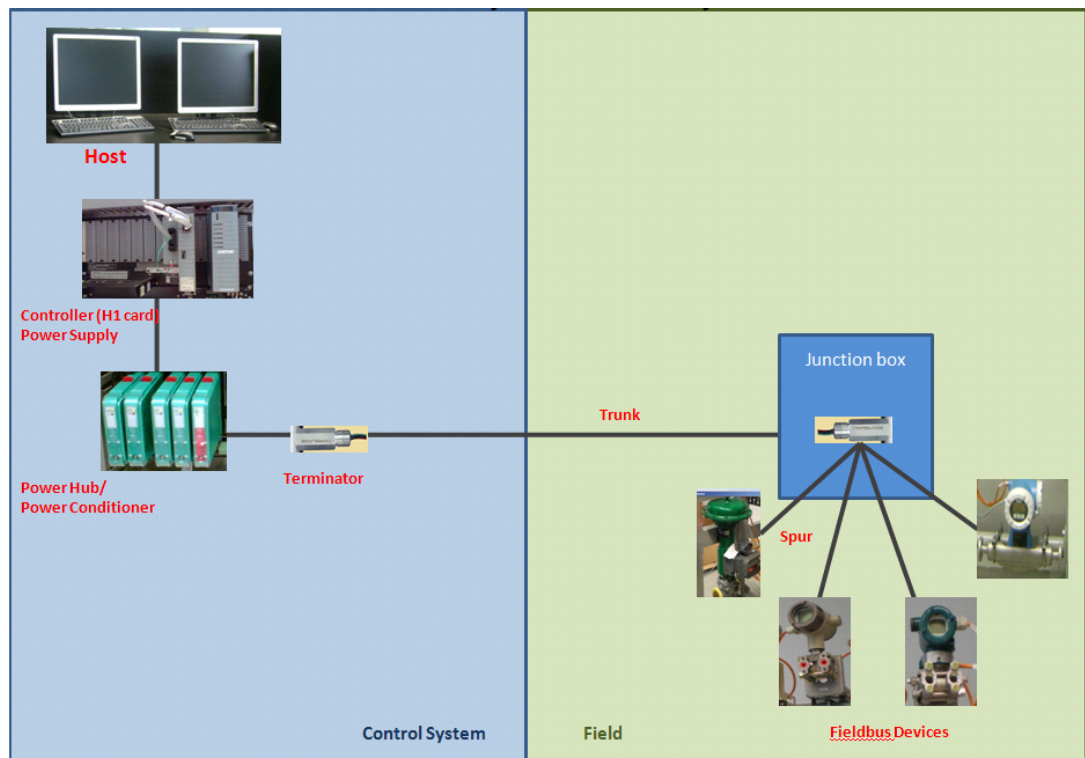


Figure 3: FOUNDATION Fieldbus Topology [2]

Furthermore, FOUNDATION Fieldbus will also improve safety by providing operators with earlier notification and warning of pending and current hazardous conditions.  Since process production plant plants are heterogeneous and complex in many aspects such as long cables distributed across buildings and floors also many different types of instrument such as transmitter and sensors, limiting the amount of energy in explosion hazardous area is crucial [2] [9].

Process production plants are heterogeneous and complex in many respects where field devices of very different types are mounted alongside conventional motors and simple digital sensors. Sites place requirements for long cable lengths distributed across buildings and floors, with installation in safe and explosion-hazardous areas with their stringent safety regulations. In short, a typical plant layout consists of practically any type of application, and this has to be taken into consideration when designing and installing fieldbus systems. To validate the overall intrinsic safety it is required to compile all field devices' and cables' safety parameters, and match them against the power source. In the beginning this effort and the very low amount of energy initially available prohibited application of fieldbus in hazardous areas. Today the market is able to look back on a respectable and rapid development of intrinsically safe fieldbus implementation [2].

- *Fieldbus Concept (HI Concept)*

Since we shall be using the H1 in the project, the study was mainly done for the H1 concept only. There are six conceptual parts to a Fieldbus network: links, devices, blocks and parameters, linkages, loops, and schedules.

- *Four Fieldbus Layers*

FOUNDATION Fieldbus communication layers consists of the physical layer, the communication stack, and the user layer.

Figure 3 shows a diagram of the Fieldbus layers compared to the Open Systems Interconnect (OSI) layered communication model. Notice that the OSI model does not define a user layer [7].
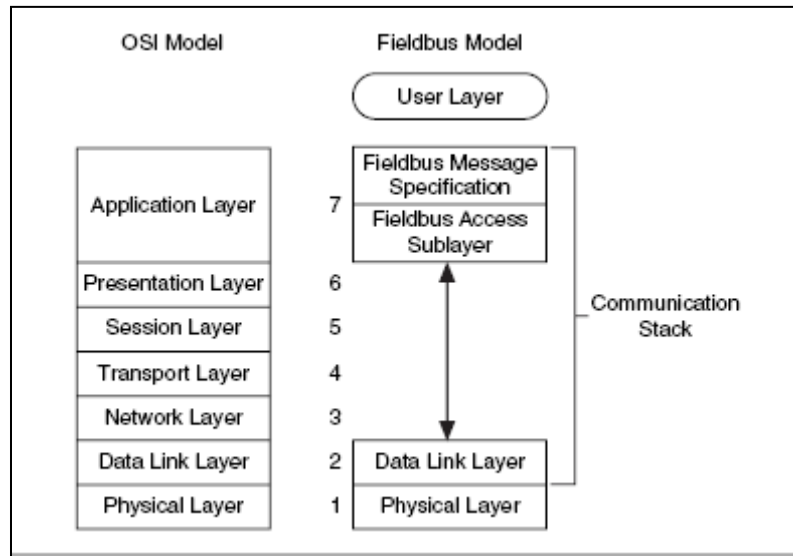


Figure 4: The Communication Layers of FOUNDATION Fieldbus [7]

FOUNDATION Fieldbus does not implement layers three, four, five, and six of the OSI model because the services of these layers are not required in a process control application. A very important part of Foundation Fieldbus is the defined user layer, often referred to as layer eight [7].

The physical layer converts digital fieldbus messages from the communication stack to physical signals on the fieldbus transmission medium and vice versa. It performs the services required to interface the user layer to the physical layer. The communication stack consists of three layers: the Fieldbus Message Specification, the Fieldbus Access Sub layer, and the Data Link Layer. It encodes and decodes user layer messages and ensures efficient and accurate message transfer [6] [2].

The Data Link Layer manages access to the fieldbus through the Link Active Scheduler by splitting data into frames to send on the physical layer, receiving acknowledgment frames, and re-transmitting frames if they are not received correctly. It also performs error checking to maintain a sound virtual channel to the next layer. The Fieldbus Access Sub layer provides an interface between the Data Link Layer and the Fieldbus Message Specification layer. Within the Fieldbus Messaging Specification layer are two management layers called System Management and Network Management. System Management assigns addresses and physical device tags, maintains the function block schedule for the function blocks in that device, and distributes application time. The device can be located through System management [10]

The user layer provides the interface for user interaction with the system. It uses the device description to tell the host system about device capabilities. It defines blocks and objects that represent the functions and data available in a device. Rather than interfacing to a device through a set of commands, like most communication protocols, FOUNDATION Fieldbus lets user interacts with devices through a set of blocks and objects that define device capabilities in a standardized way. The user layer for one device consists of the resource block, and one or more transducer blocks and function blocks [3] [2]

A key objective for Foundation Fieldbus is interoperability, the ability to build systems comprised of devices from a variety of manufacturers. Instead of requiring that device manufacturers use only a given set of functions in a device to ensure that a system can always communicate with a new device, Foundation Fieldbus uses device descriptions, which describe all the functions in a device. They allow manufacturers to add features beyond the standard Foundation Fieldbus interface without fearing loss of interoperability [8] [7].

## 2.3 The Type of Tests

Fieldbus technology is one of process application that widely used in process control application. It is a digital, two ways, multi drop communication mechanism that will connect host systems, field devices and other automation systems on a network [1]. Fieldbus is the equivalent of the current LAN type connections, which require only one communication at the controller level and allow multiple of analog and digital points to be connected at the same time thus reducing both the length of the cable required, and the number of cables required [2]. The testing for the FOUNDATION Fieldbus consists of two main tests, the reliability test and the interoperability test [1].

- *The Basic Interoperability Test*

The reliability test consists of three tests. The Basic Interoperability test which perform during the device commissioning. The test should show the effect of the device beforehand, the interoperability between different host and field device, the online device replacement, the bus health inspection and the device firmware upgrade [3].

- *Stress Test*

The second test is the Stress Test. This test should involve the fully loaded segment which confirm the maximum number of devices that could be used, the power failure recovery, communication integrity soak test, back up of LAS (Link Active Scheduler), the control in field and the test of maximum cable length and different cable type [3].

- *Diagnostic*

The third test is the diagnostic capability which involves the verification operation of advance function blocks, the device health check, the verification interoperability between different vendor devices and host and the ease of calibration check and trims [4].

- *Full Interoperability Test*

The other main test which is the interoperability test involves the host communication test and the full system test. The host communication test will check only the control system from the HI interface cards to the operator workstations without connecting all the field instrument devices. A single field instrument device will connect to the HI interfaces one by one and check the basic communication between a device and the interface. The full system test will verify the system hardware and configuration data downloaded to the field devices. This approach has the benefit that all control functions, including the field devices, are checked and problems solved before arrival at site [5].

# CHAPTER 3

# METHODOLGY / PROJECT WORK

## 3.1 Methodology

There are four vendors taking part in this project that is; Emerson, Foxboro, Honeywell and Yokogawa. Each of them provides different Distributed Control System (DCS) for fieldbus system and architecture. For these two semesters, this project will be covering the **Basic Test** also a design for loop control using Emerson Delta V System will be introduced**.**

The following are the scope of Basic Interoperability Test that will be conducted throughout this project:
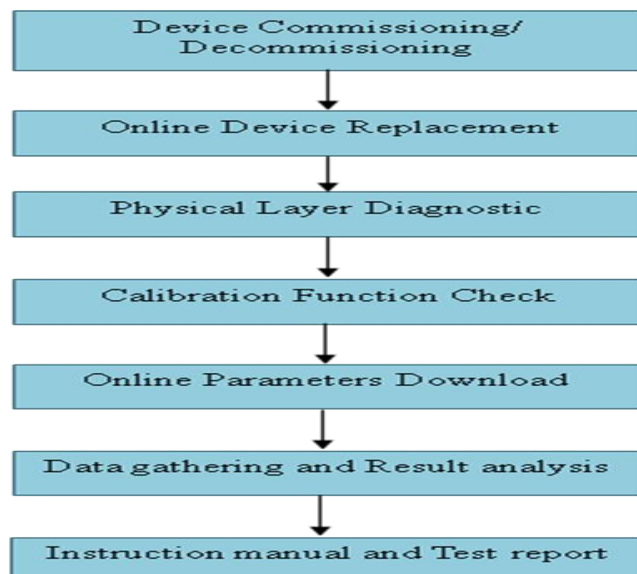
3.1.2 Basic Tests



Figure 5: Methodology of Basic test

## 3.1.2 Control Loop Design

Flow chart below shows the method in designing the control loop using Emerson Delta V System.

```
┌─────────────────────┐
│  Design Flow Control │
│    Plant (DCS)       │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│  Get Parameters (best│
│  controller, ranges) from│
│      simulation      │
└─────────────────────┘
           │
           ▼
┌─────────────────────┐
│   Implement the      │
│   design to Delta V  │
└─────────────────────┘
```
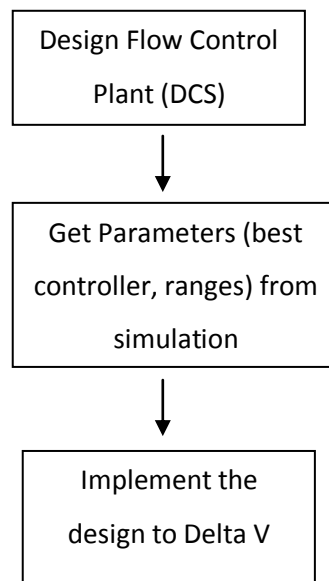
Figure 7: The Methodology in Designing Control Loop

## 3.2 Tools and Equipment

For this project, all equipment and tools are provided by vendors which are Emerson, Yokogawa, Foxboro and Honeywell. Figure below shows the external instrument assembly layout in the FOUNDATION Fieldbus lab at Universiti Teknologi PETRONAS.
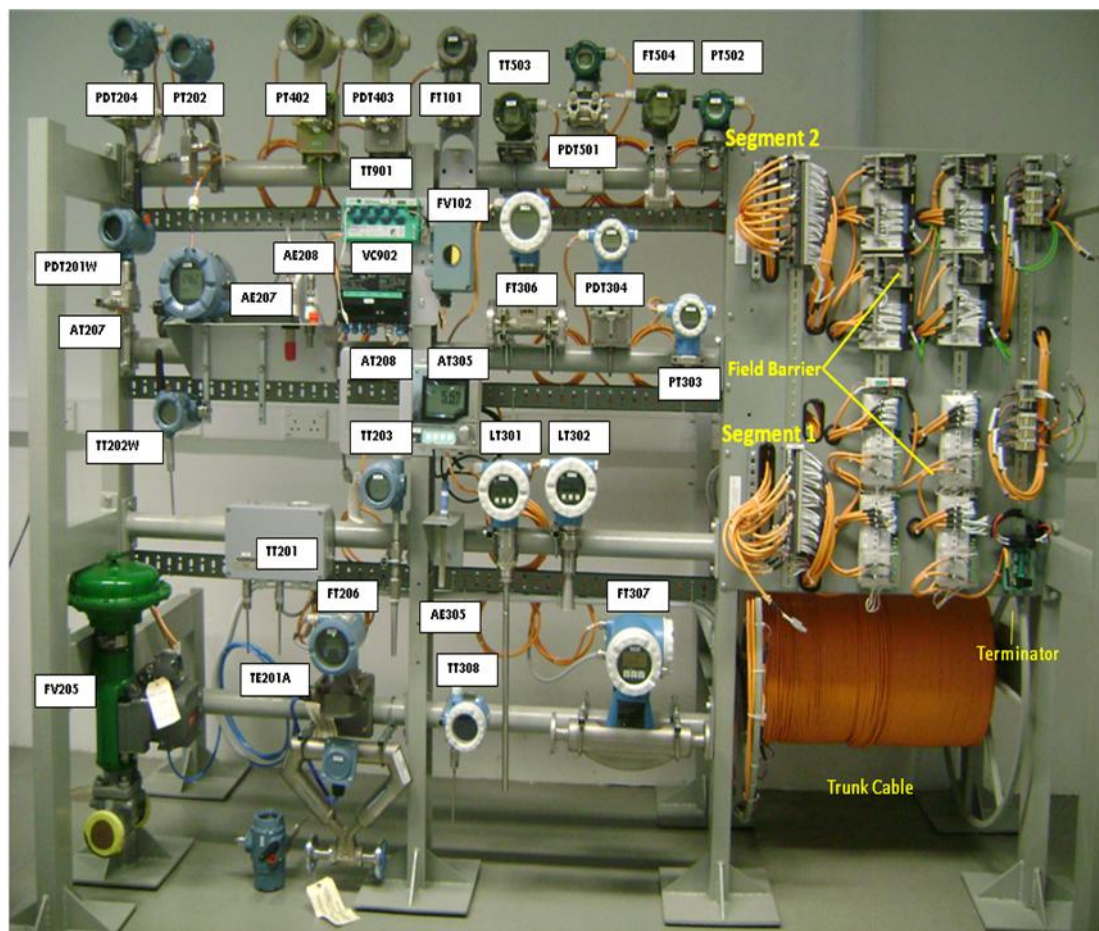


Figure 8: External Instrument Assembly Layout at Building 23

There are two segments of devices which Segment 1 contains 14 instruments and segment 2 contains 13 instruments. Segment 1 is power up by PNF power supply while segment 2 using MTL.

Below are the tables of instrumentations of each segment. There are 14 various Fieldbus devices connected to segment 1 and 13 devices connected to segment 2.

Table 1: Segment 1 Instrumentations List

| TAG NO. | ADDRESS | MANUFACTURES | TYPE |
|---|---|---|---|
| AT 207 | 28 | Rosemount Analytical Inc. | |
| AT 208 | 29 | Rosemount Analytical Inc. | Xmt-CT FF Fieldbus Transmitter |
| FT 206 | 27 | Micro Motion Inc. | 2000 |
| FV 205 | 26 | Fisher Controls | Fisher DVC 6000f |
| PDT 204 | 25 | Rosemount Analytical Inc. | 5051 Fieldbus Pressure Transmitter |
| PDT 501 | 30 | Yokogawa Electric | EJX |
| PT 202 | 23 | Rosemount Analytical inc. | 3051 Filedbus Pressure Transmitter |
| PT 502 | 31 | Yokogawa Electric | EJX |
| TT 201 | 22 | Rosemount Analytical Inc. | 848 Fieldbus temperature Device |
| TT203 | 24 | Rosemount Analytical Inc. | 3144 Foundation Fieldbus temperature Transmitter |
| TT 503 | 32 | Yokogawa Electric | YT A 320 |
| TT901 | 34 | Peppel + Tuchs | Temperature Multiplexer |
| VC902 | 35 | Peppel + Tuchs | FD-0-VC-EX4. Foundation Fieldbus |
| FT 504 | 33 | Yokogawa Electric | DYF/LCI |

Table 2: Segment 2 Instrumentation List

| TAG NO. | ADDRESS | MANUFACTURES | TYPE |
|---|---|---|---|
| AT 305 | 26 | Endress+Hauser GMbH. | Liquiline MCM 42pH/ORP |
| FT 101 | 33 | Invensys Process System | SRD 991 |
| FT 306 | 27 | Endress+Hauser GmbH | Prowirl 73 |
| FT 307 | 28 | Endress+Hauser GmbH | Promass 83 |
| FV 102 | 34 | Invensys Process System | SRD 991 |
| LT 301 | 22 | Endress+Hauser GmbH | Level Flex M |
| LT 302 | 23 | Endress+Hauser GmbH | Micropilot M |
| PDT 304 | 25 | Endress+Hauser GmbH | Deltabar m |
| PDT 403 | 32 | Honeywell | PT |
| PT 303 | 24 | Endress+Hauser GmbH | Cerabar S |
| PT 402 | 31 | Honywell | PT |
| TT 308 | 29 | Endress+Hauser GmbH | TMT 162 |

Figure below shows the network architecture of FOUNDATION Fieldbus. As mentioned earlier, there are four hosts involve. However, for this project Emerson will be the host. Emerson as the host provides their own equipment.
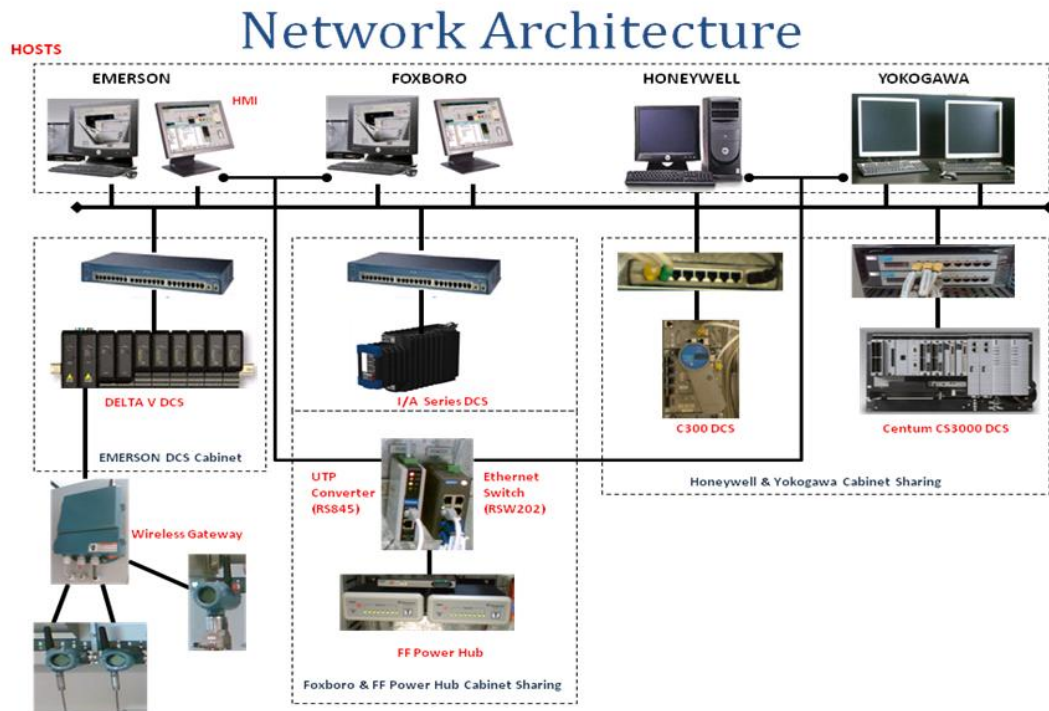


Figure 9: Network Architecture of Fieldbus System at UTP [3]

EMERSON has 2 main stations that are called PROPLUS and Asset Management System (AMS). The PROPLUS acts as an engineering workstation which consist of 2 main softwares, DeltaV Operate and DeltaV Explore. The DeltaV Operate is for the operator to do the monitoring while the DeltaV Explore is functioning more for the configuration and maintenance purposes [9] [10].

# CHAPTER 4

# RESULT AND DISCUSSION

## 4.0 Basic Test

4.1 Device Commissioning

Initial download (partial download) on both segments need to be performed first before the commissioning begin. The initial download took about 10-15 minutes. It is likely that some devices need to performed individual device download when partial download on those devices is unsuccessful. Individual device commissioning took about 5 minutes and built in wizard is available to assist the user.
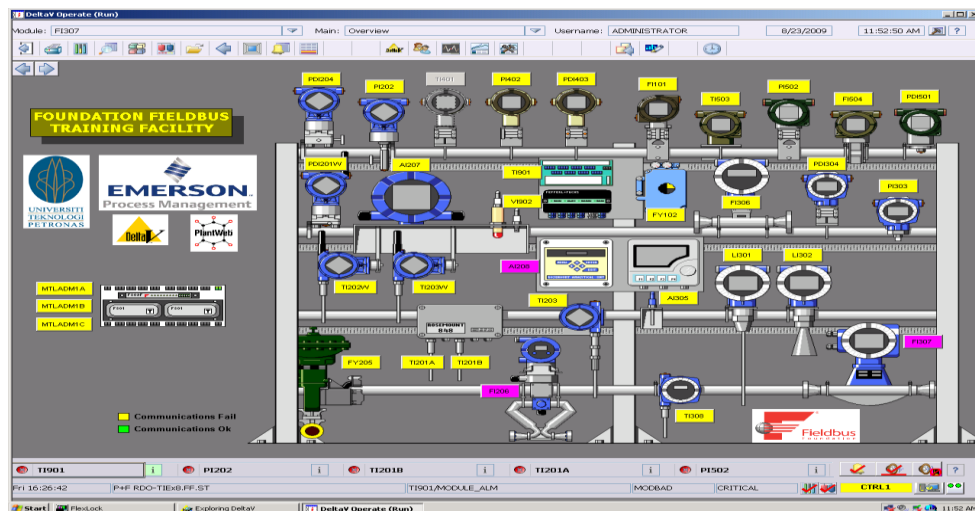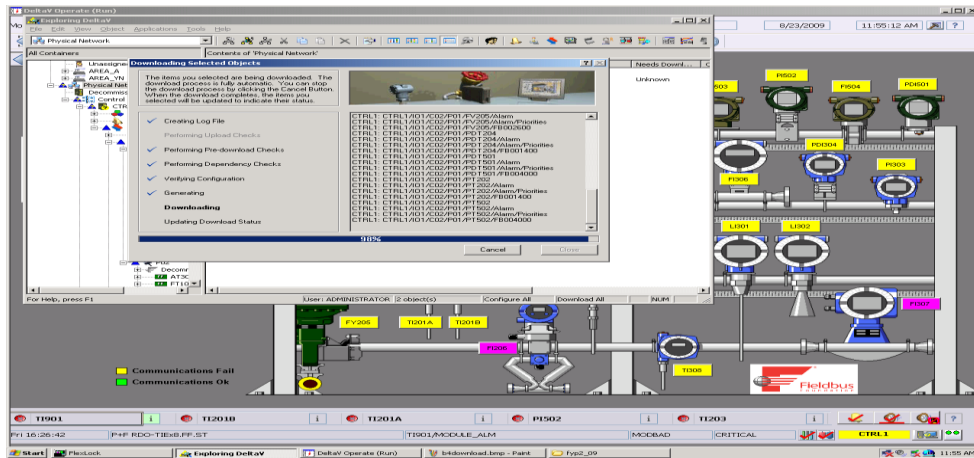


Figure 10: Device Status before Partial Download

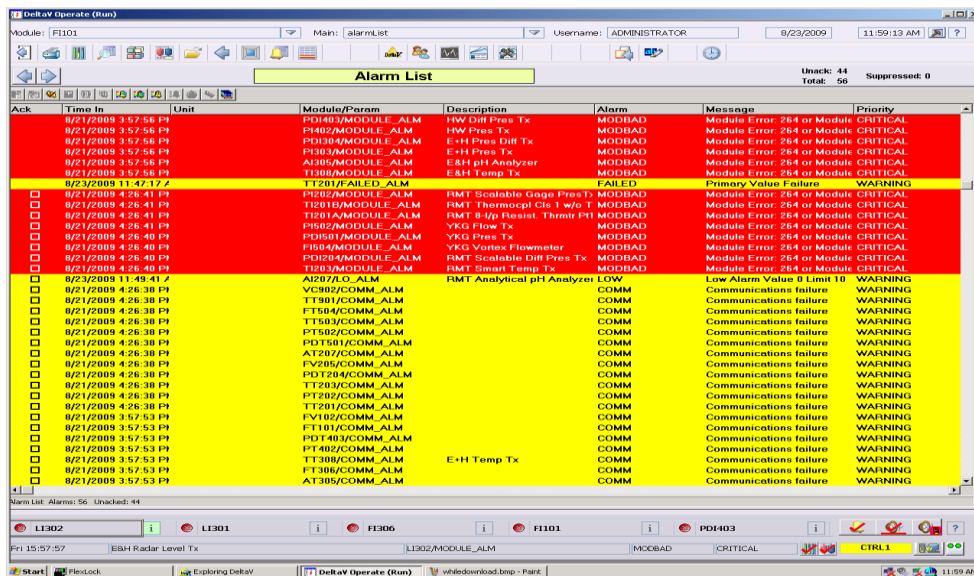Figure 11: Pop-up Wizard While Downloading the Segment



Figure 12: Alarm While Downloading the Segment

Table 3: Summary on Alarm Warning During Device Commissioning

| ALARM | ERROR | DESCRIPTION | | |
|-------|-------|-------------|---|---|
| PI 402 | IO Input Error | Function | Block | Bad Active |
| PDI 403 | IO Input Error | Function | Block | Bad Active |
| TI 503 | IO Input Error | Function | Block | Bad Active |
| VI 902 | IO Input Error | Function | Block | Bad Active |
| PDI 304 | IO Input Error | Input Transfer Error | | |
| PI 303 | IO Input Error | Input Transfer Error | | |
| AI 208 | Input Error | Function | Block | Bad Active |
| TI 203 | Input error | Function | Block | Bad Active |
| AI 305 | IO Input Error | Function | Block | Bad Active |
| FI 206 | IO Input Error | Function | Block | Bad Active |
| TI 308 | IO Input Error | Function | Block | Bad Active |
| TI 307 | IO Input Error | Function | Block | Bad Active |

After the alarms had been acknowledged, the most of the devices show function properly except for Temperature Transmitter 308, Analyzer Transmitter 208 and Flow Transmitter 206. These three devices are suspected has been disconnected from the Fieldbus network.
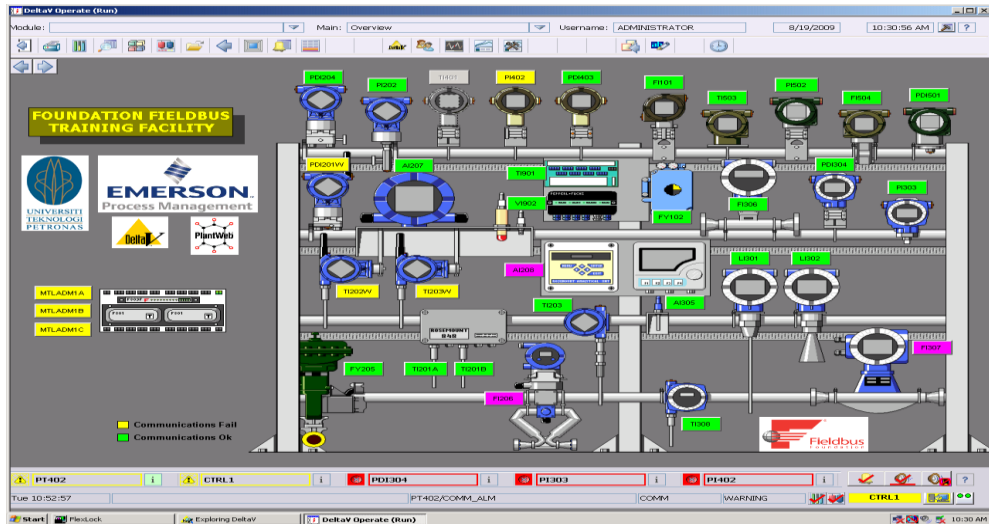
Figure 13: Device Status after Partial Download

4.2 Online Device Replacement

The Online device Replacement testing is to observe the response of fieldbus network when a device is replaced while the system is online. The related device will be removed from fully functioning device system and will be reconnecting again to replace the device. Fieldbus replacement Wizard will guide the user to perform the procedures.
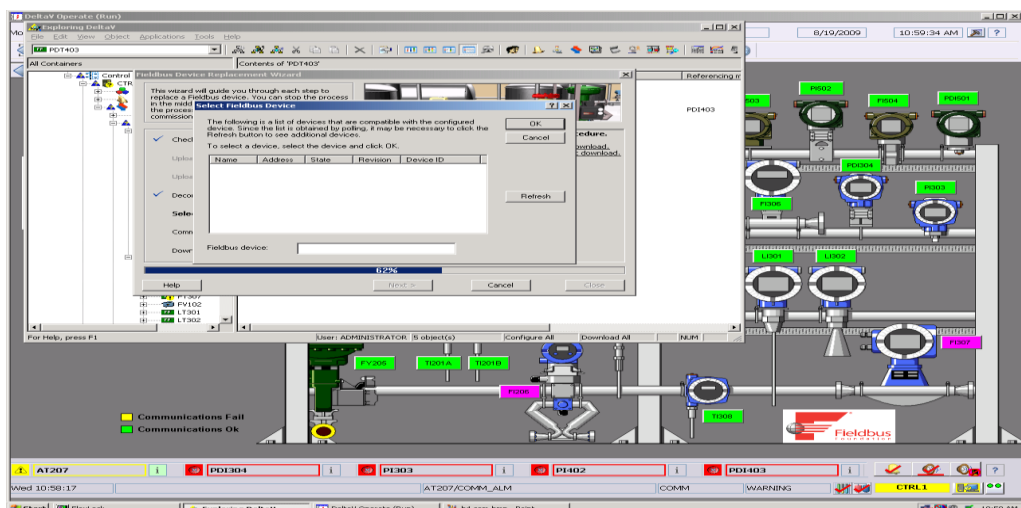


Figure 14: Fieldbus Device Replacement Wizard

Table 4: Summary of Online device replacement

| PORT 1 | Time(s) | Notes | PORT 2 | TIME | Notes |
|---|---|---|---|---|---|
| AT 207 | | Alarm at AT 207 | AT 305 | 38.2 | - |
| AT 504 | 23.6 | - | FT 101 | 29.1 | - |
| FV 205 | 20.2 | - | FT 306 | 23.1 | - |
| PDT 204 | 32.7 | - | FV 102 | 25.8 | - |
| PDT 501 | 29.7 | - | FT 301 | 55.5 | - |
| PT 202 | 29.6 | - | LT 302 | 1.00 | - |
| PT 502 | 26.1 | - | PDT 304 | 52.5 | - |
| PT 201 | 23.0 | - | PDT 403 | 20.8 | - |
| TT 203 | 24.4 | Alarm at PT 201 | PT 303 | 42.4 | - |
| TT 503 | 35.2 | - | TT 402 | 29.7 | - |
| TT 901 | 42.2 | - | TT 308 | 21.9 | - |
| VC 902 | 33.3 | - | | | - |

Figure above shows the time taken for each device to be commissioned again after being reconnected from the network. Mostly, there is no alarm occur during the online replacement which can be concluded that online device replacement on one device at site will not affect the communication of other device.

However, when AT 207 is being replaced, there is alarm occur and online replacement at this device cannot be performed successfully. There is also alarm occur at PT 201 when TT 203 is replaced. This might caused by the cable conflict bus, this alarm does not affect the device performance.

## 4.3 Calibration Function Check

Fieldbus device range value can be changed while in Out Of Service (OOS) mode. For basic test purposes, the parameter download is limited to change the range of the device using Host and 375 HART/FF Communicator. Rescale cannot be performed using Emerson AMS(iAMS)Asset Management System.

Summary Method:

1. Change the mode of respective device to OOS.
2. Change the range XD_scale and OUT_scale
3. Change back the mode to Auto. Record the response
4. Repeat the steps using 375 Communicator.

### 4.3.1 Using Host

The range of XD_scale and OUT_scale are edited at Control Studio. The Auto mode is changed to OOS at AI Block. When the mode is changed back to Auto, the new value of range is updated automatically by the device.

Table 5: Calibration Function Check using Host

| Device | Message |
|--------|---------|
| FT 101 | Alarm occurs if the data XD_scale and OUT_scale is not the same. |
| FT 306 | • Alarm occurs at AI 305 when the mode is changed from Auto to OOS<br><br>• The communication of others not affected. Alarm can be acknowledged. |
| PT 402 | Range is changed successfully |
| PT 207 | • Alarm occurs at PT 402<br><br>• The range between XD_Scale and OUT_scale must be the same<br><br>• Status: Function Block Problem |
| FT 504 | Alarm occur when change to OOS and can be acknowledge |
| Ti 901 | Range of XD_scale and OUT_scale must be the same |
| PI 202 | Alarm occur and can be acknowledge |

4.3.2 Using 375 Communicator

The range change using the communicator is sent to the device and updated at the system. However at some devices, 375 Communicator failed to extract the device information. Thus, it failed to change the range. This is due to missing DD file and mostly affected a number of Endress + Hauser Transmitters.

Table 6: Function calibration Check Using 375 Communicator

| Tag | Device Type | Files in Device | Files in 375 | Match | Error message |
|-----|-------------|-----------------|--------------|-------|---------------|
| LT 301 | Level FlixM | Dev Rev 4 DD Rev 1 | Dev Rev 3 Dev Rev 3 | Mismatch | Communicator can scan device but unable to view more information |
| LT 302 | Micropilot M | Dev Rev 5 DD Rev 1 | Dev Rev 3 Dev Rev 3 | Mismatch | Communicator can scan device but unable to view more information |
| PT 303 | Carebar | Dev Rev 5 DD Rev 1 | Dev Rev 5 DD Rev 2 | Match | Able to view the function block and information Unable to change parameter |
| PDT 304 | Deltabar S | Dev Rev 5 DD Rev 1 | Dev Rev 5 DD Rev 2 | Match | Able to view the function block and information Unable to change parameter |
| AT 305 | Liquillin | Dev rev 1 DD Rev 1 | N/A | | Can view information Success to make change in parameter |
| FT 306 | Prowill 73 | Dev Rev 1 DD Rev 1 | Dev Rev 1 DD Rev 1 | Match | Ok |
| FT 307 | Promass 83 | Dev rev 3 DD Rev 1 | Dev Rev 2 DD Rev 1 | Missmatch | Can scan device but unable to view information |
| TT308 | TMT 162 | Dev Rev 1 | N/A | | Device Offline. Unable to test |

Output range trim can be done via system at control studio and via 375 communicator and usually at site. The changes done also will be automatically update once the device mode is changed back to auto.

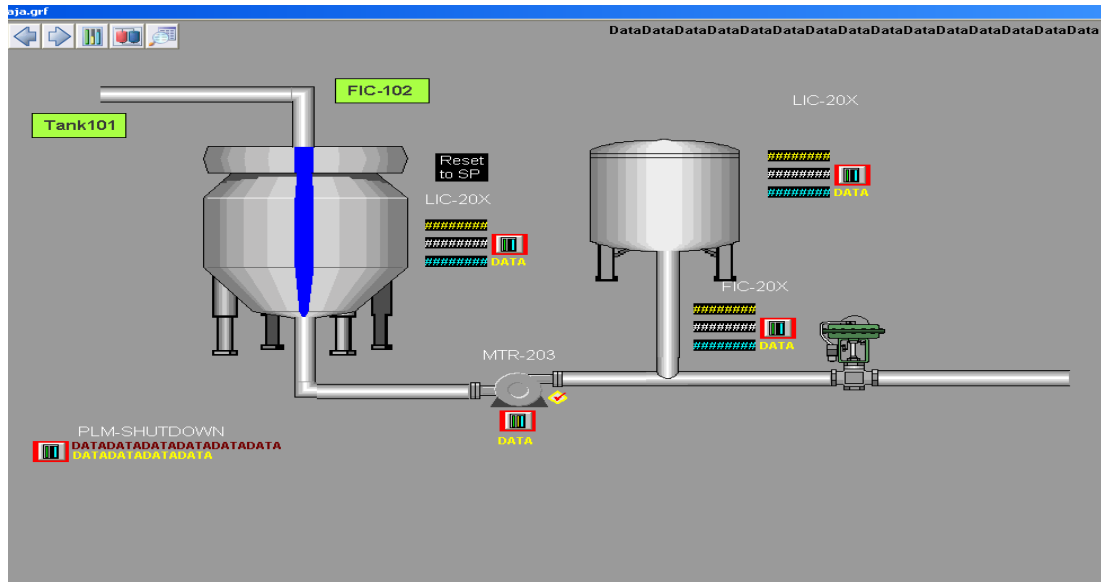## 4.1 Control Loop Design and System Configuration



Figure 15: Loop Design for Level and Flow Control Plant

Figure above showed a simple plant design. Tank 101 will receive a reactant A from the incoming and will pass the reactant A to tank 102. Here, the reactant A will be mixed- up with Reactant B to produce reactant C. The reactant C will then be sent to another tank. The original design will be a loop design however, the simple plant need to be connected to the real devices available in the lab before a redesign the simple system to a complicated process flow

There are several transmitters and controller to control the performance of the system. Valve and pump as the final element will take an appropriate decision if the system varies from actual point. The controller used for this system is proportional and integral (PI).

# CHAPTER 5

# CONCLUSION

## 5.1 Conclusion

The basic test which is the first test of Foundation Fieldbus Interoperability Testing has been completed within the range of time. The virtual plant also has been designed using Delta V system.

As conclusion, upon completing this project, a comprehensive technical report on the Foundation Fieldbus Interoperability Testing (FFIT) will be emerged after carrying out an intensive testing and research of the Foundation Fieldbus system. Generally, two main testing will be done which are the stress test and diagnostic capability test. A control loop design will be implemented on Delta V for better understanding on system and its configuration and for further researches.

The main outputs of this project are:

1. Perform basic test which including Device Commissioning, Online Device Replacement and Calibration Function Check.

2. Design a control loop using Delta V software. The objective is to model the plant using Delta V and implement on the real device. However due to some limitation of the system capability that Delta V only allow certain function, the real plant implementation cannot be conducted.

**5.2 Recommendation**

Further action can be carried out for the next stage of Interoperability testing for Foundation Fieldbus Network

1. Perform Stress Test according to PETRONAS Technical Standard (PTS).

2. Perform the capability diagnostic test on the network to discover the real limitation of fieldbus network.

# REFERENCES

[1] PETRONAS E-Learning Modules 3 (Plant Monitoring Control System) and Modules 4 (Process Control Theory)

[2] Foundation Fieldbus Interoperability Testing – Terms of Reference, SKG 14, PETRONAS.

[3] Hisashi Sato, Journal of *'The Recent Movement of FOUNDATION Fieldbus Engineering'*, SICE Annual Conference in Fukui, August 4-6, 2003

[4] Technical Support and Professional Services, National Instruments, May 2003 Edition.

[5] Fieldbus Org, Citing Internet source URL http://www.fieldbus.org

[6] FOUNDATION Fieldbus , Citing Internet sources

    URL http://www.foundationfieldbus.com

[7] Emerson, Citing Internet source URL http://www.emerson.com

[8] EMERSON Fieldbus Tutorial Book and manuals

[9] Yologawa, Citing Internet source URL http:// www.yokogawa.com

[10] William Stallings, "Data and Computer Communication", Eight Edition: Pearson Education International Publishing, 2007.

# APPENDIX

**Appendix 2**

**DeltaV Component Electrical Specification**

DeltaV System Power Supply will supply power to all DeltaV controller and I/O Module on the installed carrier. It converts an incoming 24VDCsupply to 12VDC (isolates)

| Item | Specification |
|---|---|
| Model no | VE5006 |
| Input<br>12 VDC<br>24 VDC | <br>11.4 VDC to 12.6 VDC<br>21.6 VDC to 26.4 VDC |
| Inrush (soft start) | 12 A peak maximum for 5 ms over the 12 VDC input range (excluding 12 VDC output)<br><br>20 A peak maximum for 5 ms over the 24 VDC input range (including 12 VDC outputs) |
| Output rating | + 12 VDC at 13.0 A (12 VDC input)<br>+ 12 VDC at 4.5 A (24 VDC input)<br>+ 5 VDC at 2.0 A<br>3.3 VDC at 2.0 A |
| Output power | 10 W total at 60°C (combined outputs of 5 VDC and 3.3 VDC) |
| Input protection | Internally fused, non-replaceable fuses |
| Overvoltage protection | Output protected at 110% to 120% |
| Hold-up time | Output remains within 5% of nominal at full load and minimum input voltage for 5 ms (excluding 12 VDC current with 12 VDC input) |
| Mounting | On either slot of 2-wide power/controller carrier |
| External connectors: | |
| Primary power | DC input, 2-wire |
| Alarm contacts | 2-wire normally open relays; relays are closed when 3.3 and 5 VDC outputs are within +/-4% of nominal |
| Alarm relay contact rating | 30 VDC at 2.0 A, 250 VAC at 2.0 A |

**Appendix 3**

**DeltaV Series 2 Serial Card, 2 Ports, RS232/RS485**

DeltaV Series 2 Serial Card, 2 Ports, RS232/RS485

The DeltaV Serial Card provides an interface to a variety of serial devices that use the Modbus RTU or ASCII protocol. With the DeltaV Explorer, it is possible to configure each of the two ports provided on the serial card to support RS232, RS422/485 half duplex, or RS422/485 full duplex signals and you can configure the baud rate of each port. The serial card requires a DeltaV Serial Terminal Block to provide terminations for wiring.

If the RS422/485 ports are used, the shield must also provide the ground reference for the port. Connect the cable shield to the corresponding ground (GND) terminal on the serial terminal block.

| Item | Specification |
|---|---|
| Model | VE4036P2 |
| Number of serial ports | Two |
| Port types | RS232, RS422/485 half duplex, RS422/485 full duplex (configurable with the DeltaV Explorer) |
| Isolation | Each port is optically isolated from the system and from each other and factory tested to 1500 VDC. The ports must be grounded via the external device. |
| Baud rate | Configurable with the DeltaV Explorer |
| Maximum cable lengths | RS232: 15 m (50 ft) RS422/485: 610 m (2000 ft) |
| LocalBus current (12 VDC nominal), per card | 200 mA typical, 300 mA maximum |
| Field circuit power, per card | None |
| Mounting | Assigned slot of I/O carrier |

**Appendix 4**

**HI Card Specification**

| Item | Specification |
|---|---|
| Model | VE4037P0 |
| Number of Ports | Two |
| Port Type | Foundation Fieldbus H1 - 31.25 Kbit/second |
| Isolation | Each channel is optically isolated from the system and from each other and factory tested to 1500 VDC. |
| Localbus current (12VDC nominal), per card | 400 mA typical, 600 mA maximum<br><br>Series 2:<br><br>200 mA typical<br><br>300 mA maximum |
| Field circuit power, per card | None. |
| Fieldbus power (for Series 2 card) | 9 to 32 VDC, 12 mA per port |
| Mounting | Assigned slot of I/O carrier |

**Appendix 5**

**375 Communicator Foundation Fieldbus Application- Features**



# 375 Field Communicator

- □ Supports all HART / Ff devices
- □ Intrinsically Safe
  - ⇨ ATEX compliant
  - ⇨ FISCO compliant
- □ User upgradable on-site!
- □ Designed for use in the Plant
- □ Fieldbus network Diagnostics
- □ Supports HART Rev. 6
- □ Interfaces with AMS 6.2
- □ Supports device-specific applications

**Appendix 6**
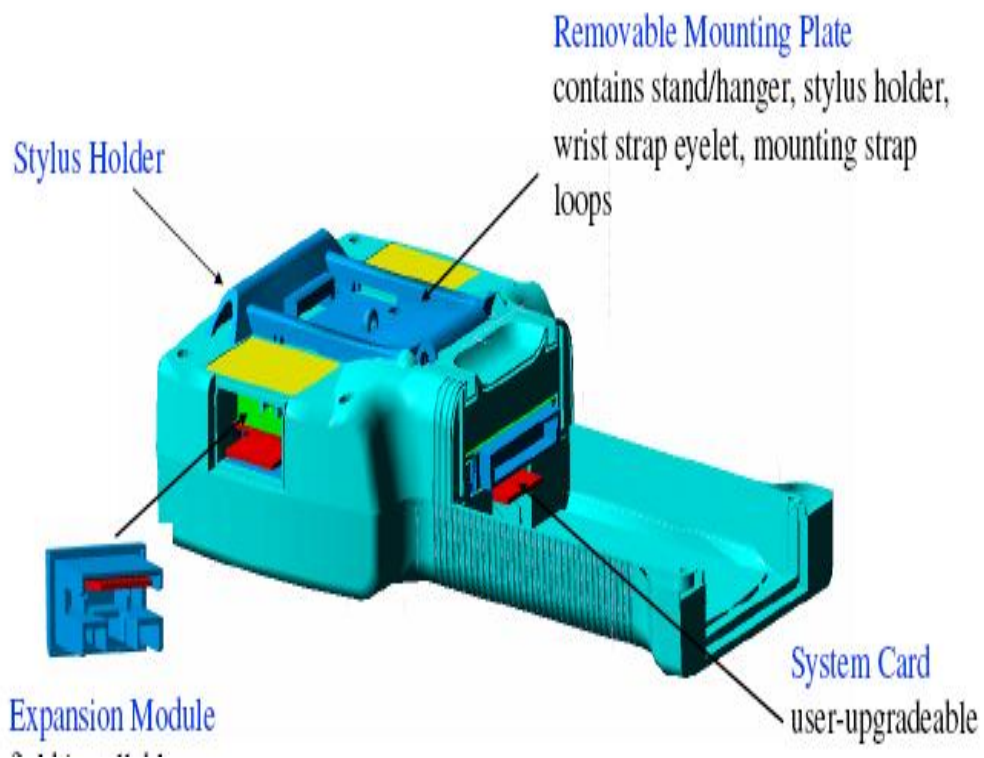
**375 Communicator Foundation Fieldbus Application- Functions.**

**Appendix 7**

**375 Communicator Foundation Fieldbus Application- Primary Component**



# Primary Components

□ Upper Housing Assembly
□ System Card
□ Battery Pack
□ Expansion Module

**Removable Mounting Plate**
contains stand/hanger, stylus holder, wrist strap eyelet, mounting strap loops

**Stylus Holder**

**System Card**
user-upgradeable

**Expansion Module**

**Appendix 8**

**375 Communicator Foundation Fieldbus Application-Wiring**



Diagram of Relcom Power Hub/Conditioner