جامعة الأمير محمد بن فهد
PRINCE MOHAMMAD BIN FAHD UNIVERSITY

College of Engineering

Department of Electrical Engineering

Spring 2019-18

Senior Design Project Report

Demand Response Controller

In partial fulfillment of the requirements for the Degree of Bachelor of Science in Electrical Engineering

Team Members

	Student Name	Student ID
1	Ali Almarri	201402732
2	Abdulrahman Saed	201300522
3	Safar Almaymouni	200900309
4	Abdullah Alsalem	201101602

Project Advisors:

Advisor Name: **Mr. SAIFULLAH SHAFIQ**

Co-Advisor Name: **CHEDLY YAHYA**

Abstract

There is a vision about applying some kind of control on the electricity consumption because the prices of electricity bill become expensive. However, if we did not apply proper systems to monitor the power consumption, we will end up with a big failure in our monthly budget. Reducing any energy that using in our home saving our money, increases our energy security, and reduces the pollution that is emitted from non-renewable sources of energy. If we are aiming to install a small renewable energy system to make our own electricity such as a solar electric system or a small wind turbine that are reducing our electricity loads is the first step-saving our money by allowing us to purchase a smaller system for our demands. There are many ways we can reduce electricity usage in our homes. First of all, using an advanced power for reducing electricity that is wasted. There are kinds of demand response such as economic demand response and services demand response. demand response is putting to avoid service interruptions during times of supply. Also, Economic demand response is putting to let electricity customers to cut their consumption when the productivity or convenience of consuming that electricity is worth less to them than paying for the electricity. services demand response consists of a number of specialty services that are needed to ensure the secure operation of the transmission grid and which have traditionally been provided by generators. So, our Demand Response Controller provides an opportunity for consumers to play a significant role in the operation of the electric grid by reducing their electricity usage during peak periods in response. It can lower the cost of electricity in markets, and in turn, lead to lower all methods of engaging customers in demand response efforts include critical peak pricing. It also includes direct load control automatically which provide the ability for power companies by designing a smart home that is consisting of controlling circuits to controlling the demand loads during our times of days.

Table of *Contents*

1. Introduction

1.1 Project Definition

To design a smart home and to control the energy and electricity demand according to a change in the voltage automatically without the need for someone doing it manually. This system is useful for all homes in terms of reducing electricity and power usage or in terms of reduced electricity bills.

1.2 Project Objectives

1- Reduce electricity consumption.
2- Increase public awareness in term of electricity bills.
3- Facilitate utility to control the load demand.
4- To defer investment cost.
5- To facilitate the end user to control the electricity bills.

1.3 Project Specifications

1- Power system 220V.
2- The power rating up to 200 watts.
3- Microcontroller based demand response control.
4- Following American National Standard (ANSI C84.1)
5- Controls the loads of demand automatically.
6- Reduce carbon footprints, reduce costs.

1.4 Product Architecture and Components

- **Power** source (Grid).

- **Voltage Monitoring** using appropriate sensors to determine voltage level.
- **Control circuit** microcontroller to process sensors output and give the appropriate instruction.
- **Isolation circuit** transformer for stepping down the voltage provided by the grid.

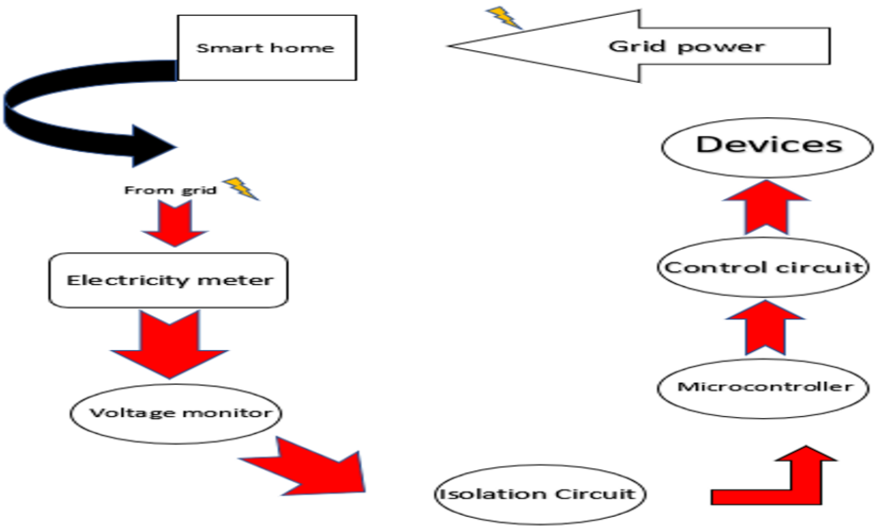


Figure 1.1. Basics parts of Smart home of Demand Response controller.

1.5 Applications

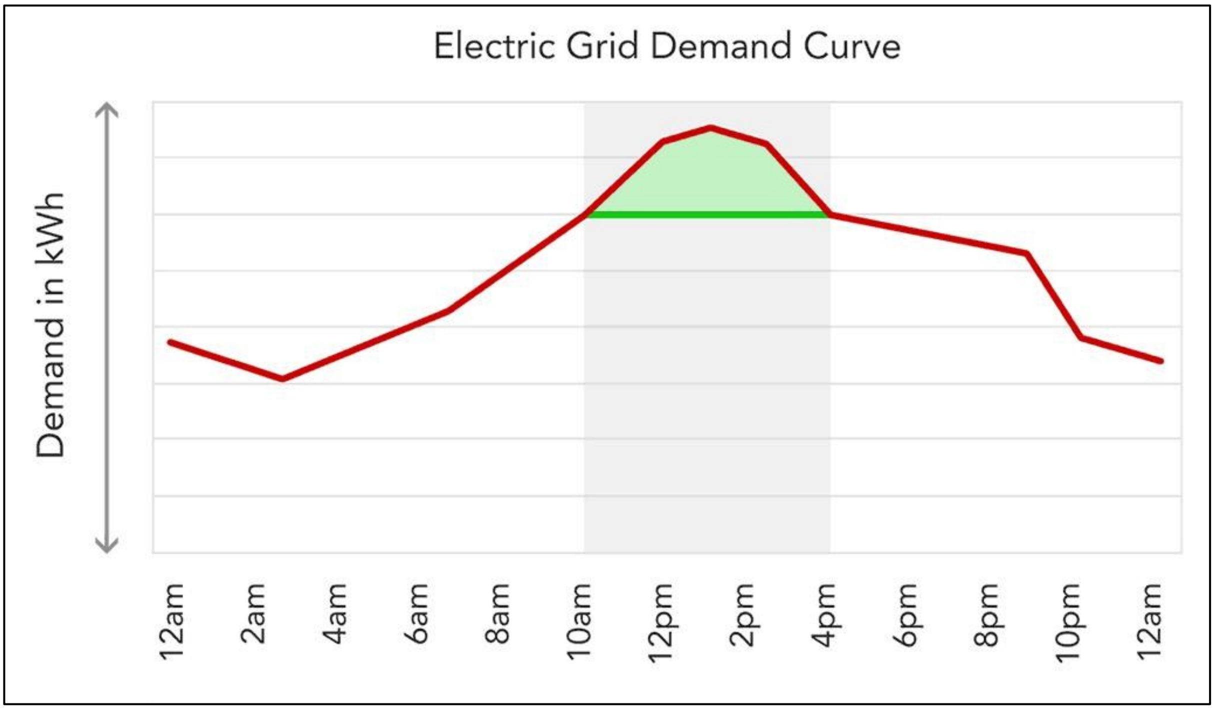
The proposed system can be used:

- In residential homes for metering, monitoring and billing purposes.
- In residential homes to implement demand management measures.
- In educational, commercial or industrial building to implement energy monitoring and demand management.

2. Literature Review

2.1 Project background

Demand Response controller can make an evaluation of your power use and determine that you are using too much or using it at the wrong time of day. To reduce both electricity loads and energy costs for end users in a residential building. Demand-response controller seek to reduce peak demands during times when reliability may be threatened or wholesale market prices are high. The advantage of controlling the demand are Take control of your energy needs costs, automatically reduces load, eliminate excessive demand side penalties and costs, reduce peak demand in plants or a building, reduce energy, reduce carbon footprint and, reduce costs. There is a picture that is clarifying how the people globally are consuming the demand of loads during the day:



our project is focusing to reduce that consumption of the loads based on the system conditions by designing smart home that consisted of demand response controller. The purpose of demand response controller is controlling the demand of loads automatically based on the system conditions of response. For example, there is peak demand of loads between 10AM to 4PM as shown in figure, there is light green tells that the demand has high loads of consumption, so the Demand Response Controller contributes to reduce the consumption of loads during that time of the day. As we knew, in real live the loads is not fixed the load is sometimes get high voltage, if it is got high the voltage will drop. Also, the utility cannot have much loads, or there is much loads in peak hours and no much generator to consume and cover the loads, so the Demand Response controller will do.

2.2 Previous Work

<u>Previous Projects (**1**):</u>

Demand Response Management System, Jan 2018

Demand Response Management System (DRMS) is a proven platform that allows utilities to manage all aspects of their demand response (DR) through a single, and integrated system.

Can be fully integrated with utility systems to leverage investments in Smart Grid technology.

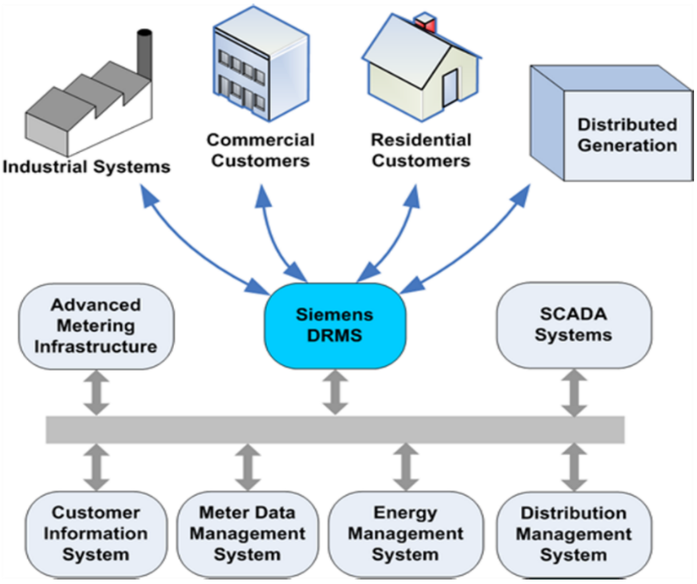


Figure 2.1. design of Previous Projects (1)

<u>Previous Projects (**2**)</u>

25 December 2017 , Prince Mohammad bin Fahd university (PMU)

To design a smart energy system with communication, automated billing and demand management functions. The system will use a commercial smart meter to monitor and measure power consumption in residential homes.

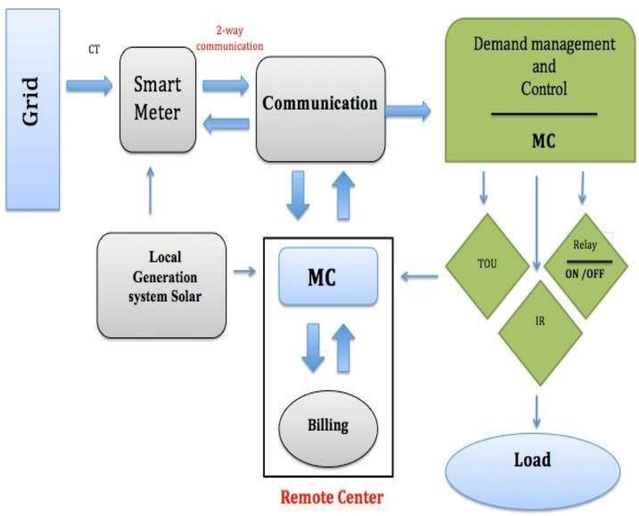


Figure 3.1. design of Previous Projects (2)

2.3 Comparative Study

Projects	1	2	Our Project
Voltage monitoring	✓	✓	✓
Communication-Free			✓
monitoring	✓	✓	✓
Demand management	✓	✓	✓
Local power generation (distribution)		✓	

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3. System Design

3.1 Design Constraints

While performing the design of the demand response controller we have faced some difficulties which delay us to start building our system. On the other hand, it leads us to do many modifications until we reached to the right required design.

- Sustainability
- Social
- Economic

3.1.1 Design Constraints: Sustainability

With Demand Response controller we have made an evaluation of our power use and determined that we are using too much and using it at the wrong time in the day. Demand-response controller allows us to reduce the peak demands during time when reliability may be threatened or wholesale market prices are high.

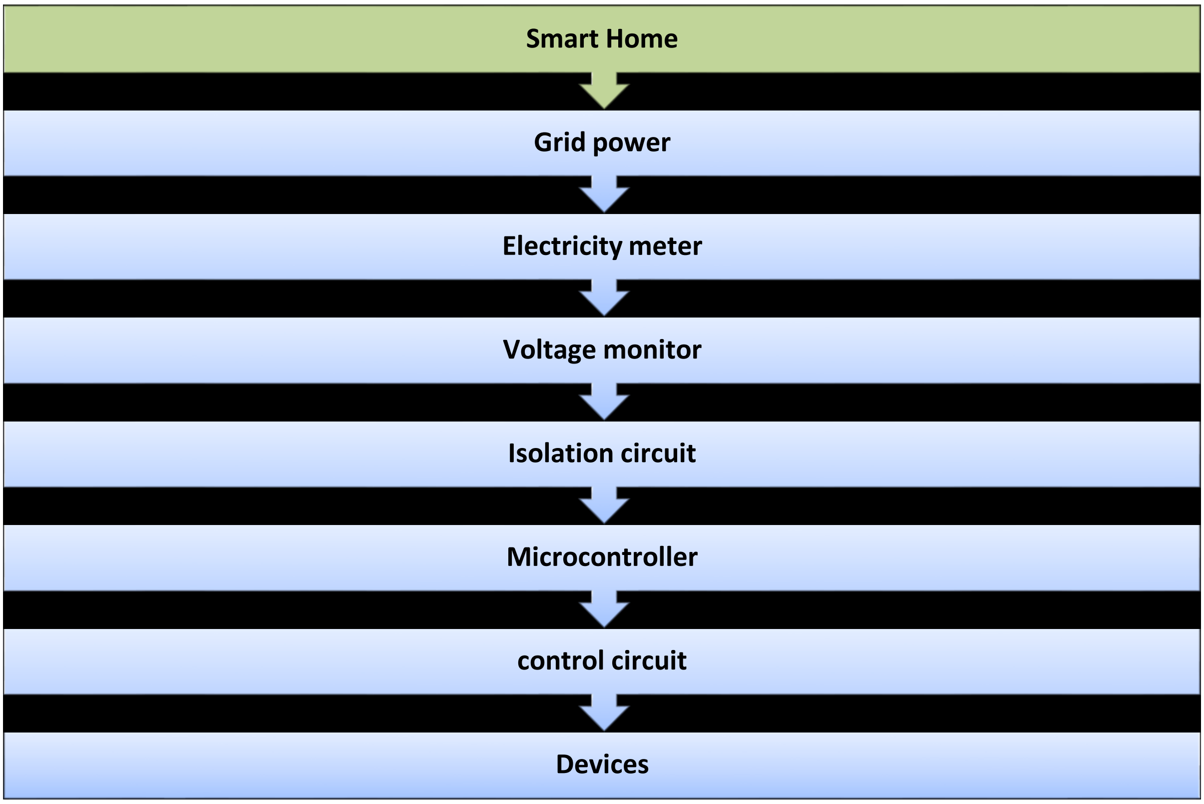
3.1.2 Design Constraints: Social

We have established an electricity meter and voltage monitor which let the people in the smart home to see the voltage consumption. On the other hand, they can act based on the measured voltage to reduce the excessive power consumption manually.

3.1.3 Design Constraints: Economic

In our residential building we have aimed to reduce both electricity loads and energy costs for us as end users. This has been by targeting to switch off unnecessary power usages such as utility lights, water heaters, etc.… during the peak time at a day.

3.2 Design Methodology



To have a smart home which controls the power consumption based on demand especially in the peak time we have designed our demand response controller. First of all we are going to receive the power supply from the grid. Then, it is going to pass through the electricity meter which measures the electricity consumption for the belling. After that, we have connected our voltammeter monitor the voltage consumption and to send it to the isolation circuit. Next, through the isolation circuit voltage will be converted from AC to DC volte and will be stepped down to 5v which is suitable to be send to the Microcontroller. After that the Microcontroller will do the comparison between the measured voltage and the set point. Finally, if the measured voltage is higher than the set points the Microcontroller will send a signal through the control circuit to switch off unnecessary lights or heaters or anything connected to be switched off in case of high consumption based on priorities.

3.3 Product Subsystems and Components

1. Microcontroller

2. Voltage sensor
3. IRF 840 (MOSFET)
4. Big resistor 15 Watts
5. Circuit board
6. Optocoupler
7. Smart house prototype

3.3.1 Product Subsystem1: Voltage Transducer LV 25-P/SP5

Features:

- Closed loop (compensated)voltage transducer using the Hall effect
- Insulating plastic case recognized according to UL 94-V0.

Special features:

TA = - 40 °C .. + 85 °C

Ud = 4.2 kV (4 kV DC / 5 min).

Principle of use:

For voltage measurements, a current proportional to the measured voltage must be passed through an external resistor R1 which is selected by the user and installed in series with the primary circuit of the transducer.

Advantages:

- Excellent accuracy
- Very good linearity
- Low temperature drift
- Optimized response time
- Wide frequency bandwidth
- High immunity to external interference.

Applications:

- Single or three phase inverters
- Propulsion and braking choppers
- Propulsion converters
- Auxiliary converters
- Battery chargers.

Application Domain:

- Traction.

3.3.2 Product Subsystem2: Optocoupler

Description:

This datasheet presents five families of Vishay industry standard single channel phototransistor couplers. These families include the 4N35, 4N36, 4N37, 4N38 couplers. Each optocoupler consists of gallium arsenide infrared bulbs and a silicon NPN phototransistor. These couplers are Underwriters Laboratories (UL) listed to comply with a 5000 VRMS isolation test voltage. This isolation performance is accomplished through Vishay double molding isolation manufacturing process. DIN EN 60747-5-5 partial discharge isolation specification is available for these families by ordering option 1. These isolation processes and the Vishay ISO9001 quality program results in the highest isolation performance available for a commercial plastic phototransistor optocoupler. The devices are available in lead formed configuration suitable for surface mounting and are available either on tape and reel, or in standard tube shipping containers.

Features:

- Isolation test voltage 5000 VRMS
- Interfaces with common logic families
- Input-output coupling capacitance < 0.5 pF • Industry standard dual-in-line 6 pin package
- Compliant to RoHS Directive 2002/95/EC and in accordance to WEEE 2002/96/EC

Applications:

- AC mains detection
- Reed relay driving
- Switch mode power supply feedback
- Telephone ring detection
- Logic ground isolation
- Logic coupling with high frequency noise rejection AGENCY APPROVALS

Agency Approvals:

- UL file no. E52744 (pending)
- cUL tested to CSA 22.2 bulletin 5A
- DIN EN 60747-5-2 (VDE 0884)/DIN EN 60747-5-5 (pending), available with option

- BSI: EN 60065, EN 60950-1
- FIMKO
- CQC

3.3.3 Product Subsystem3: *Transistor IRF 840 (MOSFET)*

For designing the run from a 5V logic drive to make easier responding with microcontroller use, that it will receive 1 Transistor in Anti-Static bag, it relies on a switching mechanism that provides a more precise control than other models, particularly in low-power due to its quicker switching capabilities. This in turn produces less heat as less energy is lost through the switching process. The result is a part that runs cooler efficiently. This process to make our responding from Microcontroller of performance of the circuit as a whole, while also being a more reliable unit due to the cooler running condition causing less stress to the internal electronics into our control circuit.

FEATURES:

Dynamic dV/dt rating
Repetitive avalanche rated
Fast switching
Ease of paralleling
Simple drive requirements
Material categorization: for definitions of compliance

SPECIFICATIONS:

Drain-Source Breakdown Voltage VDS
Zero Gate Voltage Drain Current IDSS

3.4 Implementation

1. First of all, we connected the Voltage to read from Microcontroller after that we put the isolation circuit. The voltage senor will read the voltage and send it to the microcontroller and then microcontroller will take actions based on the voltage value voltage.

2. In this design the main idea behind it is to reduce the load consumption in the peak time by targeting some devices which can be modified to solve this issue. Also, we have considered multiple alternatives in our subsystem which give us enough margins to achieve our main goal. Next, we have selected our components based on the data sheet supplied along with it to confirm it is the appropriate for our system. On the other hand, after we get the components to design our system we have started connecting it with each other and it was tested in the lab of PMU. Finally, after the completion of the test in the PMU lab we have confirmed that the testing result was satisfactory.
3. After checked our components, our team designed smart home that including the circuit control of demand to reduce and control the demand of loads consumptions as shown in figure (3.2).

figure (3.2). smart home

After the implementation, we get measure the voltage gets into our system and we but some issues like if the voltage from 209V to 220V the loads will work at the maximum and from 176V to 208V the loads will decreasing linearly. If we decrease the voltage from 175V and less that it will turn off all the loads.

4. System Testing and Analysis

4.1 Subsystem 1: Voltage Transducer LV 25-P/SP5

After connecting the voltage transducer to the Microcontroller, it was connected to an AC voltage source to measure the voltage and to see the actual value in the Microcontroller.
It is monitoring very accuracy and responding into the circuit control.

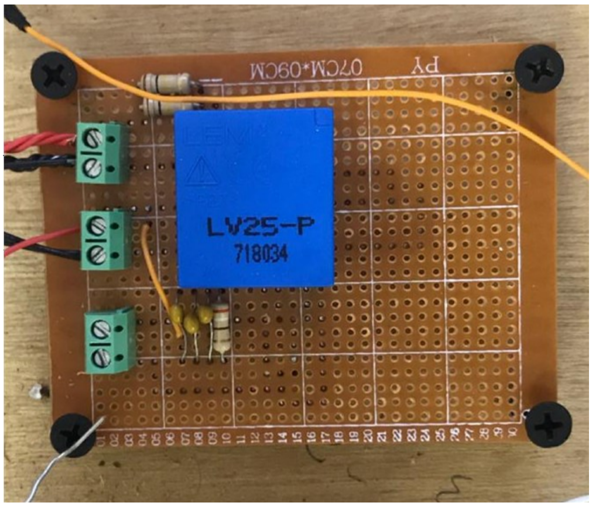


Figure 4.1. Voltage Transducer into control circuit

4.2 Subsystem 2: Optocoupler

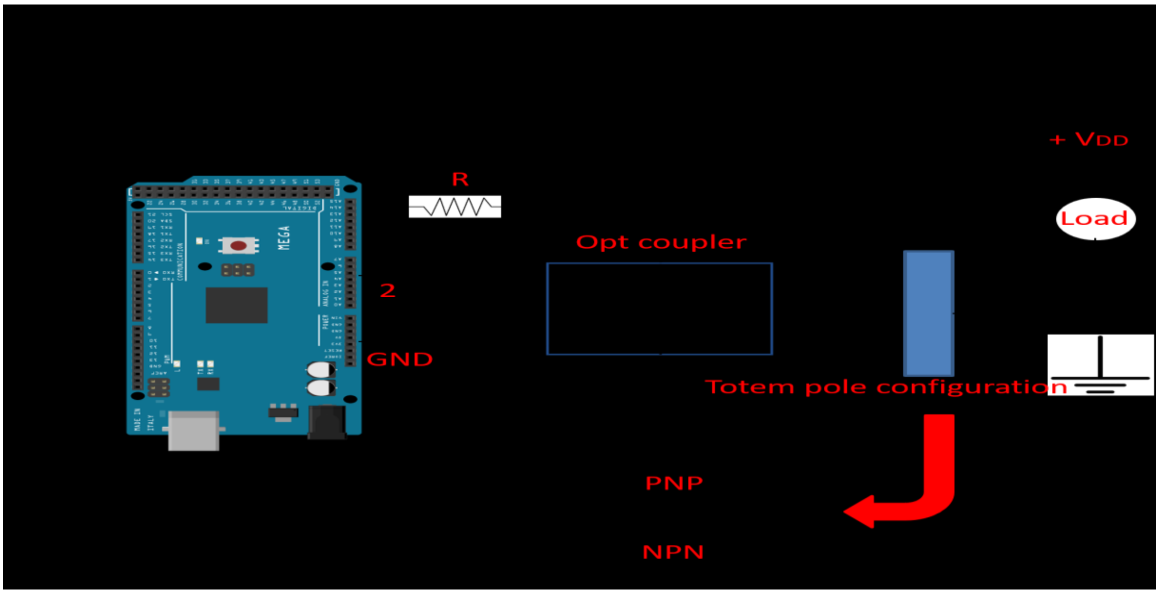


Figure 5.1. Optocoupler connection

For the subsystems we have tested the output signal after implementing the Arduino software configurations. The main thing here as shown in the above figure is the Optocoupler testing. Finally, we can see the duty cycle test result in the below figure:

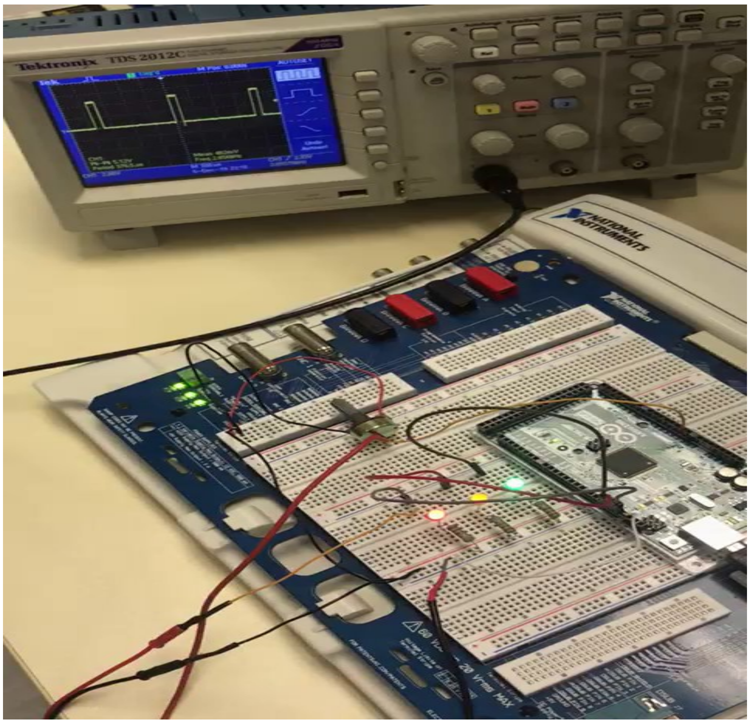


Figure 6.1. Voltage Duty cycle measurements

The lab instruments which been used in this test were as follow:

- Oscilloscope
- Connection bored
- 5 DC volte supply

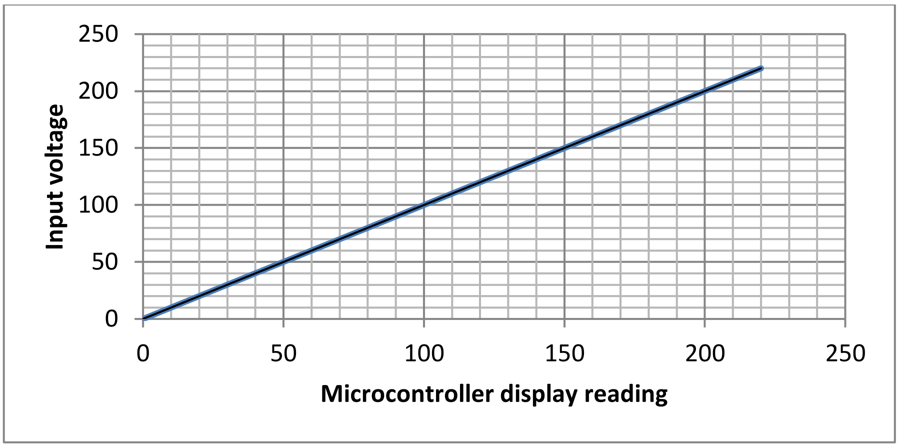
4.3 Overall Results, Analysis and Discussion

- In the below line chart, we can see the linear relationship between the voltage transducer and the Microcontroller display.

  This shows the level of accuracy which we have in this circuit.

Input voltage	Microcontroller display reading
0	0
40	40
80	80
120	120
160	160
200	200
220	220

Table 7.1. connection



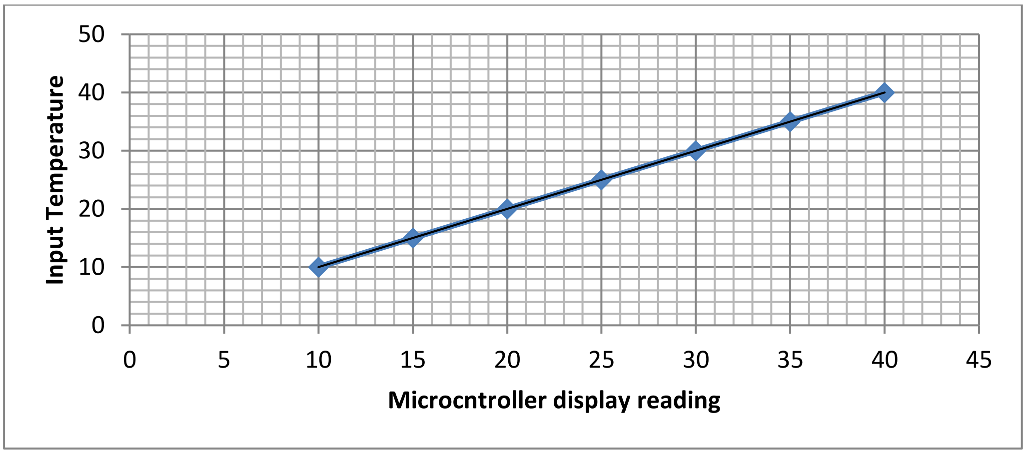
- In the below line chart we can see the linear relationship between the temperature transducer and the Microcontroller display.

This shows the level of accuracy which we have in this circuit.

Figure 4.3-2 Input Temperature VS Microcontroller display values.

Input Temperature	Microcontroller display reading
10	10
15	15
20	20
25	25
30	30
35	35
40	40

Table 8.1. connection



In the below phot we have seen the duty cycle which show that how we can reduce the power consumption by almost 50%.

This proves that how the duty cycle will play a major role in reducing the power consumption.

Optocoupler Output	Oscilloscope display
0	0
5	5
0	0
5	5
0	0
5	5

Table 9.1. connection

5. Project Management

3.2 Contribution of Team Members

We are four members in one team that each member has specific task and looking forward to make some differences than other projects as previous once. We've been meeting from time to another time every week in Abdullah's house usually for Planning. It is helpful to make success of our project, as you notice in the table below. We decided for each member of our team focusing on specific task completely under our oversees such as Ali mostly focusing on search and acquire components as that clearly in table:

Task	Ali	Abdulrahman	Abdullah	Safar	Task Total
Search & acquire components	**35%**	**30%**	**15%**	**20%**	**100%**
Design Subsystems	**30%**	**35%**	**10%**	**25%**	**100%**
Test Subsystems	**35%**	**35%**	**15%**	**15%**	**100%**
Write Reports & Presentations	**30%**	**30%**	**15%**	**25%**	**100%**

5.3 Project Execution Monitoring

There are various activities:

- We have some meetings with our advisor Mr. Saifullah to guide us with our options of our project for Demand Response Controller. He opens his door to us and telling what we should complete it next, from beginning until final presentation. We meet often in Saifullah's office every Tuesday and Thursday per week.
- We've meeting many times in Abdullah's house and Abdulrahman's house. All members of our team come in and decide which components are suited and how much will cost us to following certain standard as much as possible for users' safety. Also,

we met in Jamoka Café when we have a little pressure of exams to shortcut the time then made another appointment for meeting whether in house, Labs, and Jamoka Café in PMU.

- For testing we focusing on our subsystem each one to make sure all components are working and fitting our project than other components. We went to lab of electronics in the Prince Mohammed Bin Fahad University for measuring our subsystems and components especially with oscilloscope and other instruments for measuring and testing.

5.4 Challenges and Decision Making

Challenges Faced: There are challenges we faced in our project that impacted in the schedule, scope or expected results.

We sometimes got some issues because of witch subsystem is better than others. Most of us ended by voting.

- The problem we were worried about in shipping. We had been waiting three weeks to check when the shipment was coming. We ordered voltage transducer as we decided that will fit our needs by Amazon.com for looking to biggest selections of needs. Definitely, we got delayed in shipping.
- The testing for the Optocoupler is taking more time to show the results in Oscilloscope for displaying values. Also, not all subsystems are available.
- **Decision Making:** we used some Alternatives for testing each task. we tested our components relating to measurements of bulbs as devices and implemented voltage meter to take readings in in our test circuit. for delaying we tended to buy low quality of components temporarily which those are available in markets to serve our testing until the shipment is arrived to us. For voting as team to select better component often turned bake to our advisor

to feed us more about his experiences of knowledge. Despite this we have different opinions to face this issue in every few meetings but at the end we convinced for the best choice of quality according to our components before time is running out.

5.5 Project Bill of Materials and Budget

Item	Quantity	Unit Cost (SR)	Subtotal (SR)
Microcontroller	1	200	200
Voltage sensor	2	292	583
NAND Gate	2	10	20
IRF 840 (MOSFET)	4	5	20
Resistor 15 Watts	3	7	21
Circuit board	3	60	60
Optocoupler	4	5	20
Smart house prototype	1	800	800
Battery + charger	1	300	300
Miscellaneous			300 SR
Total			2324 SR

4. Project Analysis

6.1 Life-long Learning

We got more things to learn by ourselves after getting courses that motivate us to do researches. The most common things for engineers is the ambitious to understand more on how things work and what reason makes some components better than others. We did some researches in the Internets by looking to similar projects and getting feedback and wrote down what is necessary and what is not. As team each member has different skills more likely than other members at the same team, so with designing we have time restricted as deadline to finish all things as required. As following that what we learned:

- We used hardware devices such as (Arduino, advantages of transducer, how to handle PC relating to our project).
- We use software such as (C++, Assembly language, Microsoft excel and, Microsoft word)
- Time management skills are the most important skill. As a team member you should respect the meetings dates that was set by the leader our advisor in terms of completing the project without any delay or unexpected problems that leads to delay in the results.

6.2 Impact of Engineering Solutions

The Demand Response Controller is very helpful to every unit of our society that is using electricity. The demand of loads is consuming more energy especially when the market prices get high. While the period of works in environments need to develop their businesses that consuming more energy. However, people need to save their money to cover their other needs of live. Reduce the energy effort will help to get smart live of smart home.

6.3 Contemporary Issues Addressed

Demand Response controller enhances decreasing Annual electricity demand for the average household declines by 4 percent, from 12.1 megawatt hours (MWh) in 2019 to 11.6 MWh in 2020, the largest uses of electricity at the household level are space cooling, small devices and other minor electric uses, and lighting. In 2030, electricity consumed for devices per household is 40 percent lower, and electricity use for minor electric end uses and for space cooling rises by 33 percent, respectively. Regulations implementing the Demand Response Controller with ANSI standard contributes to lower the Energy Independence and Act a major factor in efficient compact.

7. Conclusions and Future Recommendations

7.1 Conclusions

Our project is to design and build a Demand Response Controller to control the demand of different residential appliances. The load demand of appliances can be controlled by adjusting the duty cycle of PWM signals fed to the devices. For initial results, we have written an Arduino code that controls the duty cycle of the PWM fed to some LEDs. The duty cycle is adjusted based on the input voltage received from the potentiometer. The previous projects have not designed the autonomous demand response controllers. Moreover, they need communication to know about how much load should be reduced. One of the challenges was to obtain the voltage transducer. Furthermore, we found some challenges in generating PWMs having different frequencies and duty cycles. Until now we have learnt how to generate PWMs using Arduino, how to control the duty cycle, and how to adjust the output frequency. We have also learnt how ADC works.

7.2 Future Recommendations

Currently, we are just checking voltage however, in future we may include the frequency as well. More loads can be considered as well

References

[1] https://www.ceicdata.com/en/saudi-arabia/electricity-statistics/electricity-consumption

[2] https://w3.usa.siemens.com/smartgrid/us/en/demand-response/demand-response-management-system/pages/demand_response_management_system1019-6647.aspx

[3] file:///Users/abdullahkhalid/Desktop/buildings-08-00013.pdf

[4] https://www.ofgem.gov.uk/gas/retail-market/metering/transition-smart-meters/energy-demand-research-project

[5] http://www.powerqualityworld.com/2011/04/ansi-c84-1-voltage-ratings-60-hertz.html

Appendix A: Progress Reports

Title: Smart Electric Car	Advisor: Mr Saifullah Shafiq	Design II (ASSE 3)	Spring 2019
Ali Almarri	201402732	Project PLAN & Progress	
Abdulrahman Saed	201300522	ProgRpt No. 1	
Safar Almaymouni	200900309	Plan updated (Date): Feb 4, 2019	
Abdullah Alsalem	201101602	Instructor: Dr. Chedly B. Yahya	

Period Highlight: 4 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write plan	1	1	ALL	1	1	100%
Design subsystem 1 (Voltage monitoring)	2	1	ALL	2	3	100%
Test subsystem 1	2	1	ALL	2	2	90%
Buy all the componants needed	3	2	732	3	4	100%
Finish with subsystem 1	3	3	732	5	5	80%
Design subsystem SS2 (control circuit)	4	2	522, 309			50%
Select & acquire components for SS2	5	2	732			0%
Order components for SS2 (Control Circuit)	5	3	732			0%
Implement Design for SS2	5	2	602, 309			0%
Test and refine design for SS2	6	1	522, 732			0%
Prepare midterm Presentation	7	3	ALL			0%
Integrate subsystems SS1 & SS2	8	1	602,309			0%
Designing structure of smart house	9	4	ALL			0%
Verify overall design	10	3	ALL			0%
Fitting the whole system in the smart home	10	2	ALL			0%
Prepapre final report	12	2	ALL			0%
Prepapre final presentation	12	2	ALL			0%
Prepare Project Demo	13	3	ALL			0%
Submit Rpt/PPT/Brochure	14	2	522			0%
						0%
						0%
						0%

Progress Details:
We have completed the preparation of the plan for our project in the first week. After that, in the second week we have completed the design of subsystem 1 (Voltage monitoring). In the third week we did the test in the machinery lab along with programing but unfortunately it doesn't work we are still troubleshooting to make the system working well. Finally, in the fourth week we have bought all the components needed for our project.

Issues (delay ...):
We have faced an issue with the optocoupler since we couldn't find it locally and we have to buy it through the internet. This will take time which will impact our progress. Later on we found an alternative one which can do the same function and it was available locally. Also, the subsystem 1 doesn't work after we have completed all connections and programing and we couldn't sort the issue yet.

Title: Smart Electric Car	Advisor: Mr Saifullah Shafiq	Design II (ASSE 3)	Spring 2019
Ali Almarri	201402732	Project PLAN & Progress	
Abdulrahman Saed	201300522	ProgRpt No. 2	
Safar Almaymouni	200900309	Plan updated (Date): Feb 18, 2019	
Abdullah Alsalem	201101602	Instructor: Dr. Chedly B. Yahya	

Period Highlight: 4 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15): 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write plan	1	1	ALL	1	1	100%
Design subsystem 1 (Voltage monitoring)	2	1	ALL	2	3	100%
Test subsystem 1	2	1	ALL	2	2	100%
Buy all the componants needed	3	2	732	3	4	100%
Finish with subsystem 1	3	3	732	3	5	100%
Design subsystem SS2 (control circuit)	4	2	522, 309	4	3	95%
Select & acquire components for SS2	5	2	732	5	3	100%
Order components for SS2 (Control Circuit)	5	3	732	5	3	100%
Implement Design for SS2	5	2	602, 309	5	2	90%
Test and refine design for SS2	6	1	522, 732	6	2	90%
Prepare midterm Presentation	7	3	ALL			0%
Integrate subsystems SS1 & SS2	8	1	602,309			0%
Designing structure of smart house	9	4	ALL			0%
Verify overall design	10	3	ALL			0%
Fitting the whole system in the smart home	10	2	ALL			0%
Prepapre final report	12	2	ALL			0%
Prepapre final presentation	12	2	ALL			0%
Prepare Project Demo	13	3	ALL			0%
Submit Rpt/PPT/Brochure	14	2	522			0%
						0%
						0%
						0%

Progress Details:
We have selected all the required components for subsystem 2 and we bout it from a local agent in Saudi Arabia. Then, after doing the connection the test have been conducted for subsystem 2, it was found functioning well, witnessed by our advisor, and the remaining part is to connect it to Arduino.

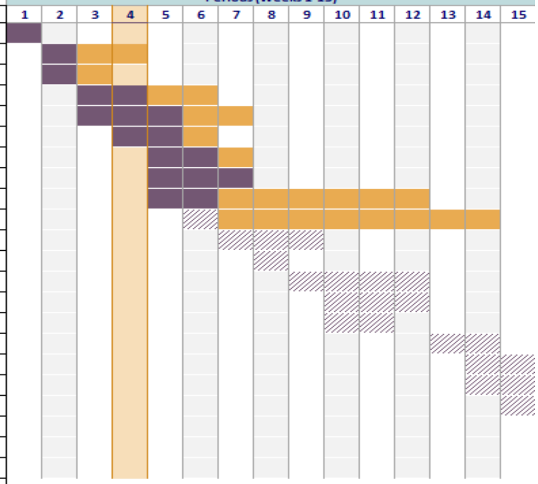
Issues (delay ...):
We have faced an issue with the Arduino codes since we couldn't implement it in the right way and we are still working on it to get it done as soon as possible along with our advisor.

Demand response controller	Advisor: Mr Saifullah Shafiq	Design II (ASSE 3)	Spring 2019
Ali Almarri	201402732	Project PLAN & Progress	
Abdulrahman Saed	201300522	ProgRpt No. 3	
Safar Almaymouni	200900309	Plan updated (Date): Mar 3, 2019	
Abdullah Alsalem	201101602	Instructor: Dr. Chedly B. Yahya	

Period Highlight: 4 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write plan	1	1	ALL	1	1	100%
Design subsystem 1 (Voltage monitoring)	2	1	ALL	2	3	100%
Test subsystem 1	2	1	ALL	2	2	100%
Buy all the componants needed	3	2	732	3	4	100%
Finish with subsystem 1	3	3	732	3	5	100%
Design subsystem SS2 (control circuit)	4	2	522, 309	4	3	100%
Select & acquire components for SS2	5	2	732	5	3	100%
Order components for SS2 (Control Circuit)	5	3	732	5	3	100%
Implement Design for SS2	5	2	602, 309	5	8	100%
Test and refine design for SS2	6	1	522, 732	7	8	100%
Prepare midterm Presentation	7	3	ALL			0%
Integrate subsystems SS1 & SS2	8	1	602,309			0%
Designing structure of smart house	9	4	732			0%
Verify overall design	10	3	ALL			0%
Fitting the whole system in the smart home	10	2	ALL			0%
Prepapre final report	13	2	ALL			0%
Prepapre final presentation	14	2	ALL			0%
Prepare Project Demo	14	3	ALL			0%
Submit Rpt/PPT/Brochure	15	2	522			0%
						0%
						0%
						0%



Progress Details:
We test the SS2 and its work with us and we get the measurement like we want. The SS1 we finished it from the last semester and its work with us and its complete. We order the home to implement all of the SS1 And SS2 inside it.

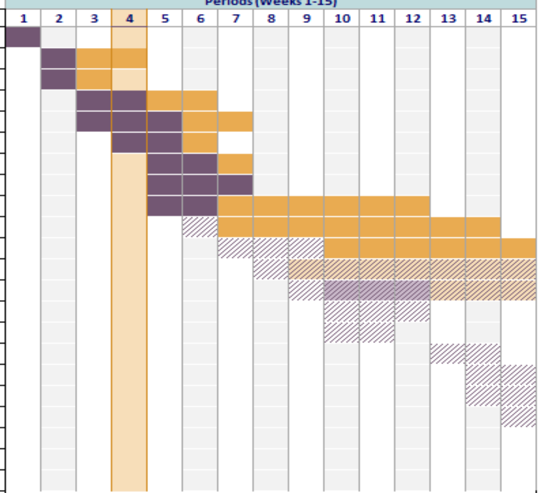
Issues (delay ...):
We have faced an issue with the Arduino codes since we couldn't implement it in the right way and we are still working on it to get it done as soon as possible along with our advisor.

Demand response controller	Advisor: Mr Saifullah Shafiq	Design II (ASSE 3)	Spring 2019
Ali Almarri	201402732	Project PLAN & Progress	
Abdulrahman Saed	201300522	ProgRpt No. 4	
Safar Almaymouni	200900309	Plan updated (Date): Mar 17, 2019	
Abdullah Alsalem	201101602	Instructor: Dr. Chedly B. Yahya	

Period Highlight: 4 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write plan	1	1	ALL	1	1	100%
Design subsystem 1 (Voltage monitoring)	2	1	ALL	2	3	100%
Test subsystem 1	2	1	ALL	2	2	100%
Buy all the componants needed	3	2	732	3	4	100%
Finish with subsystem 1	3	3	732	3	5	100%
Design subsystem SS2 (control circuit)	4	2	522, 309	4	3	100%
Select & acquire components for SS2	5	2	732	5	3	100%
Order components for SS2 (Control Circuit)	5	3	732	5	3	100%
Implement Design for SS2	5	2	602, 309	5	8	100%
Test and refine design for SS2	6	1	522, 732	7	8	100%
Prepare midterm Presentation	7	3	ALL	10	10	100%
Integrate subsystems SS1 & SS2	8	1	602,309	9	8	0%
Designing structure of smart house	9	4	732	10	9	0%
Verify overall design	10	3	ALL			0%
Fitting the whole system in the smart home	10	2	ALL			0%
Prepapre final report	13	2	ALL			0%
Prepapre final presentation	14	2	ALL			0%
Prepare Project Demo	14	3	ALL			0%
Submit Rpt/PPT/Brochure	15	2	522			0%
						0%
						0%
						0%



Progress Details:
We get the entire component for the smart home and we started to build it and we need it in a good way. We selected the plastic because we need every one to see inside the home like the circuit or the loads.

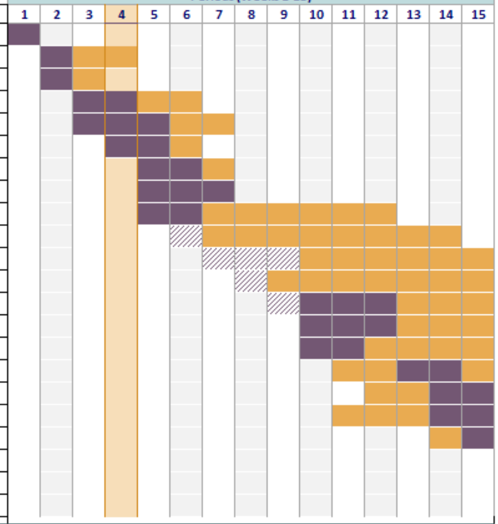
Issues (delay ...):
In the First of the semester we need the home made from the fiberglass and we search about it and we can't find it. We have faced an issue with the fiberglass and we changed with the plastic to can see everything inside the home.

Demand response controller	Advisor: Mr Saifullah Shafiq	Design II (ASSE 3)	Spring 2019
Ali Almarri	201402732	Project PLAN & Progress	
Abdulrahman Saed	201300522	ProgRpt No. 5	
Safar Almaymouni	200900309	Plan updated (Date): Mar 31, 2019	
Abdullah Alsalem	201101602	Instructor: Dr. Chedly B. Yahya	

Period Highlight: 4 — Plan — Actual — Actual (beyond plan) — % Complete (beyond plan)

Periods (Weeks 1-15)

ACTIVITY	PLAN START	PLAN DURATION	Assigned To	ACTUAL START	ACTUAL DURATION	PERCENT COMPLETE
Write plan	1	1	ALL	1	1	100%
Design subsystem 1 (Voltage monitoring)	2	1	ALL	2	3	100%
Test subsystem 1	2	1	ALL	2	2	100%
Buy all the componants needed	3	2	732	3	4	100%
Finish with subsystem 1	3	3	732	3	5	100%
Design subsystem SS2 (control circuit)	4	2	522, 309	4	3	100%
Select & acquire components for SS2	5	2	732	5	3	100%
Order components for SS2 (Control Circuit)	5	3	732	5	3	100%
Implement Design for SS2	5	2	602, 309	5	8	100%
Test and refine design for SS2	6	1	522, 732	7	8	100%
Prepare midterm Presentation	7	3	ALL	10	10	100%
Integrate subsystems SS1 & SS2	8	1	602,309	9	8	100%
Designing structure of smart house	9	4	732	10	9	100%
Verify overall design	10	3	ALL	10	11	100%
Fitting the whole system in the smart home	10	2	ALL	10	12	100%
Prepapre final report	13	2	ALL	11	13	100%
Prepapre final presentation	14	2	ALL	12	12	100%
Prepare Project Demo	14	3	ALL	11	12	100%
Submit Rpt/PPT/Brochure	15	2	522	14	14	100%
						0%
						0%
						0%



Progress Details:
We tried all the SS1 and the SS2 and its all working but we need to implement all the SS1 and SS2 inside the home to finish it. When we finish implementing all the circuit we will start to writing the final report because of that we need to finish fast.

Issues (delay ...):
We have faced problem with the paint for the roof and the front of the home because the plastic can't be painted with any paint. There are a specific paint for the plastic and we order it.

Appendix B: Bill of Materials

Item	Quantity	Unit Cost (SR)	Subtotal (SR)
Microcontroller	1	200	200
Voltage sensor	2	292	583
NAND Gate	2	10	20
IRF 840 (MOSFET)	4	5	20
Resistor 15 Watts	3	7	21
Circuit board	3	60	60
Optocoupler	4	5	20
Smart house prototype	1	800	800
Battery + charger	1	300	300
Miscellaneous			300 SR
Total			2324 SR

Appendix C: Datasheets

TEXAS INSTRUMENTS

LM35

SNIS159H –AUGUST 1999–REVISED DECEMBER 2017

LM35 Precision Centigrade Temperature Sensors

1 Features

- Calibrated Directly in Celsius (Centigrade)
- Linear + 10-mV/°C Scale Factor
- 0.5°C Ensured Accuracy (at 25°C)
- Rated for Full −55°C to 150°C Range
- Suitable for Remote Applications
- Low-Cost Due to Wafer-Level Trimming
- Operates From 4 V to 30 V
- Less Than 60-µA Current Drain
- Low Self-Heating, 0.08°C in Still Air
- Non-Linearity Only ±¼°C Typical
- Low-Impedance Output, 0.1 Ω for 1-mA Load

2 Applications

- Power Supplies
- Battery Management
- HVAC
- Appliances

3 Description

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range. Lower cost is assured by trimming and calibration at the wafer level. The low-output impedance, linear output, and precise inherent calibration of the LM35 device makes interfacing to readout or control circuitry especially easy. The device is used with single power supplies, or with plus and minus supplies. As the LM35 device draws only 60 µA from the supply, it has very low self-heating of less than 0.1°C in still air. The LM35 device is rated to operate over a −55°C to 150°C temperature range, while the LM35C device is rated for a −40°C to 110°C range (−10° with improved accuracy). The LM35-series devices are available packaged in hermetic TO transistor packages, while the LM35C, LM35CA, and LM35D devices are available in the plastic TO-92 transistor package. The LM35D device is available in an 8-lead surface-mount small-outline package and a plastic TO-220 package.

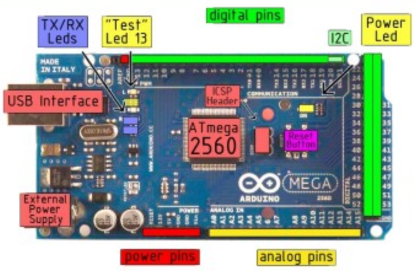
Technical Specification

EAGLE files: arduino-mega2560-reference-design.zip Schematic: arduino-mega2560-schematic.pdf

Summary

Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB
Clock Speed	16 MHz

the board



LEM

Voltage Transducer LV 25-P

I_{PN} = 10 mA
V_{PN} = 10 .. 500 V

For the electronic measurement of currents: DC, AC, pulsed..., with galvanic separation between the primary circuit and the secondary circuit.

Electrical data

I_{PN}	Primary nominal rms current	10		mA
I_{PM}	Primary current, measuring range	0 .. ± 14		mA
R_M	Measuring resistance	$R_{M\,min}$	$R_{M\,max}$	
	with ± 12 V @ ± 10 mA max	30	190	Ω
	@ ± 14 mA max	30	100	Ω
	with ± 15 V @ ± 10 mA max	100	350	Ω
	@ ± 14 mA max	100	190	Ω
I_{SN}	Secondary nominal rms current	25		mA
K_N	Conversion ratio	2500 : 1000		
U_C	Supply voltage (± 5 %)	± 12 .. 15		V
I_C	Current consumption	10 (@ ± 15 V) + I_S		mA

Accuracy - Dynamic performance data

X_G	Overall accuracy @ I_{PN}, T_A = 25 °C @ ± 12 .. 15 V	± 0.9		%
	@ ± 15 V (± 5 %)	± 0.8		%
ε_L	Linearity error	< 0.2		%
		Typ	Max	
I_O	Offset current @ I_P = 0, T_A = 25 °C		± 0.15	mA
I_{OT}	Temperature variation of I_O 0 °C .. + 25 °C	± 0.06	± 0.25	mA
	+ 25 °C .. + 70 °C	± 0.10	± 0.35	mA
t_r	Step response time [1] to 90 % of I_{PN}	40		µs

General data

T_A	Ambient operating temperature	0 .. + 70	°C
T_S	Ambient storage temperature	- 25 .. + 85	°C
R_P	Resistance of primary winding @ T_A = 70 °C	250	Ω
R_S	Resistance of secondary winding @ T_A = 70 °C	110	Ω
m	Mass	22	g
	Standards	EN 50178: 1997 UL 508: 2010	

Features

- Closed loop (compensated) current transducer using the Hall effect
- Insulating plastic case recognized according to UL 94-V0.

Principle of use

- For voltage measurements, a current proportional to the measured voltage must be passed through an external resistor R_1 which is selected by the user and installed in series with the primary circuit of the transducer.

Advantages

- Excellent accuracy
- Very good linearity
- Low thermal drift
- Low response time
- High bandwidth
- High immunity to external interference
- Low disturbance in common mode.

Applications

- AC variable speed drives and servo motor drives
- Static converters for DC motor drives

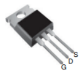
VISHAY. www.vishay.com

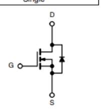
IRF840, SiHF840
Vishay Siliconix

Power MOSFET

PRODUCT SUMMARY		
V_{DS} (V)	500	
$R_{DS(on)}$ (Ω)	V_{GS} = 10 V	0.85
Q_g max. (nC)	63	
Q_{gs} (nC)	9.3	
Q_{gd} (nC)	32	
Configuration	Single	

TO-220AB





N-Channel MOSFET

FEATURES

- Dynamic dV/dt rating
- Repetitive avalanche rated
- Fast switching
- Ease of paralleling
- Simple drive requirements
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb Available
RoHS* Available

Note
* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non-RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details.

DESCRIPTION

Third generation power MOSFETs from Vishay provide the designer with the best combination of fast switching, ruggedized device design, low on-resistance and cost-effectiveness.
The TO-220AB package is universally preferred for all commercial-industrial applications at power dissipation levels to approximately 50 W. The low thermal resistance and low package cost of the TO-220AB contribute to its wide acceptance throughout the industry.

RS Radiosp... RADIONICS

SHARP

PC817XNNSZ0F

PC817XNNSZ0F Series

DIP 4pin
Photocoupler

■Description

PC817XNNSZ0F Series contains an IRED optically coupled to a phototransistor.
It is packaged in a 4-pin DIP.
Input-output isolation voltage(rms) is 5kV.
Collector-emitter voltage is 80V.

■Agency approvals/Compliance

1. Approved by UL
   file No. E64380 (as model No. PC817)
2. Approved by CSA
   file No. CA95323 (as model No. PC817)
3. Package resin : UL flammability grade (94V-0)

■Applications

1. Programmable controllers
2. Facsimiles
3. Telephones

■Features

1. 4-pin DIP package
2. Double transfer mold package (Ideal for Flow Soldering)
3. High isolation voltage between input and output (Viso(rms) : 5kV)
4. High collector-emitter voltage(V_{CEO} : 80V)
5. Current transfer ratio (CTR : MIN. 50% at I_F=5 mA, V_{CE}=5V)
6. RoHS directive compliant

Appendix D: Program Codes

```
void setup() {
pinMode(4, OUTPUT);
pinMode(13,OUTPUT);
Serial.begin(9600);
TCCR0A=0;//reset the register
TCCR0B=0;//reset tthe register
TCCR0A=0b10100011;// fast pwm mode
TCCR0B=0b00000011;// prescaler 64
OCR0A=100;//duty cycle for pin 6
OCR0B=50;//duty cycle for pin 5
}
void loop() {
//int A = analogRead(A0);
//int duty_cycle = (A/1024.0)*255.0;
//Serial.println(duty_cycle);
//OCR0A=duty_cycle;
//OCR0B=duty_cycle;

int B = analogRead(A1);
delay(20);
int B2 = analogRead(A1);
delay(20);
int B3 = analogRead(A1);
delay(20);
int B4 = analogRead(A1);
delay(20);
int B5 = analogRead(A1);
delay(20);
int B6 = analogRead(A1);
delay(20);
int B7 = analogRead(A1);
delay(20);
int B8 = analogRead(A1);
delay(20);
int B9 = analogRead(A1);
```

```
double B_avg = (B+B2+B3+B4+B5+B6+B7+B8+B9)/9;
double Vout = (B_avg/1023.0)*5.0;
double voltage = (Vout*220.3/4.52);
if (B_avg>=877){
OCR0A = 255;
OCR0B = 255;
}
else if (B_avg<733){
OCR0A = 0;
OCR0B = 0;
}
else {
  OCR0A = (B_avg - 733)*255.0/(877-733);
  OCR0B = (B_avg - 733)*255.0/(877-733);
}

int duty_cycle = (B_avg/1024.0)*255.0;
//Serial.print("The value of B is ");
//Serial.println(B_avg);
//Serial.print("The value of Vout is ");
//Serial.println(Vout);
Serial.print("The value of voltage is ");
Serial.println(voltage);

delay(2000);


}
```

Appendix E: Operation Manual