A Voting Algorithm for Fire and Gas Detection and Monitoring System in an Industrial Plant

by

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16945

Dissertation submitted in partial fulfilment of the requirement for the Bachelors of Engineering (Hons)
(Electrical and Electronics)

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CERTIFICATION OF APPROVAL

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Electrical and Electronics Programme
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Approved by,

____

(ASSOC. PROF. DR. NORDIN BIN SAAD)

UNIVERSITI TEKNOLOGI PETRONAS
BANDAR SERI ISKANDAR PERAK
January 2015

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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MOHD NAZRULDIN MOHD NADZIR

ABSTRACT

Nowadays, health and safety are the things that always plays an important role in any industrial sector especially in oil and gas industry. It deals with substance that can cause us to escalation of tragic incident such as injury and death of workers, explosion, combustion and also damages of properties of the plant. Fire and gas systems or so called FGS, is one of the crucial thing in industrial facilities especially in safety and operation maintenance. The function of FGS safety system is to monitor unusual situation like uncontrollable flame and leakage of hazardous gas. The way the system works is as follows, it will provides early warning and take initial action in order to reduce consequences of horrible accident or damage that may result to death, injury and property damaged. The project report provides a progress for the final year project 2 titled A Voting Algorithm for Fire and Gas Detection and Monitoring System in an Industrial Plant. The aim is to implement voting algorithm in Fire and Gas System using Function Block Diagram as well as Human-Machine Interface as one complete project. The result obtained in the report shows overall project completion. The project would deliver a new voting technique with regards to a safety study and also an implementation of the voting technique on TRISTATION 1131 with regards to a safety study.

ACKNOWLEDGEMENTS

First and foremost, praise to God Almighty Allah S.W.T for His blessings that finally able to complete this two (2) semesters of final year project, thus finishing this dissertation report. Besides, opportunity taken to thank Universiti Teknologi PETRONAS for the opportunity created for students to finish the final year project which allow the author to relate theoretical knowledge with application in the industry through a well-planned final year project period.

This would not have been possible without the support of many people. Therefore, deepest gratitude expressed for those who involved on providing the possibility to complete the report. A special gratitude to the FYP supervisor, Associate Professor Dr. Nordin bin Saad, who contribute in stimulating suggestion and encouragement during two (2) semesters of final year project. His willingness in leading and assisting is highly appreciated.

Secondly, many thanks given to Pn. Raziah binti Saluki, Division Manager of Trisystems Engineering Sdn. Bhd. and the staffs on the company for having trust to the author to use TriStation software for this project. Their guidance and support are highly appreciated.

Next, En. Azhar for his priceless attention, time, knowledge and guidance along the duration of this final year project. The knowledge and experience that I have gained from him is hoped to be beneficial in the future. Besides, Siti Aisyah binti Abd. Rahaman, who played an important role in assessing my performance and competency of this project. Therefore, it’s been honored to be able to gain her support and advice.

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ABBREVIATIONS AND NOMENCLATURE

BMS : Burner Management Systems

CEM : Cause and effect matrix

DDE : Dynamic Data Exchange

ESD : Emergency Shut Down

FBD : Function block diagram

FD : Flame Detector

FGS : Fire and Gas System

FYP : Final Year Project

GD : Gas Detector

HFT : Hardware-Fault Tolerance

HMI : Human-Machine Interface

IEC : International Electrotechnical Commission

LAN : Local Area Network

LEL : Lower Explosive Limit

OS : Open Source

PC : Personal Computer

PLC : Programmable Logic Controller

PTS : Petronas Technical Standard

SIL : Safety Integrity Level

UTP : Universiti Teknologi PETRONAS

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Fire, gases, vapours, mists and dusts are substance that are harzadous and very dangerous especially to offshore and onshore industry. Offshore and onshore industry offers one of the risky job that can be found in any industry sector. This is because the industry is dealling with oil and gas which is very sensitive to combustion, explosion and property damages with the presence of fire, smoke and hazardous gas. This might pose a high risk to a person, property as well as environment.

In order to overcome this tragic indicent, fire and gas system (FGS) in oil and gas industry was created. FGS is a plant's safety and protection alarm system that monitors unnormal condition and hazardous situation and trigger proactive response to prevent unexpected events and improve the safety of the plant. The detection and monitoring of fire, gas, and smoke in a process plant is significant and these can be achieve via automation.

To meet very high safety standard in oil and gas industry, instrument strategy plays an important role. Incorrect detector spot cause high potential of unexpected incident to occur. Voting technique is an approach that usually used in oil and gas industry in order to increase plant's safety and plant's availability. Instruments will be located in each process area of plant according to the zone provided in safety standard. In Malaysia, Petronas Technical Standard (PTS) is the standard that should be refered to the detector's placement

1.2 PROBLEM STATEMENT

As much as safety and monitoring system applied in FGS, controller network is needed in order to perform the system such as voting technique and Human-Machine Interface (HMI). Apart from that, voting approach must be suitable based on the specific requirements.

This project addresses the critical safety and alarm system of a process plant with several variables (fire, gas and smoke) using a TRISTATION 1131 (software equivalent of a TRICONEX Programmable Logic Controller). The main focus is to study and perform a voting technique as related to the respective detection of the sensors. The voting technique will be implemented by creating a logic program on the TRISTATION 1131.

Furthermore, intended HMI program is designed as for monitoring purposes. The application needs to be user friendly, able to read the data that has been transferred to server PC and compatible to integrate with TRISTATION 1131 running in PLC as one complete project.

1.3 OBJECTIVES

The specific objectives of this project are as follows:

i. To design a safety and alarm system for an industrial process.
ii. To develop and construct a fuction block diagram, including the voting technique, for the system via TRISTATION 1131.

1.4 SCOPE OF STUDY

One of the aims in this project understands the theoretical knowledge regarding fire and gas system. Without proper understanding, the project cannot be finished successfully. After that, plant mapping should be prepared in order to determine the detector placement of certain process plant before proceed to the next step.

Apart from that, the next project target which is creating FGS using Programmable Logic Controller or PLC. An industrial PLC will be used to conduct the project where it uses functional block diagram as a programming language. Basically there are five (5) programming languages in PLC which are structure text programming, ladder diagram, functional block diagram, instruction list and sequential function chart.

Next, developing FGS graphic using Human Machine Interface (HMI). Instead of monitoring cause and effect of FGS using complicated graphical language PLC, HMI graphic is developed. The function of HMI is only for the monitoring purpose. Besides, it's easier for the user to understands and monitor the status of detector in a simple graphical display.

Since the HMI can be used as a graphical representation for FGS, both PLC and HMI can be integrated as one complete project. This is an ultimate objectives of this project. However the project is still in progress and hopefully the project will be achieve the objectives stated within the time.

CHAPTER 2

LITERATURE REVIEW

2.1 2D MAPPING VS 3D MAPPING

There are two ways to determine suitable FGS detector spot in an industrial process which are 2D mapping and 3D mapping. 2D mapping is a detector's layout that represented in two-dimensional (usually top-view) of process plant while 3D mapping represented in three-dimensional process plant. Figure 1 and 2 are example of 2D and 3D mapping in a same plant view of the fire zone where visibility color of black is visible to 0 detectors, blue is visible to 1 detector, red is visible to 2 detectors, green is visible to 3 detectors and yellow represent to 4 or more detectors [7].

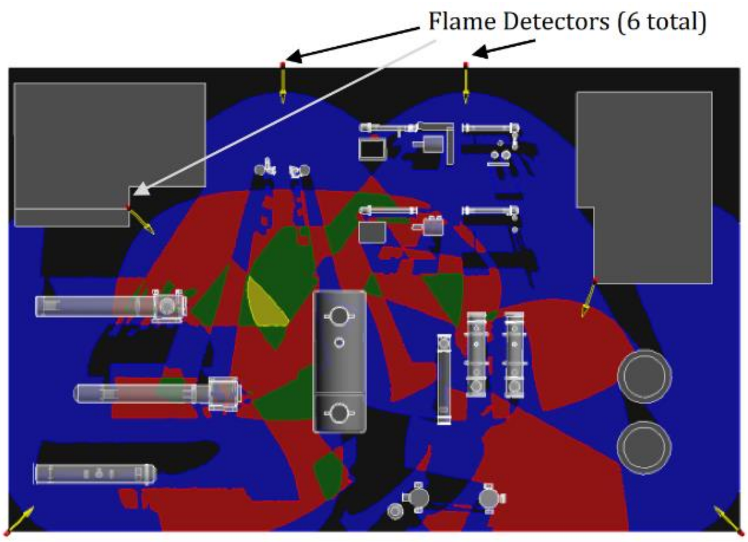


Figure 1: Two-dimensional fire and gas mapping [7]

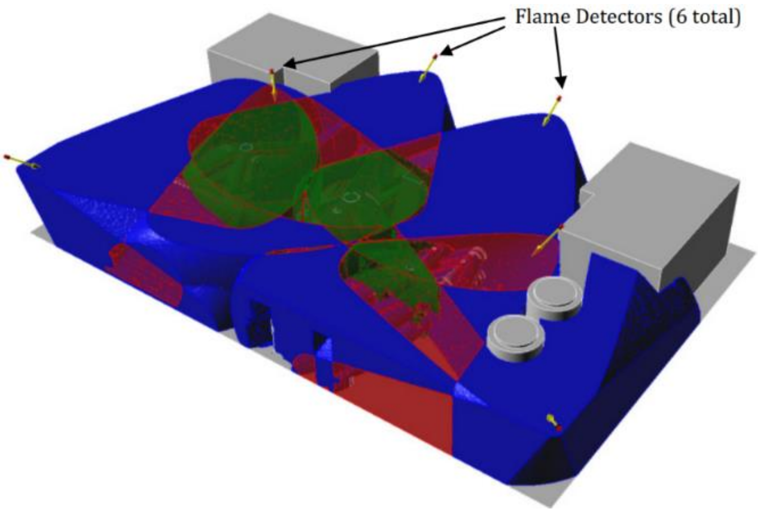


Figure 2: Three-dimensional fire and gas mapping [7]

Based on observation, it shows that 2D mapping has it's weakness as compared to 3D mapping. Although 2D mapping can be done by hand using overlays on the layout of facility compared to 3D mapping which require computer analysis but visibility statistics or contour map can only valid at whichever representative height is chosen. Table 1 shows the comparison of visibility statistics generated by 2D and 3D mapping. 3D mapping gives only one set of visibility statistics. Other than 2D, various statistics produced depending on chosen reference height [7].

Table 1: Visibility statistics generated by 2D and 3D mapping [7].

	Visibility to Detectors		
	Zero	One or More	Two or More
3D Mapping (% Volume)	**32.6**	**67.4**	**30.0**
2D Mapping (% Area)			
Ground Level	40.4	59.7	19.4
1 m Height	37.6	62.4	23.2
2 m Height	33.4	66.6	30.2
3 m Height	27.0	73.0	37.5
Total 2D Mapping Range	**26.5 – 40.6**	**59.4 – 73.5**	**19.4 – 37.7**

Table 2: Flame and Gas Detection coverage with respect to performance grading

Performance Grade	Fire and Gas Detection Coverage
A	0.90
B	0.85
C	0.60

2.2 VOTING STRATEGY

Detector selection is a criteria that should take into account in FGS. This is important in order to improve safety and also increase plant productivity. Voting strategy is one of the technique that being used in FGS detector selection. The function of voting strategies is for making sure that false alarm do not cause false alerts or shutdown of plant [3]. With the help of computer-aided detector or so-called mapping process, the FGS detector selection will be much easier and understandable [6]. Hardware-Fault Tolerance (HFT) can be increased by its own system design. The example of voting is 2-out-of-3 (2oo3) voting and 1-out-of-3 (1oo3) voting [4].

2.3 FUNCTIONAL BLOCK DIAGRAM

IEC-1131 is the first international standard for process control software. By using IEC-1131, a programmer can develop a control algorithm for a particular brand of controller, and import that same program to another brand with minimum modifications, primarily to process input/output subsystems.

Function block diagram (FBD) is one of the five control language used in Programmable Logic Controller (PLC) where the function of the system is described in a form of block. Besides, it describes the operation from system input to desired output by connecting them with a simplified block diagram as one complete PLC [5]. Unlike other programming languages, FBD is not complicated, flexible and easy to be implemented in various PLC applications.

The function of the Function Block Diagram Language is to allow control algorithms to be developed graphically by inserting the program units called Functions and Function Blocks into a control program. These blocks can be called from a library of functions specified by the IEC standard, or can be called from manufacturer-supplied or user-created libraries. The good thing is, these function blocks can be written in any of the five languages, including the Function Block Diagram language again. Figure 3 is the calculation shown, as a Function Block Diagram:

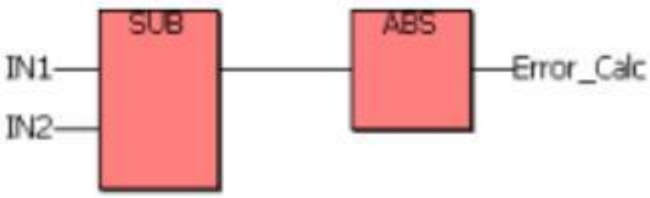


Figure 3: Function Block Diagram

2.4 CAUSE AND EFFECT MATRIX (CEM)

Cause and effect can be categorized as a part of process document or also as a part of instrument deliverables by some project. Theoretically, “cause” means something that makes something else happen and “effect” is the consequences occurred as a result of the cause.

The interaction between cause and effect could simple and complex. For instance in process control, “cause” could be a tank high liquid level alarm and “effect” could be open valve the tank outlet. Another example could be like voting technique, if two out of three flame detectors detect fire in area 1 and coincide with one flame detector detect fire in area 2, then it should close valve A, close valve B, open valve C, de-energize the power outlet and so on.

Cause and effect is represented in a form of matrix. The “causes” are listed in left section while the “effects” are listed on top section, both are described in form of tag number with their descriptions and other additional information such as P&ID according to PETRONAS Technical Standard (PTS). The marked intersection between both means that they are related as cause-effect. Marks could be in form of letter “X” or a single dot which mean effect will be activated as shown in Figure 4. There are two category of Cause and Effect Diagram which are ESD C&E Diagram and Fire and Gas C&E Diagram

Cause and effect matrix (CEM) is widely use in the practice of developing a logic system. It is put in a readable matrix format which has two major components. These two components are the causes that meant to be the identified problems meanwhile the effects are the actions taken. The cause and effect are located at the row and column of the matrix respectively.

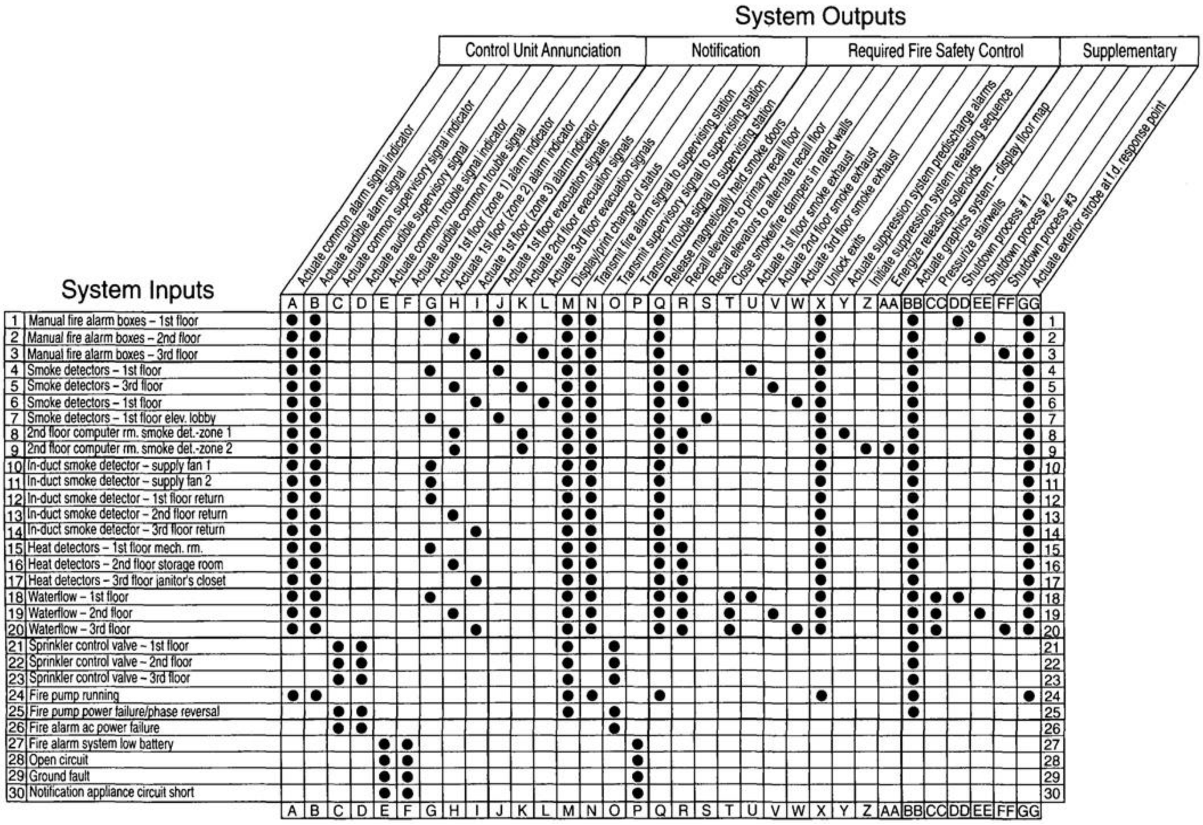


Figure 4: Cause and Effect Matrix for Fire and Gas System

2.5 HUMAN MACHINE INTERFACE (HMI)

HMI is a user interface in a manufacturing or process control system. It provides a graphics-based visualization of an industrial control and monitoring system. Human Machine Interface (HMI) equipment provides a control and visualization interface between a human and a process, machine, application or appliance. HMIs allow user to control, monitor, diagnose and manage our application. HMI equipment spans from simple text displays, graphical operator panels, touchscreens, industrialized PCs (iPC), Supervisory Control and Data Acquisition (SCADA) and web-based HMI Solutions.

2.6 DYNAMIC DATA EXCHANGE (DDE)

Windows provides several methods for transferring data between applications. One method is to use the Dynamic Data Exchange (DDE) protocol. The DDE protocol is a set of messages and guidelines. It sends messages between applications that share data and uses shared memory to exchange data between applications. Applications can use the DDE protocol for one-time data transfers and for continuous exchanges in which applications send updates to one another as new data becomes available.

An integration between two electronic devices using Microsoft Windows can be achieved by DDE server. DDE is a built in protocol which allows sharing data when these two devices are connected through Ethernet as well as Internet [8]. The connection will create a server-client network where the PLC is set as server and the HMI as the client feed all data to the server [9].

2.7 TRICONEX TRICON CONTROLLER

According to Schneider Electrics, Tricon is one of a Invensys' safety and critical control, fault tolerant controller from Triconex TMR products based on patented Triple-Modular Redundant (TMR) architecture that also utilize TriStation 1131 application software that provides the ability to program in function block diagram, structured text or ladder logic for quick and easy configuration and program emulation[10].

Now, Triconex has installed Tricon safety systems in over 50 countries, to provide safety, reliability and availability to a worldwide installed base. The typical applications for Tricon controller includes Emergency Shutdown Systems (ESD), Burner Management Systems (BMS), Fire and Gas Systems (FGS), Turbomachinery Control and Nuclear 1E Safety Systems{10].

The advantage of the Tricon TMR which is very high safety integrity system designed such as emergency safety shutdown or other critical applications that requires Safety Integrity Level (SIL) 1, 2 or 3 as defined in the IEC 61508 Standard on Functional Safety. Not only Tricon TMR system provides high safety but also high availability of the plant industries. This is because the main feature of this controller is able to operate three functional Main Processors. Thus, faulted modules can be replaced while the system is operational for continuous uninterrupted control. Besides, the cost maintenance is low due to extensive built-in diagnostics which automatically pinpoint faults to field replaceable modules so that clients can save time and resources[10]. Figure 5 below shows the Invensys' safety and critical control Tricon.

Figure 5: Triconex Tricon Controller[10]

CHAPTER 3

METHODOLOGY

This project can be approached according to *The Waterfall Methodology Model.* This model is a tidy development approach, as it flows steadily downwards like a waterfall through the phases of requirement specification, software design, project implementation, verification, and lastly maintenance.

The first phase is requirement specification. Before proceed to the project application, the problem statement must be identified followed by the objectives. After that, few research or study case are adopted to ensure adequate resourceful data and information are obtained. This phase can be approach by collecting information about background of FGS such as voting alarm technique, hazardous zone categorization and mapping system in order to obtain knowledge about project related. In addition, some case study of 2D graphic and 3D graphic for fire and gas detector selection is studied. Other than that, information about HMI graphic has been studied. This is because the graphic presentation is more clear and understandable rather than bunch of function block in PLC.

Second phase adopted is the software design approach. After FGS Mapping is prepared, the input and output from FGS Mapping can be tabulated. From an input/output listing, cause and effect matrix can be created. The reason is because C&E matrix ease the user on mapping out how data value is transmitted from the input (cause) factors of the system to the product outputs (effects)

Project implementation, which is third phase where PLC program coding can be done using industrial software TriStation 1131. To make the project more effective and understandable, an intended HMI graphic will be done and will be implemented in another PC. After that, PC that contain PLC program will be integrated with another PC that holds HMI graphic under DDE protocol using internet switch. The configuration and connection are shown in Figure 6 and 7 respectively.

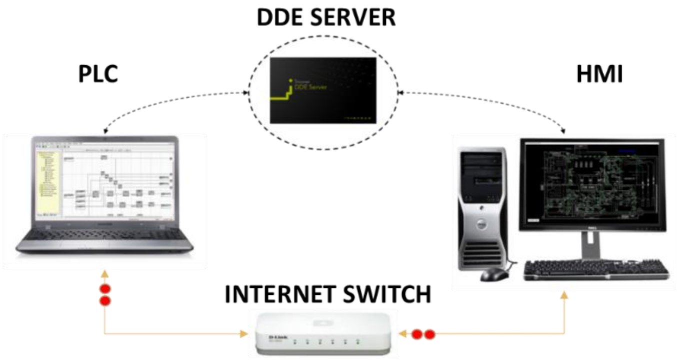


Figure 6: Hardware configuration

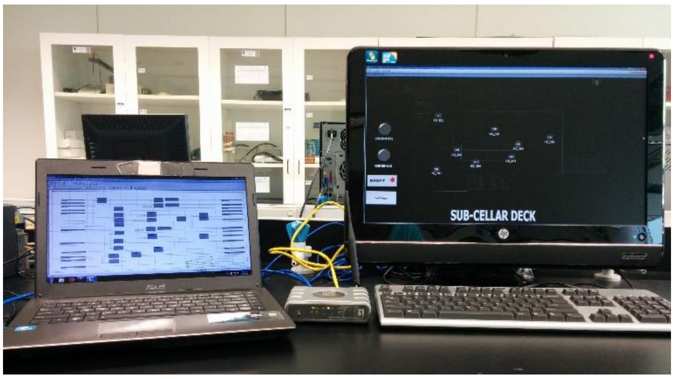


Figure 7: Hardware connection

Next approach is where both PLC program and HMI graphic will be the testing and verification. The result will be recorded and compare with C&E matrix to prove the concept done in study case at the beginning of approach. Lastly, project alteration or modification can be done after the concept has been verified. This is to make the project looks more complex and attractive. All approach was tabulated in Gantt Chart (see appendix) and summarized in simple flow chart shown in Figure 8:

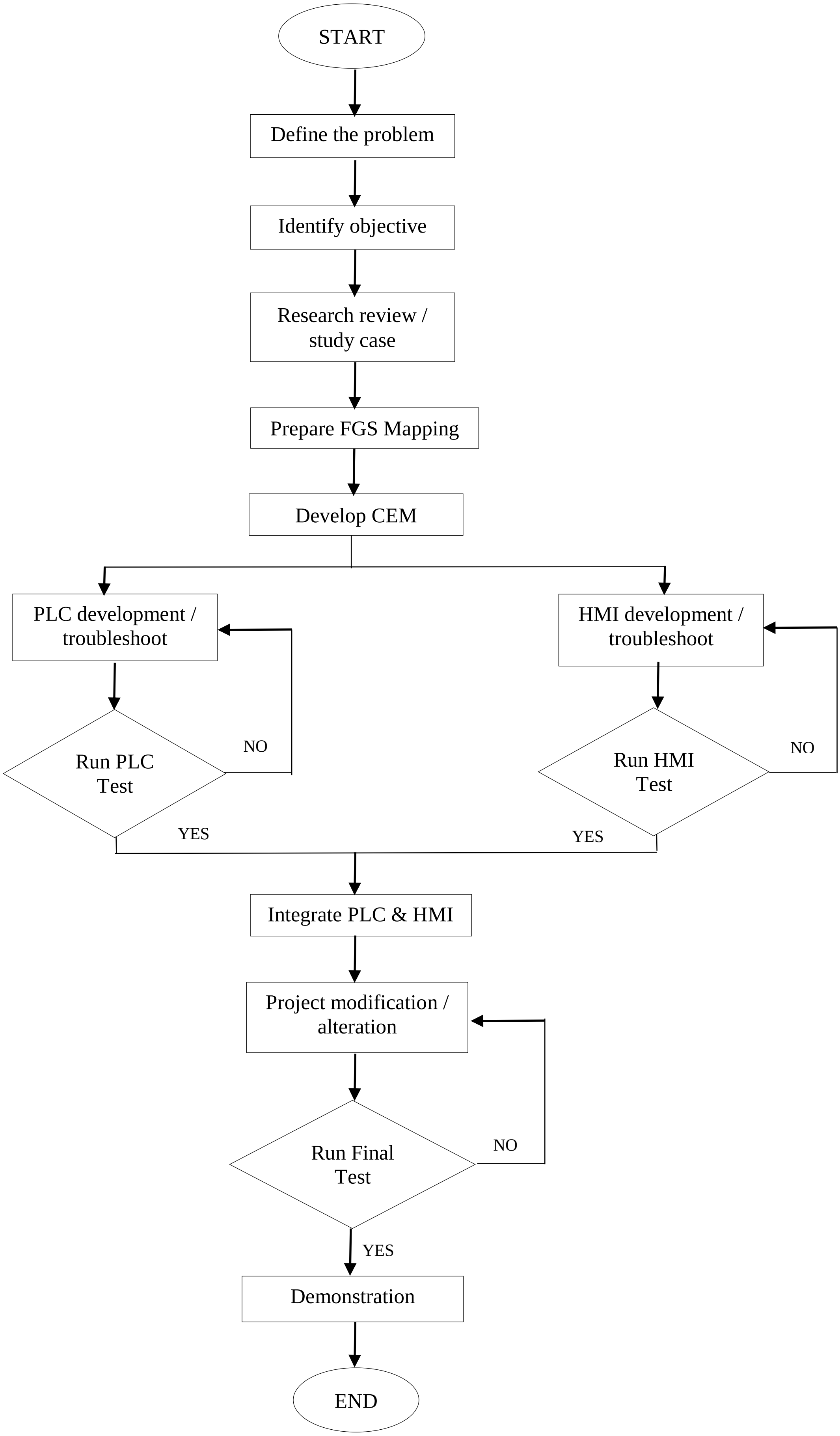


Figure 8: Flow Chart of the project work

3.1 TOOLS AND SOFTWARE

The project require both software and hardware tools to achieve one complete project. However, the project is still in progress. The tools involved during final year project are:

1. Fire and Gas Mapping sample
   - Source from PETRONAS Carigali

2. Microsoft Excel 2013 software
   - Used to develop cause and effect matrix

3. Triconex TriStation 1131 software by Invensys
   - Industry Standard Development Software
   - The language used in this PLC software application is functional block diagram.
   - Used for designing, developing and experimenting safety-critical and process control applications.

4. Wonderware InTouch version 10.1 software by Invensys
   - Industry Human Machine Interface (HMI) software
   - Demo version (Limited to 30 windows, 29 tagnames and 2 hours runtime)
   - Used for detector monitoring purpose applications.

5. Dynamic Data Exchange (DDE) Server software by Invensys
   - The Triconex DDE protocol allows Windows-based applications to share data.
   - This protocol used in this project to enable communication between workstation's PC and HMI PC.

6. Personal Computer (PC)
   - Two (2) PCs will be used in this project.
   - Laptop PC is set as the workstation to run the PLC logic to run TriStation 1131 software
   - Desktop PC is set as HMI platform to run HMI software

7. Windows Open Source (OS)
   - Version: Windows 7
   - To run the application or software.
   - Compatible with PLC software and HMI software

8. Network Switch and LAN Cable
   - Multi-port computer networking device used to physically interconnect desktop and laptop on a computer network.
   - LAN cable will be used instead of using Wi-Fi to avoid data loss.
   - To connect workstation and HMI through Local Area Network (LAN).

CHAPTER 4

RESULTS AND DISCUSSION

4.1 FIRE AND GAS MAPPING

According to project schedule (refer Gantt Chart for FYP 2 in Appendix I), the project should have developed 3D mapping. However due to time constrain and this limitation of 10-days trial the software, the 3D mapping software will not considered. Besides, 2D software was also not available in open source to download due to confidential purpose. With a help of the author's supervisor Dr. Nordin, a 2D fire and gas mapping samples was obtained from PETRONAS Carigali Company. As for that, the project will be less trouble. The FGS mapping for Flame and Gas Detector Assessment can be referred to APPENDIX II.

4.2 I/O LISTING

Table 3: List of input and output obtained from fire and gas mapping

INPUT	OUTPUT
Single Flame detector 1	Triggered Alarm for Flame Detector 1
Single Flame detector 2	Triggered Alarm for Flame Detector 2
Single Flame detector 3	Triggered Alarm for Flame Detector 3
Single Gas detector 1	Triggered Alarm for Gas Detector 1
Single Gas detector 2	Triggered Alarm for Gas Detector 2
Single Gas detector 3	Triggered Alarm for Gas Detector 3
Single Gas detector 4	Triggered Alarm for Gas Detector 4
Single Gas detector 5	Triggered Alarm for Gas Detector 5
Short/Open circuit in Flame Detector 1	Fault Alarm for Flame Detector 1
Short/Open circuit in Flame Detector 2	Fault Alarm for Flame Detector 2
Short/Open circuit in Flame Detector 3	Fault Alarm for Flame Detector 3
Short/Open circuit in Gas Detector 1	Fault Alarm for Gas Detector 1
Short/Open circuit in Gas Detector 2	Fault Alarm for Gas Detector 2
Short/Open circuit in Gas Detector 3	Fault Alarm for Gas Detector 3

Short/Open circuit in Gas Detector 4	Fault Alarm for Gas Detector 4
Short/Open circuit in Gas Detector 5	Fault Alarm for Gas Detector 5
Voted Flame Detector (2oo3)	Beacon Alarm (Confirmed Fire)
Voted Gas Detector (2oo5)	Beacon Alarm (Confirmed Gas)

4.3 CAUSE AND EFFECT MATRIX

Cause and effect matrix can be viewed in Appendix III.

4.4 PROGRAMMABLE LOGIC CONTROLLER (PLC)

Since the Tricon controller cannot afford to be purchased for FYP due to over-budget, the supportive TriStation 1131 software is enough to operate this project. The overall logic programming in this project can be referred in APPENDIX IV.

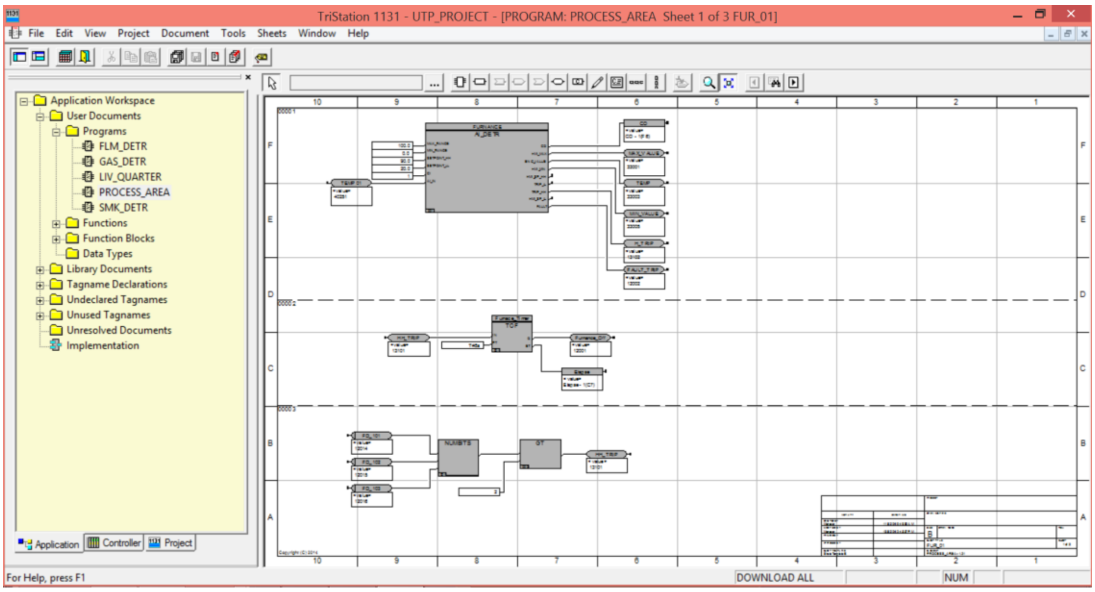


Figure 9: Functional block diagram development using TriStation 1131

Table 4: Condition of PLC in TriStation 1131

<table>
<tr><th>CONDITION</th><th>PICTURE</th></tr>
<tr><td>

Triggering Single Alarm (Flame Detector)

</td><td>

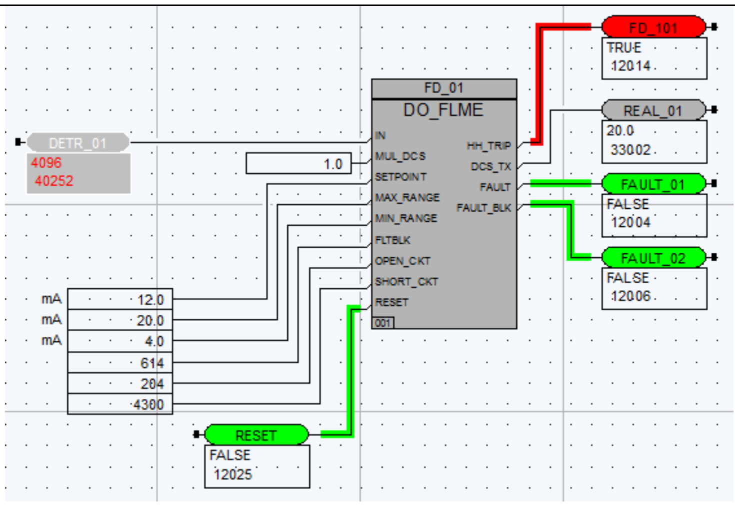


Figure 10: Triggering Alarm for flame detector

</td></tr>
<tr><td>

Triggering Single Alarm (Gas Detector)

</td><td>

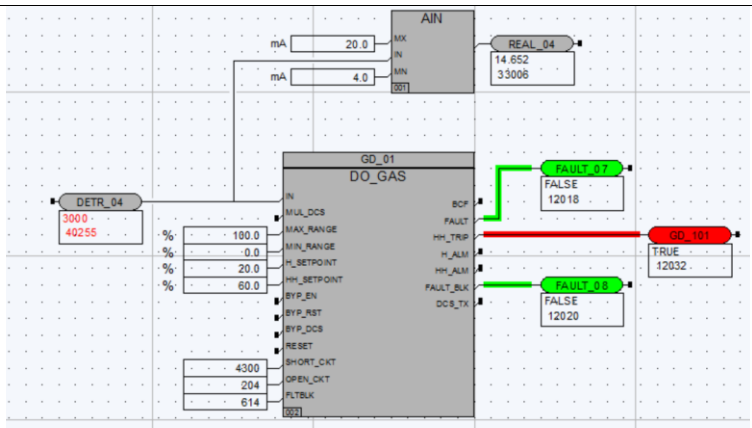


Figure 11: Triggering Alarm for gas detector

</td></tr>
<tr><td>

Fault Alarm for Flame Detector

</td><td>

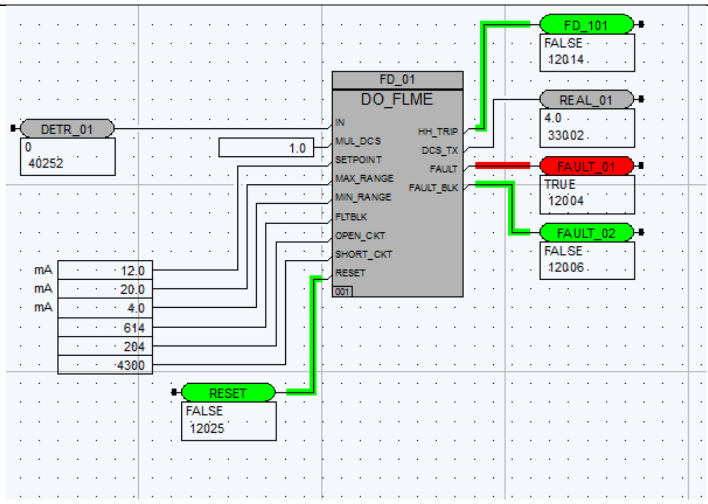


Figure 12: Flame Detector Fault Alarm (Caused by short circuit / open circuit)

</td></tr>
</table>

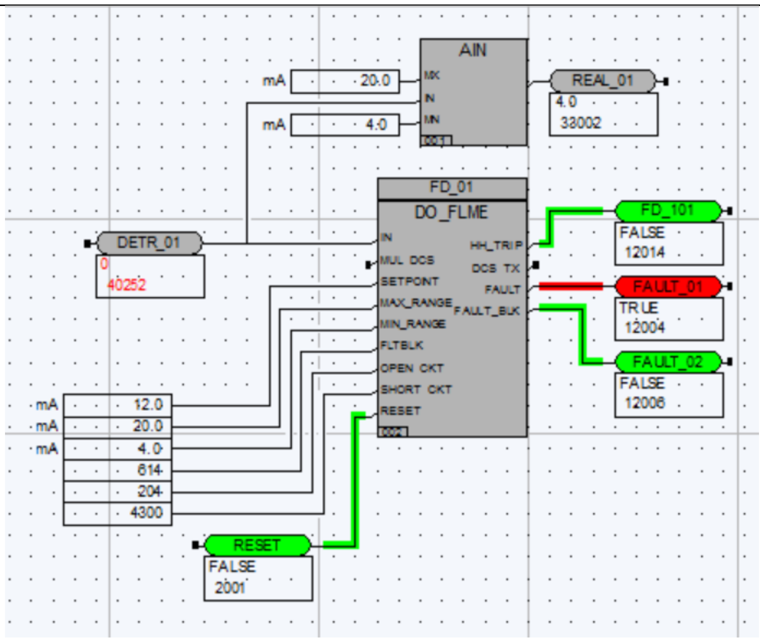
<table>
<tr>
<td>Fault Alarm for Gas Detector</td>
<td>

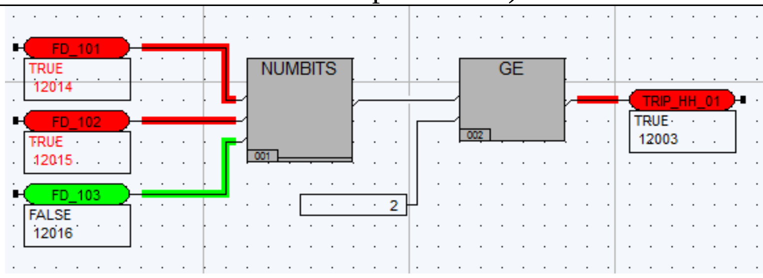
Figure 13: Gas Detector Fault Alarm (Caused by short circuit / open circuit)</td>
</tr>
<tr>
<td>Voting Alarm for Flame Detector (2 out of 3)</td>
<td>

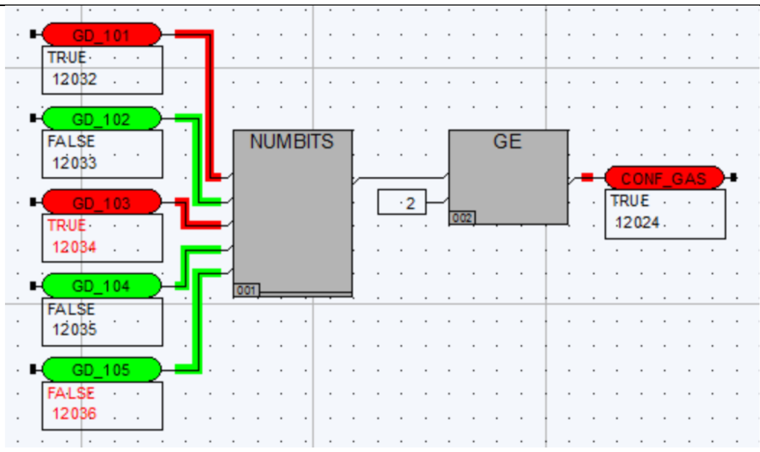
Figure 14: Voting Alarm (2oo3)</td>
</tr>
<tr>
<td>Voting Alarm for Gas Detector (2 out of 5)</td>
<td>

Figure 15: Voting Alarm (2oo5)</td>
</tr>
</table>

All conditions are determined by standard raw count level made in TriStation 1131 software. Figure 16 shows the level condition set in the project.

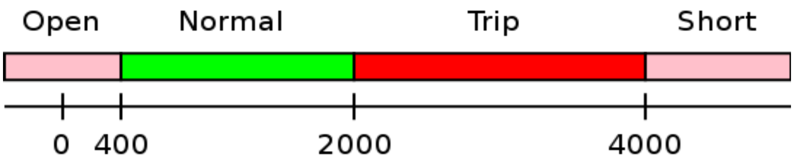


Figure 16: Raw Count Level Condition

Raw Count is a standard value used to set an input value in the PLC logic. Raw count has no units. Since there's no detectors equipment used in this project, this raw count is set the value from 819 until 4096 in TriStation software for 4mA to 20mA measurement in the detectors respectively. The value of 0 until 399 indicates that the detectors are in an open circuit condition, 400 until 1999 indicates healthy or normal condition, 2000 until 3999 shows the detector sense the presence of fire or 60 percent Lower Explosive Limit (LEL) gas and the value of 4000 and above shows the short circuit condition of the detector. Appendix V shows the conversion tool that can be used as reference when set the input value in the PLC logic later.

4.5 HUMAN MACHINE INTERFACE (HMI)

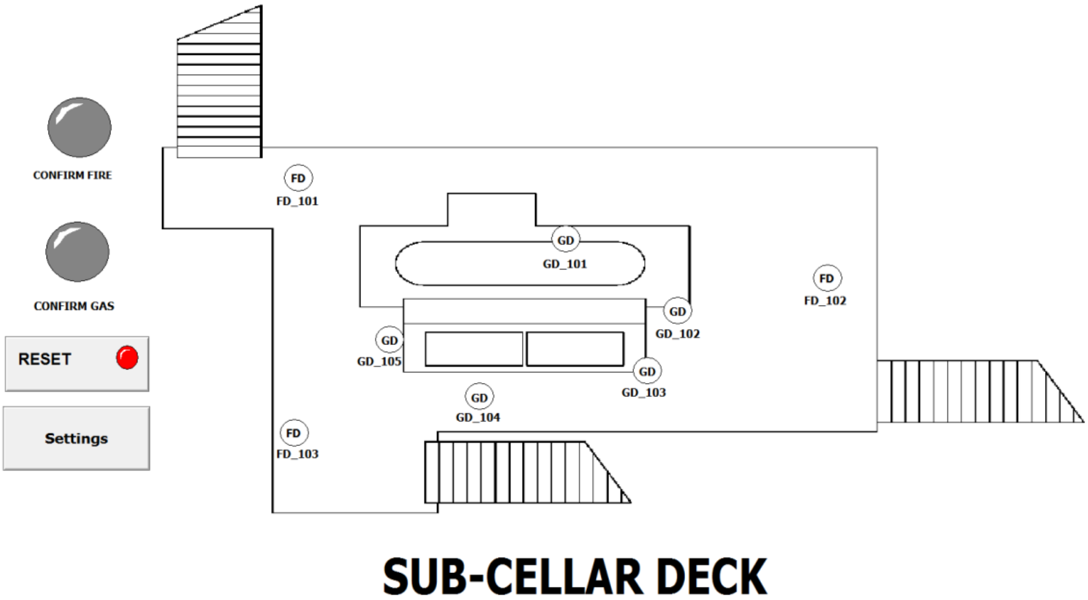


Figure 17: HMI Graphic window 1

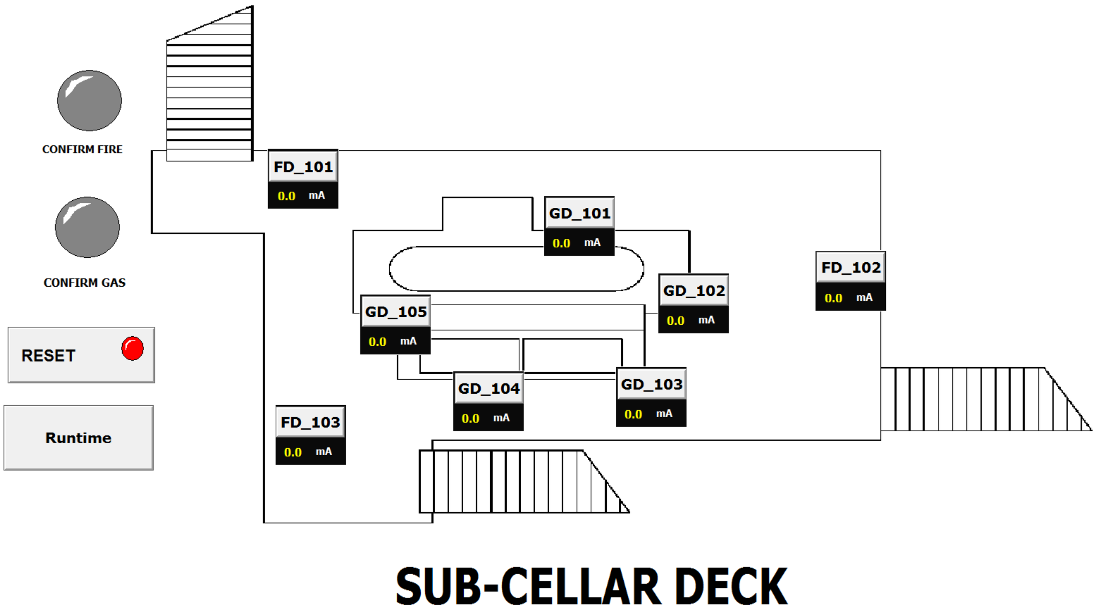
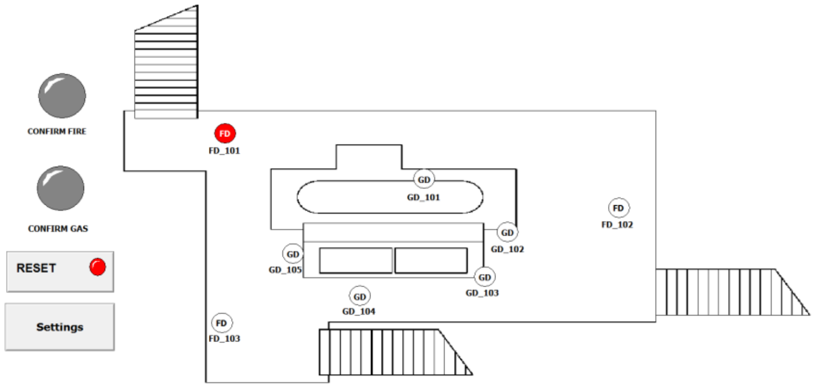
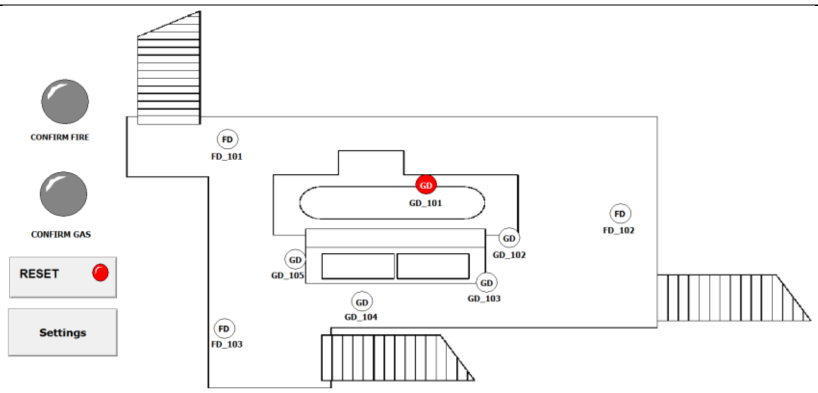
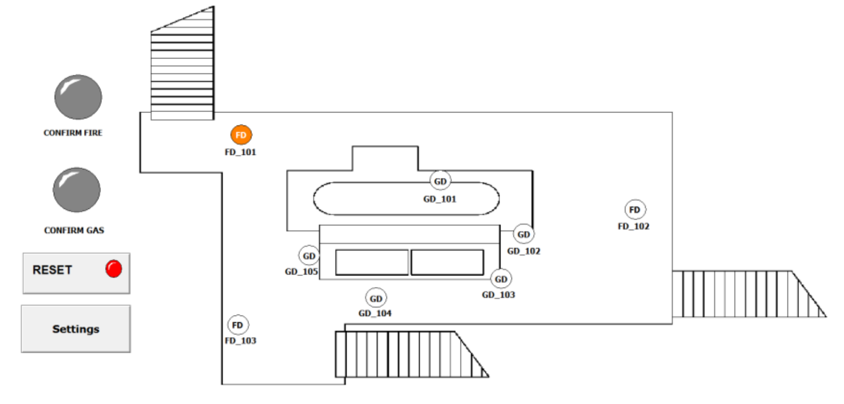
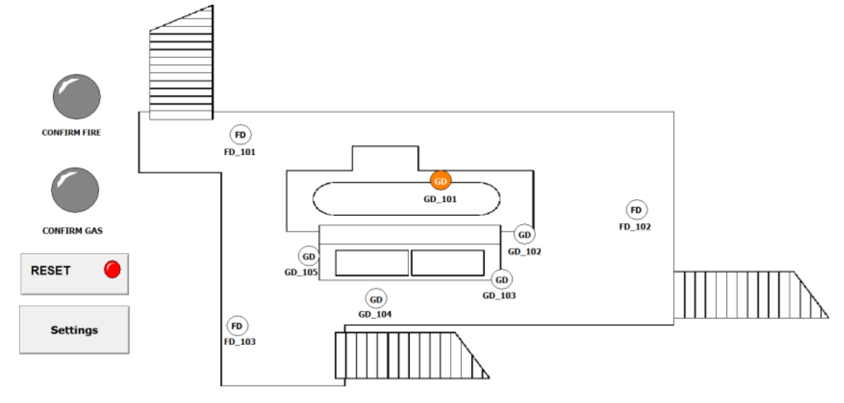
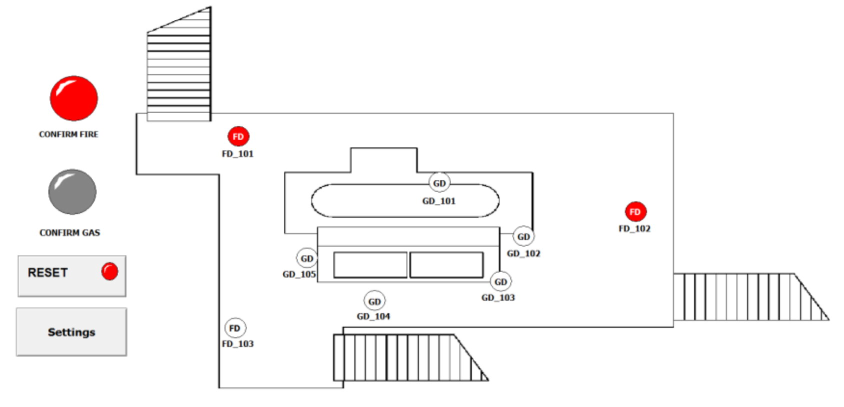
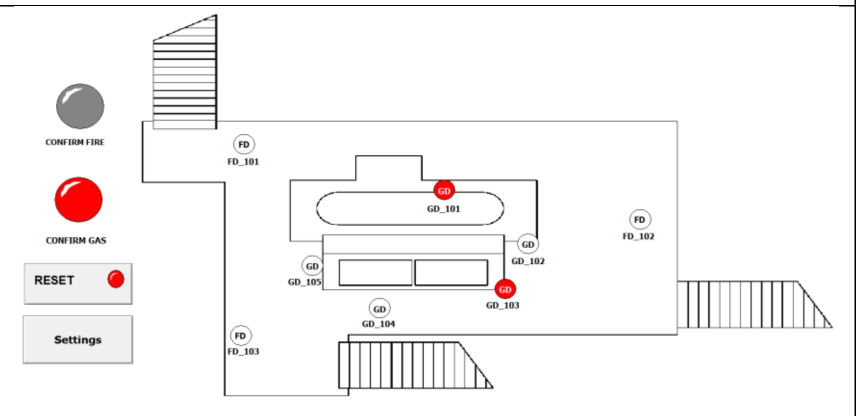


Figure 18: HMI Graphic window 2

Table 5: Condition of HMI in Wonderware InTouch software

CONDITION (EXPECTED)	PICTURE
Triggering Single Alarm (Flame Detector)	
Triggering Single Alarm (Gas Detector)	

Fault Alarm for Flame Detector	
Fault Alarm for Gas Detector	
Voting Alarm for Flame Detector (2 out of 3)	
Voting Alarm for Gas Detector (2 out of 5)	

Below are the legends that are available in Wonderware InTouch software

Table 6: HMI legends for Flame Detector

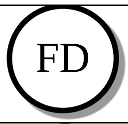
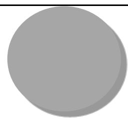
FLAME DETECTOR CONDITION	**SYMBOL**
Healthy	
Triggered	
Fault (due to short/open circuit)	
Confirmed Fire (2oo3 voted)	

Table 7: HMI legends for Gas Detector

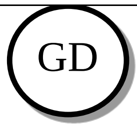
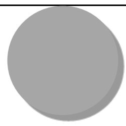
GAS DETECTOR CONDITION	**SYMBOL**
Healthy	
Triggered	
Fault (due to short/open circuit)	
Confirmed Fire (2oo3 voted)	

Figure 19 shows the timeline of final year project development before project demonstration. Green colour represent accomplished works, red colour represent remaining work and black colour shows the milestone of project. According to FYP 2 Gantt Chart in Appendix I, project development was slightly different with timeline in Figure 19 due to late desktop provided by UTP staff, En. Azhar for HMI application which was available in week 8 therefore, all the activities after PLC and HMI development will be started after week 8. Besides, access card was done so that the HMI development and project integration can be done in weekend at block 22 instrumentation laboratory to pursue time left before project demonstration later.

Until this week (week 13), the voting technique is successfully developed and simulated using functional block diagram based on FGS Mapping and HMI graphic is successfully designed. However, the HMI is still unable to get signal from the PLC logic due to communication problem in DDE server software. Therefore, more troubleshooting to be done for integration part before the project demonstration in week 14 later. Even though the PLC logic unable to integrate with HMI graphic but the simulator in TriStation software itself is enough to achieve the objective of this project.

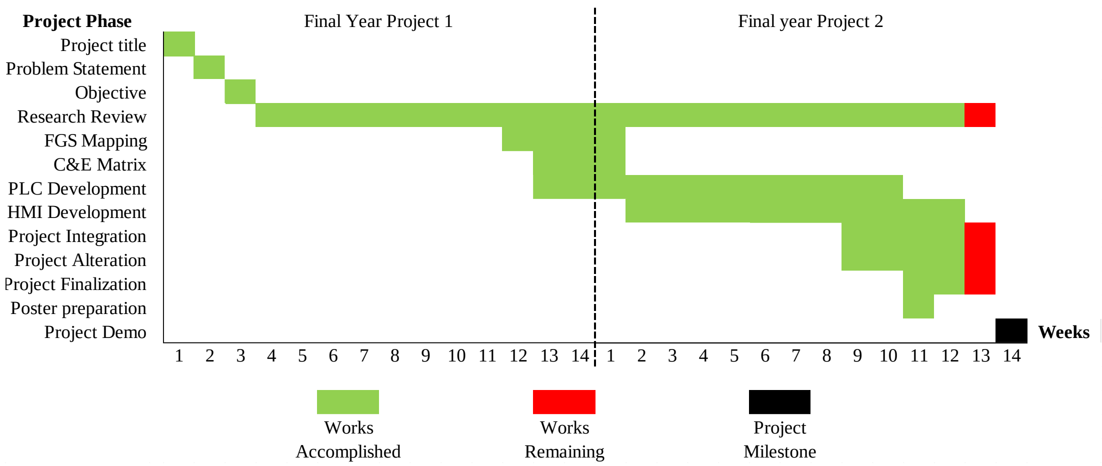


Figure 19: Timeline of project progress

CHAPTER 5

CONCLUSION AND RECOMMENDATION

This reports shows an update of the final year project titled *A Voting Algorithm for Fire and Gas Detection and Monitoring System in an Industrial Plant*. The title of this project was changed after *A Fire and Gas Detection and Monitoring System For An Industrial Plant Using An Industrial Programmable Logic Controller* title due to conflict with the term 'Programmable Logic Controller' and the main project objective was not highlighted in the title which is the voting algorithm. Based on timeline in Figure 19 and Gantt Chart (see Appendix I), there's a difference in time period with planned project due to late desktop provided by UTP staff, En. Azhar for HMI which was available in week 8. However, the project is still achieved its objectives.

The expected result can be obtained for this project is a new voting technique with regards to a safety study. Besides, an implementation of the voting technique on industrial with regards to the safety study. To make the detector monitoring more applicable, an intended HMI graphic is designed. Last but not least, an integration between the function block diagram of PLC and graphical application of HMI can be work according to the cause and effect provided. Combining all the deliverables will achieve the ultimate objective of the project.

Recommendation can be done for future work which is more detail study that includes 3D mapping. The implementation in FGS based on 3D mapping will result more precise and coverage different in voting technique. Besides, larger plant can be implemented with more complex zoning and safety system features such as Emergency Shutdown (ESD) or Shutdown System (SDS) with final execution action after trip for example initiate sprinkler in order to meet high availability and reliability of industrial plant.

REFERENCES

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APPENDICES

- **APPENDIX I : GANTT CHART**
- **APPENDIX II : FGS MAPPING**
- **APPENDIX III : CAUSE AND EFFECT MATRIX**
- **APPENDIX IV : LOGIC PROGRAMMING**
- **APPENDIX V : RAW COUNT VONVERSION TABLE**

APPENDIX I: GANTT CHART

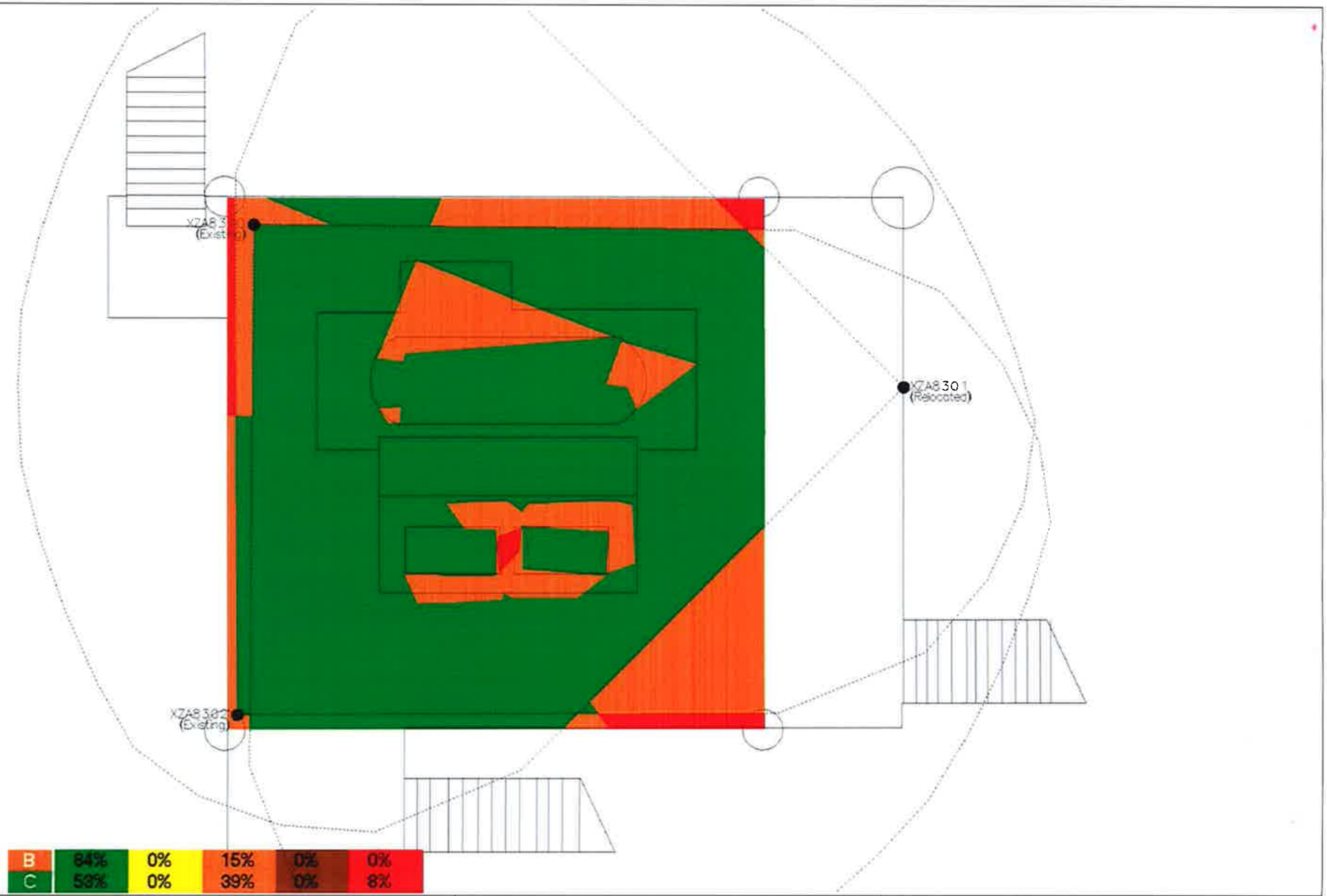
FYP 1 GANTT CHART

Activities \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
FYP 1 Briefing	■													
FYP Selection	■													
Project Title Proposal	■													
IRC E-Resources Briefing		■												
IRC Bibliographic Management			■											
Plagiarism & Turnitin Talk				■										
Literature Review				■	■	■	■	■	■	■	■	■		
Innovate Competition Briefing						■								
Extended Proposal						■								
3D Mapping (Fire & Gas)						■	■							
TriStation 1131 Programming						■	■	■	■					
Finalize Programming								■	■					
Viva: Proposal Defense									■					
Interim Report Preparation										■	■	■	■	
Draft Interim Report (Hardcopy)													■	
Interim Report Submission														■

FYP 2 GANTT CHART

Activities \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
FYP 2 Briefing	■															
HMI Preparation		■	■	■	■	■	■	■								
Project Integration					■	■	■	■								
Project Alteration / Modification							■	■								
Progress Report Submission								■								
Project Finalization									■	■	■	■	■			
Draft Final Report (Hardcopy)													■			
Final Report Submission														■		
Technical Report Submission														■		
Poster Preparation														■	■	
Viva: Demonstration															■	
Final Report Finalization															■	
Final Report (Hard Cover)																■

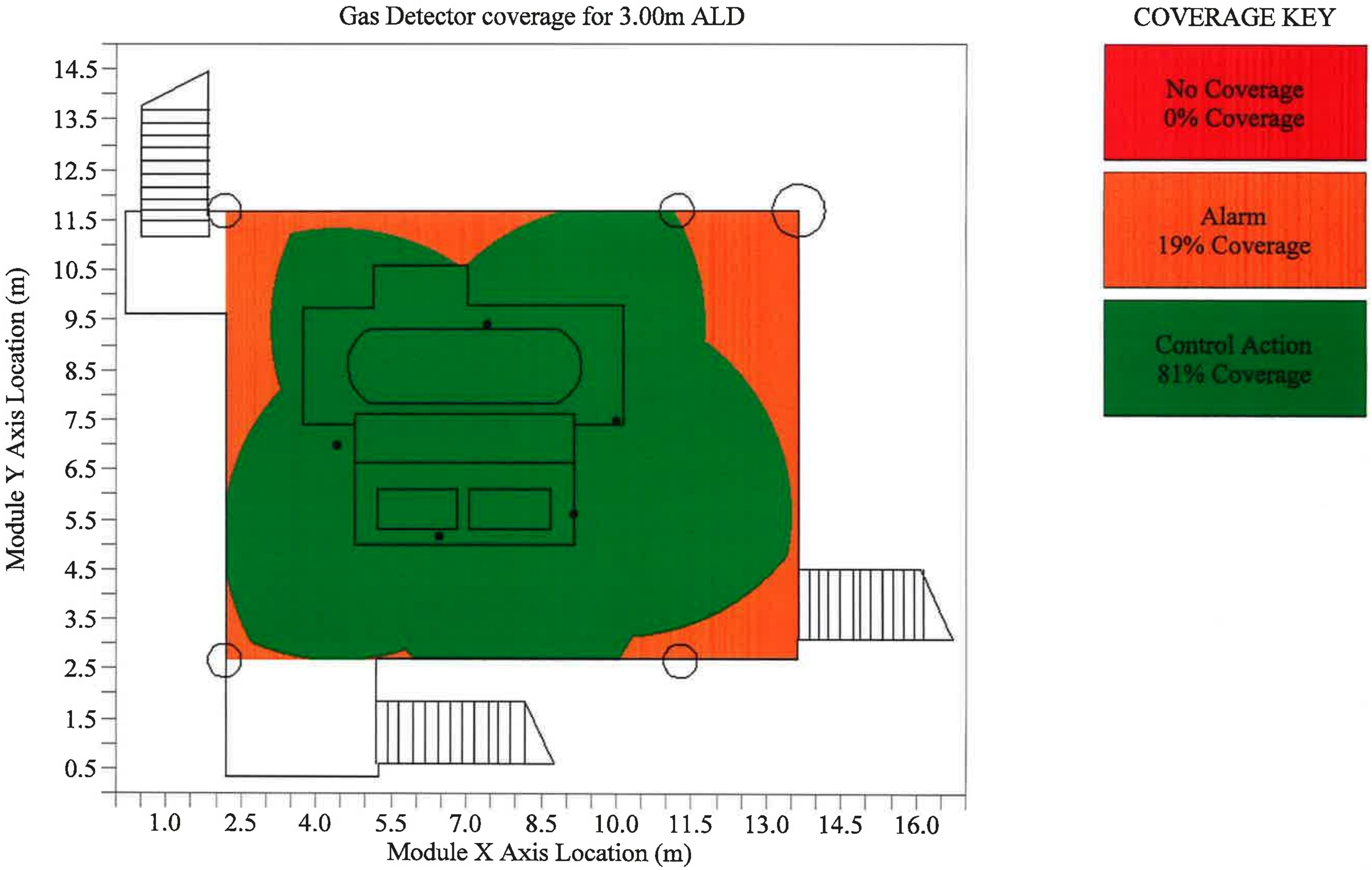
APPENDIX II: FGS MAPPING



Micropack (Engineering) Ltd	Drawing Description	Platform/site	Petronas ERB West Platform
	FDA Proposed Sub-Cellar Deck	Drg category + rev	Assessment (rev 4, 19-Apr-2011)

3/3

SUB-CELLAR DECK

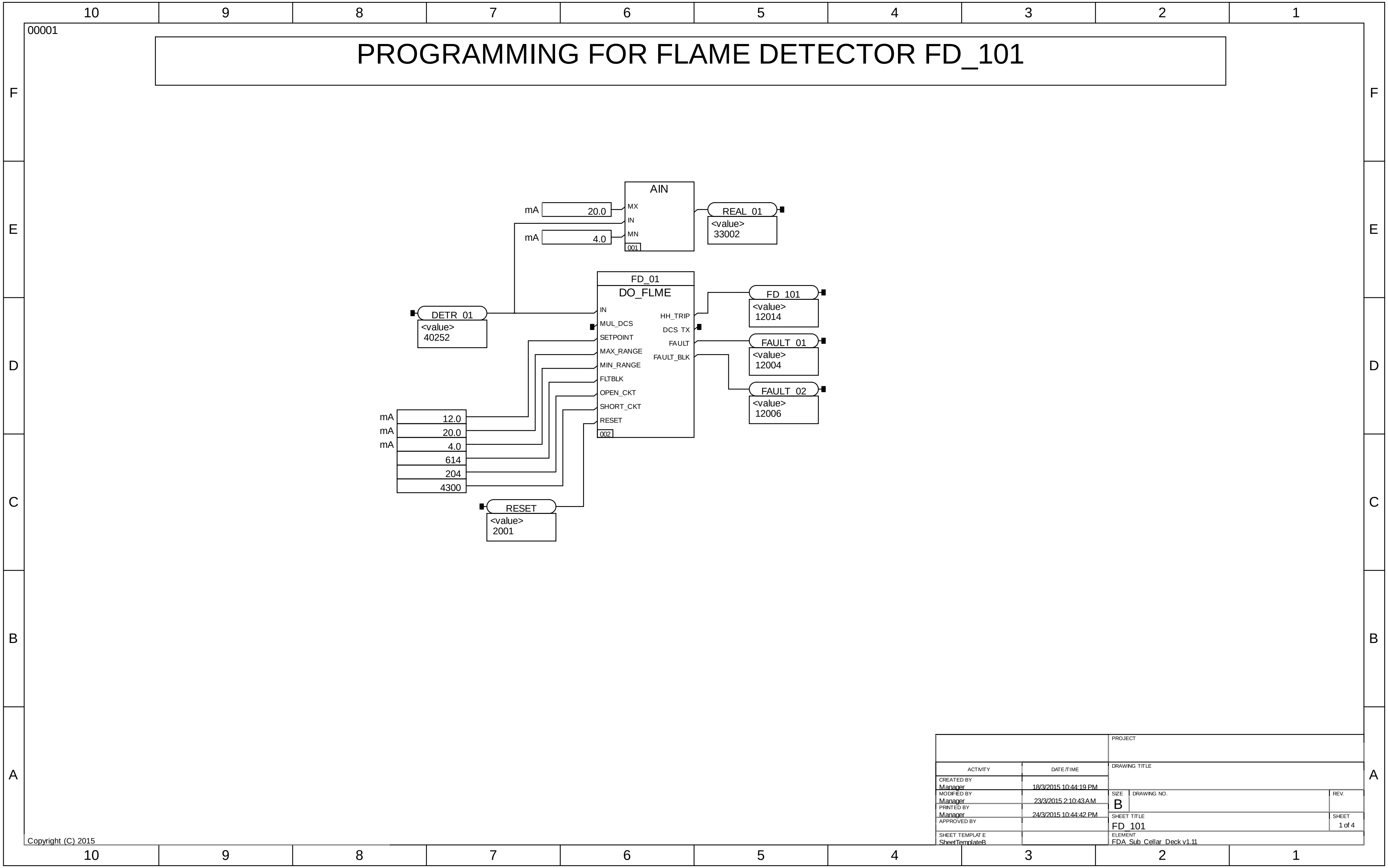


Micropack (Engineering) Ltd	Drawing Description	Platform/site	Petronas ERB West Platform
	GDA Proposed Sub-Cellar Deck	Drg category + rev	Assessment result (rev: 14, 19-Apr-2011)

APPENDIX III: CAUSE AND EFFECT MATRIX

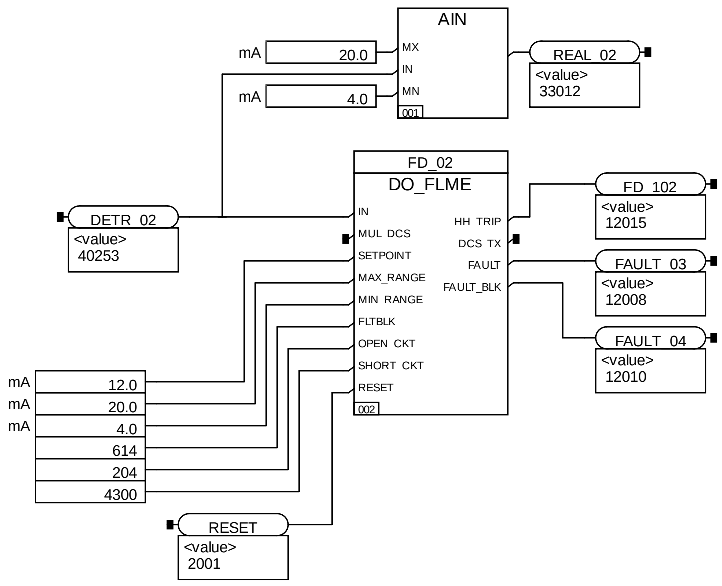
FIRE AND GAS SYSTEM CAUSE AND EFFECT MATRIX				EFFECT	DESCRIPTION	INDICATE SINGLE FIRE ALARM	INDICATE SINGLE FIRE ALARM	INDICATE SINGLE FIRE ALARM	INDICATE SINGLE GAS ALARM	INDICATE SINGLE GAS ALARM	INDICATE SINGLE GAS ALARM	INDICATE SINGLE GAS ALARM	INDICATE SINGLE GAS ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	INDICATE FAULT ALARM	CONFIRMED FIRE	CONFIRMED GAS
					TAGNAME	FD_101	FD_102	FD_103	GD_101	GD_102	GD_103	GD_104	GD_105	FAULT_01	FAULT_03	FAULT_05	FAULT_07	FAULT_09	FAULT_11	FAULT_13	FAULT_15	CONF_FIRE	CONF_GAS
CAUSE																							
TITLE	TAGNAME	DESCRIPTION	STATUS	ORIGIN																			
SUB-DELLAR DECK	DETR_01	SINGLE FLAME DETECTED	TRUE	FIELD		X																X	
	DETR_01	VOTED FLAME DETECTED	2 o o 3	FIELD																			
	DETR_01	FAULT ALARM DETECTED	OC/SC	FIELD										X									
	DETR_02	SINGLE FLAME DETECTED	TRUE	FIELD			X																
	DETR_02	VOTED FLAME DETECTED	2 o o 3	FIELD																		X	
	DETR_02	FAULT ALARM DETECTED	OC/SC	FIELD											X								
	DETR_03	SINGLE FLAME DETECTED	TRUE	FIELD				X															
	DETR_03	VOTED FLAME DETECTED	2 o o 3	FIELD																		X	
	DETR_03	FAULT ALARM DETECTED	OC/SC	FIELD												X							
	DETR_04	SINGLE GAS DETECTED	20%	FIELD					X														
	DETR_04	VOTED GAS DETECTED	2 o o 5	FIELD																			X
	DETR_04	FAULT ALARM DETECTED	OC/SC	FIELD													X						
	DETR_05	SINGLE GAS DETECTED	60% LEL	FIELD						X													
	DETR_05	VOTED GAS DETECTED	2 o o 5	FIELD																			X
	DETR_05	FAULT ALARM DETECTED	OC/SC	FIELD														X					
	DETR_06	SINGLE GAS DETECTED	60% LEL	FIELD							X												
	DETR_06	VOTED GAS DETECTED	2 o o 5	FIELD																			X
	DETR_06	FAULT ALARM DETECTED	OC/SC	FIELD															X				
	DETR_07	SINGLE GAS DETECTED	60% LEL	FIELD								X											
	DETR_07	VOTED GAS DETECTED	2 o o 5	FIELD																			X
	DETR_07	FAULT ALARM DETECTED	OC/SC	FIELD																X			
	DETR_08	SINGLE GAS DETECTED	60% LEL	FIELD									X										
	DETR_08	VOTED GAS DETECTED	2 o o 5	FIELD																			X
	DETR_08	FAULT ALARM DETECTED	OC/SC	FIELD																	X		

APPENDIX IV: LOGIC PREGRAMMING



00002

PROGRAMMING FOR FLAME DETECTOR FD_102



DRAWING TITLE		
SIZE B	DRAWING NO.	REV.
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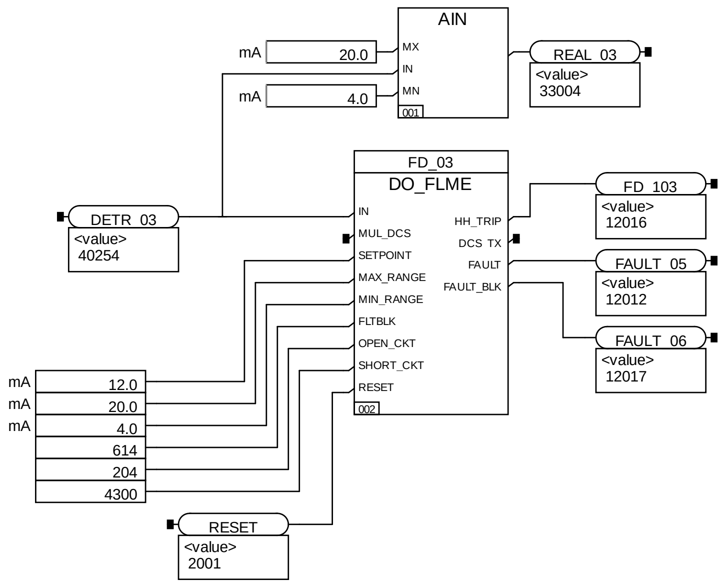
ELEMENT FDA_Sub_Cellar_Deck v1.11		

00003

PROGRAMMING FOR FLAME DETECTOR FD_103



DRAWING TITLE	
SIZE B	DRAWING NO.	REV.
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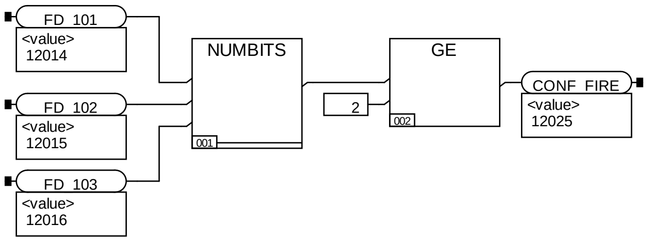
ELEMENT FDA_Sub_Cellar_Deck v1.11	

00004

2ooN VOTING



DRAWING TITLE		
SIZE B	DRAWING NO.	REV.
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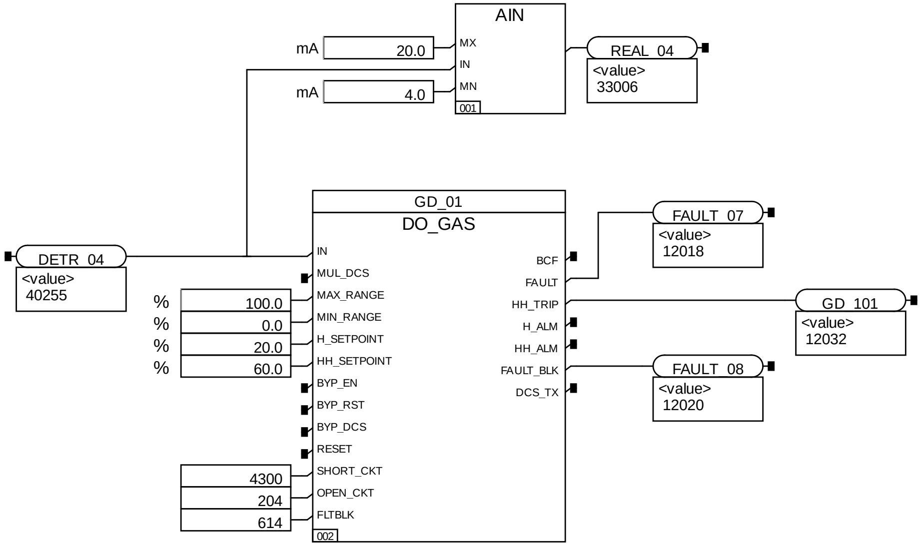
ELEMENT FDA_Sub_Cellar_Deck v1.11		

00001

PROGRAMMING FOR GAS DETECTOR GD_101



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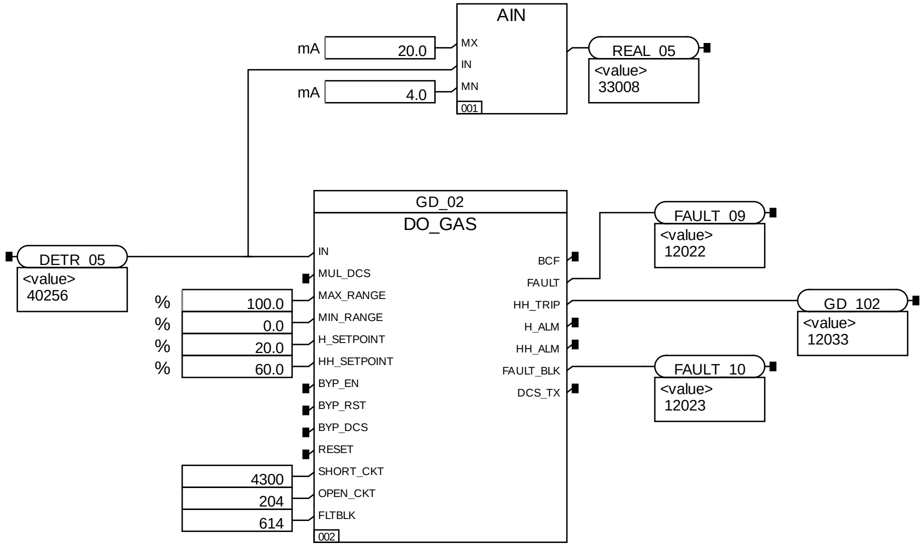
MODIFIED BY Manager	23/3/2015 2:10:42 AM	SIZE B	DRAWING NO.	REV.
PRINTED BY Manager	24/3/2015 11:03:47 PM	SHEET TITLE GD_101		SHEET 1 of 6
APPROVED BY				
SHEET TEMPLATE SheetTemplateB		ELEMENT GDA_Sub_Cellar_Deck v1.7		

00002

PROGRAMMING FOR GAS DETECTOR GD_102



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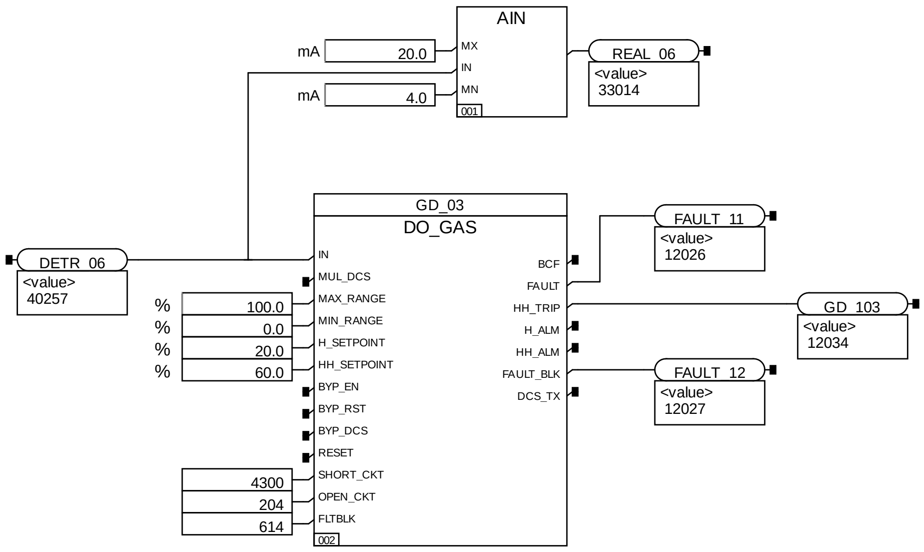
ELEMENT GDA_Sub_Cellar_Deck v1.7		

00003

PROGRAMMING FOR GAS DETECTOR GD_103



DRAWING TITLE		
SIZE B	DRAWING NO.	REV.
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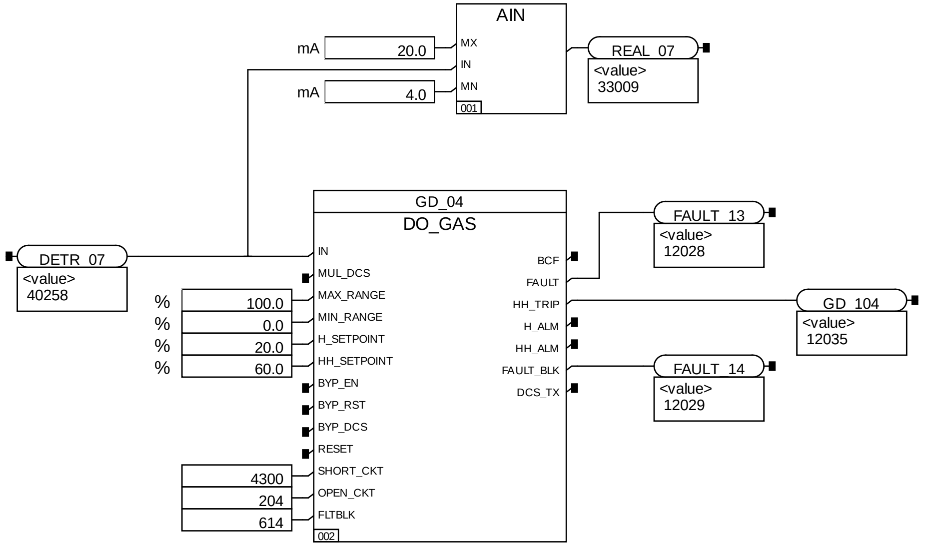
ELEMENT GDA_Sub_Cellar_Deck v1.7		

00004

PROGRAMMING FOR GAS DETECTOR GD_104



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SIZE B	DRAWING NO.	REV.
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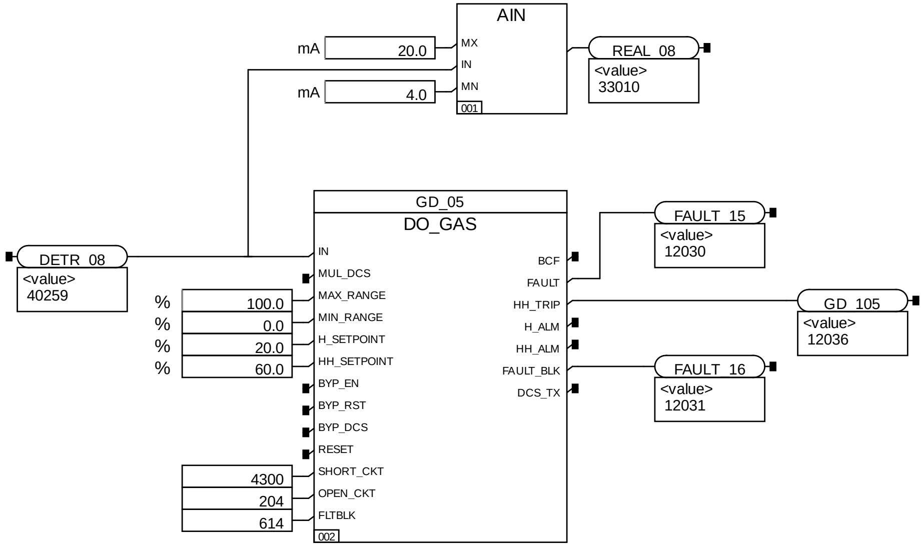
ELEMENT GDA_Sub_Cellar_Deck v1.7		

00005

PROGRAMMING FOR GAS DETECTOR GD_105



DRAWING TITLE		
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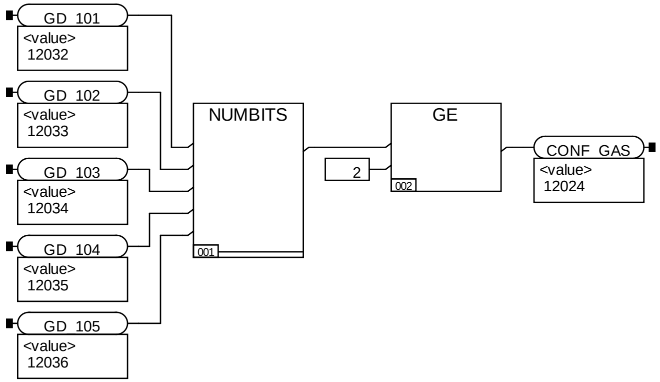
SHEET TITLE GD_105		SHEET 5 of 6
ELEMENT GDA_Sub_Cellar_Deck v1.7		

00006

2ooN VOTING



DRAWING TITLE

SIZE B | DRAWING NO. | REV.

SHEET TITLE VOTING | SHEET 6 of 6

ELEMENT GDA Sub Cellar Deck v1.7

APPENDIX V: RAW COUNT VONVERSION TABLE

CONVERSION TOOL				
CURRENT (mA)	**RAW COUNT**	**%**	**MIN/MAX**	**VALUE**
4	819	0%	0	0
4.8	982.8	5%		8
5.6	1146.6	10%		16
6.4	1310.4	15%		24
7.2	1474.2	20%		32
8	1638	25%		40
8.8	1801.8	30%		48
9.6	1965.6	35%		56
10.4	2129.4	40%		64
11.2	2293.2	45%		72
12	2457	50%		80
12.8	2620.8	55%		88
13.6	2784.6	60%		96
14.4	2948.4	65%		104
15.2	3112.2	70%		112
16	3276	75%		120
16.8	3439.8	80%		128
17.6	3603.6	85%		136
18.4	3767.4	90%		144
19.2	3931.2	95%		152
20	4095	100%	160	160