CERTIFICATION OF APPROVAL

FOUNDATION FIELDBUS INTEROPERABILITY TEST, SYSTEM CONFIGURATION AND LOOP DESIGN OF FLOW, PRESSURE AND TEMPERATURE PLANT (EMERSON DELTAV)

by

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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.

Ayuni Yazib

ABSTRACT

Fieldbus is a computer network protocols used for real-time distributed control. Previously in control systems, workstations were connected using the Direct Digital Control (see Appendix 1). The integrated of this serial communication that has been currently used which is 4-20 mA communication schemes which require each device to have its own communication point at the controller level. This condition will eventually increase the cost. However, the Fieldbus technology manages to solve this disadvantage by connecting the multiple of analog and digital points to the controller level at the same time and other advantages [1]. The further research and test on it performance need to be done. Hence, the FOUNDATION Fieldbus Interoperability Test, System Configuration and Loop Design are to perform the technical verification and interoperability of every FOUNDATION Fieldbus host and devices. This project comes from four vendors which are EMERSON, YOKOGAWA, HONEYWELL and FOXBORO. However, this project would be focusing on EMERSON system. This project aims to provide a brief familiarization to the FOUNDATION Fieldbus system and explore more about the performance of this technology for the industrial applications. The laboratory testing (dry test) will covers several tests which are the basic interoperability test, stress test and diagnostic capability test. However this project only covers the basic test. Due to the delayed from PETRONAS SKG14, the Stress test and Diagnostic Test will be postponed. Thus, the interoperability of the FOUNDATION Fieldbus goal is not being accomplished yet. Other than that, this project also covers the loop design using the DeltaV system by Emerson. The outcome of this FOUNDATION Fieldbus test will be compiled in the form of standards and guidelines that will be implemented by PETRONAS Groupwide.

ACKNOWLEDGEMENT

In the Name of Allah, The Most Merciful and Compassionate, praise to Allah, He is the Almighty.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

FF	FOUNDATION Fieldbus
PGTS	PETRONAS Group of Technical Solution
SKG14	Skill Group 14 (Instrument & Control)
DCS	Distributed Control System
LAS	Link Active Scheduler
LM	Link Master
DD	Device Description
CF	Capability File
HSE	High Speed Ethernet
LT	Level transmitter
PT	Pressure transmitter
AT	Analyzer transmitter
FT	Flow transmitter
FV	Flow valve
P&ID	Piping & Instrumentation Drawing

CHAPTER 1

INTRODUCTION

1.1 Background of study

A comprehensive understanding on the operability of the FOUNDATION Fieldbus is important for the automated control system industry. The advantage of this technology has help on reducing the cost of wiring, cabinet space, and also the analog and digital input cards because the communication is already in digital and there is no need for any controller "CPU" cards since control is done in the field devices and to ease the maintenance work [10]. The FOUNDATION fieldbus technology also enhances the data available from the plant [2]. However, the performances of the FOUNDATION Fieldbus need to be explored. Therefore, the interoperability tests need to be done. In order to accomplish this project, UTP will provide the process laboratory for installation and commission testing facilities (together with vendors, contractors and SKG 14 team projects) for the FOUNDATION Fieldbus system. UTP will be the owner of the testing facilities, including the equipment.

1.2 Problem statement

The former and even current analog control systems used the 4-20mA output signals that produced from each instruments used. This will result in hundreds sometimes thousands of cables used and eventually increased the cost in building the plant. Other than that, the traditional 4-20mA field wiring results in a messy and untidiness of wires, cables and termination [2]. FOUNDATION Fieldbus system has come out to help solve the problem. However, this technology is still new in the control system for the industry to adopt with. There is still a need of comprehensive understanding and research on the operability of the system.

1.3 Objectives and scope of the study

The main objectives of the FOUNDATION Fieldbus Interoperability Testing (FFIT) project are:

- To perform interoperability testing of FOUNDATION Fieldbus system namely the basic test, stress test and diagnostic test.
- To perform the loop design using the FOUNDATION Fieldbus by EMERSON DeltaV.
- To provide familiarization on the FOUNDATION Fieldbus system for scientific researchers and engineers, and be a basis for further development of the technology for industrial applications.

This project will be started by researching the knowledge and theories upon the FOUNDATION Fieldbus system. The basic understanding about FOUNDATION Fieldbus during the Industrial Internship Training would be very helpful in doing the tests of the FOUNDATION Fieldbus. This understanding and knowledge will be implementing during the loop design task. This project has to come out with a comprehensive technical report on FFIT that will be the guideline for FOUNDATION Fieldbus system in PETRONAS.

CHAPTER 2

LITERATURE REVIEW

2.1 History of Fieldbus

In the 1940's, process instrumentation used the pressure signals of 3-15 psi to monitor the control devices. However, the process instrumentation industry had spread out and starting from 1960's, the DCS the 4-20 mA analogue signal standard was introduced for instrumentation control (see Appendix 2). The 4-20 mA was using various signal levels in order to suit with the instruments. The development of digital processors in the 1970's, lead to the use of computers to monitor and control a system of instruments from a central point. While in the 1980's smart sensors began to be developed and implemented in a digital control, microprocessor environment called FOUNDATION Fieldbus. This development is to optimize the system performance, [8].

In order to integrate the enormous range of control instruments, provide the interfaces to operate with various devices simultaneously, and set a communication protocol, Fieldbus need to be standardized. Some of the company such as Instrument Society of America (ISA), the International Electrotechnical Commission (IEC), Profibus (German national standard) and FIP (French national standard), had form the IEC/ISA SP50 Fieldbus committee to reach the Fieldbus international standard, [8].

2.2 Fieldbus VS Conventional Process Control

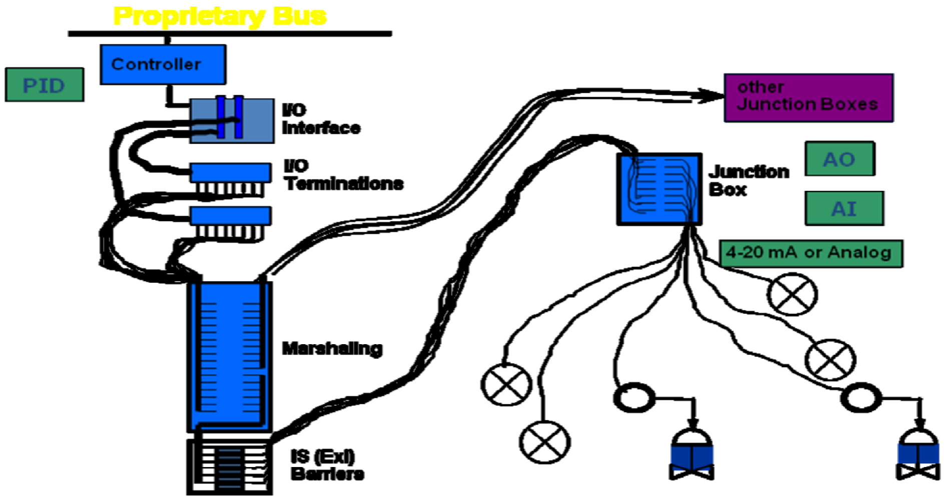


Figure 1: Conventional process control architecture

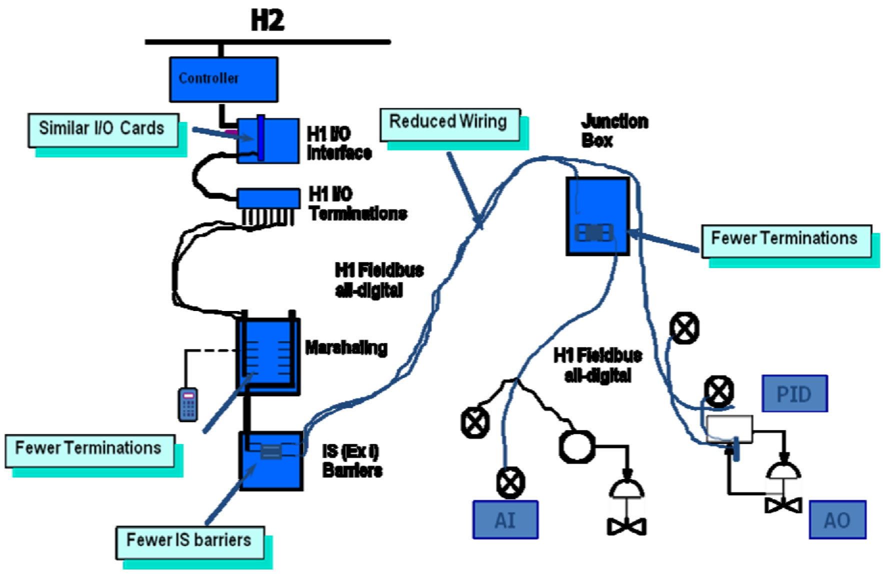


Figure 2: Fieldbus architecture

From both Figure 1 and 2 above, it is clearly shown the difference and improvement in the process control development. The Fieldbus architecture in Figure 2 shows several saving in its architecture in terms of wiring, I/O cards and cables, terminations, IS barriers and of course documentation.

2.3 Overview on FOUNDATION Fieldbus

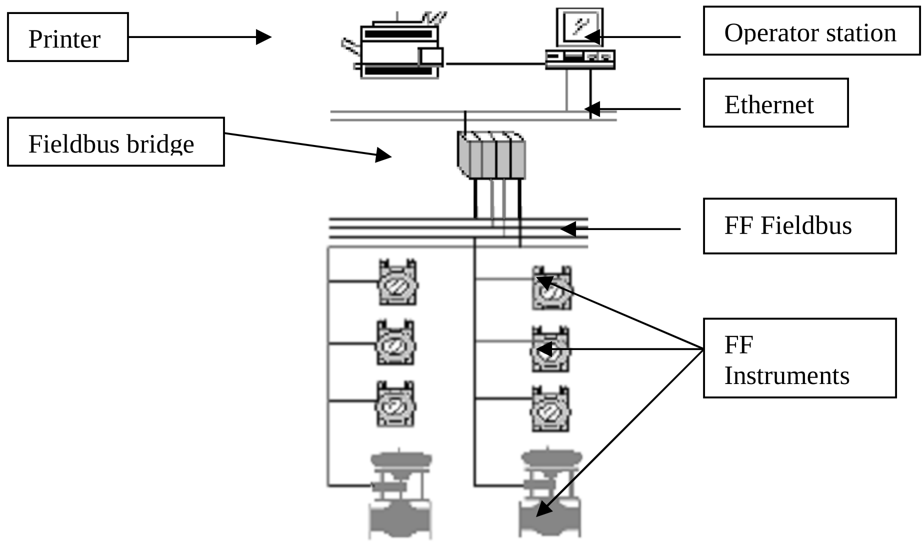


Figure 3: Basic architecture of the FOUNDATION Fieldbus system

Figure 3 is the basic architecture of the FOUNDATION Fieldbus (FF) implementation. The communication between the workstation and controller provides by the Ethernet Local Area Network. The figure shows that many FF devices can be connected to the same single pair of wires to form a multidrop network and eventually, reducing the length of cables and the cable cost [3].

Fieldbus is a digital, serial and bi-directional communication protocol. It interconnects devices such as actuators, sensors, discrete devices with the controllers in the field. According to Sato [4], FF works as a Local Area Network (LAN) for instruments that enables basic control and I/O to be moved to the field devices. In implementing the Fieldbus, the standard of the Fieldbus itself must be understood and also the software used by the vendor [6].

The former control functions had been performed by a distributed control system but now it can be done by FF technology using the function blocks, Device Descriptions (DD) and Capability File (CF). Function blocks reside in the FOUNDATION Fieldbus devices that contain information needed for online control function which is enabling the devices to execute control in the field. When the location of the function block is determined, the function block schedule is generated and downloaded to each field devices. When the device is online, function block that reside in the device will execute at offsets and determined by the system configuration. The period time needed for execution is called the macro cycle [7].

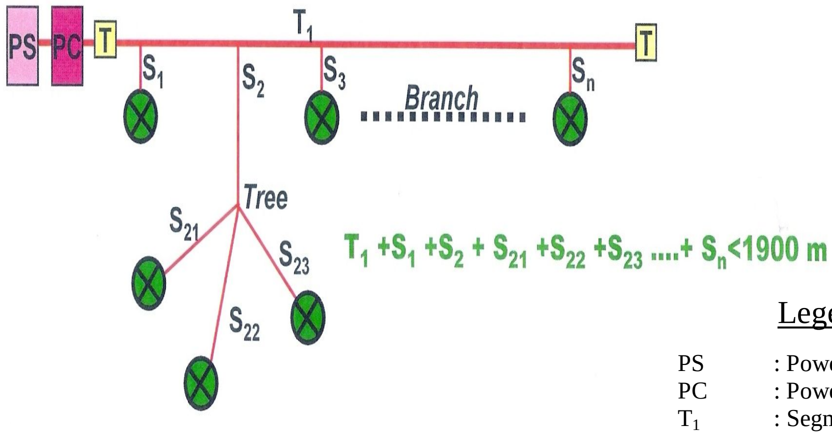
DD and CF provide the additional information needed for the purpose of configuration and display [7]. This additional information is a unique physical device tag and a corresponding network address that assigned to the device when it is commissioned and the device retains the tag in its memory when it is disconnected [1].

2.3.1 Segment

FOUNDATION Fieldbus allows multiple types of instruments being connected to one single cable, called a segment. This segment is a single twisted pair wire that carried digital signal and DC power and the maximum length of this segment is 1900m per segment. This one segment can connects up to 32 FOUNDATION Fieldbus devices such as temperature, flow, level and pressure transmitters, smart valves, actuators, etc. However, in practice, there are only twelve to sixteen instruments are being connected due to the current limiting couplers. This is because the device will act as a load which will increase in resistance. Thus, the current will decrease as resistance increase due to the Ohm’s Law, I=V/R. As the device increase beyond sixteen devices, the power conditioner can not support the current flow through the whole segment. That is why in the industry, the device being used is only up to sixteen devices per segment.

2.3.2 Spur

Spur is a branch line from the segment as shown in Figure 4. Spur is used to distribute the devices along the segment and also act as final circuit. The maximum length can be up to 120m.



Legend

PS	: Power supply
PC	: Power conditioner
T_1	: Segment
T	: Terminator
$S_{1,\,2,n}$	: Spur

Figure 4: Segment and Spur

As stated earlier, the maximum length of segment is up to 1900m is based on above calculation meaning the length of segment and spurs must be less than 1900m [9].

2.3.3 Terminator

Terminator is a kind of R-C circuit act to prevent the distortion and signal loss due to the reflection of the signal at the ends of segment. It is used to obtain the voltage mode signal on the segment. Terminator was placed after the Power conditioner and between the devices along the segment. For each segment, there is two terminator needed in each end [9].

2.3.4 Topology

The field network can de laid in three topologies that are bus with spur, daisy chain and tree topology as figure below. The difference of these topologies is the placement of the terminator.

Bus with spur

Daisy chain

Tree

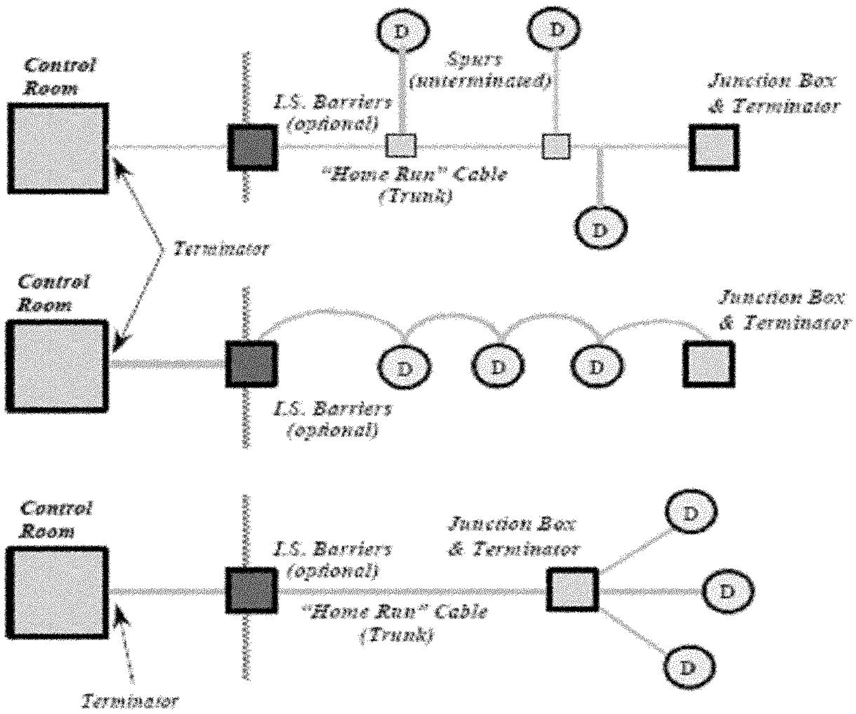


Figure 5: FOUNDATION Fieldbus topologies

Bus with spur topology has the terminator mounted at the ends of the trunk. From the Figure 5, it can be clearly seen that the terminator is place at the end of each segment not spur. The advantage of bus topology is that it minimizes the amount of cable required to connect the devices. However, the disadvantage of this topology is it requires several junction boxes that will result in many connections.

Daisy chain topology required same placement of the terminator as the bus topology. However, since the chain is interconnected, the devices with this topology are difficult to change and maintain because it will affect other devices on the chain.

Tree topology has the layout of the branches out into the individual devices from a single junction box. Thus it minimizes the number of connections and junction box. The devices with this topology can be installed and removed under power and it will not affect other devices. However, the disadvantage of this topology is it increases the usage of cable especially when the devices are not particularly close together. [12]

2.3.5 Segment Power

The bulk voltage that can be supplied to the FOUNDATION Fieldbus cable can be up to 32V. However, the voltage at any device can be as low as 9V. This is to ensure that the device operate correctly. Figure 6 below explain the concept further.

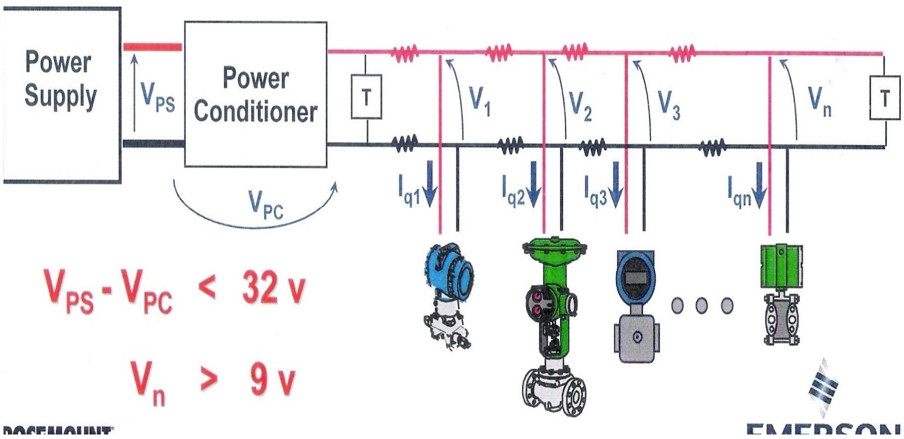


Figure 6: Segment Power

From the Figure 6 we can see that the power supply is not connected directly to the FOUNDATION Fieldbus cable, this is because the power supply will absorb the communication signal on the cable in order to maintain the constant voltage level on the cable. Therefore, the power from the power supply needs to be conditioned first before supplying through the FOUNDATION Fieldbus cable using power conditioner [9].

2.4 FOUNDATION Fieldbus system architecture layer

FOUNDATION Fieldbus system architecture layer or H1 physical layer has three layers which are physical layer, communication layer and user application layer as shown in Figure 9. This FOUNDATION Fieldbus layer was modeled using the Open Systems Interconnect (OSI) model, [1].

The physical layer functioned to provide connection to communication media [7]. It convert the received messages from the Communication Layer (Stack) into signals on the FOUNDATION Fieldbus segment and receives signals on the FOUNDATION Fieldbus segment thus converts them into messages, [1].

The communication layer is in the form of stack called Communication Stack. It is made up of the Data Link Layer, Fieldbus Access Sublayer, and Fieldbus Message Specification. The Data Link Layer is a layer that controls the transmission of messages on the Fieldbus segment, [1]. This layer using the concept of non-collision based communication protocol. The digital communication signals on a Fieldbus segment are synchronized by LAS. Figure 7 shows that LAS will control the time for the device to communicate, so the signals would not collide during the communication.

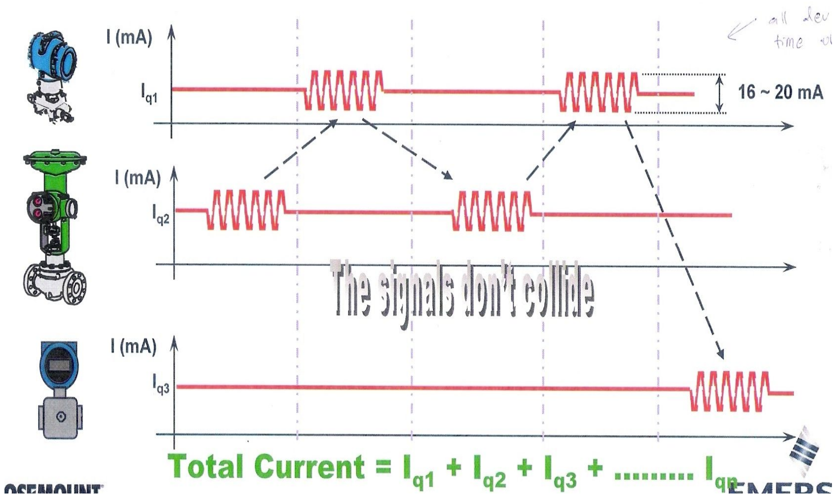


Figure 7: Non-collision protocol

While the third layer of the H1 physical layer is the user layer. This layer consists of function block, system management, DD and common file format. This layer is where the real functionality of the device takes place. Via this layer level the data formats and semantics are defined that allow the devices to execute the data and perform the control. Thus, the interoperability can be achieved.

2.4.1 Link Active Scheduler (LAS)

LAS function to separates the time for the process data to send the signal in preventing the traffic during communication. If the time for the sent signal is not managed, then the signal will collide and corrupted. There is only one function LAS at a time. The devices will only send the transmission frames on the segment when being instructed by LAS. LAS also function to maintain the list of all devices on the segment besides than recognizing and adding the new devices [9]. For the non-responsive devices, LAS will automatically remove that device so that the LAS would not need to provide the transmission time for it and the scheduler would not be disturb.

However, there is a time when the LAS are not functioning. In order to overcome this, Link Master will backup the LAS. Link Master can be any other device such as valve or pressure transmitter and all the ROSEMOUNT devices is a Link Master. There can be many LM, but only the main LM could be the LAS as in Figure 8. Basic Device (BD) can not perform as a LM [9].

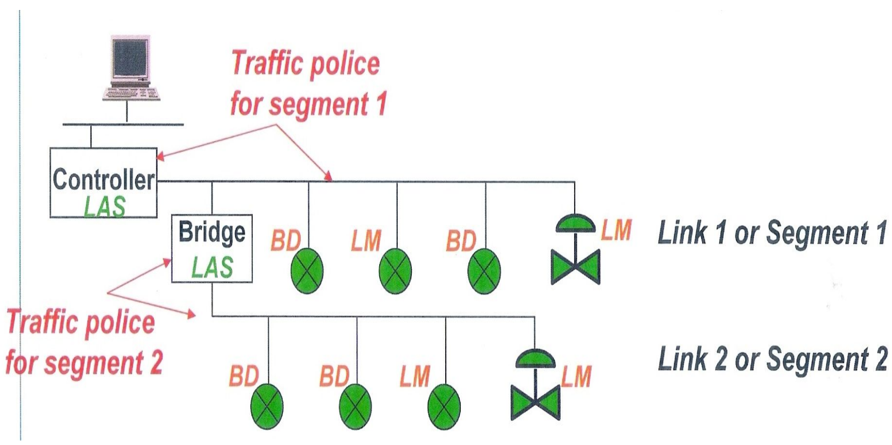


Figure 8: Link Master

In achieving the objective for the interoperability between devices and subsystems from different manufacturers, one layer called User layer of a common language is used [7]. User layer enables user to configure the FOUNDATION Fieldbus devices, establish communication between FOUNDATION Fieldbus and conventional devices, and also monitor the performance of the control loops operating in the FOUNDATION Fieldbus devices, [1].

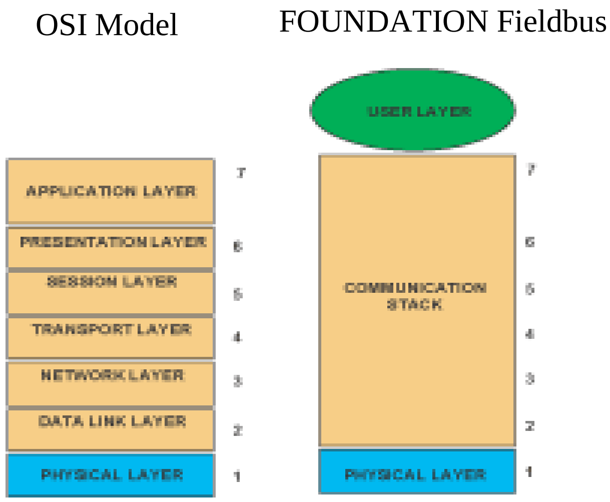


Figure 9: FOUNDATION Fieldbus system architecture layer

2.5 H1 and High Speed Ethernet (HSE)

H1 and HSE are the two profiles used to connect the device to physical media. H1 runs at 31.25 Kbit/s for field device integration in process control and hybrid applications while HSE runs at 100 Mbit/s and it is designed as a high performance control backbone for integration of H1 and other subsystems, high density data generators such as PLCs and analyzers, and plant data servers, [7].

Table 1: Characteristics of H1 and HSE

H1	HSE
Speed is 31.25 Kbit/s	Tested at 100 Mbit/s, but it use 1 Gbit/s speeds
Use single twisted pair and length up to 1900 Meters without repeater	- Standard twisted-pair Ethernet cables length up to 100 meters between an Ethernet switch and the device - HSE full-duplex fiber optic cable length up to 2000 meters between a switch and device
Used up to 4 repeaters to extend distance	Switches are often interconnected with fiber optic cable to extend distance
Use tree, bus or a combination topology	Use star topology
Supports Intrinsic Safety (IS) that placed between power supply (safe area) and the device (hazardous area).	Do not support IS.

2.6 Fieldbus Layers Network Architecture

Figure 10 below shows the network architecture of the FOUNDATION Fieldbus that located in the UTP lab. The hosts in the architecture are provided by four vendors from Emerson, Yokogawa, Honeywell and Foxboro, while the transmitters, control valves, power conditioners and power supply are provided by Fisher Rosemount, Endress Hauser (E&H), Pepperl & Fuchs (P&F) and MTL. This whole architecture was divided into two segments which are Segment 1 and Segment 2.

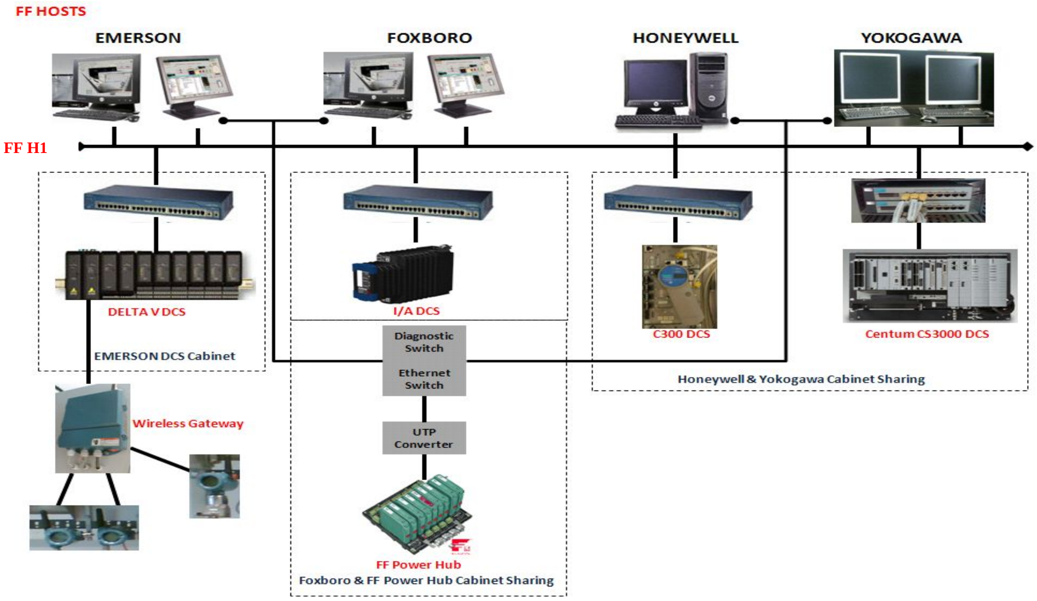


Figure 10: FOUNDATION Fieldbus Network Architecture

CHAPTER 3
METHODOLOGY

3.1 Procedure Identification

This project consists of two parts which are the Basic Test and control loop design. The Basic Test is redoing for the understanding on the communication of FF system.

3.1.1Basic Test

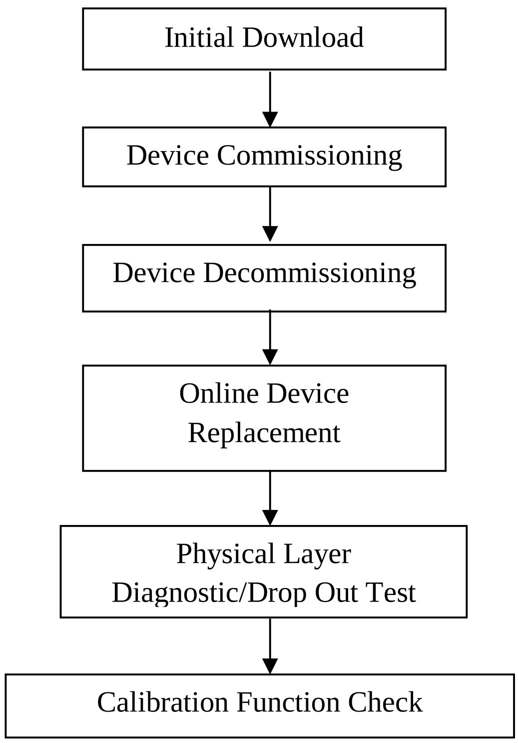


Figure 11: Flowchart of Basic Test

The basic test will de divided to six subtests that will be conducted one by one at different time. These six subtests will be explained further detail in later part.

3.1.1.1 Initial Download

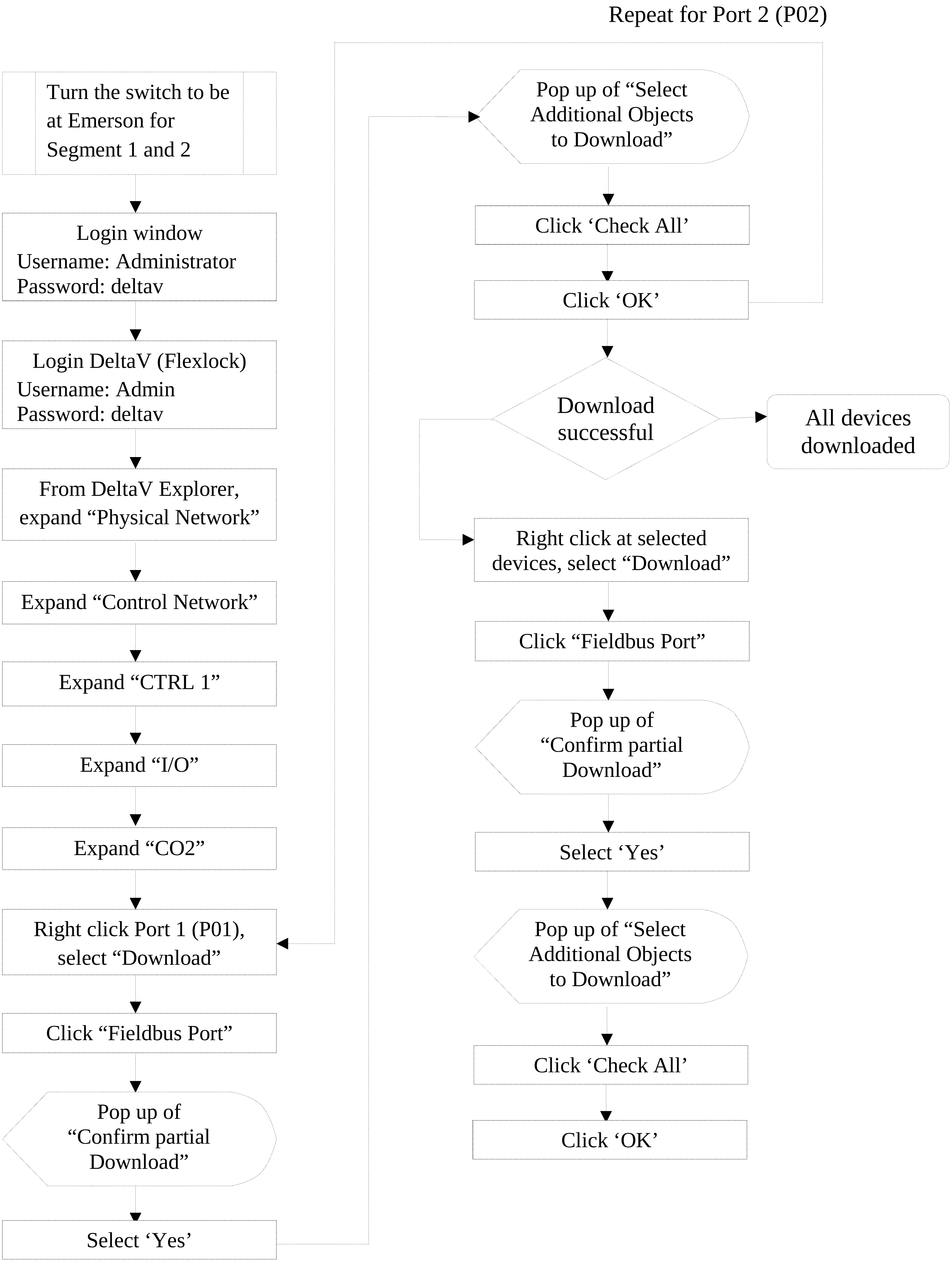


Figure 12: Flowchart of Initial Download

Initial Download is done after the host of the system had been switched. This is to ensure that all the devices in the system are recognize by the selected host and completely loaded with the identified configuration and updated with current data. This method is done by changing the selector switch to Emerson for both Segment 1 and 2. The initial download was performed as the step in the flow chart above. This triangle sign ▲ will indicate that the device needs to be downloading. Hence, the individual device download need to be performed. The figures below show the step of downloading the device. [11]

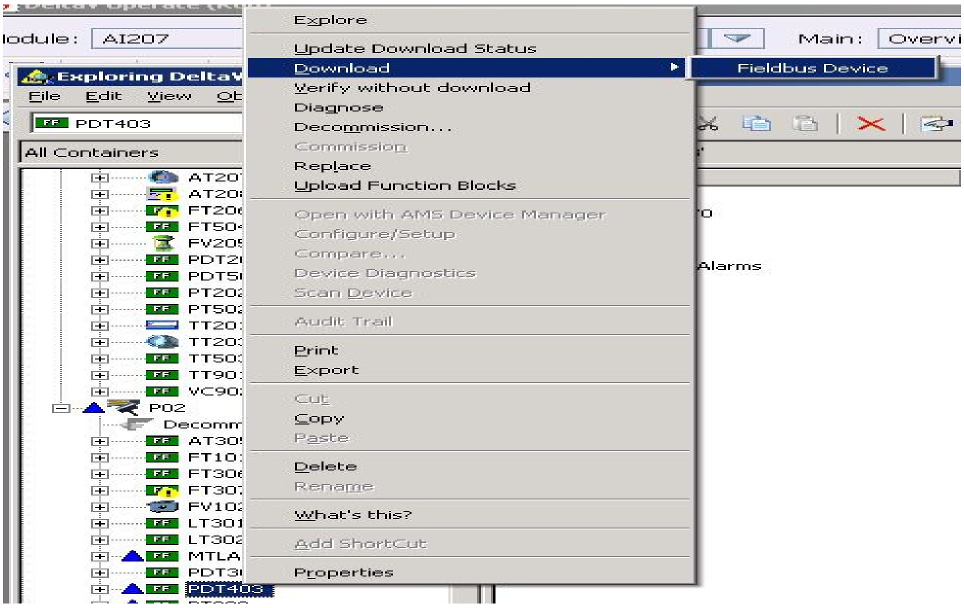


Figure 13: Device selected to be download

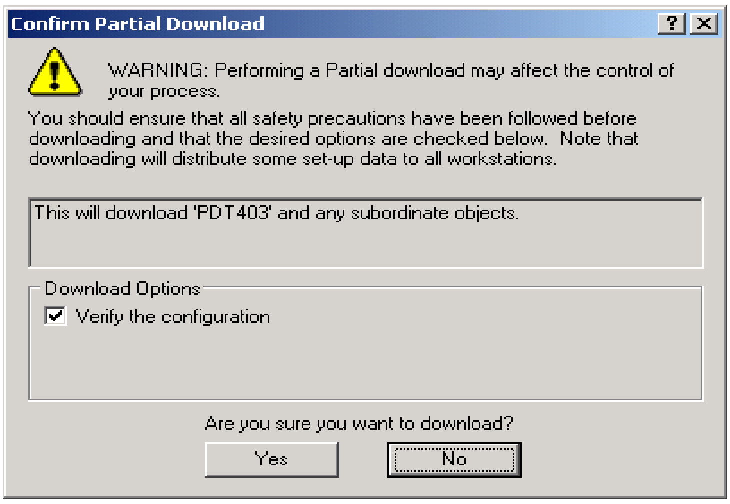


Figure 14: Confirm partial Download pop up

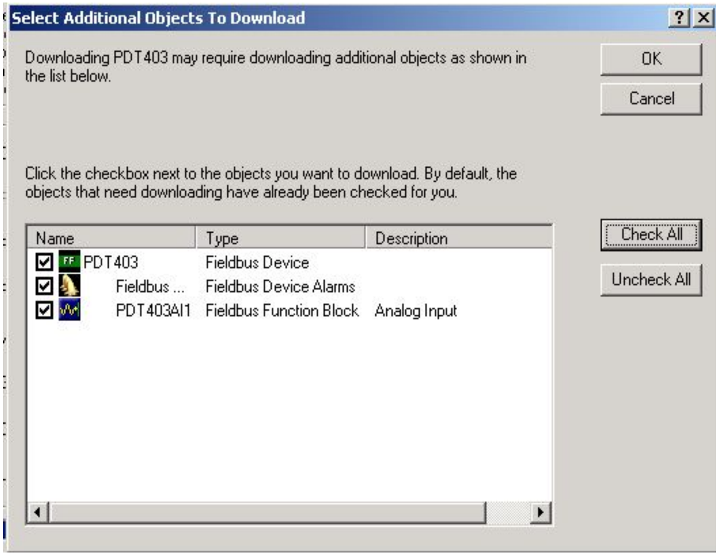


Figure 15: ‘Select Additional Objects to Download’ pop up

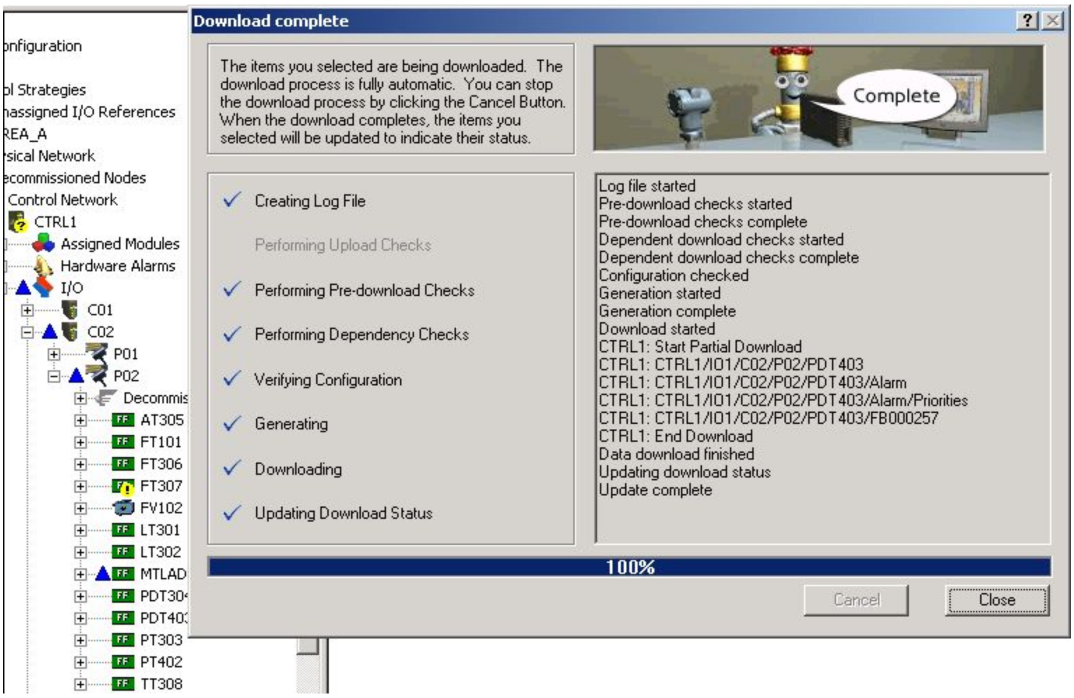


Figure 16: Device download completed

Figure 16 shows the device download completed. The blue triangle sign is no longer at the tag indicates that the device is successful downloaded. Open the DeltaV Operate Run and click the ‘Overview’ button. From the graphic displayed, call-up the faceplate for each device and acknowledge the alarm, if any. [11]

3.1.1.2 Device Commissioning

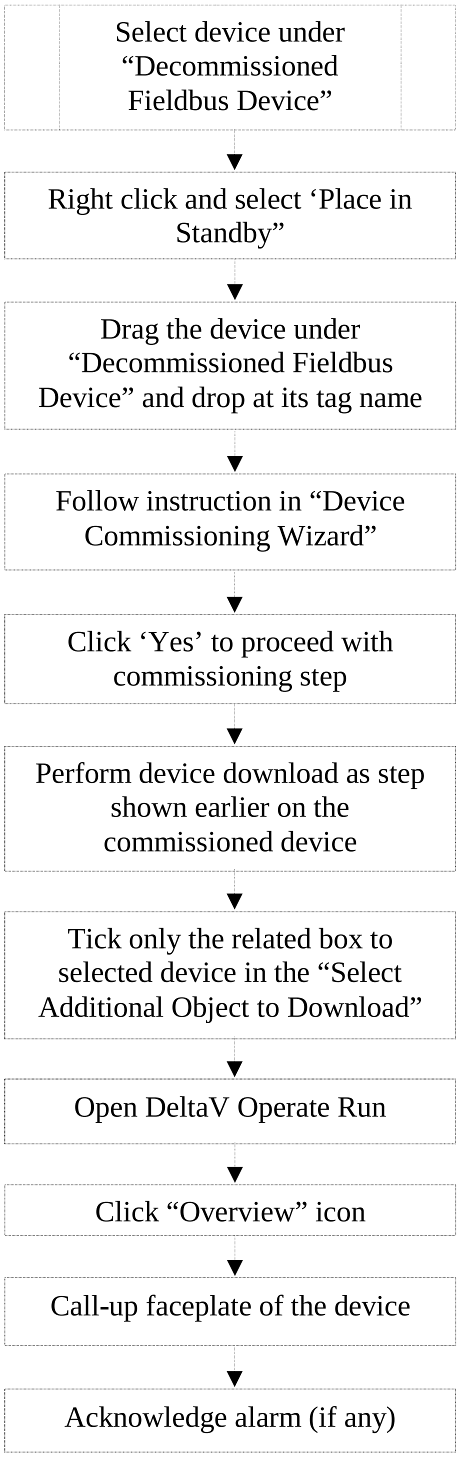


Figure 17: Flow Chart of Device commissioning

Device commissioning is like to register the device to the system. The commissioning process must not interrupt the system or affect other devices on the segment. The device display tag at DeltaV Operate Run (Overview) will be in yellow for the decommissioned device and turn to green after commission. Acknowledging the alarm is important to confirm the commissioning is successful [11]. Alarm can be acknowledged from the call-up faceplate or from the alarm list.

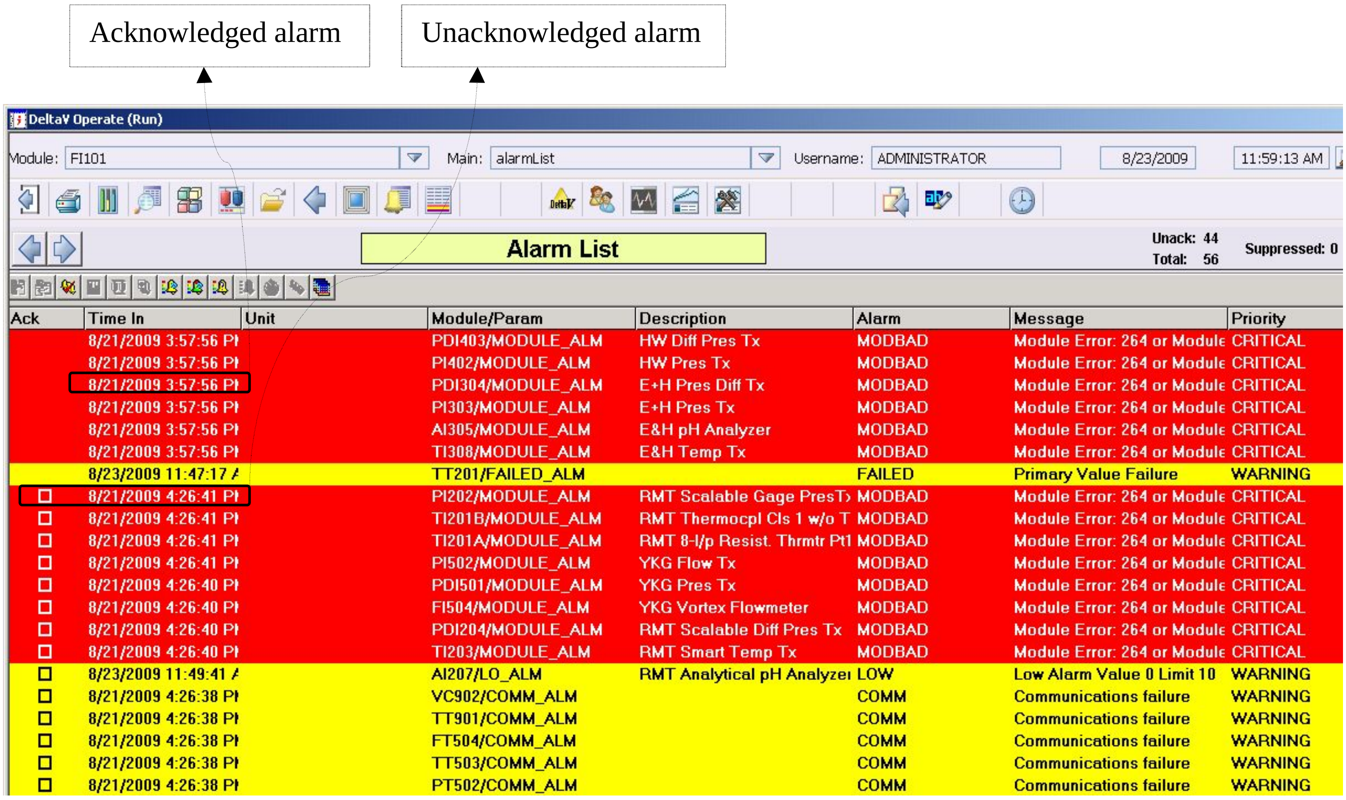


Figure 18: Alarm List

3.1.1.3 Device Decommissioning

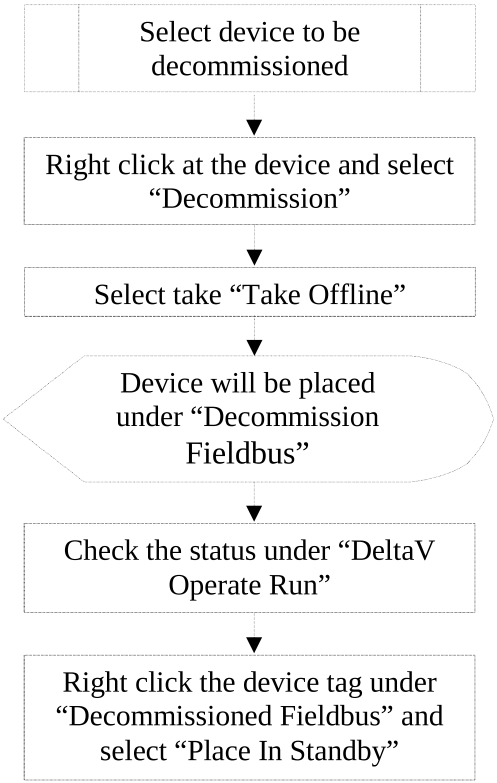


Figure 19: Flow Chart of Device decommissioning

Decommissioning is a method of putting the device in offline mode or to detach the device from the segment for example to do maintenance or replace with other device. The decommissioned device needs to be taken off-line and it will take some time before it will be placed under "Decommission Fieldbus". The status of the device needs to be checked at the graphic in the DeltaV Operate Run. If the device is successfully decommissioned, the display tag will change from green to yellow. [11]

3.1.1.4 Online Device Replacement

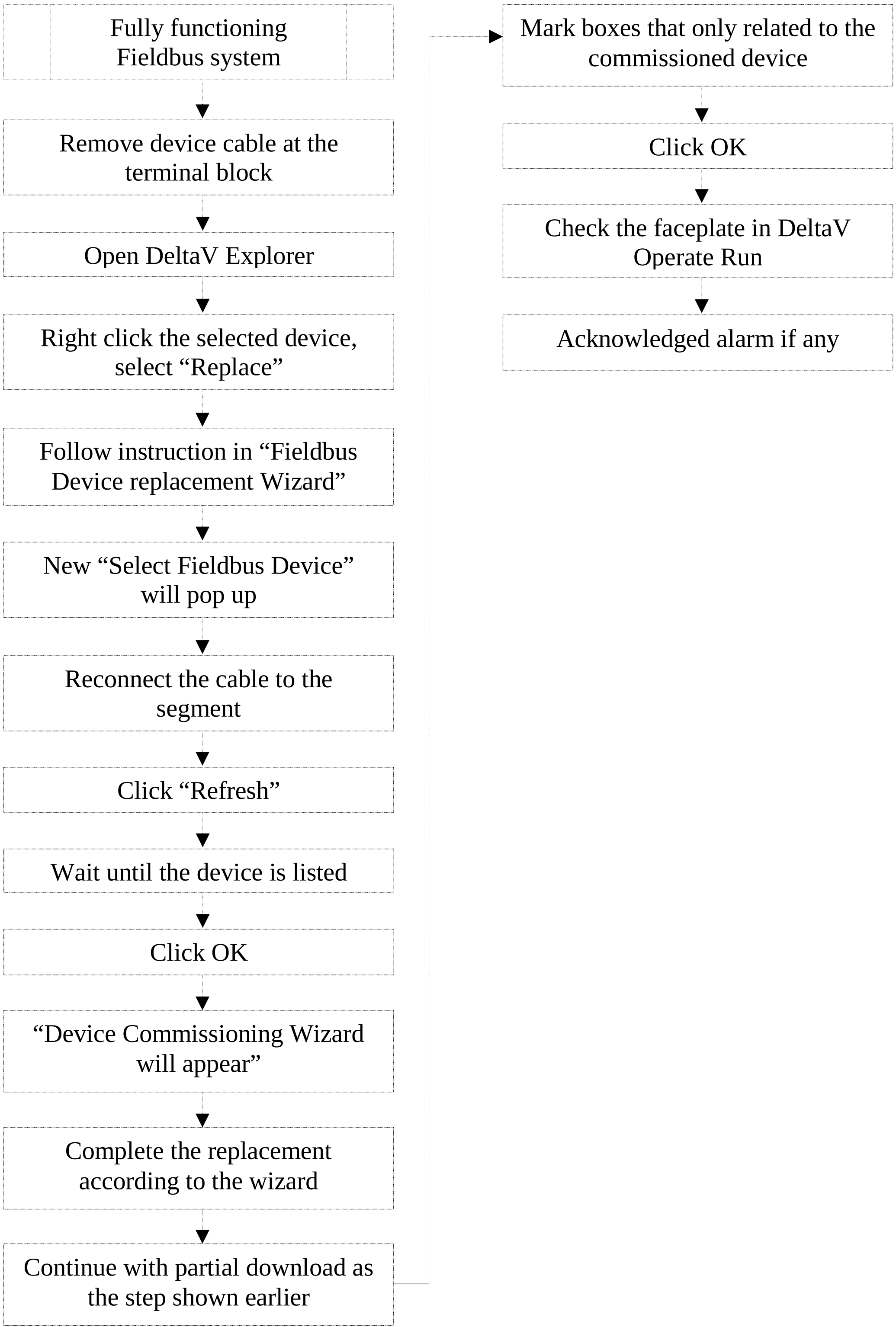


Figure 20: Flow Chart of Online Device Replacement

This test was done to understand steps required to do an online device replacement. This test also proves the existing of DD file where all information regarding the device was still in the system after reconnect and downloading the device. The device cable need to be removed while ensuring the parallel wiring to other device is not broken. Figure 21 below shows the device AT 207 being replaced. After reconnect the cable and the "Refresh" button clicked, the device will be listed in the "Select Fieldbus Device" box. [11]

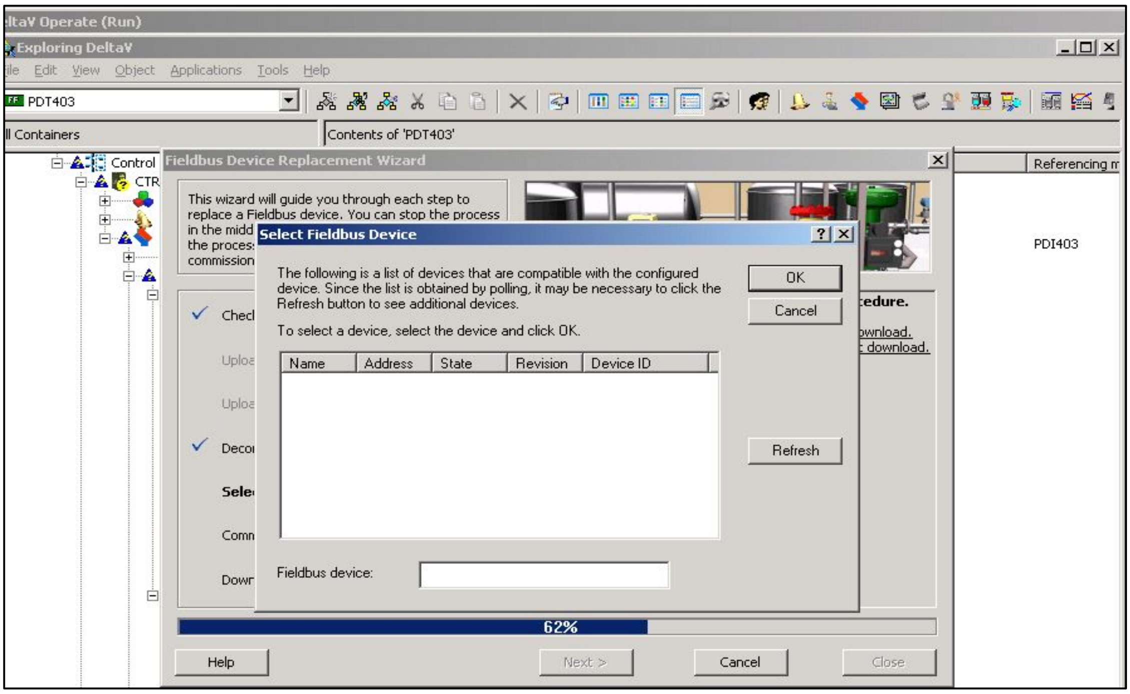


Figure 21: AT 207 being replaced

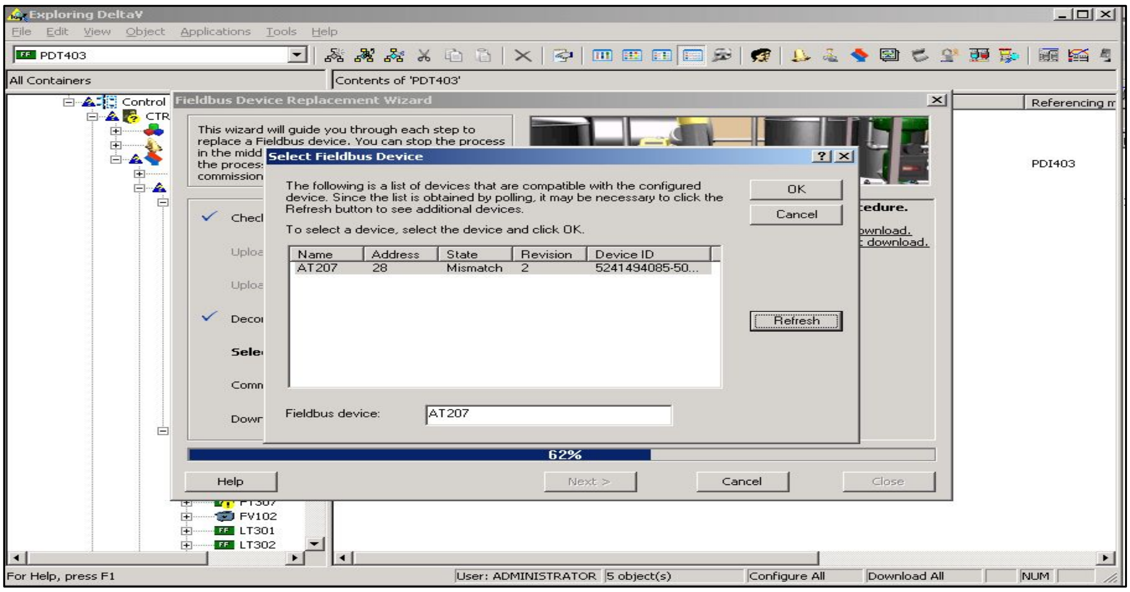


Figure 22: After refresh the replace device

3.1.1.5 Physical Layer Inspection/ Device Drop Out

Using Fieldbus communicator (375 Field Communicator)

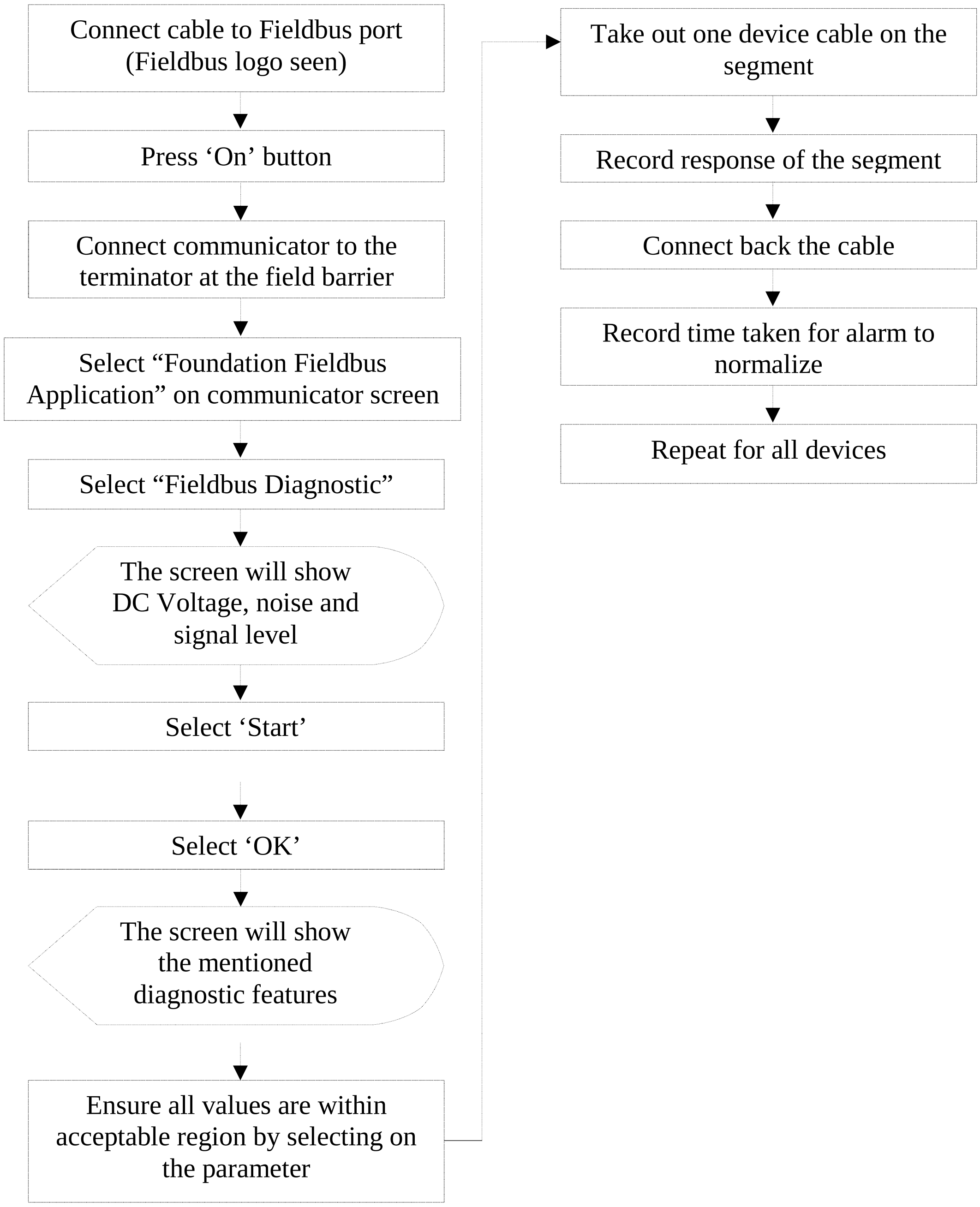


Figure 23: Flow Chart of Physical Layer Inspection/Device Drop Out

Physical layer inspection test was done to measure the signal voltage and ensure that all parameters are within the acceptable range. While the device drop out test was to ascertain that device failure would not affect the overall segment or any other healthy device. The time taken for alarm to be normalized is to indicate whether the signal is automatically recovered once the device is online. [11]

3.1.1.6 Calibration Function Check

Using Host

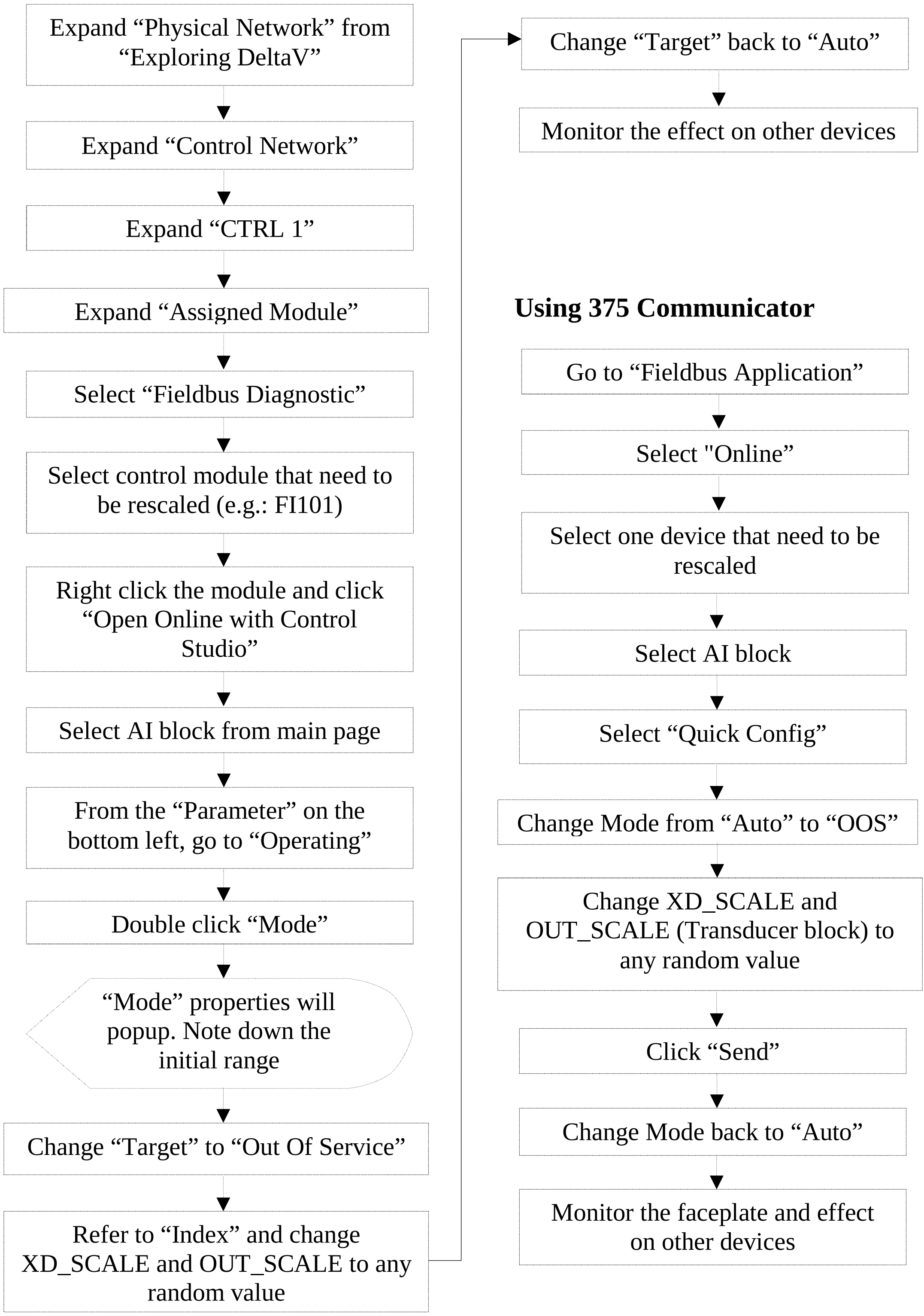


Figure 24: Flow Chart of Calibration function Check

This test is shows the step needed in changing the device range of the parameter download and its effect on other device. The device range was change from XD_SCALE and OUT_SCALE. The upper and lower range of the XD_SCALE and OUT_SCALE was change to any random value. The changes were identified at the faceplate of the device. By using 375 Field Communicator, the same identification applied in monitoring the changes of XD_SCALE and OUT_SCALE. For the basic test, the parameter download can only be changed using host and 375 Field Communicator only. [11]

3.1.2 Control loop design

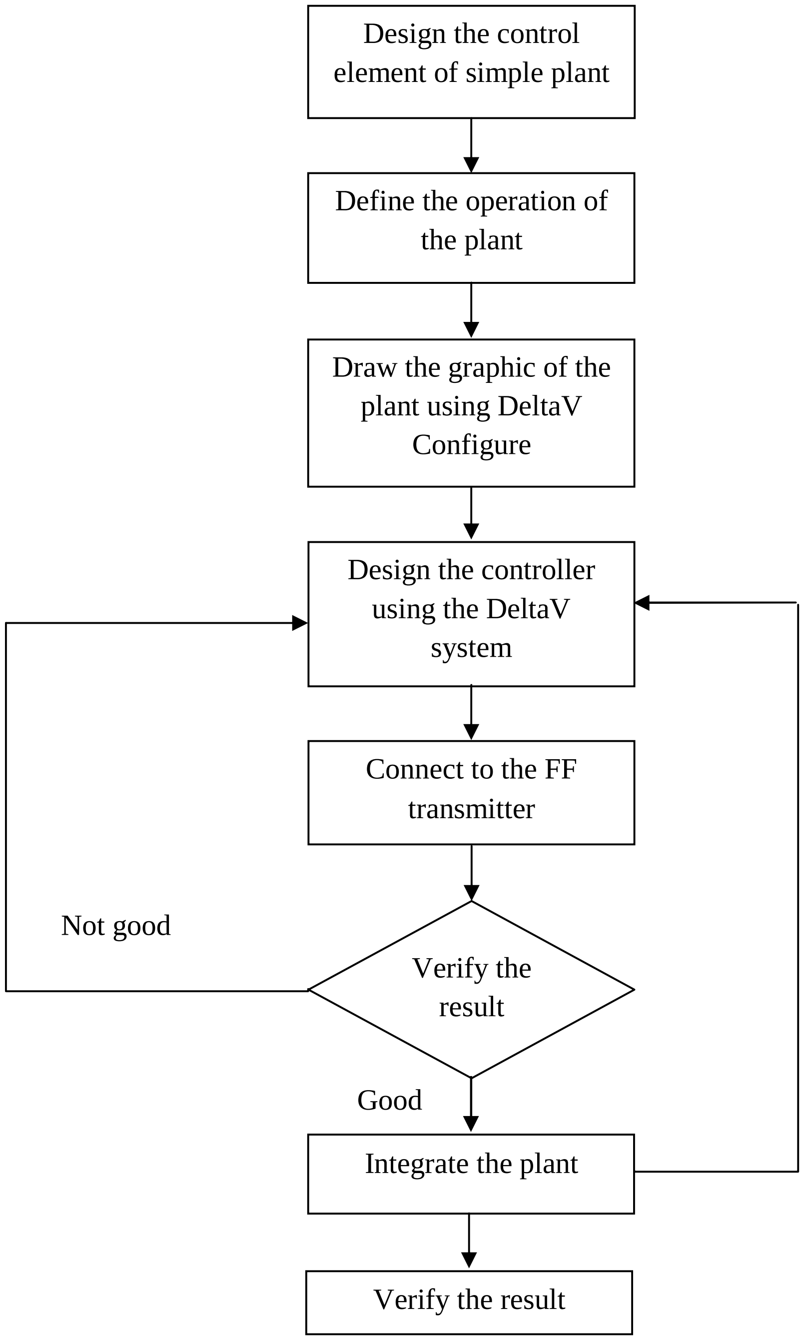


Figure 25: Flowchart of Control Loop Design

In designing the control loop, the flow chart in Figure 25 shows that first is to design the control element for a simple plant such as the flow, pressure and temperature. The operation of the plant is defined after determining those control elements. Next is to draw the graphic of the plant design using the DeltaV Configure and proceed with the controller design using DeltaV system. The testing of the plant would be done by downloading the controller (software) design to the hardware (FF transmitter). The result would be verified and if the FF transmitter did not function according to the simulation, then the logic of controller need to be checked. If the hardware and software did communicate well, the test will be proceeded to integrate the plant to make it looping. The procedure is repeated as in Figure 25.

3.2 Gantt Chart

The project had been completed without very much trouble. However, during June until July the project had been paused because of the semester break. In the first one month of the new semester, the project had been continued by redoing the basic test. The project had been delayed again for one week because SKG14 had come to discuss about the procedure of stress test. The rest activity can be viewed in the Gantt chart in Appendix 3.

3.3 Tools

The tools used in these projects are consisting of hardware and software.

3.3.1 Hardware

Table 2 shows the list of the devices used based on the segments:

Table 2: List of Foundation Fieldbus Devices

No.	Descriptions	**Device Name**
	Segment 1	
1	ROSEMOUNT 8-input Temperature Transmitter	TT201
2	ROSEMOUNT Scalable Classic Cage Pressure Transmitter	PT202
3	ROSEMOUNT Smart Temperature Transmitter	TT203
4	ROSEMOUNT Scalable Classic Differential Pressure Transmitter	PDT204
5	FISHER Fieldvue	FV205
6	Micromotion Coriolis Density Flowmeter	FT206
7	ROSEMOUNT Analytical pH Analyzer	AT207
8	ROSEMOUNT Analytical OXMT	AT208
9	YOKOGAWA Differential Pressure Transmitter	PDT 501
10	YOKOGAWA Pressure Transmitter	PT502
11	YOKOGAWA Temperature Transmitter	TT503
12	YOKOGAWA Vortex Flow Meter	FT504
13	P&F RDO-TIEx8.FF.ST	TT901
14	P&F FDO-VC-Ex4.FF	VC902
	Segment 2	
1	FOXBORO Intelligent Electronic D/P Cell Transmitter	FT101
2	FOXBORO Intelligent Positioner (Intrinsically Safe)	FV102
3	E&H Guided Wave Radar Level Transmitter	LT301
4	E&H Radar Level Transmitter	LT302
5	E&H Pressure Transmitter	PT303
6	E&H Differential Pressure Transmitter	PDT304
7	E&H pH Analyser	AT305
8	E&H Prowirl Vortex Flowmeter	FT306
9	E&H Promass Coriolis Mass Flowmeter	FT307
10	E&H Temperature Transmitter	TT308

11	HONEYWELL Temperature Transmitter RTD Sensor with Thermowell	TT401
12	HONEYWELL Pressure Transmitter	PT402
13	HONEYWELL Differential Pressure Transmitter	PDT403

SOURCE: ICPE Site Activity Plan

<u>Legend</u>

FT : Flow transmitter
FV : Flow Positioner
TT : Temperature Transmitter
PT : Pressure Transmitter
AE : Analyser Sensor
AT : Analyser Transmitter
LT : Level Transmitter
VC : Valve Cuppler
PDT: Pressure Differential Transmitter

<u>1st Number</u>

1 : FOXBORO
2 : EMERSON
3 : ENDRESS + HAUSER
4 : HONEYWELL
5 : YOKOGAWA
9 : P + F

- 375 Handheld Communicator

Figure 26: 375 Handheld Communicator

3.3.2 Software

The software used is DeltaV system that has features such as:

i. DeltaV Configure mode

ii. DeltaV Run

iii. DeltaV Explorer

iv. DeltaV Diagnostic

v. DeltaV Control Studio

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Result

4.1.1 Loop Control Design

In order to start on the designing the loop control, the simple plant as in the P&ID of Figure 27 was obtained. This is a Flow, Pressure and Temperature plant [5]. This plant is going to be control by developing the control system using DeltaV and will be connected to the device provided in the lab. The devices that will be used are Pressure Transmitter, Temperature Transmitter, Flow Transmitter and valve as stated in the P&ID.

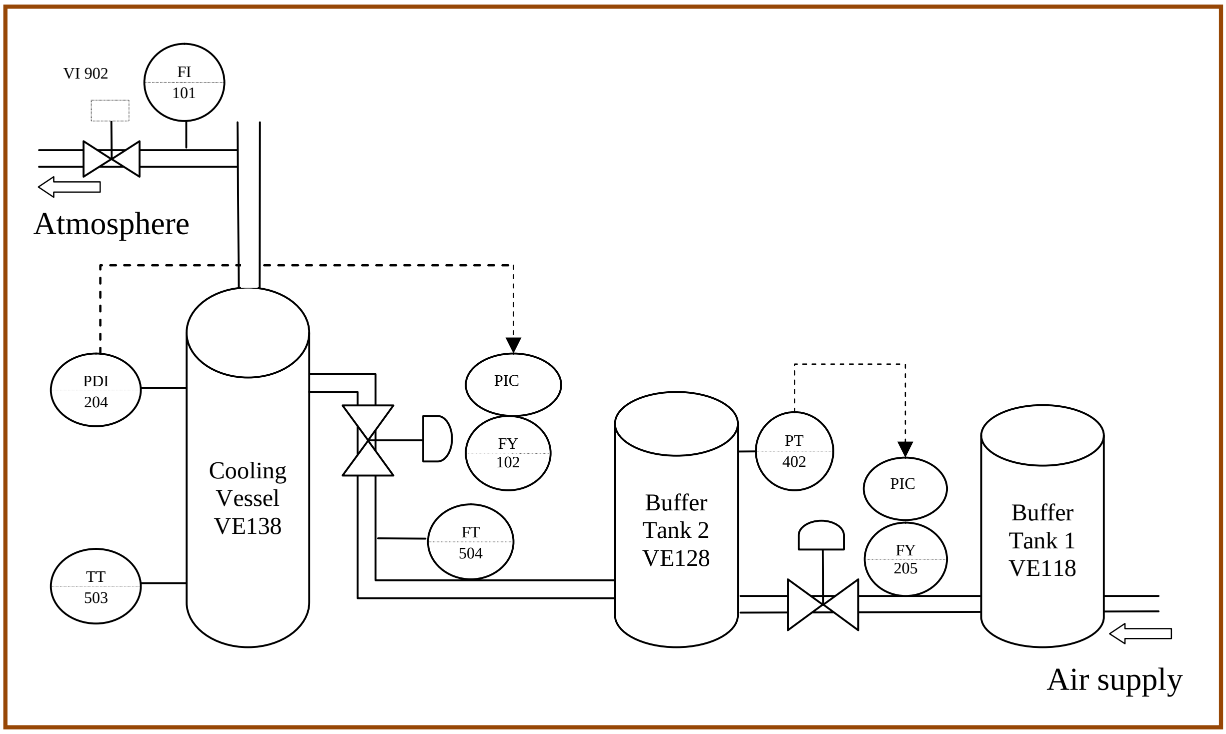


Figure 27: Flow, Pressure and Temperature plant P&ID

Figure 28 below shows the graphic of the Flow, Pressure and Temperature plant that had been drawn referred to the P&ID in Figure 27 using the DeltaV Configure.

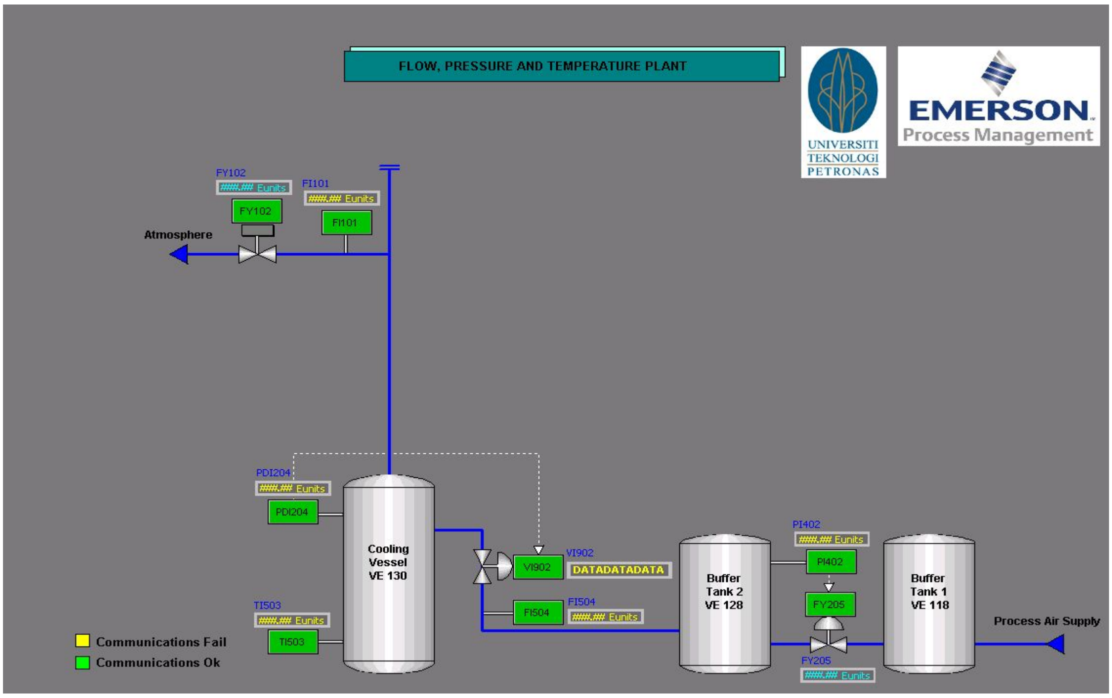


Figure 28: Flow, Pressure and Temperature plant

The devices used in this plant such as FY102, FI101,PDI204, TI503,VI902, FI504, PI 402 and FY205 are all from the devices used for the FFIT. These devices were downloaded in order to have a good communication. All the alarms were acknowledged. If the tag name of the device appears to be yellow in DeltaV Run mode, then the communication of that device is fail. If the tag name is green, it indicates that the communication is good.

4.1.2 Training by EMERSON

The PETRONAS Group of Technical Solution (PGTS) had organized the training for the PGTS members as well as the students on 7th to 9th April 2009 for three days. The training was given by the Emerson as one of the host for the FFIT. The training was held at Fieldbus lab in building 23, Universiti Teknologi PETRONAS.

4.1.3 Basic Test

Basic Test covers six subtests which are:

- Initial Download
- Device Commissioning
- Device Decommissioning
- Online Device Replacement
- Physical Layer Inspection/Device Drop Out
- Calibration Function Check

This test includes the device from two segments which are 13 devices from Segment 1 and 12 devices from Segment 2. The list of device is listed in Table 2. This project scope only covers the devices in Segment 2. However, there are some devices in the segment are failed to be tested due to the DD file and there are also some devices are not attached.

4.1.3.1 Initial Download

Table 3: Initial download result

No.	VENDOR	DEVICE NAME	INITIAL DOWNLOAD		
			SEGMENT DOWNLOAD	PARTIAL DOWNLOAD	ALARM ACKNOWLEDGED
1	E+H	AT305	N	Y	N
2	E+H	LT302	Y	-	Y
3	E+H	PT303	Y	-	N
4	E+H	PDT304	Y	-	N
5	E+H	LT301	Y	-	Y
6	E+H	FT306	Y	-	Y
7	E+H	FT307	N	N	N
8	HONEYWELL	PT402	Y	-	Y
9	HONEYWELL	PDT403	Y	-	Y
10	FOXBORO	FT101	Y	-	Y
11	FOXBORO	FV102	Y	-	Y
12	MTL	MTLADM1	N	N	Y
13	E+H	TT308	Y	-	N

* Segment Download: Download all the devices in the port at one time at port

* Partial Download: Download only the required device at one time.

* Alarm Acknowledged: Clear alarm

Y = SUCCESS

N = FAIL

Table 3 shows the result of the initial download test and alarm acknowledged. There are two devices that can not be downloaded either through segment or partial download which are FT307 and MTLADM1. The time taken for initial download is approximately 10.53 minutes. Besides that, there are several devices that their alarm can not be acknowledged.

4.1.3.2 Device Commissioning

Table 4: Device commissioning result

No.	VENDOR	DEVICE NAME	FULL DOWNLOAD	PARTIAL DOWNLOAD	COMMISSION
1	E+H	AT305	Y	N	Y
2	E+H	LT302	Y	N	Y
3	E+H	PT303	N	Y	Y
4	E+H	PDT304	N	Y	Y
5	E+H	LT301	Y	N	Y
6	E+H	FT306	Y	N	Y
7	E+H	FT307	N	N	N
8	HONEYWELL	PT402	N	Y	Y
9	HONEYWELL	PDT403	N	Y	Y
10	FOXBORO	FT101	Y	N	Y
11	FOXBORO	FV102	Y	N	Y
12	MTL	MTLADM1	N	N	N
13	E+H	TT308	N	Y	Y

* Segment Download: Download all the devices in the port at one time at port
* Partial Download: Download only the required device at one time.

Y = SUCCESS
N = FAIL

In segment 2, all devices can be commission except for FT 307 and MTLADM1. The time taken for each device to commission is about 1.13 minutes and the full download take about 13 minutes while the partial download of each device take times of 2 minutes in average. After commissioning, all the device tag in the DeltaV Operate is green.

4.1.3.3 Device Decommissioning

Table 5: Device decommissioning result

No.	VENDOR	DEVICE NAME	DECOMMISSION
1	E+H	AT305	Y
2	E+H	LT302	Y
3	E+H	PT303	Y
4	E+H	PDT304	Y
5	E+H	LT301	Y
6	E+H	FT306	Y
7	E+H	FT307	N
8	HONEYWELL	PT402	Y
9	HONEYWELL	PDT403	Y
10	FOXBORO	FT101	Y
11	FOXBORO	FV102	Y
12	MTL	MTLADM1	N
13	E+H	TT308	Y

Y = SUCCESS
N = FAIL

As the result shown in Table 5, the device that cannot be commissioned which is FT 307also can not be decommissioned. The time taken for each device to decommission is about 1.25 minutes. As the device being decommissioned, the device tag in the graphic is changed to yellow.

4.1.3.4 Online Device Replacement

Table 6: Online device replacement result

No.	VENDOR	DEVICE NAME	RESULT
1	E+H	AT305	Y
2	E+H	LT302	Y
3	E+H	PT303	Y
4	E+H	PDT304	Y
5	E+H	LT301	Y
6	E+H	FT306	Y
7	HONEYWELL	PT402	Y
8	HONEYWELL	PDT403	Y
9	FOXBORO	FT101	Y
10	FOXBORO	FV102	Y
11	E+H	TT308	Y

Y = SUCCESS
N = FAIL

The Table 6 shows that all the device in Segment 2 can be replace online. However there are some issues that need to be highlighted while doing the testing. After removing the cable from the terminal block, the tag in the graphic must changed to yellow first before clicking for replace or the device cannot be replace. There are two alarms that need to be acknowledged in this test which are Module Alarm (Red) and Communication Alarm (Yellow).

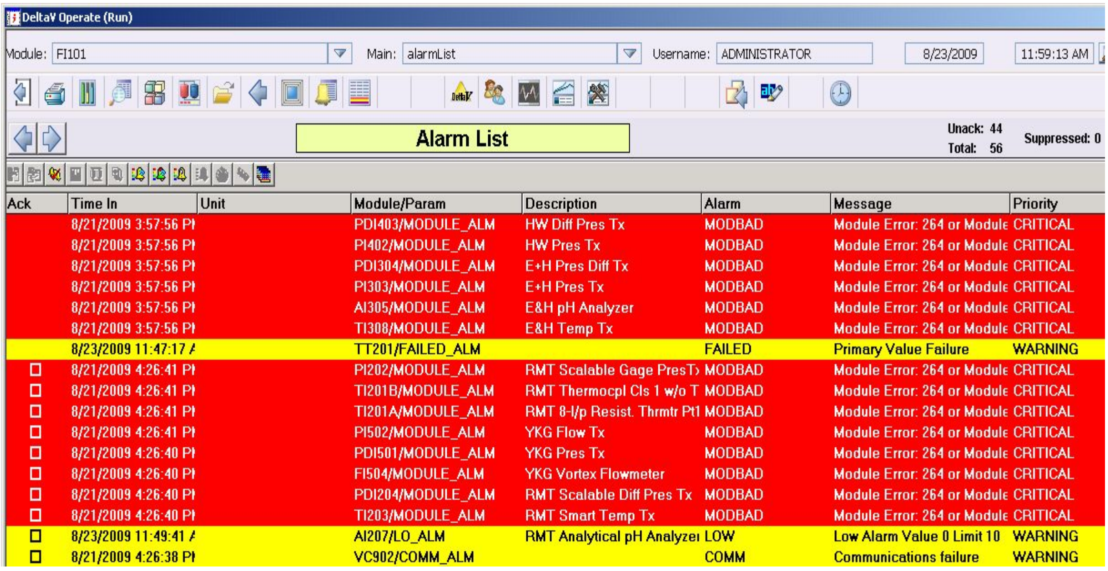


Figure 29: Communication Alarm and Module Alarm

4.1.3.5 Device Drop Out

Table 7: Physical layer inspection/device drop out result

No.	VENDOR	DEVICE NAME	DEVICE AFFECTED	ALARM NORMALIZED(sec)
1	E+H	AT305	-	38.2
2	E+H	LT302	-	60.2
3	E+H	PT303	-	42.4
4	E+H	PDT304	-	52.5
5	E+H	LT301	-	55.5
6	E+H	FT306	-	23.1
7	HONEYWELL	PT402	-	29.3
8	HONEYWELL	PDT403	TT308	20.8
9	FOXBORO	FT101	-	29.1
10	FOXBORO	FV102	-	25.8
11	E+H	TT308	-	21.9

* Device Affected: Device that affect by the devices being take out

* Alarm Normalized: Clear alarm

Table 7 shows the result of the device drop out test result. All the alarm of each device can be acknowledged with the difference time taken. However there are certain device alarms that still appear but not blinking even after acknowledged. While the PDT 403 was being taken out, the alarm of TT 308 appear to be blinking. The reason will be discussed in later part.

4.1.3.6 Calibration Function Check

Table 8: Table of the calibration result

No.	VENDOR	DEVICE NAME	CALIBRATION	
			375 COMMUNICATOR	HOST
1	E+H	LT301	N	Y
2	E+H	LT302	N	Y
3	E+H	PT303	N	Y
4	E+H	PDT304	N	Y
5	E+H	AT305	Y	Y
6	E+H	FT306	Y	Y
7	E+H	TT 308	Y	Y
8	HONEYWELL	PT402	Y	Y
9	HONEYWELL	PDT403	Y	Y
10	FOXBORO	FT101	Y	Y
11	FOXBORO	FV102	Y	Y

* 375 Communicator: Device used to do calibration of control devices in field Y = SUCCESS
* Host: Main workstation in this case is Emerson Proplus *N = FAIL*

All the devices can be calibrated using the host. However, there are some of them that fail to be calibrated using the 375 Communicator because the device DD file not exists at the communicator. Besides that, the calibration of FT 101 only can be done when the XD_SCALE and OUT_SCALE in the same value otherwise the alarm will blinking and the device tag name will change to yellow.

4.2 Discussion

4.2.1 Loop Control Design

The plant obtained in Figure 28 however is not a loop control. A simple plant is design to be controlled first. After succeeding with the simple design, then the plant will be integrated to be loop. The logic to the devices has been taken from the logic of FFIT. The main idea is to create the logic, but due to the limitation of privilege and hardware that is in terms of the termination, the logic cannot be created.

4.2.1.1 Plant operation

The plant in Figure 28 consists of two buffer tanks, VE 118 and VE 128 that functioned to supply regulated, compressed air to the cooling vessel, VE 138. As more the air supplied entering the VE128, the pressure inside the vessel will be increase. In order to ensure safety, the compressed air will be controlled by using the valve, FY205, [5].

The air from the source will be supplied through the VE 118 to the VE 128. The PT402 at VE 128 will measure the pressure inside the tank and the signal will be sent to the controller. If the pressure measured is over the high limit, the signal will be sent to the valve to decrease the opening in order to maintain the pressure within the specified range. This operation is also goes to the controller at the FY102 which is to maintain the pressure inside the cooling vessel VE 138.

In order to ensure safety, which is one of the control objectives, the flow of the output will be controlled. The flow transmitter, FI101 will measure the flow rate of the compressed air and sent the signal to the controller, FIC. If the flow measured by the FI101 is less than the low limit, the controller, FIC will sent the pneumatic signal to the valve, VI902 to increase the opening so that the compressed air can be flown out to the atmosphere.

Figure 28 shows the graphic of the plant that had been drawn using DeltaV Configure and Figure 30 is the graphic in DeltaV Run mode that going to be used by the operator in monitoring the running of the plant. For example, the Analog Input of TT503 will show the display of the temperature in the VE138 and if it is over the low or high limit, the block will be blinking in red color. The set point can be set at the faceplate of the device as in the Appendix 4.

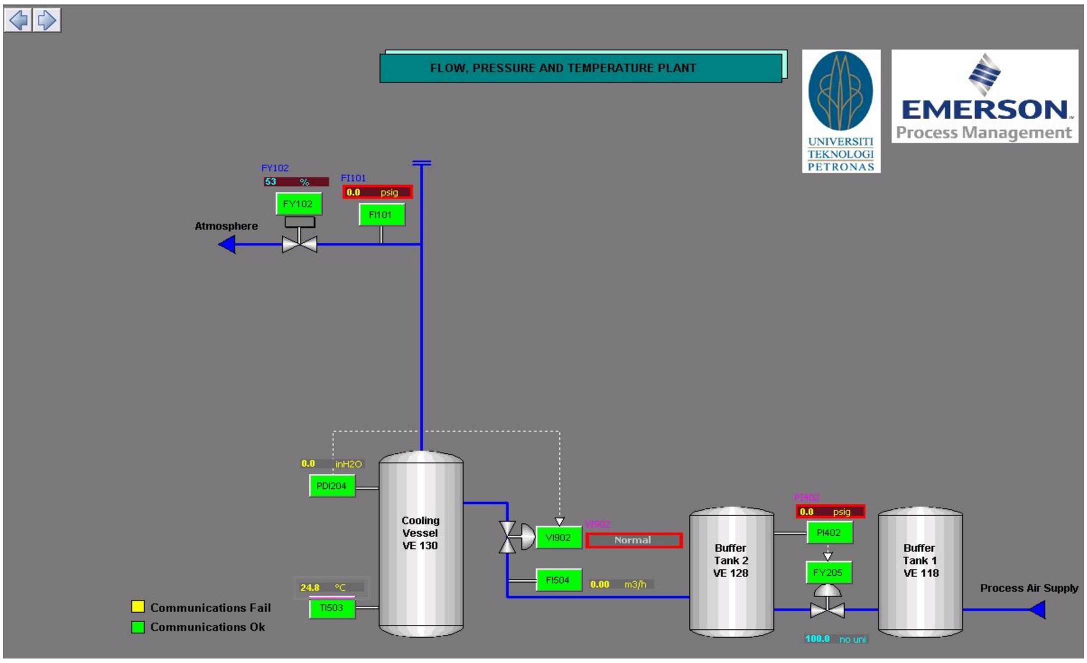


Figure 30: Flow, Pressure and Temperature Plant in DeltaV Operate Run mode

4.2.2 Training by EMERSON

The training provided by Emerson is about the FOUNDATION Fieldbus Device Service Basic Theory, 375 Field Communicator, Wireless technology by Emerson, AMS Intelligent Device Manager, Analytical and Flow.

This training is to provide the basic understanding about this technology to the PGTS members and students working on this project to perform the interoperability test and improve understanding on Fieldbus system by Emerson better.

4.2.3 Basic Test

The discussion in this part will be focused on each of the test of the basic test which is the initial download, commissioning, decommissioning, online device replacement, drop out test and calibration function check test.

4.2.3.1 Initial Download

There are two devices that cannot perform the segment download which are FT 307 and MTLADM1. FT 307 cannot be downloading because it is detached from the segment while MTL is a power conditioner that did not need to be downloaded but it required a channel for its power device diagnostic feature. The alarm can not be acknowledged because the system is already detected the online device but the device itself was not updated with this information. The initial download needs to be performed every time host being switched as to register the device to the selected system.

4.2.3.2 Device Commissioning

Commissioning needs to be performed to make sure that all devices is functioning and can be recognize by the host. In this test, all the devices can be fully commission and download either by full download or partial download. Download action must be perform for the device to communicate with the host. The time taken for the device to commission is considered short indicates that all the devices are in good condition. Furthermore, all the device tag is green in the DeltaV Operate indicates that the commissioning is successful and the devices can be recognized by the host. The important point is that no devices being interrupt during the commissioning. It means that commissioning device can be done during the fully functioning system.

4.2.3.3 Device Decommissioning

Decommission is performed when to remove the device either for maintenance or to change with other device. For this test, all the devices can be fully decommission. The time taken can be considered as short and in normal condition as it less than 2 minutes. Placing the decommission device on standby mode is necessary before the device can go online. The device decommissioning can also de done during the fully functioning system because it does not disturb other devices in the segment.

4.2.3.4 Online Device Replacement

Online device replacement test is to prove that the device can be removed online and after reattach to the segment and completing the commission, the device can function well as the device before. It means that, the system can recognize the device. The device might be replaced because of the corruption of old device or maintenance. However, the new device must have the same DD file as the old one. In this test, as the device tag in the graphic change to yellow, the device is removed. Since all the alarm can be acknowledged, all the devices being replaced can be recognized by the host after completing the wizard. The replacement also not interrupts the whole process and other devices in the segment.

4.2.3.5 Drop Out Test

The drop out device in this test is to show that the failure of one device in the segment is not affecting the segment performance or other device. The alarm appears to inform the user of the disconnected device. The alarm will be normalized after reattach the device to the segment. The alarm appear but it is not blinking is because the alarm had been normalized but the condition of the device is not back to normal yet. While replacing the device, the other alarm device appears because of while removing the cable, the hand might touch the other loose device cable and alarm appears.

4.2.3.6 Calibration function checks

The calibration function check is used to change the output range of the device. This test proved that the output range can be change via host at Control Studio and 375 Field Communicator at the field. Any changes done to the device is automatically detected by the system. During the test, there are some of the devices cannot be calibrated via 375 Field Communicator because of their DD files were not loaded or updated by the vendor in the 375 communicator. Thus the data cannot be retrieving from the device.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

This project was aimed to do research on the FOUNDATION Fieldbus interoperability in collaboration with PETRONAS SKG14. In running the project, the basic test managed to give better understanding on the FOUNDATION Fieldbus system, it characteristics as well as its communication system. The result of Basic Test on Segment two shows that the MTL power conditioner require a channel for its device diagnostic feature that eventually will increase the cost compared to the P&F power conditioner on Segment one that not require a channel. However, the interoperability limitation of the FOUNDATION Fieldbus still can not be solved because the project can not be proceed with stress test and diagnostic test due to the delay from the PETRONAS SKG14. The design of a Flow, Pressure and Temperature plant was done but there are some limitation occurs in terms of privilege and hardware. The outcome of this project will be used as a resource for developing standards and guidelines for implementation in PETRONAS Groupwide.

5.2 Recommendation

This project can be expanded and obtained an efficient result with some recommendation as below:

1. The enhancement of scheduling, so that the delay in performing the test would not be too long.
2. Provide one team of the UTP student to in charge or cooperate in doing the testing rather than the FYP students.
3. Provide more training in terms of hardware rather than only software, so that the research on this project can be done efficiently by the students.

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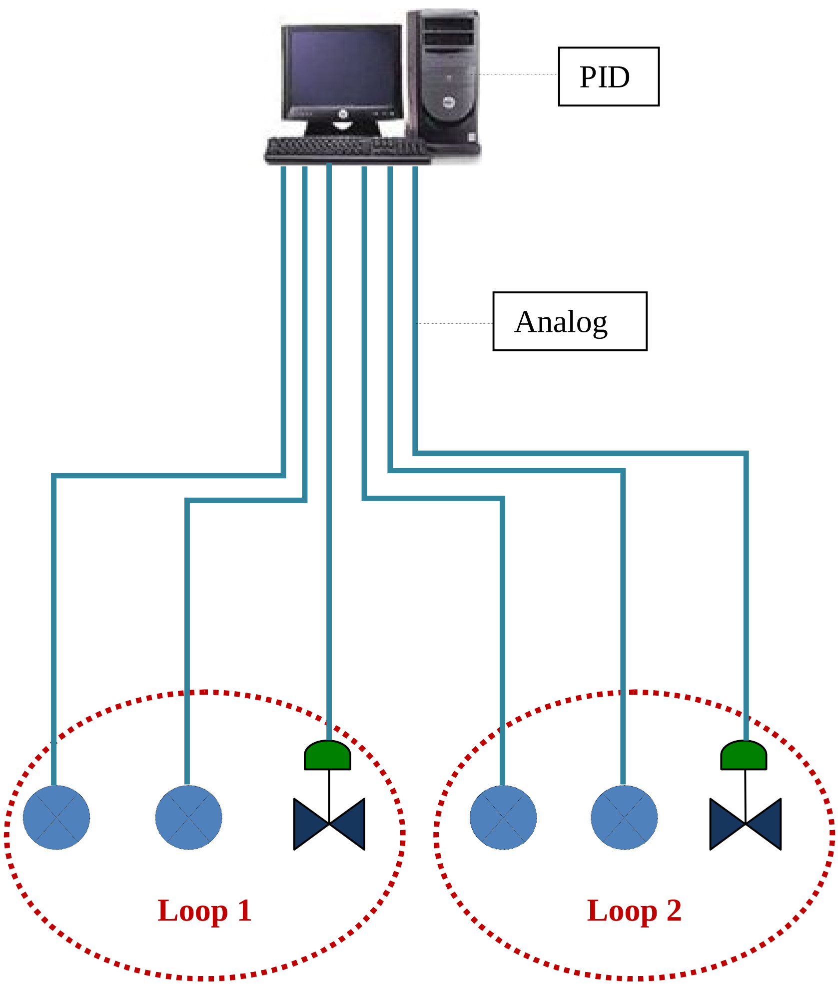
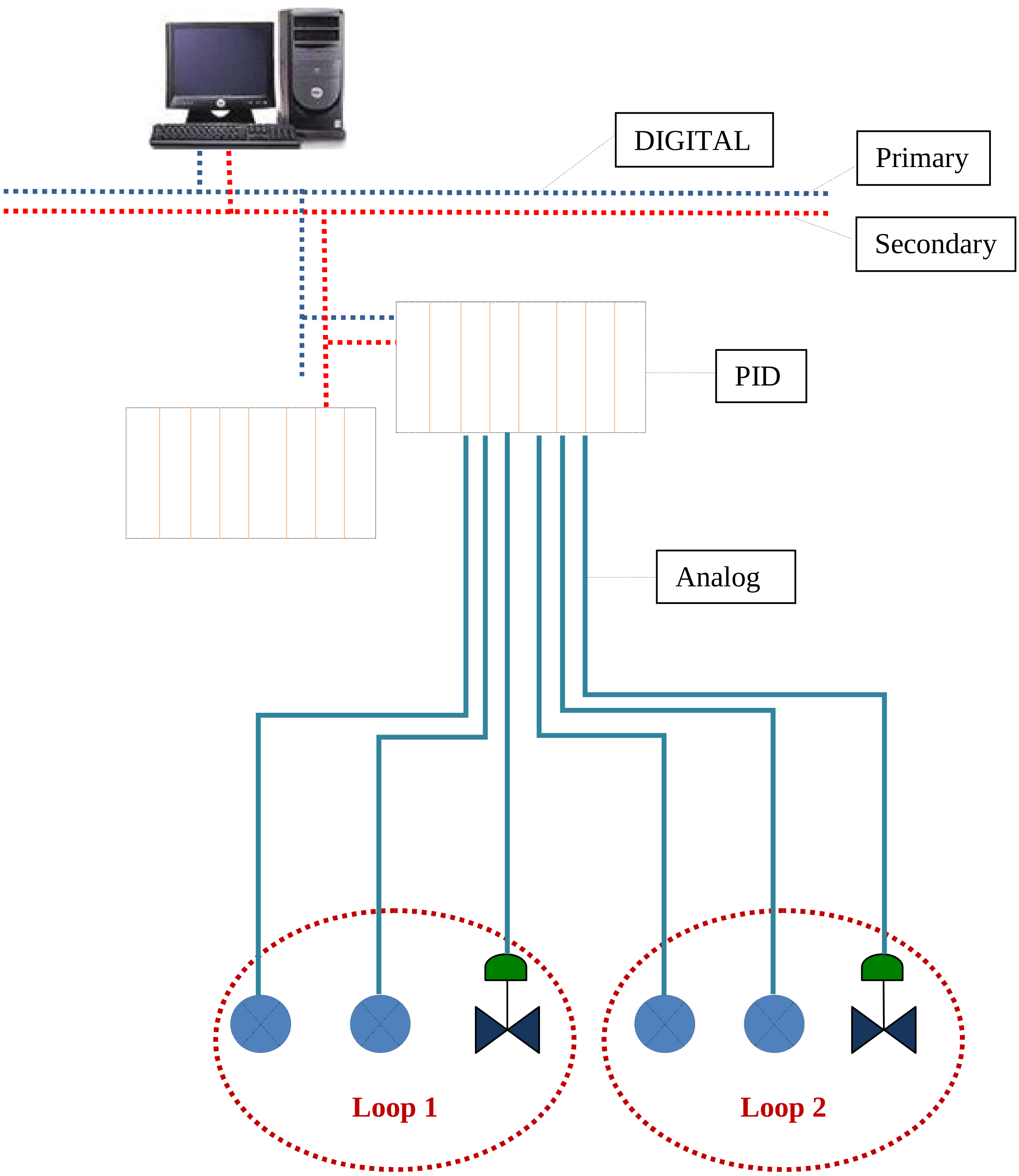
APPENDICES

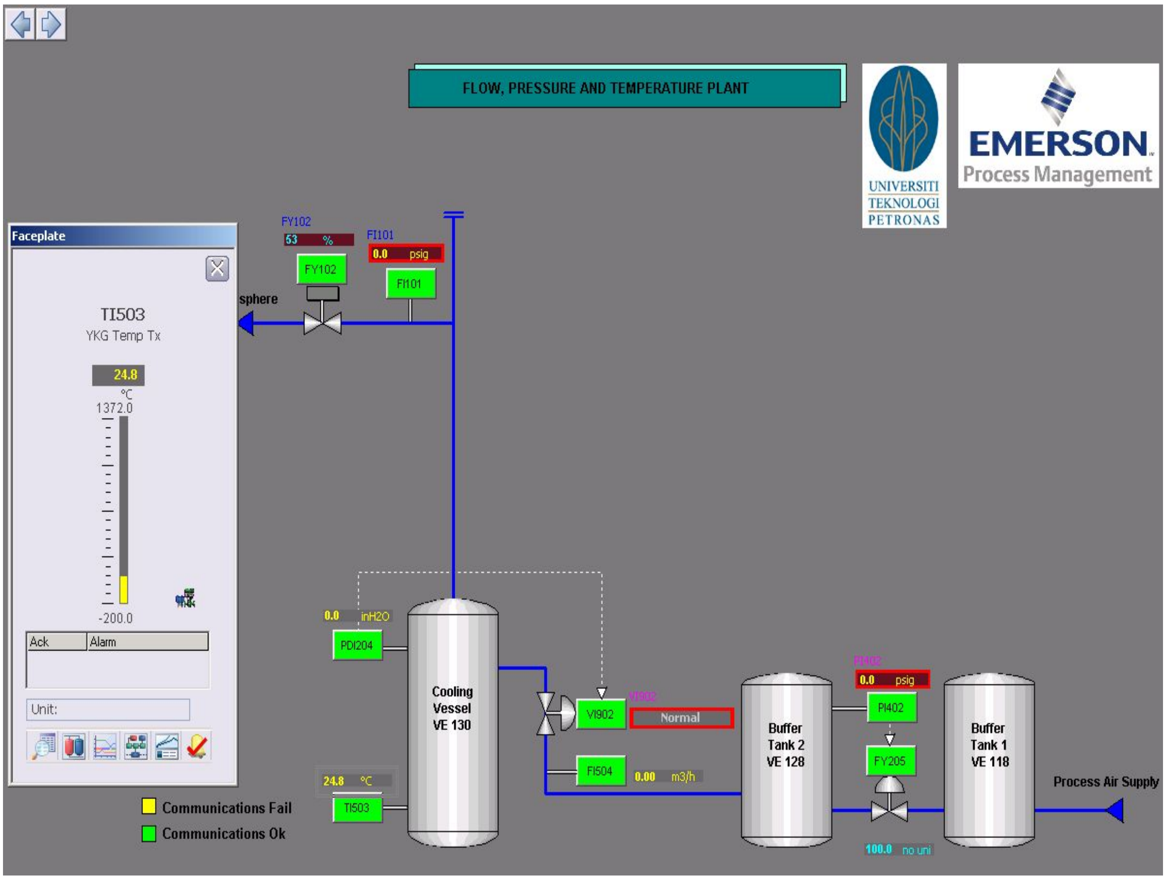
Appendix 1: Direct Digital Control Architecture



Appendix 2: Distributed Control System (4-20mA)



Appendix 3: Flow, Pressure and Temperature plant



Appendix 4: Project Milestone

No.	Detail/ Months	1	2	3	4	5	6	7	8	9	10	11
1	Research on the topic											
2	Training from EMERSON											
3	Basic test											
	Initial download / Commissioning											
	Decommissioning / Online Device Replacement											
	Physical Layer Inspection											
	Calibration Function Check											
2	Create function block and Area for control loop model											
3	Submission of Progress Report											
4	Continue with control loop modeling											
5	Preparing for Poster submission											
6	Finalize the project											

Milestone Process