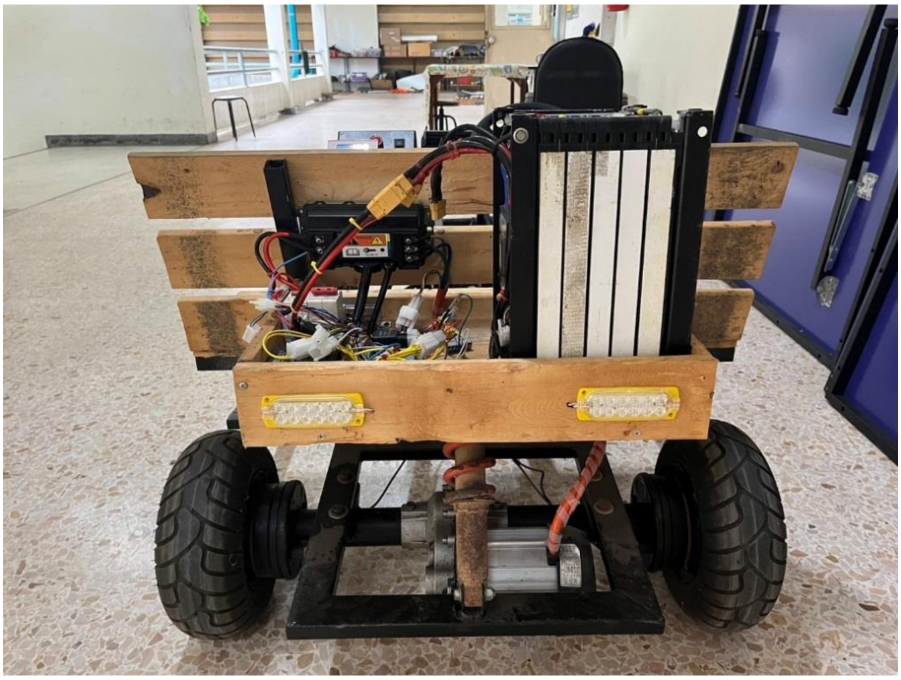
ภาคผนวก ก

ขั้นตอนการดำเนินงาน

ชุดทดลองยานยนต์ไฟฟ้า

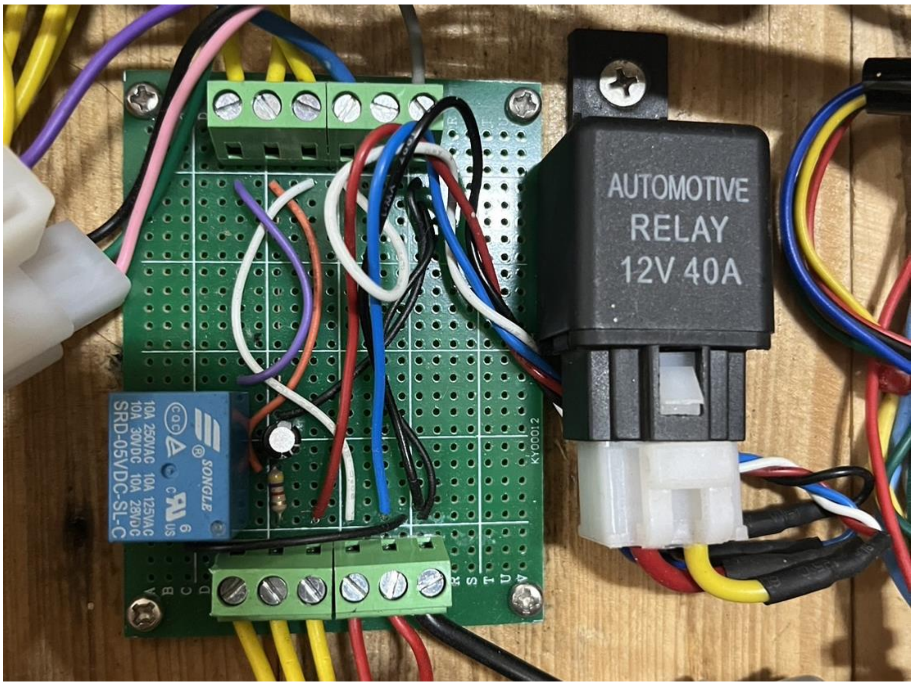
รูปที่ 6.1 ด้านหน้ารถ ATV



รูปที่ 6.2 ด้านท้ายรถ ATV

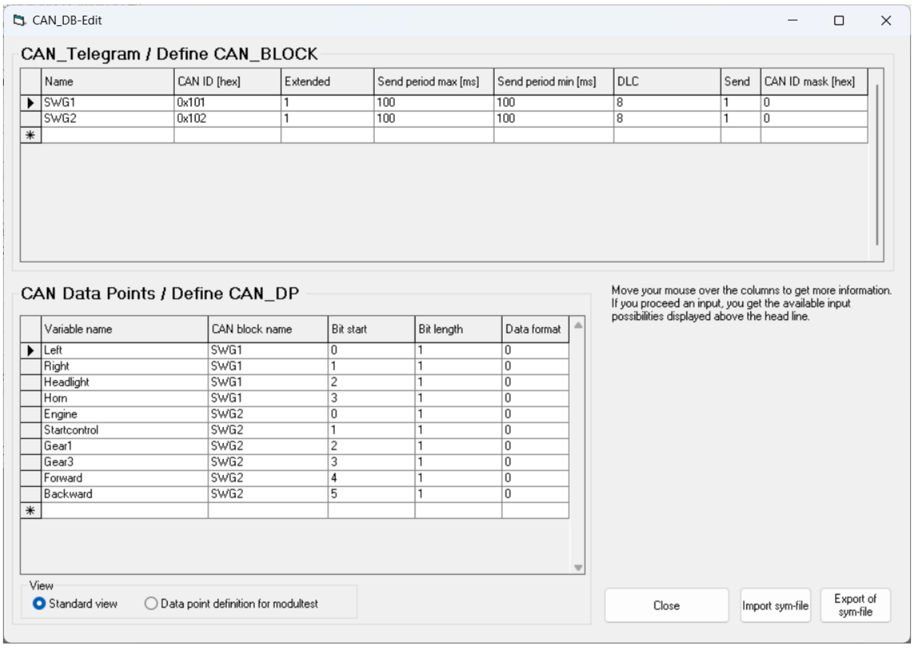
รูปที่ 6.3 ชุดควบคุมด้านหน้ารถ ATV

รูปที่ 6.4 หน้าจอแสดงสถานะรถ ATV

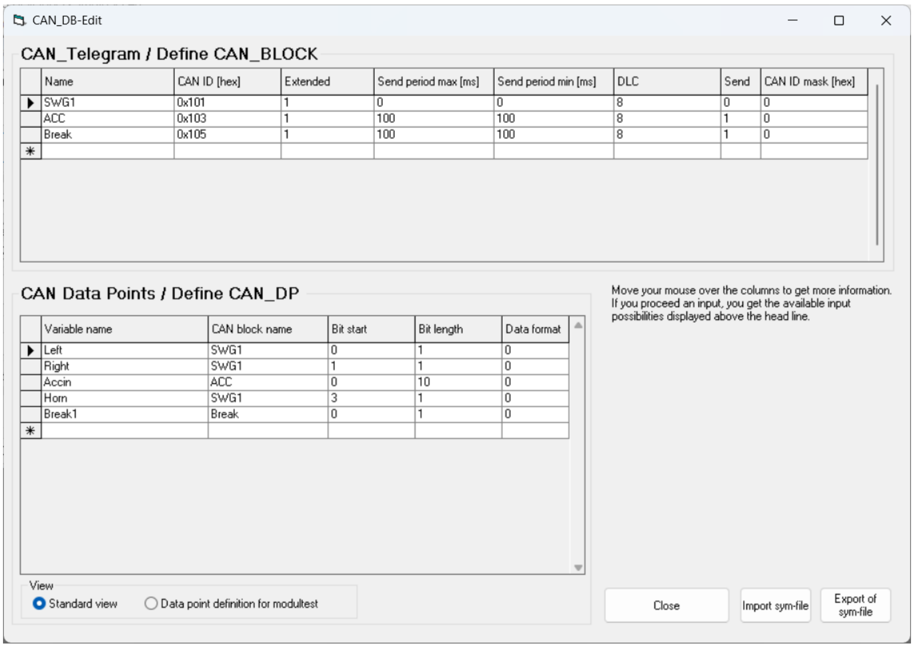


รูปที่ 6.5 ชุดแปลงสัญญาณ Low Pass Filter

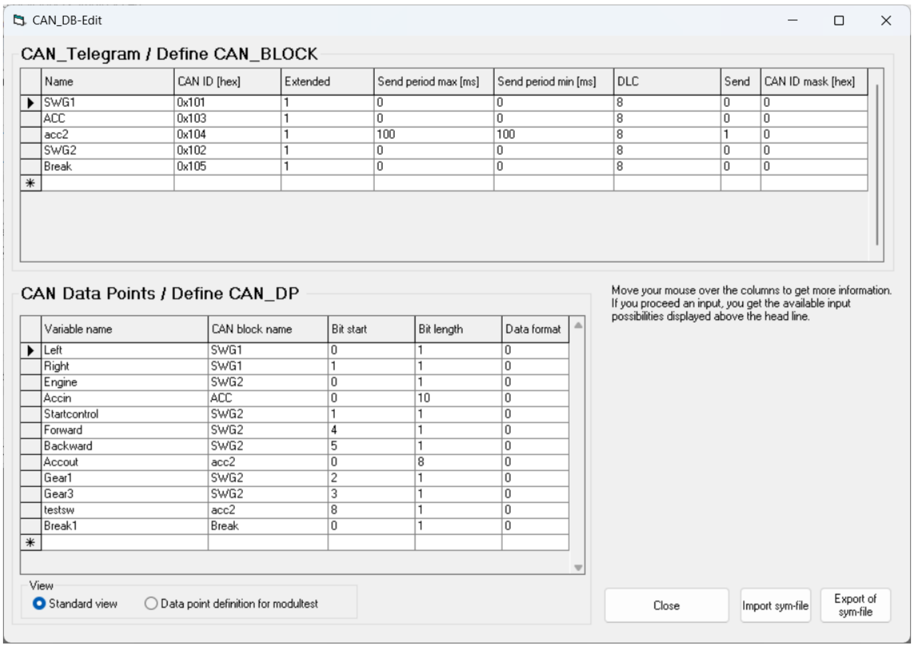
รูปที่ 6.6 กล่องควบคุมมอเตอร์



รูปที่ 6.7 CAN_DB กล่อง CANBUS ที่ 1



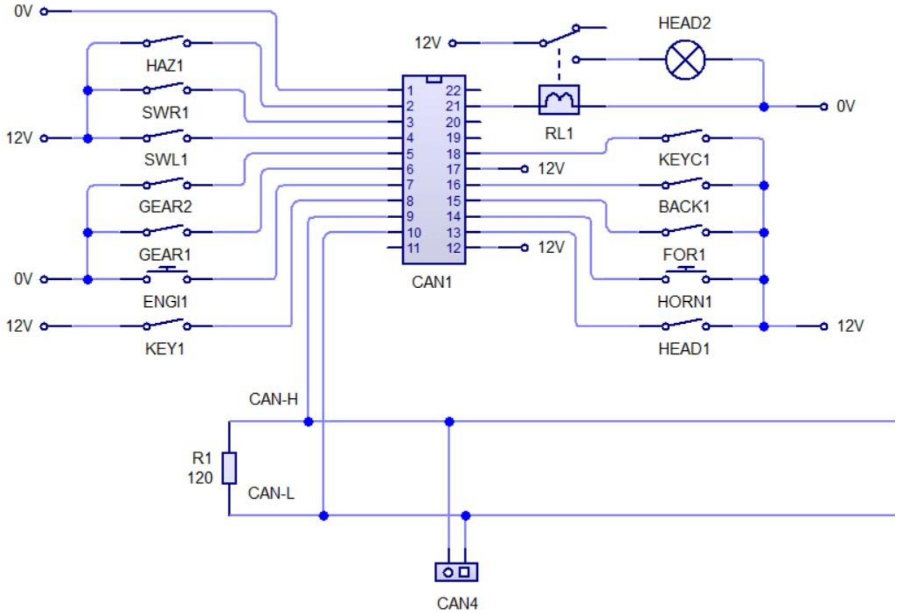
รูปที่ 6.8 CAN_DB กล่อง CANBUS ที่ 2



Name	CAN ID [hex]	Extended	Send period max [ms]	Send period min [ms]	DLC	Send	CAN ID mask [hex]
SWG1	0x101	1	0	0	8	0	0
ACC	0x103	1	0	0	8	0	0
acc2	0x104	1	100	100	8	1	0
SWG2	0x102	1	0	0	8	0	0
Break	0x105	1	0	0	8	0	0

Variable name	CAN block name	Bit start	Bit length	Data format
Left	SWG1	0	1	0
Right	SWG1	1	1	0
Engine	SWG2	0	1	0
Accin	ACC	0	10	0
Startcontrol	SWG2	1	1	0
Forward	SWG2	4	1	0
Backward	SWG2	5	1	0
Accout	acc2	0	8	0
Gear1	SWG2	2	1	0
Gear3	SWG2	3	1	0
testsw	acc2	8	1	0
Break1	Break	0	1	0

รูปที่ 6.9 CAN_DB กล่อง CANBUS ที่ 3



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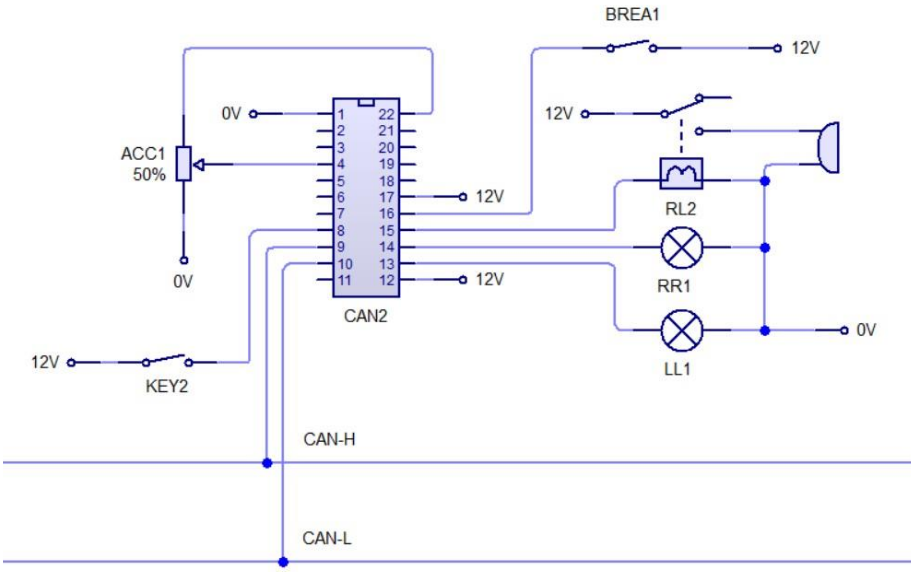
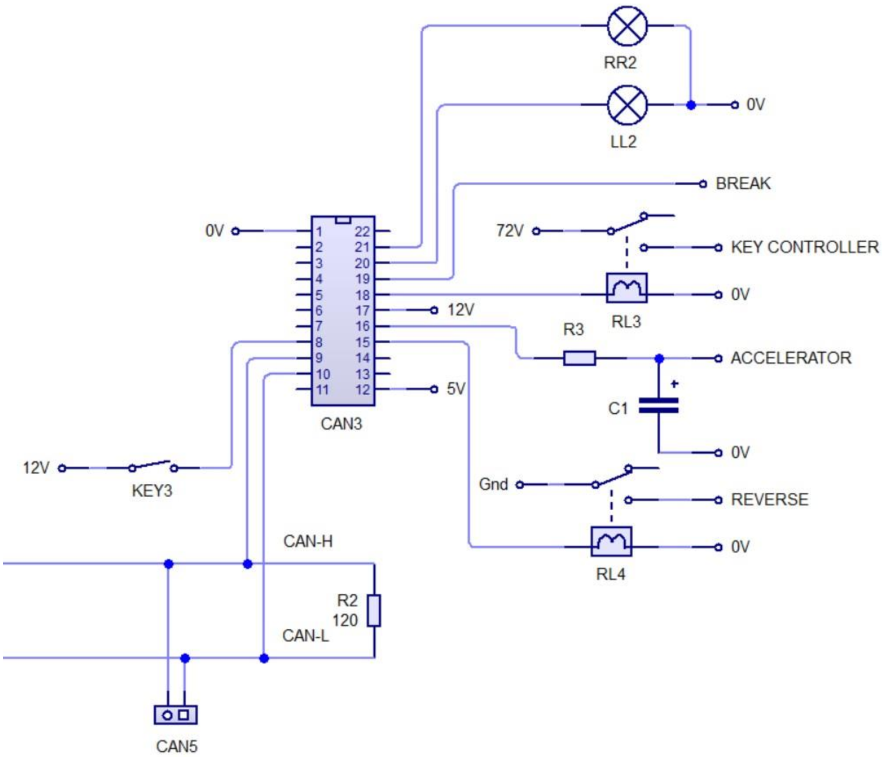


รูปที่ 6.11 วงจรไฟฟ้า กล่อง CANBUS ที่ 2



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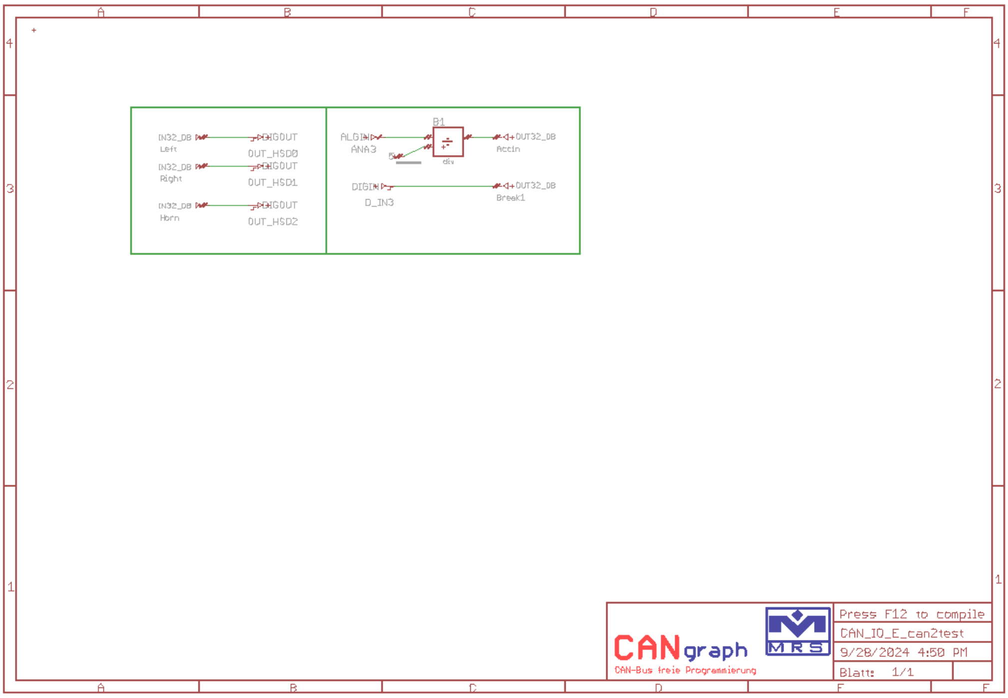
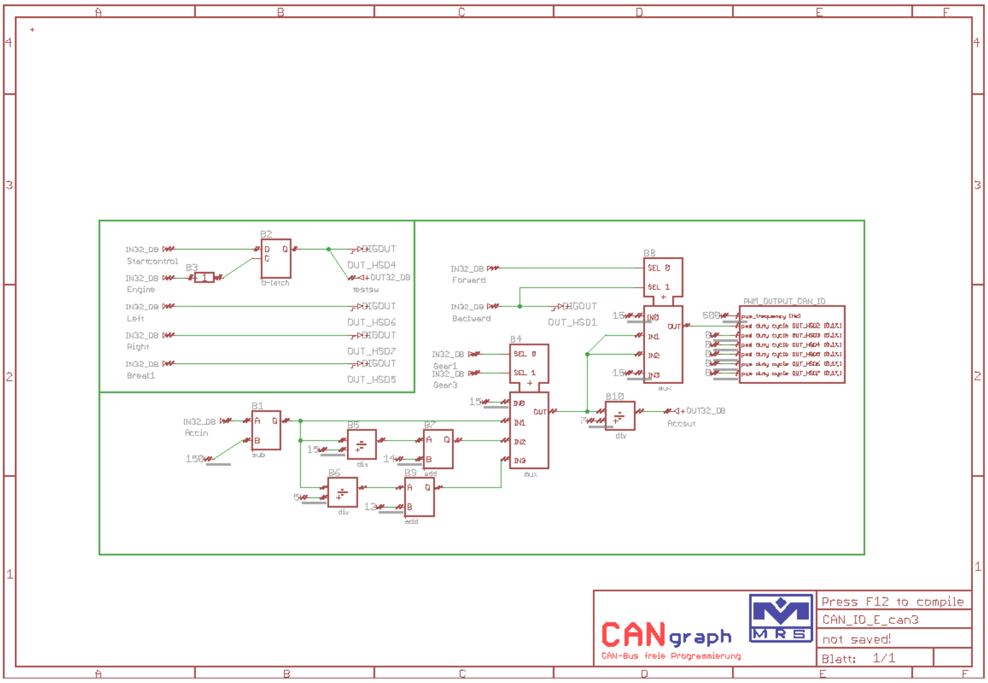
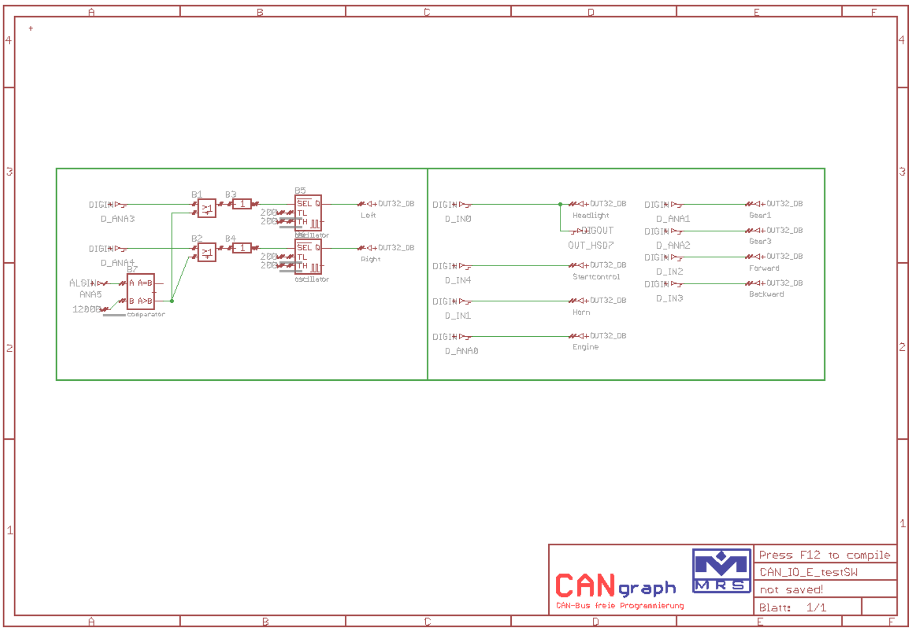


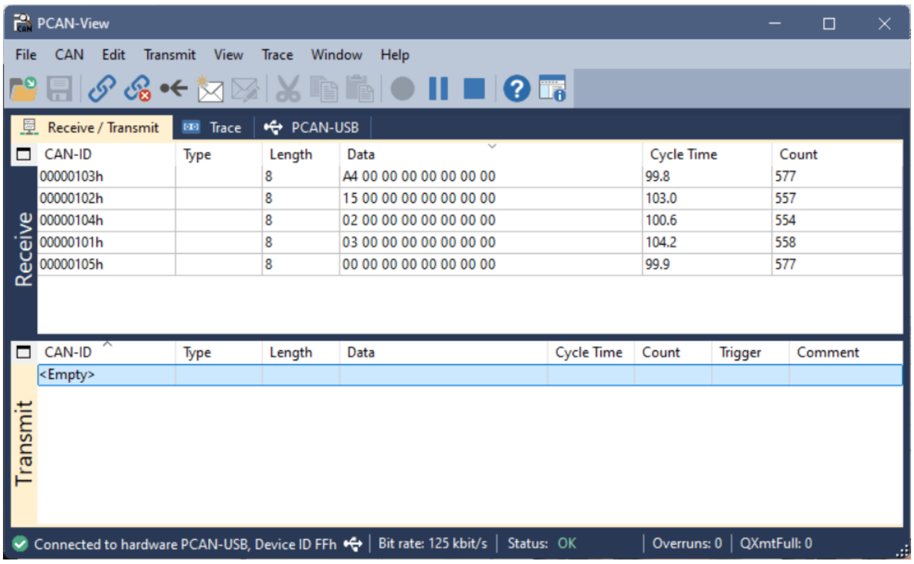
รูปที่ 6.13 โปรแกรมกล่อง CANBUS ที่ 1



รูปที่ 6.14 โปรแกรมกล่อง CANBUS ที่ 2



รูปที่ 6.15 โปรแกรมกล่อง CANBUS ที่ 3



รูปที่ 6.16 ข้อมูลการสื่อสารของ CANBUS

ภาคผนวก ข

บทความที่ได้รับการตีพิมพ์เผยแพร่

รายชื่อบทความวิชาการที่ได้รับการตีพิมพ์เผยแพร่

Nambunlue, W., Donjaroennon, N., Leeton, U., Nuchkum, S., Singhand, K., Promlungd, N., & Srisertpol, J. (2024). Internet of Things (IoT) With the Power Meter Using V-BOX. ISCEAS-0055(1), 183-192.

ISCEAS-0055
Internet of Things (IoT) With the Power Meter Using V-BOX

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Abstract

This paper is a study of working and applying the Internet of thing (IoT) together with Power Meter, bringing data from Power Meter into the Cloud, such as History Data, Alarm, graphing or monitoring. Display required data in the form of Web Cloud SCADA. And data can be viewed through Computer/Laptop or Smartphone that measures and collects energy consumption data both in real-time and in retrospect. In addition, it can notify system errors and send notification messages to the application line to help users obtain and analyze data immediately and maximize efficiency and this paper will use V-BOX to validate power meter data.

Keywords: Internet of Thing (IoT), Power Meter, V-Box Software.

1. INTRODUCTION

Nowadays, in the industrial sector, it is an era where manufacturers and entrepreneurs are accelerating to transform themselves into a full industry 4.0. Everyone is aware of the benefits of incorporating technology into their operations to increase work efficiency even further. Digital technology and the Internet are important factors in the development of industries in the age of Industry 4.0, especially the Internet of Things (IoT) [1], which plays an important role in helping collect data to analyze, improve and increase the efficiency of industrial processes [2]. And can facilitate the worker.

The Internet of Things is an important part that will enable the industry to move towards Industry 4.0, which facilitates operators. What makes Industry 4.0 better than any other era [3]. That is, there is a development in data recording, data allocation, and various resources that connect the industry. Industry 4.0 makes every job easier, more detailed and can make changes to plans efficiently [4].

Thailand's industry today has developed rapidly resulting in the use of energy in various forms in addition, every year, therefore, it is necessary to manage energy sufficiently and appropriately [5]. There are many forms of energy management, such as improving the power factor and managing electricity usage (Demand Controller) and choosing high-efficiency appliances. (Electrical appliances or devices that work more but consume less electricity), etc. Peak Demand Configurator which is an important component of the electricity bill in some factories, especially factories that operate machinery only during the daytime, may find that 30 - 35 % of the total electricity bill is a part of the calculation of the peak demand, which has a high electricity price. Therefore, controlling the use of electric power appropriately will help the factory to reduce the electricity bill to be lower [6]. Or pay the same electricity cost but can use more electricity.

2. SMART IOT OF THE POWER METER

2.1 T330 Power Meter

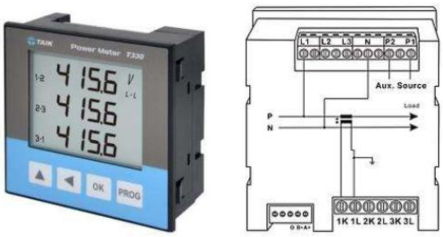

Fig. 1: T330-Power Meter

T330 Power Meter sends and receives data in the form of MODBUS Frame, which is communication and framing based on hexadecimal code, valid MODBUS address ranges from 1-255 address, Function code: 03H for reading data, 06H for Writing data, Data field: Starting address of register N WORDS reading and N writing, Error check: 16bit CRC, Bit Per Byte: Access to sub-menus 485>>FrAE to set-up. That is a communication using hexadecimal numbers set in Table 1. bit and byte transmission from the power meter and Table 2. addresses used to send data.

Table 1: BIT AND BYTE TRANSMISSION FROM THE POWER METER

Start Bit	Data Bit	Parity	Stop	Frame
1	octal number	NONE	2	N-8-2
1	octal number	ODD	1	O-8-1
1	octal number	EVEN	1	E-8-1
1	octal number	NONE	1	N-8-1

Table 2: ADDRESSES USED TO SEND DATA

Adress	Hex-number	Parameter	Type	Word	Access	Unit
4096	1000H	I_R L1	F	2	R	Amp
4098	1002H	V_RN	F	2	R	Vol
4100	1004H	V_RS	F	2	R	Vol
4102	1006H	VA_R	F	2	R	VA
4104	1008H	W_R	F	2	R	Watt
4106	100AH	Var_R	F	2	R	Var
4108	100CH	PF_R	F	2	R	PF
4138	102AH	∑A	F	2	R	Amp
4140	102CH	∑VØ	F	2	R	Vol
4142	102EH	∑VL	F	2	R	Vol
4144	1030H	∑VA	F	2	R	VA
4146	1032H	∑W	F	2	R	Watt
4148	1034H	∑Var	F	2	R	Var
4150	1036H	∑PF	F	2	R	PF
4152	1038H	∑HZ	F	2	R	Hz

* F is Float

2.2 V-BOX Wecon IoT Gateway

V-NET is a data management program for V-BOX. That acts like a SCADA program. V-BOX can create display graphics, create ALARM tables, generate power buttons to control connected devices. And most importantly, can control and manage many V-BOX simultaneously and located on CLOUD SERVER which does not need to install any program. All done through a web browser, Following in Fig. 2 Private Cloud Solution.

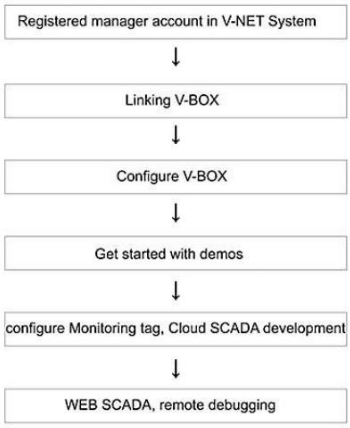

Fig. 2: Private Cloud Solution.

3. METHODOLOGY

3.1 Design and Control system

The design of the data transmission control system is shown in Figure 3. The equipment consists of the T330 Power Meter, Current Transformer, Switching, Sensor and V-BOX Control.

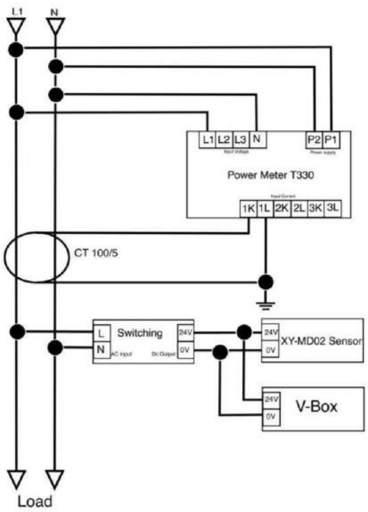

Fig. 3: Power Line Diagram

V-BOX has S Series, E Series and H Series, and each Series V-BOX supports three usage modes. V-BOX is the basic hardware of Industrial Internet of Things, it is a data exchange and protocol conversion device for loT cloud platform to communicate with the system. In addition, the WECON LCM Series remote IO modules can communicate directly with the V-BOX without using a PLC and implement simple logic control and analog acquisition using edge computing [7]. The V-BOX communication is shown in Figure 4.

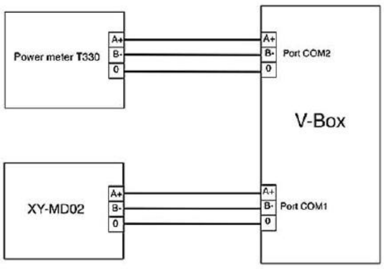

Fig. 4: V-BOX Communication

3.2 Load Lamps

Figure 5. shows the lamp working load of the circuit. The analysis will collect electrical parameters, humidity and temperature. To be adapted as an IoT control system, including notifying the working status sent back to the application line

Fig. 5: Communicate Diagram.

3.3 V-Box Use and Connection Procedure

V-BOX is a device that receives and sends data from control devices such as PLC, Remote-I/O, Power Meter, etc. by connecting with standard protocols (Modbus Protocol) such as RS485, RS422 or Ethernet and sends data to V- NET on the Cloud [8] or through the Internet, or even send data to Brokers with the MQTT Protocol by using LUA Script, which can be written into V-BOX immediately, starting from the V-BOX login. As in Figure 6, when logging in, the V-NET window will appear for designing the IoT system to be used for control as in Figure 7.

Fig. 6: V-BOX Software

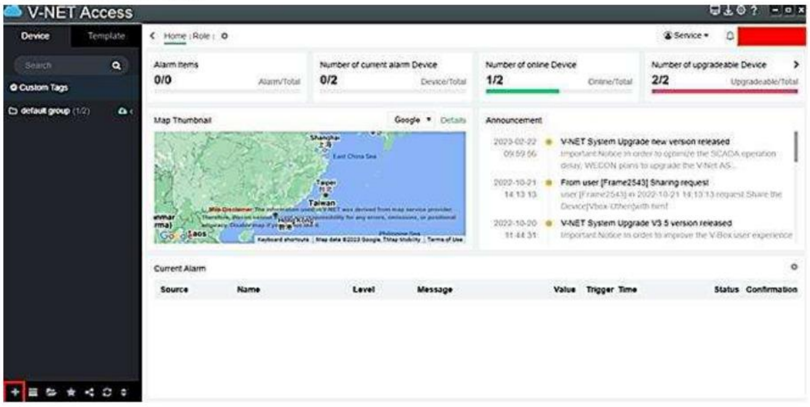

Fig. 7. V-NET Access

3.4 Code to notify information via the Application line

This paper shows the code used to write part of the paper. That will show the lamp status check and Alarm notification.

- ***Check the lamp status and notify Alarm***

```
local LineToken = "lXJc3fwGjcFuZaILRdPP2nccP0I5zcRpLNSAZDlM1Er"
local https = require("https")
local ltn12 = require("ltn12")
function getHttpsUrl(url,header,reqbody)
    local    headers, status = https.request{
        method = "POST",
        url = url,
        source = ltn12.source.string(reqbody),
        headers = header }
```

```
end
function getMessageUrl(lineMessage)
    local url = "https://notify-api.line.me/api/notify"
    local reqMess = "message="..lineMessage
    local headers = {["Authorization"] = "Bearer "..LineToken,
    ["Content-Type"] = "application/x-www-form-urlencoded",
            ["Content-Length"] = #reqMess }
          getHttpsUrl(url, headers, reqMess)
end

function Line_Notify.main()
    local bitValue = addr_getfloat("@Current")
    local message = ' '
     local C=bitValue*1000
    C=math.ceil(C)
    C=C/1000
    if bitValue > 0.3 and bitValue<0.6 then
         message = ' V-Box Current, Load on 1 Lamp Value='..C
         getMessageUrl(message)
     elseif bitValue > 0.7 and bitValue< 1 then
         message = ' V-Box Current, Load on 2 Lamp Value='..C
         getMessageUrl(message)
     elseif bitValue > 1.1 and bitValue<1.5 then
         message = ' V-Box Current, Load on 3 Lamp Value='..C
         getMessageUrl(message)
     elseif bitValue > 1.5 and bitValue<1.9 then
         message = ' V-Box Current, Load on 4 Lamp Value='..C
         getMessageUrl(message)
     elseif bitValue > 1.9 and bitValue<2.3 then
         message = ' V-Box Current, Load on 5 Lamp Value='..C
         getMessageUrl(message)
     elseif bitValue > 2.3 then
         message = ' V-Box Current, Load on 6 Lamp Value='..C..'\n!!! V-Box Alarm, Over Current
Value !!!'
         getMessageUrl(message)
    end
end
```

- Parameter notifications sent to line applications

```
local LineToken = "IXJc3fwGjcFuZaILRdPP2nccP0I5zcRpLNSAZDlM1Er"
local https = require("https")
local ltn12 = require("ltn12")
function getHttpsUrl(url,header,reqbody)
    local headers, status = https.request{
    method = "POST",
    url = url,
    source = ltn12.source.string(reqbody),
    headers = header }
end
function getMessageUrl(lineMessage)
    local url = "https://notify-api.line.me/api/notify"
    local reqMess = "message="..lineMessage
    local headers = {["Authorization"] = "Bearer "..LineToken,
    ["Content-Type"] = "application/x-www-form-urlencoded",
    ["Content-Length"] = #reqMess }
    getHttpsUrl(url, headers, reqMess)
end
function Value_Voltage.main()
    local Current = addr_getfloat("@Current")
    local Voltage = addr_getfloat("@Voltage")
    local ActiveP = addr_getfloat("@Active Power")
    local AppearanceP = addr_getfloat("@Appearance Power")
    local PF = addr_getfloat("@PowerFactor")
    local Freq = addr_getfloat("@Frequancy")
    local Watthour = addr_getfloat("@WH")
    local Temp = addr_getfloat("@Temperature 1")
    local Humu = addr_getfloat("@Humidity 1")
    local T=Temp*1000
    T=math.ceil(T)/1000
    local H=Humu*1000
    H=math.ceil(H)/1000
    local C=Current*1000
    C=math.ceil(C)/1000
    local V=Voltage*1000
    V=math.ceil(V)/1000
    local pf=PF*1000
```

```
    pf=math.ceil(pf)/1000
    pf=math.abs(pf)
    local f=Freq*1000
    f=math.ceil(f)/1000
    local WH=Watthour/1000
    local P=math.ceil(ActiveP)
    P=P/1000
    S=math.ceil(AppearanceP)
    S=S/1000
    local message = ''
    message ='V-Box ,Load Current Value = '..C..' A\nVoltage Value = '..V..' V\nActive Power Value = '..P..' kW\nAppearance Power Value = '..S..' kVA \nPower Factor Value = '..pf..'\nFrequancy Value = '..f..' Hz\nWatt-hour Value = '..WH..' kWhr\nTemperature Value = '..T..' C\nHumidity Value (Persent RH) = '..H
    getMessageUrl(message)
end
```

4. RESULT

Figure 8. shows real-time data display in the Cloud SCADA system, users can view through the V-NET program or on the browser and mobile application. That is a remote data display online.

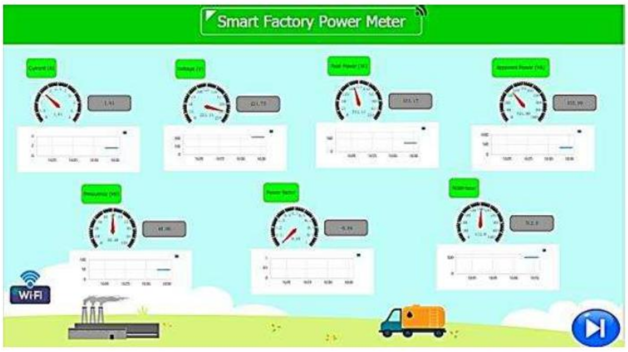

Fig. 8. Real-time Power Meter Data Visualization on Cloud SCADA.

Alarm display on the Cloud SCADA web page, there will be an alarm notification sound asset following in Figure 9. Users can view the alarm through the browser website or V-NET program and mobile application. It is a remote display on the system. Online, To set, Alarm, 5 alarm parameters are set: Voltage Alarm ±10%, Current Alarm > 2.3 A (6 Lamps), Temperature Alarm > 70 C, Humidity Alarm > 45%RH

Fig. 9. Real-time data alarm results in Cloud SCADA.

Real-time data display on V-NET program that users can view real-time data through V-NET program and edit data. It is a way to display remote information and modify the system remotely online. Following in Figure 10-11.

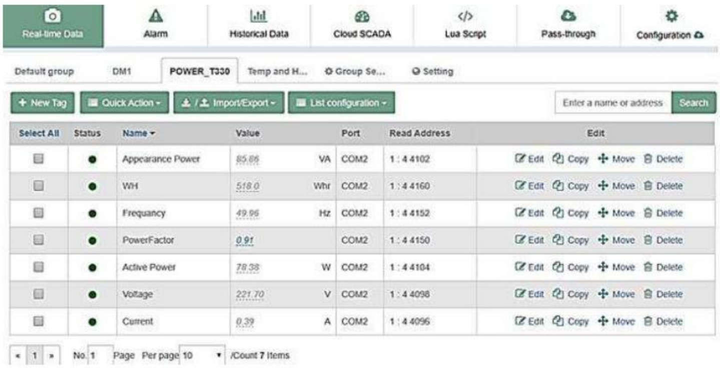

Fig. 10. Real-time data display of Power Meter

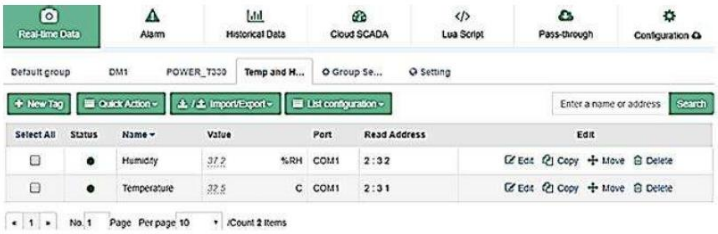

Fig. 11. Real-time data display of Sensor XY-MD02 (Temp&Hum).

Historical Data collection results show the measurement results of the Power Meter and Sensor [9] XY-MD02 of all 6 lamp loads. It can display remote data and modify the system remotely online as Figure 12, can be used to analyze the operation and various problems in the system to fix and improve in the future.

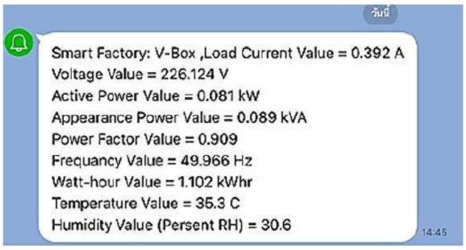

Fig. 12. Notify daily parameters via the application line.

5. CONCLUSION

Internet of Things (IoT) technology is an intermediary measuring device. In this paper are Power meters and temperature and humidity sensors. Send data to the Internet on the cloud (Cloud), which connects via Port RS485 and Internet signal (Wifi), can view values online via Web Cloud SCADA, which records data backward and real-time, can alert the error of system according to predetermined conditions. In addition, notifications can be sent to the application line by taking data from those saved values for analysis. Management of controlling or improving the use of electricity with maximum efficiency.

ACKNOWLEDGMENT

This work was supported by the Suranaree University of Technology.

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