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AUTOMATIC MAIN FAILURE (AMF) SYSTEM

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AUTOMATIC MAIN FAILURE (AMF) SYSTEM

SAIFUL ANUAR BIN ALWI

This thesis is submitted as partial fulfillment of the requirements for the award of the Bachelor of Electrical Engineering (Power System)

Faculty of Electrical & Electronics Engineering
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"I hereby acknowledge that the scope and quality of this thesis is qualified for the award of the Bachelor of Electrical Engineering (Power System)"

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To my beloved father and mother

Alwi bin Abas

Zainab binti Sain

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In the name of Allah S.W.T, the Most Gracious, the Ever Merciful. Praise is to Allah, Lord of the Universe and Peace and Prayers be upon His Final Prophet and Messenger Muhammad S.A.W.

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ABSTRACT

Recently, solar energy has become one of the important alternative power supply for many devices due to the rises of fuel price. The limitedness of this kind of energy is its depend on the existence or the brightness of sunlight. This thesis presents a way to keep any 12V devices powered by solar power get the continuous power. The purposes of this project are to design and build a system that called Automatic Main Failure (AMF) System which can automatically allow switching from solar cell power supply to a battery as backup power supply. To execute this system, there are three main elements is used which are voltage sensor, microcontroller and relay switch. The system is continually monitoring the voltage level from solar cell. If the voltage is dropped below the allowed level, this system will switch the device to battery and switch back to solar cell when the level voltage is back to normal. If the voltage from solar cell is higher than allowed level, the voltage will be regulated to normal level through a voltage regulator. Thus the device will get a continuous power and protected from the effects of under-voltage and over-voltage.

ABSTRAK

Kebelakangan ini, tenage solar telah menjadi salah satu sumber tenaga alternatif yang penting akibat daripada kenaikan harga bahan bakar. Kelemahan sumber tenaga jenis ini adalah disebabkan kebergantungan kepada kehadiran atau kecerahan cahaya matahari. Tesis ini membentangkan mengenai satu cara untuk memastikan apa sahaja alatan bervoltan 12 volt yang menggunakan sel solar sebagai sumber tenaga mendapat tenaga yang berterusan. Projek ini adalah bertujuan mereka dan membina sebuah sistem yang dipanggil Sistem Kegagalan Utama Automatik yang mana secara automatiknya boleh memindahkan suis dari tenaga solar sel kepada bateri yang bertindak sebagai sumber tenaga sokongan. Bagi melaksanakan sistem ini, terdapat tiga elemen penting digunakan iaitu pengesan voltan, pengawal-mikro dan suis geganti. Sistem ini secara berterusan memerhati tahap voltan dari sel solar. Jika voltan jatuh dibawah tahap yang dibenarkan, sistem ini akan memindahkan sambungan alatan kepada bateri. Jika voltan dari sel solar melebihi tahap yang dibenarkan, voltan tersebut akan ditetapkan kepada keadaan normal menggunkan penetap voltan. Disebabkan itu, alatan akan mendapat tenaga yang berterusan dan dilindungi dari kesan akibat kekurangan voltan dan lebihan voltan.

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LIST OF ABBREVIATIONS

AMF	=	Automatic Main Failure
BJT	=	Bipolar Junction Transistor
IC	=	Integrated Circuit
LED	=	Light-Emitting Diode
LCD	=	Liquid Crystal Display

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Overview

Automatic Main Failure (AMF) System is a system by which can automatically transfer the switch from solar cell power supply to battery when anomaly such voltage drop, over-voltage and outage or blackout is occurred at the main power. AMF continually monitor the level of voltage at both power supplies but the priority is given to the solar cell as the main supply.

When the level of voltage is dropped below the normal condition, system will transfer the load from main power to battery as backup power to assure the load is continuously powered with allowed voltage level. And when the level of voltage is higher than the allowed voltage level, the power from solar cell will be regulated using the suitable voltage regulator to assure also the load get the proper level of voltage.

Voltage drop is the reduction in voltage in an electrical circuit between the source and load. In electrical wiring national and local electrical codes may set guidelines for maximum voltage drop allowed in a circuit, to ensure reasonable efficiency of distribution and proper operation of electrical equipment. [2]

When the voltage in a circuit or part of it is raised above its upper design limit, this is known as overvoltage. The conditions may be hazardous. Depending on its duration, the overvoltage event can be permanent or transient, the latter case also being known as a voltage spike. Electronic and electrical devices are designed to operate at a certain maximum supply voltage, and considerable damage can be caused by voltage that is higher than that for which the devices are rated. [3]

AMF system consists of three main elements which are voltage comparator, PIC microcontroller and relay switch. The voltage comparator is used to set and monitor the voltage level at both power supplies. The PIC microcontroller acts as the brain of the system that monitors the output signal from voltage comparator circuit and control the switching of relay accordingly. The relay is used to transfer the load either to the solar power as the main supply or to the battery as the backup supply.

1.2 Objectives

The objectives of this project are to:

i. Design a system that allows switching from solar power to backup power when anomaly is detected.
ii. Design an automatic system using PIC microcontroller

1.3 Scope

There are two areas or subjects matter that relevant to the project;

i. Software part that include processes of writing PIC program using MicroCode Studio software and simulate the system using ISIS Pro.

ii. Hardware part that include processes of interfacing the PIC microcontroller, voltage comparator and relay

1.4 Problem Statement

i. A device will not operate efficiently due to the voltage drop
ii. A device may damage due to overvoltage

1.5 Thesis Organization

This thesis consists of 7 chapters including this chapter. The content of each chapter are outlined as follows:

Chapter 1: Introducing the overview of project including the objective and scope of project.

Chapter 2: Introducing the background knowledge and literature review of voltage comparator, PIC microcontroller and relay.

Chapter 3: Include the project methodology. This will explain how the project was organized and the flow of system designed.

Chapter 4: The result will be analyzed and discussed.

Chapter 5: The overall conclusion of this project that have been completed.

CHAPTER 2

LITERATURE REVIEW

2.1 Voltage Comparator

A voltage comparator circuit consists of an operational amplifier, often called an op-amp, that compares input voltage and provides switches its digital output to indicate which is input is larger. A basic unit of voltage comparator circuit can be represented as in Figure 2.1. The output will stays at a high voltage level when the noninverting (+) input is greater than the voltage level at the inverting (-) input and switches to a lower voltage level when the noninverting input goes below the inverting input voltage.

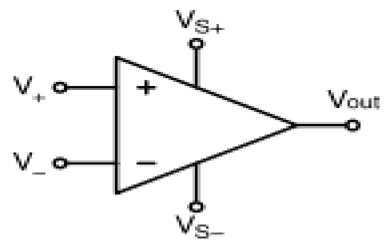
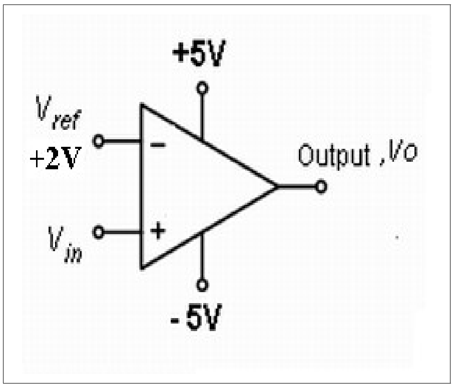


Figure 2.1 Basic unit of voltage comparator circuit

Figure 2.2a shows the example of typical connection with the inverting input connected to a reference voltage, the other connected to the input signal voltage. As long as V_{in} is less than the reference voltage level of +2V, the output remains at low voltage level. When the input is rises just above +2V, the output voltage quickly switches to a high voltage level. The waveform of the analog input signal and the digital output signal of the comparator unit in Figure 2.2a is shown in Figure 2.2b.



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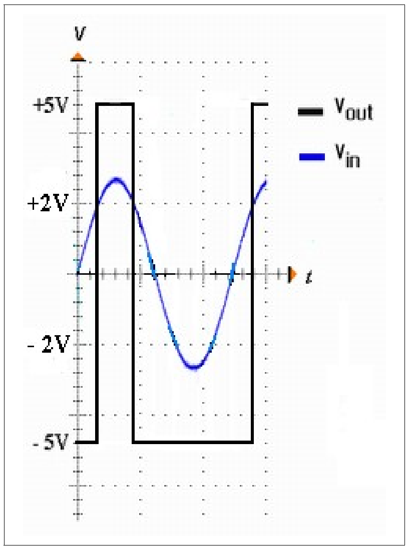


(b)

Figure 2.2 Operation of voltage comparator unit

Generally, the reference level can be any desired positive or negative or even zero voltage. Also, the reference voltage, V_{ref} may connected to either inverting or noninverting input terminal and the input signal, V_i then applied to the other input terminal.

2.2 PIC microcontroller

PIC (Peripheral Interface Controller) is the IC which was developed to control peripheral devices, alleviating the load from the main CPU (Control Processing Unit). Compared to a human being, PIC is equivalent to the autonomic nervous system.

The PIC, like the CPU, has calculation functions and memory, and is controlled by the software. However, the throughput and the memory capacity are low. Depending on the kind of PIC, the maximum clock operating frequency is about

20 MHz and the memory capacity to write the program is about 1000 to 4000 words. The clock frequency determines the speed at which a program is read and an instruction is executed. The throughput cannot be judged with the clock frequency alone. It changes with the processor architecture. However within the same architecture, the one with the highest clock frequency has the highest throughput.

The PIC is convenient for making calculations. The memory, the input or output ports and so on are incorporated into the IC (Integrated Circuit). The efficiency and the functions are limited, but the PIC can do the job of many IC's with software. So, the circuit can be compact.

2.3 Relay

A relay is an electrical switch that opens and closes under the control of another electrical circuit. In the original form, the switch is operated by an electromagnet to open or close one or many sets of contacts. Because a relay is able to control an output circuit of higher power than the input circuit, it can be considered to be a form of an electrical amplifier.

Since relays are switches, the terminology applied to switches is also applied to relays. A relay will switch one or more poles, each of whose contacts can be thrown by energizing the coil in one of three ways:

i. Normally-open (NO) contacts connect the circuit when the relay is activated; the circuit is disconnected when the relay is inactive. It is also called a Form A contact or "make" contact.

ii. Normally-closed (NC) contacts disconnect the circuit when the relay is activated; the circuit is connected when the relay is inactive. It is also called a Form B contact or "break" contact.

The following designations are commonly encountered for relay:

i. SPST - Single Pole Single Throw. These have two terminals which can be connected or disconnected. Including two for the coil, such a relay has four terminals in total. It is ambiguous whether the pole is normally open or normally closed.

ii. SPDT - Single Pole Double Throw. A common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

iii. DPST - Double Pole Single Throw. These have two pairs of terminals. Equivalent to two SPST switches or relays actuated by a single coil. Including two for the coil, such a relay has six terminals in total.

iv. DPDT - Double Pole Double Throw. These have two rows of change-over terminals. Equivalent to two SPDT switches or relays actuated by a single coil. Such a relay ha

CHAPTER 3

METHODOLOGY

3.1 Overall System Design

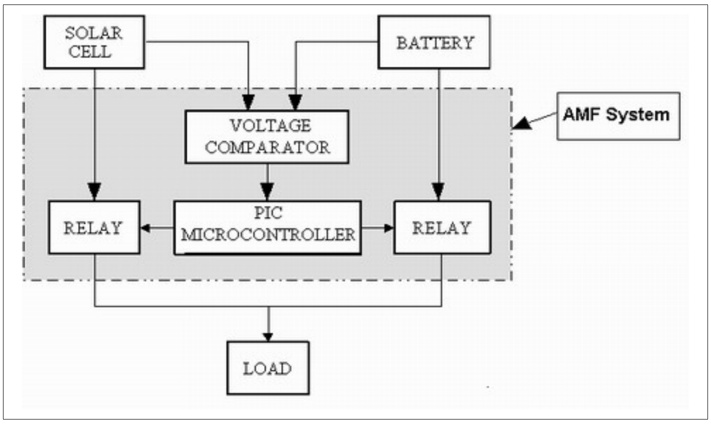
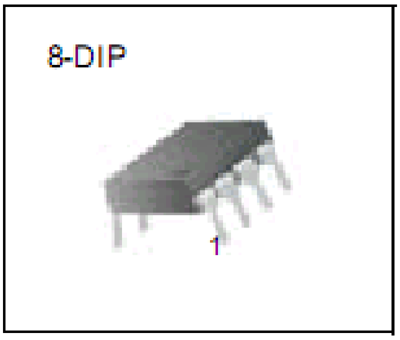


Figure 3.1 Block Diagram of the System

The block diagram in Figure 3.1 shows the interconnection of main elements in AMF systems which are voltage comparator, PIC microcontroller and relay switch.

3.2 Setting Up The Level Of Voltage

Voltage comparator usually used to set a level of voltage, both high and low. In this project, LM741 is used to implement the comparator circuit due to its low price, easiness to find and robust to heat. Figure 3.2 shows the configuration of LM741. The LM741 are general purpose operational amplifiers. It is intended for a wide range of analog applications. The high gain and wide range of operating voltage provide superior performance in integrator, summing amplifier, and general feedback applications.



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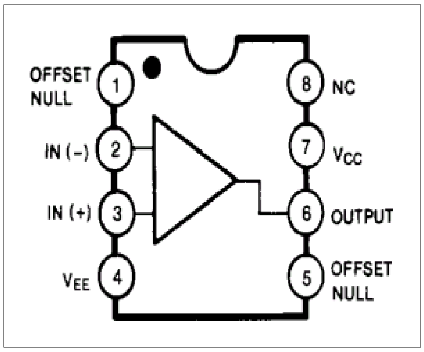

(b)

Figure 3.2 Configuration of LM741

The Figure 3.2a shows the actual LM741 while Figure 3.2b shows the internal block diagram of LM741. Pin 2 and pin 3 are the input pins while pin 6 is the output pin. Pin 8 is used for power supply and pin 4 is used for grounding. Pin 1 and pin 5 are not used and offset null. The incoming inputs are either from solar cell or battery. The voltage inputs must not exceeded the voltage of power supply. The power supply for the LM741 in this project provides 12V power.

The steps to set up the voltage level are started with select the voltage level for low level and high level. For low level the voltage reference is set to be 9V and for the high level voltage reference is set to be 15V.

3.2.1 Voltage Divider Circuit

Since the voltage for both power supply and the incoming inputs are the same, a simple voltage divider circuit is used to step down the inputs voltage. Figure 3.2.1a shows the simple voltage circuit. The input voltage that will enter the system at normal condition has been decided to be 5V. Then, the value both resistors, R_1 and R_2 need to find.

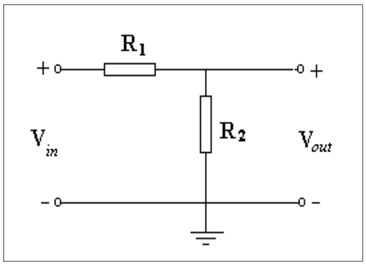

Figure 3.2.1a Simple Voltage Divider Circuit

Let assume resistor R_2 is 1kΩ, and then the value of R_1 can be find as follows;

$$V_{output} = \frac{R_2}{(R_1 + R_2)} V_{input}$$

After rearranged, the formula became;

$$R_1 = \left(\frac{R_2}{V_{output}} V_{input}\right) - R_2$$

$$R_1 = \left(\frac{(1.2\mathrm{k}\,\Omega)}{5\mathrm{V}} 12\mathrm{V}\right) - 1.2\mathrm{k}\,\Omega$$

$$R_1 = 1.68\mathrm{k}\,\Omega$$

Since there is no resistor with value 1.68kΩ is sold in the market, the value of R_1 will be a combination of resistors 1.5kΩ and 180Ω. The circuit then will be such Figure 3.2.1b.

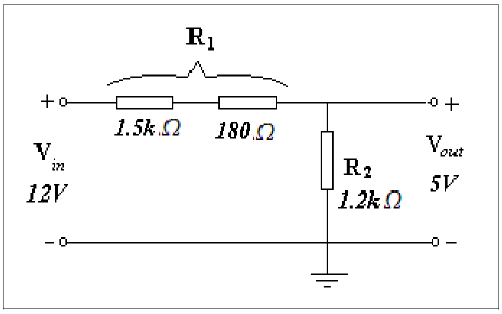

Figure 3.2.1b The Actual Voltage Divider Circuit

3.2.2 Low Level Voltage Setting

To set the low level input voltage, the following step is used; Firstly, the 9V low level voltage reference will be step down as it goes through the voltage divider circuit in Figure 3.2.2.

$$V_{low} = \frac{R_2}{(R_1 + R_2)} V_{input}$$

$$V_{low} = \frac{(1\text{k}\Omega)}{(1.4\text{k}\Omega + 1\text{k}\Omega)} 9\text{V}$$

$$V_{low} = 3.75\text{V}$$

Then, the low level voltage reference for the comparator in Figure 3.2.3 is set using the following step;

$$V_{low} = \frac{R_4}{(R_3 + R_4)} V_S$$

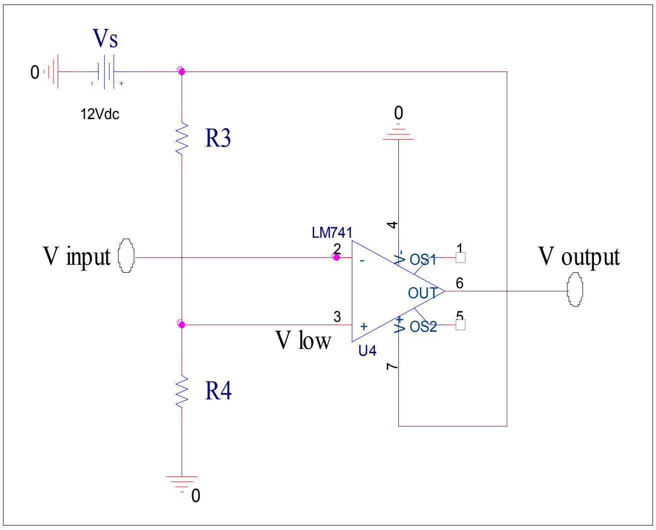

Figure 3.2.2 Low Level Voltage Comparator

Let assume the value for resistor R_4 is 20kΩ, hence the value for R_3 is

$$R_3 = (V_s \frac{R_4}{V_{low}}) - R_4$$

$$R_3 = (12\text{V} \frac{(20\text{k}\,\Omega)}{3.75\text{V}}) - 20\text{k}\,\Omega$$

$$R_3 = 44\text{k}\,\Omega$$

In actual, there is no resistor 44kΩ is sold in the market, thus the value for resistor R3 is chose to be 47kΩ and the low level voltage reference then to be;

$$V_{low} = \frac{(20\text{k}\,\Omega)}{(47\text{k}\,\Omega + 20\text{k}\,\Omega)} 12\text{V}$$

$$V_{low} = 3.58\text{V}$$

Since the input voltage is step down using voltage divider, the input voltage at low level is;

$$V_{input} = \frac{(R_1 + R_2)}{R_2} V_{low}$$

$$V_{input} = \frac{(1.4\text{k}\,\Omega + 1\text{k}\,\Omega)}{(1\text{k}\,\Omega)} 3.58\text{V}$$

$$V_{low} = 8.59\text{V}$$

3.2.3 High Level Voltage Setting

To set the high level input voltage, the following step is used; Firstly, the 15V low level voltage reference will be step down as it goes through the voltage divider circuit in Figure 3.2.2.

$$V_{high} = \frac{R_2}{(R_1 + R_2)} V_{input}$$

$$V_{high} = \frac{(1\text{k}\,\Omega)}{(1.4\text{k}\,\Omega + 1\text{k}\,\Omega)} 15\text{V}$$

$$V_{high} = 6.25\text{V}$$

Then, the high level voltage reference for the comparator in Figure 3.2.3 is set using the following step;

$$V_{high} = \frac{R_6}{(R_5 + R_6)} V_S$$

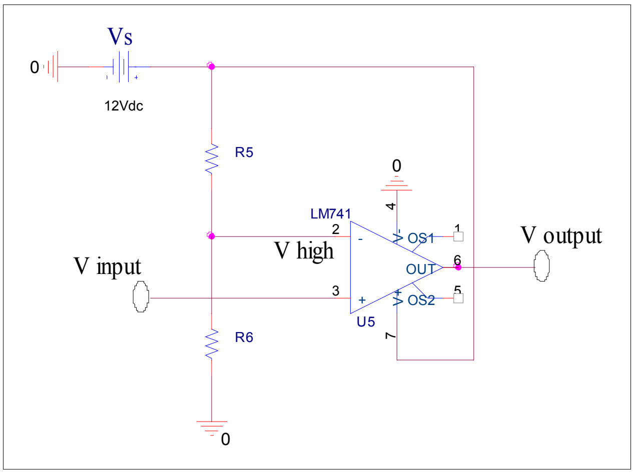

Figure 3.2.3 High Level Voltage Comparator

Let assume the value for resistor R6 is 39kΩ, hence the value for R_5 is

$$R_5 = (V_s \frac{R_6}{V_{high}}) - R_6$$

$$R_5 = (12\text{V} \frac{(39\text{k}\,\Omega)}{3.75\text{V}}) - 39\text{k}\,\Omega$$

$$R_5 = 35.9\text{k}\,\Omega$$

In actual, there is no resistor 35.9kΩ is sold in the market, thus the value for resistor R_5 is chose to be 33kΩ and the high level voltage reference then to be;

$$V_{low} = \frac{(39\text{k}\,\Omega)}{(33\text{k}\,\Omega + 39\text{k}\,\Omega)} 12\text{V}$$

$$V_{high} = 6.5\text{V}$$

Since the input voltage is step down using voltage divider, the input voltage at low level is;

$$V_{input}=\frac{(R_1+R_2)}{R_2}V_{high}$$

$$V_{input}=\frac{(1.4\text{k}\,\Omega+1\text{k}\,\Omega)}{(1\text{k}\,\Omega)}6.5\text{V}$$

$$V_{input}=15.6\text{V}$$

3.2.4 Output of the Voltage Comparator Circuit

Output from this voltage comparator circuit is a digital signal which has been setting to be either high, 12V, or low, 0V. A simulation of the comparator circuit using PSpice software shows the expected result. Figure 3.2.4a shows the simulation design of voltage comparator that can detect low voltage while Figure 3.2.4b shows the simulation design of voltage comparator that can detect high voltage.

At normal condition, the input voltage is the allowed range of voltage,; the comparator circuit produces a low signal, 0V. If there is anomaly such voltage drop or overvoltage occurred, which means the input voltage is either below the minimum allowable voltage level or above the maximum allowable voltage level, the comparator circuit will produced a high signal, 12V.

The output then goes to PIC to be monitored and execute the right operation. The maximum input voltage for a PIC is 5.5V, hence the output voltage from the voltage comparator needs to be step down. This can be implemented using a LM7805 that can regulate the high output voltage from comparator circuit to be 5V.

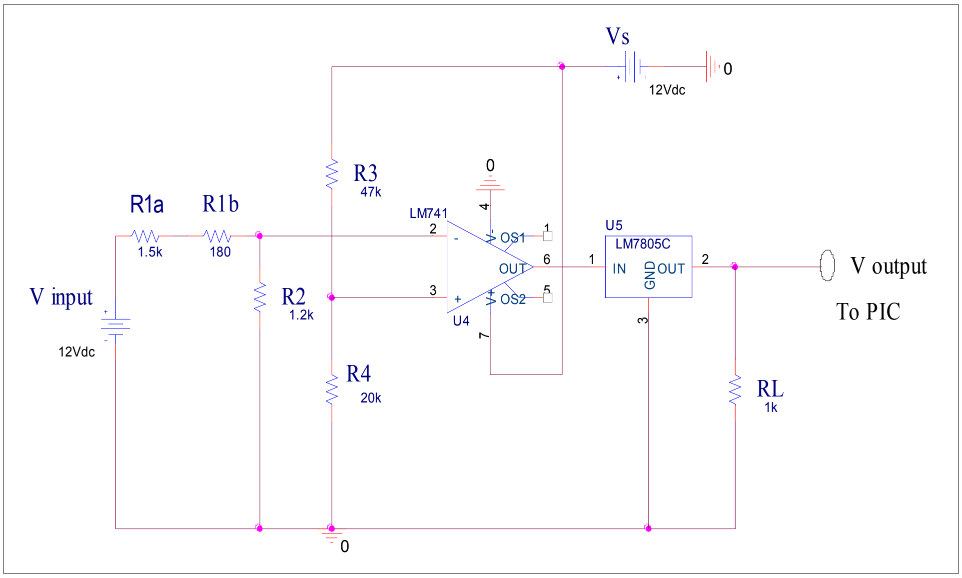

Figure 3.2.4a Low Level Voltage Comparator Circuit

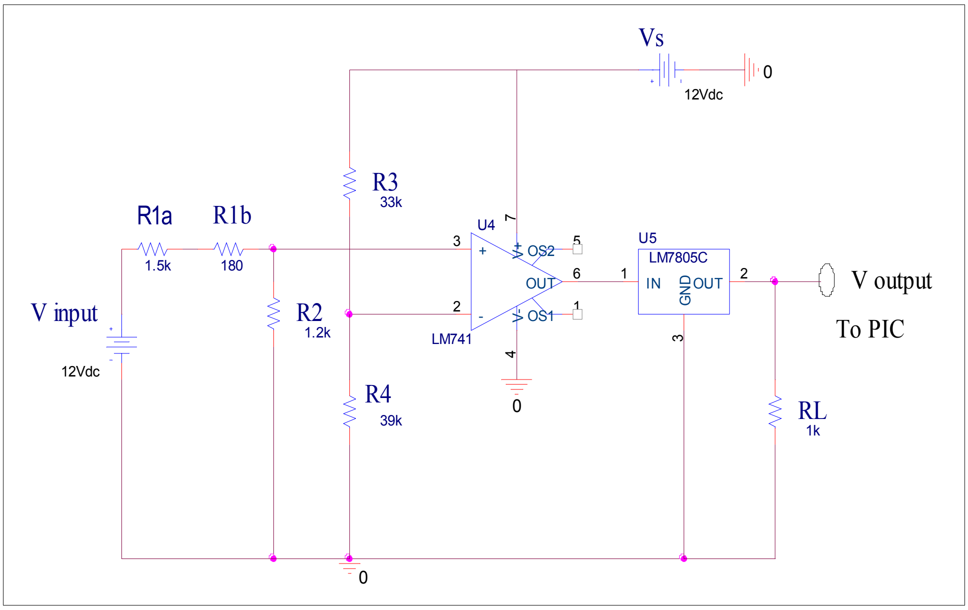

Figure 3.2.4a Low Level Voltage Comparator Circuit

3.3 Controller Circuit

In this project, Peripheral Interface Controller (PIC) is used to monitor the output from comparator circuit and control the system output. PIC 16F84A has been chosen to do all the monitor and control operation. PIC 16F84A is chosen because of cost effective and save space. This PIC has 18 pins and its size is far small than the other PIC that have more pins. The configuration of PIC 16F84A is shown in Figure 3.3.

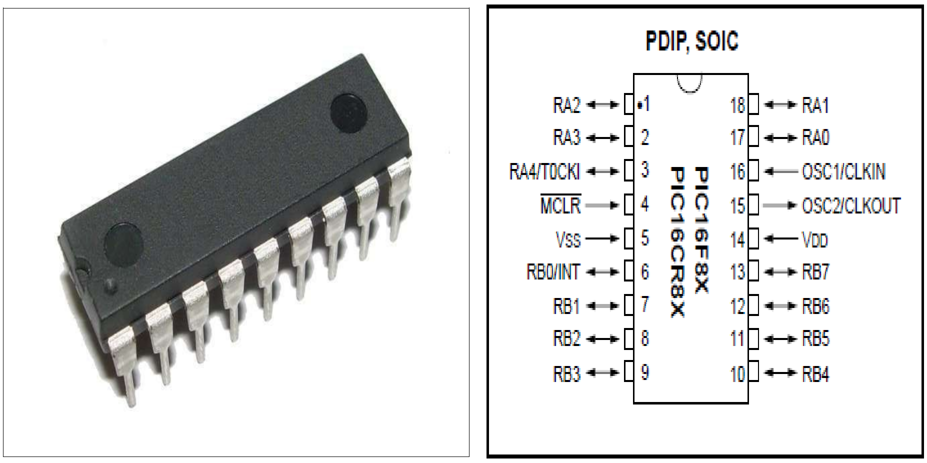

Figure 3.3a Configuration of PIC16F84A

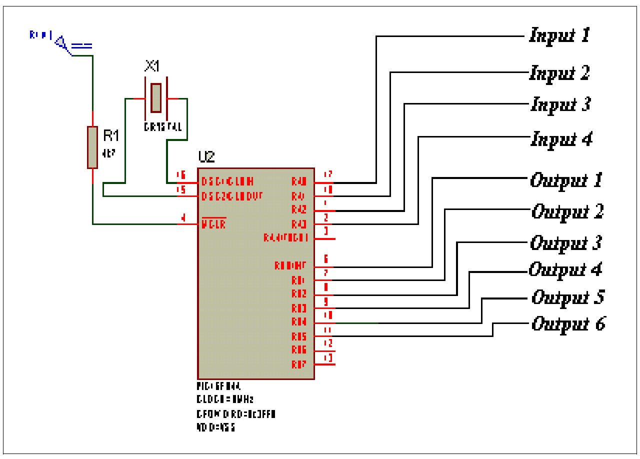

Figure 3.3b Input and Output Pins

Figure 3.3b shows the input and output pins of PIC16F84A in this system. All of the input pins are connected with different comparator circuit. Pin Input 1 is connected to a comparator circuit that detect the high level voltage from solar cell while pin Input 2 is connected to a comparator circuit that detect th low level voltage from solar cell. Pin Input 3 is connected to a comparator circuit that detect the high level voltage from battery while pin Input 4 is connected to a comparator circuit that detect th low level voltage from battery.

Each pin Output 1, 2,4 and 5 are connected to different transistor that will drive each relay according to the condition while pin Output 3 and 6 are connected to a different green LED that indicates the voltage level from each power supply is at normal condition. PIC coding of this system is shown in Appendix A.

3.4 Switching of Relay

Relay is one of the important element in this system because it is the component that can switch the load either to solar cell or battey accrdingly. In this project, the type of relay used is single pole double throw (SPDT). This relay has a common terminal connects to either of two others. Including two for the coil, such a relay has five terminals in total.

All of the relay in this AMF system is drived using bipolar junction transistor (BJT). Figure 3.4 shows the connection of the BJT and SPDT relay which the relay coil being switched by a transistor. When a coil is switched off, a large back electromagnetic field (EMF) appears across the coil.This back EMF may be several thousand volts in value, enough to destroy the transistor. The diode, which is normally reverse biased, is forward biased by the back EMF, and conducts, its low resistance short circuiting the back EMF and protecting the transistor.

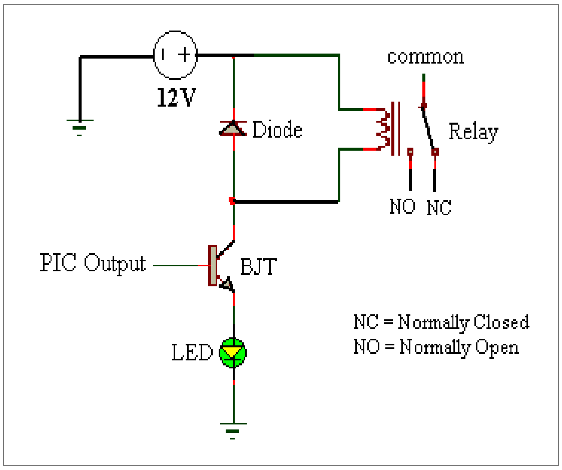

Figure 3.4 Relay Driver

In this circuit, LED is used to indicate the operation of BJT while BJT is act as switch which will closed when it get the signal from PIC. The selection of BJT is according to the resistance of relay. Since the BJT is used together with a relay that might have back EMF, the type of BJT that suitable with is power transistor because it is more robust than other type of BJT. The selection of power transistor is made according to the resistance of relay's coil. A 2N3904 or most any small signal NPN transistor can be used for relay coil resistances of 250 ohms or more. A 2N3053 or medium power (500 mA) transistor should be used for coil resistances below 250 ohms. In this system, relay 6V is used and it has 150 ohms coil resistances. Thus, the 2N3053 is used to drive the relay.

CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

This section will discussed about the result obtained from the project's test. The result of this test is shows in truth table. It shows the sequences operation of the system's.

4.2 Flow Chart of the System

Figure 4.2 shows the flowchart of the system. This system is a close loop system. It is operate by referring to the level of voltage of both power supply, solar cell and battery. The maximum allowable voltage to be fed to the load is 15.6V and the minimum voltage is 8.9V. If the voltage from solar cell is above 15.6V, the voltage from solar cell will be regulated through a 12V voltage regulator, LM7812. If the level of voltage from solar cell is below 8.9V, the load will transfer to battery and if the voltage from battery is above 15.6V, it will be regulated through a 12V voltage regulator, LM7812.

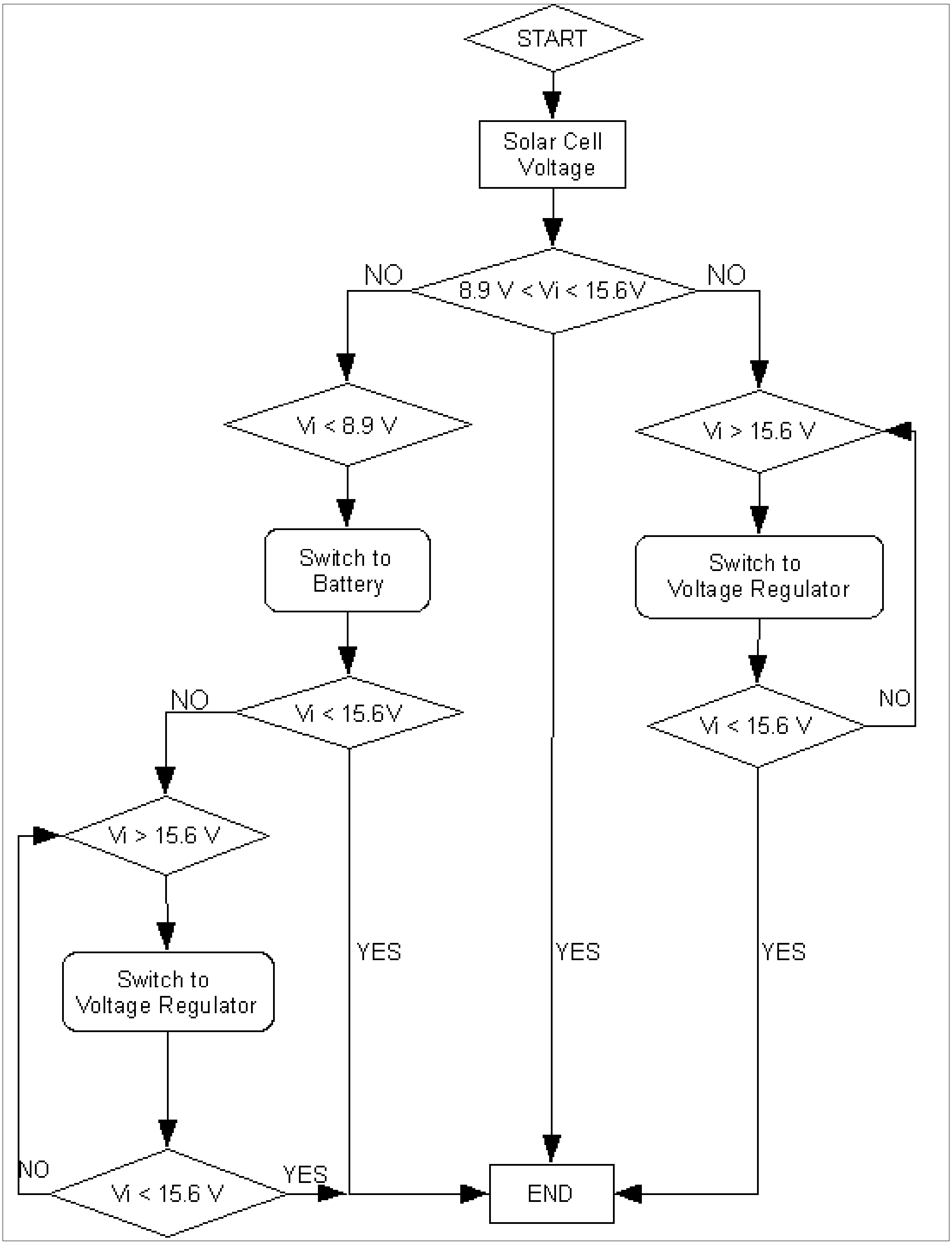

Figure 4.2 Flowchart of the system

4.3 Truth Table

Table 4.3 shows the truth table for the operation of this system. For the voltage range 8.92V<Vin<15.6V , the load is get a supply from solar cell. Whenever the voltage level from both supply is higher than 15.6V, it will be regulated 12V before being fed to the load.

Table 4.3.1 Truth Table

Solar Cell		Battery		Load's Supply
Vin < 8.92V	Vin > 15.6V	Vin < 8.92V	Vin > 15.6V	
✓		✓		Battery
✓			✓	Battery (regulated)
	✓	✓		Solar Cell (regulated)
	✓		✓	Solar Cell (regulated)

The sequences operation of this system is proven by data in Table 4.3.1. Since it is difficult to see the change of voltage level from both supply, solar cell and battery, this project is using DC power supply in laboratory to replace both supply.

The voltage from terminal solar cell is changed in increasing order started from 1V to 19V and the voltage from terminal battery is changed in decreasing order started from 18V to 9V.

Table 4.3.2 Project Result

Voltage from Solar Cell	Voltage from Battery	Voltage at Load	Load's Supply
1V	18V	12V	Battery (regulated)
2V	17V	12V	Battery (regulated)
3V	16V	12V	Battery (regulated)
4V	15V	15V	Battery
5V	14V	14V	Battery
6V	13V	13V	Battery
7V	12V	12V	Battery
8V	11V	11V	Battery
9V	10V	9V	Solar Cell
10V	9V	10V	Solar Cell
11V	8V	11V	Solar Cell
12V	7V	12V	Solar Cell
13V	6V	13V	Solar Cell
14V	5V	14V	Solar Cell
15V	4V	15V	Solar Cell
16V	3V	12V	Solar Cell (regulated)
17V	2V	12V	Solar Cell (regulated)
18V	1V	12V	Solar Cell (regulated)
19V	1V	12V	Solar Cell (regulated)

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The main objective of this project is to automatically allow switching from solar power to backup power when anomaly is detected. Through this project, the system is operate accordingly. All the troubleshooting process is done properly until the system works.

5.2 Future Recommendations

The project produced is not 100% perfect, there are some weakness needs to be overcome and improve. In this project, the driver circuit for relay is not stable and reduced the efficiency level of the system. The solution to overcome this matter is by replacing the BJT with MOSFET because MOSFET are more robust and efficient than BJT in term of switching.

Next, the system can be implement by using the other type of PIC such as PIC 16F877A and PIC 18F6490. This is because, these type of PIC has more pin compared to PIC 16F84A that used in this project. The PIC that has many pins can be used to interconnect with other device such as LCD, light emitting diodes (LEDs) and 7-segment. Lastly, the project can implement the usage of LCD or seven segments. This type of device is used as display purposes. The existence of this device will make easier to monitor the parameter that being measured in the project. For example, LCD can be used to display the magnitude of supplied voltage to the load.

5.3 Costing and Commercialization

By refering to table 5.3, the cost of this project is RM 98.00. The components of this project was bought at electronic shop around Kuantan and also get from the laboratory. Through the future recommendation discussed earlier, this project needs more development, research and efforts to make it function well and interesting. Thus, this product are not ready to be commercialized yet.

Table 5.3 Cost of components

No	Component	Quantity	Price
1	PIC 16F84A + base	1	RM 25.00
2	LM741 + base	4	RM 10.00
3	Relay 6V	4	RM 10.00
4	LM7812 + heat sink	2	RM 5.00
5	LM7805 + heat sink	5	RM 11.50
6	Transistor 2N3053	4	RM 14.00
7	Resistor	19	RM 9.50
8	Diode	10	RM 5.00
9	Crystal 8MHz	1	RM 1.00
10	Toggle Switch	2	RM 3.00
11	Capacitor	6	RM 3.00
12	LED	6	RM 1.20
		Total	RM 98.00

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[1] L. Boylestad, Robert and Louis Nashelsky. Electronic Devices and Circuit Theory. United States of America: Prentice Hall, 2006

[2] K. Alexander, Charles and Matthew N.O. Sadiku. Fundamental of Electric Circuits. Cleveland State University: McGRAW. HILL, 2004

[3] Han, Way Huang. PIC Microcontroller: An Introduction to Software and Hardware Interfacing. United States of America: Thomson Delmar Learning, 2005

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http://en.wikipedia.org/wiki/Voltage_Drop

[4] 20th March 2008, Citing Internet Sources URL
http://en.wikipedia.org/wiki/Overvoltage

[5] 20th March 2008, Citing Internet Sources URL
http://en.wikipedia.org/wiki/Transistor

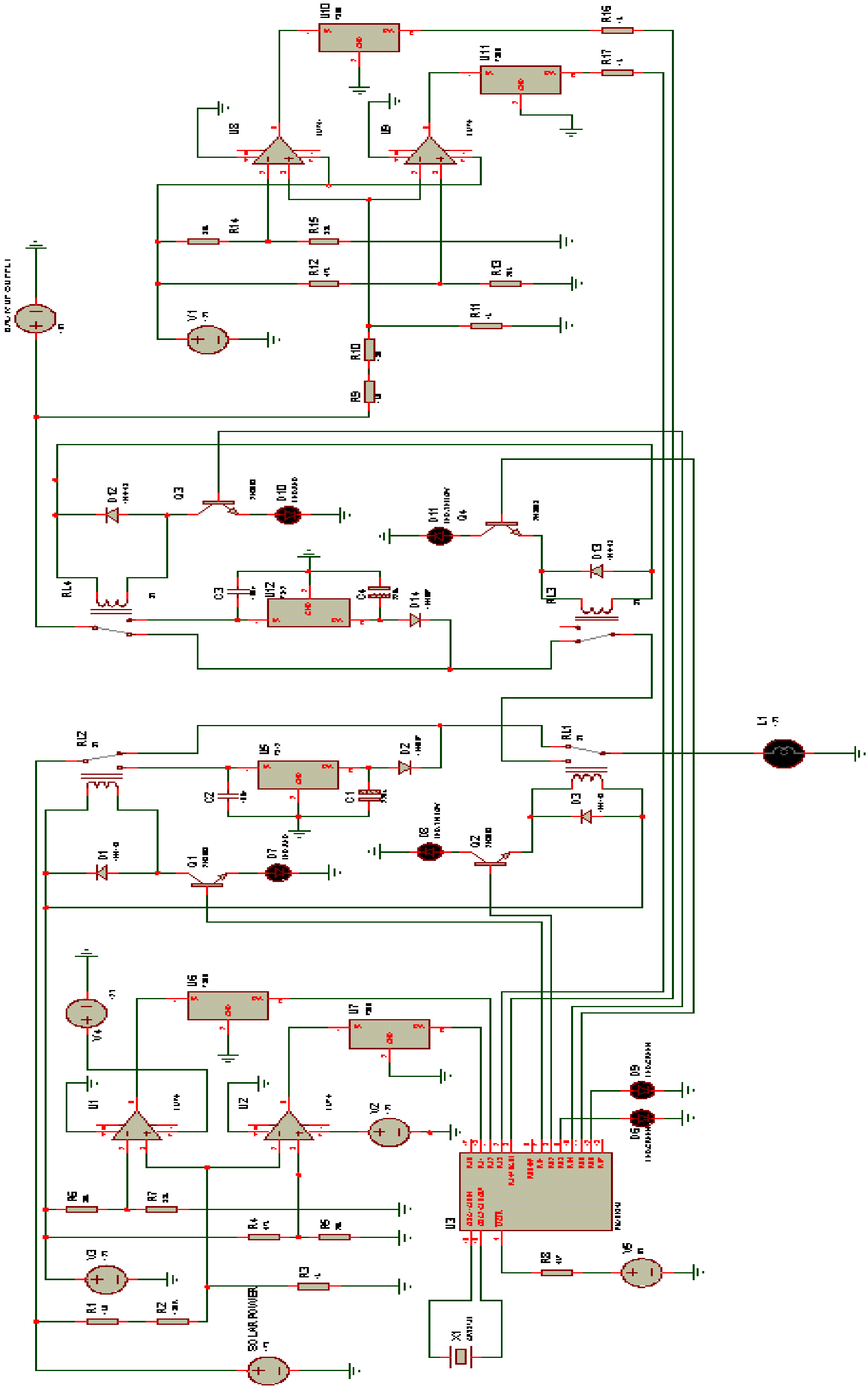
APPENDIX A

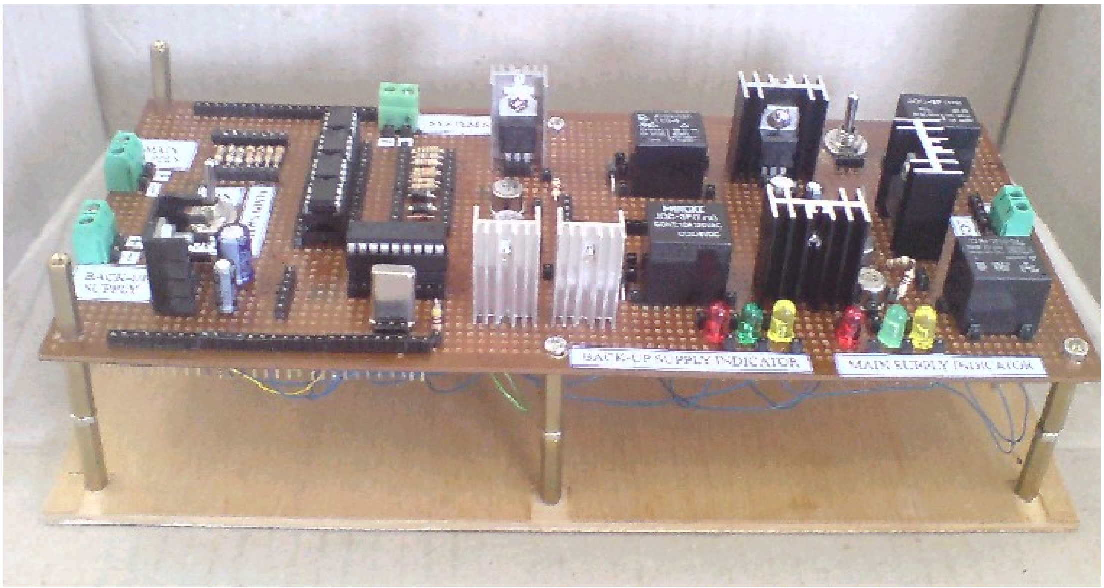
```
'****************************************************************
'*  Name    : UNTITLED.BAS                                      *
'*  Author  : [select VIEW...EDITOR OPTIONS]                    *
'*  Notice  : Copyright (c) 2008 [select VIEW...EDITOR OPTIONS] *
'*          : All Rights Reserved                               *
'*  Date    : 10/6/2008                                         *
'*  Version : 1.0                                               *
'*  Notes   :                                                   *
'*          :                                                   *
'****************************************************************
DEFINE OSC 8


TRISA.1 = 1     'INPUT1
TRISA.2 = 1     'INPUT2
TRISA.3 = 1     'INPUT3
TRISA.4 = 1     'INPUT4
TRISB.1 = 0     'OUTPUT
TRISB.2 = 0     'OUTPUT
TRISB.3 = 0     'OUTPUT
TRISB.4 = 0     'OUTPUT
TRISB.5 = 0     'OUTPUT
TRISB.6 = 0     'OUTPUT


OV VAR PORTA.1
LV VAR PORTA.2
OVBACKUP VAR PORTA.3
LVBACKUP VAR PORTA.4
LVSTOP VAR PORTB.1
OVSTOP VAR PORTB.2
MAINNORMAL VAR PORTB.3
LVBACKUPSTOP VAR PORTB.4
OVBACKUPSTOP VAR PORTB.5
BACKUPNORMAL VAR PORTB.6

MAIN:

   IF OV = 1 THEN
   OVSTOP = 1
   LVSTOP = 0
   MAINNORMAL = 0
   LVBACKUPSTOP = 0
   OVBACKUPSTOP = 0
   BACKUPNORMAL = 0
   ENDIF
```

```
IF LV = 1 THEN
LVSTOP = 1
OVSTOP = 0
MAINNORMAL = 0
LVBACKUPSTOP = 0
OVBACKUPSTOP = 0
BACKUPNORMAL = 0
ENDIF


IF LV = 0 AND OV = 0 THEN
MAINNORMAL = 1
OVSTOP = 0
LVSTOP = 0
LVBACKUPSTOP = 0
OVBACKUPSTOP = 0
BACKUPNORMAL = 0
ENDIF


IF OVBACKUP = 1 THEN
OVBACKUPSTOP = 1
LVBACKUPSTOP = 0
BACKUPNORMAL = 0
OVSTOP = 0
LVSTOP = 0
MAINNORMAL = 0
ENDIF


IF LVBACKUP = 1 THEN
LVBACKUPSTOP = 1
OVBACKUPSTOP = 0
BACKUPNORMAL = 0
OVSTOP = 0
LVSTOP = 0
MAINNORMAL = 0
ENDIF


IF LVBACKUP = 0 AND OVBACKUP = 0 THEN
BACKUPNORMAL = 1
LVBACKUPSTOP = 0
OVBACKUPSTOP = 0
OVSTOP = 0
LVSTOP = 0
MAINNORMAL = 0
ENDIF

IF LV = 1 AND LVBACKUP = 1 THEN
```

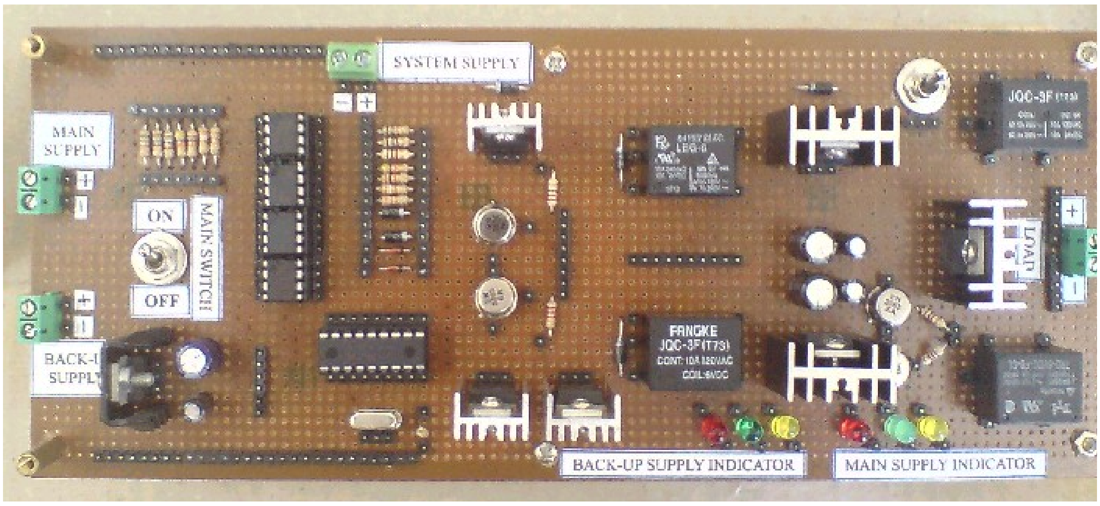
```
    LVSTOP = 1
    OVSTOP = 0
    MAINNORMAL = 0
    LVBACKUPSTOP = 0
    OVBACKUPSTOP = 0
    BACKUPNORMAL = 0
    ENDIF



    IF OV = 1 AND OVBACKUP = 1 THEN
    OVSTOP = 1
    LVSTOP = 0
    MAINNORMAL = 0
    LVBACKUPSTOP = 0
    OVBACKUPSTOP = 0
    BACKUPNORMAL = 0
    ENDIF

GOTO MAIN
```

APPENDIX B

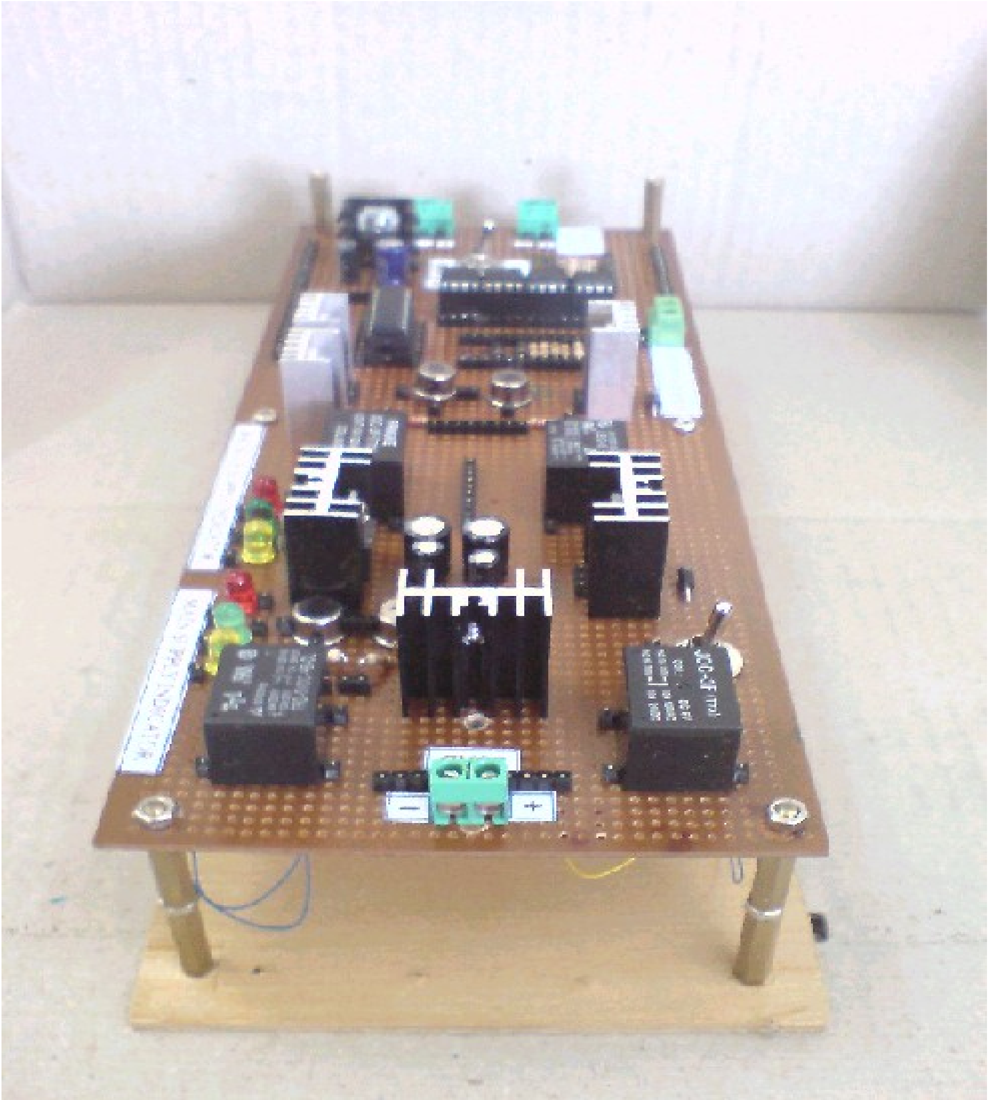




Front View



Top View



Side View

APPENDIX C

MICROCHIP

PIC16F84A

18-pin *Enhanced* FLASH/EEPROM 8-Bit Microcontroller

High Performance RISC CPU Features:

- Only 35 single word instructions to learn
- All instructions single-cycle except for program branches which are two-cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- 1024 words of program memory
- 68 bytes of Data RAM
- 64 bytes of Data EEPROM
- 14-bit wide instruction words
- 8-bit wide data bytes
- 15 Special Function Hardware registers
- Eight-level deep hardware stack
- Direct, indirect and relative addressing modes
- Four interrupt sources:
  - External RB0/INT pin
  - TMR0 timer overflow
  - PORTB<7:4> interrupt-on-change
  - Data EEPROM write complete

Peripheral Features:

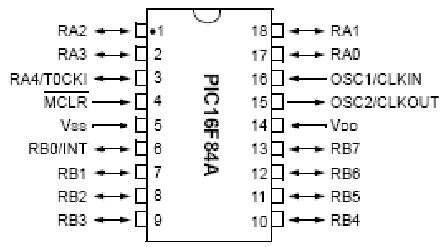
- 13 I/O pins with individual direction control
- High current sink/source for direct LED drive
  - 25 mA sink max. per pin
  - 25 mA source max. per pin
- TMR0: 8-bit timer/counter with 8-bit programmable prescaler

Special Microcontroller Features:

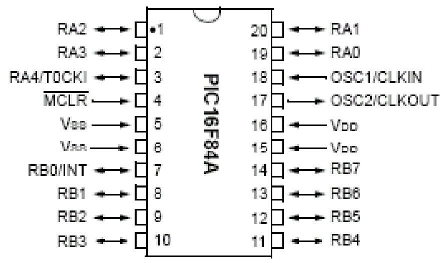
- 10,000 erase/write cycles *Enhanced* FLASH Program memory typical
- 10,000,000 typical erase/write cycles EEPROM Data memory typical
- EEPROM Data Retention > 40 years
- In-Circuit Serial Programming™ (ICSP™) - via two pins
- Power-on Reset (POR), Power-up Timer (PWRT), Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own On-Chip RC Oscillator for reliable operation
- Code protection
- Power saving SLEEP mode
- Selectable oscillator options

Pin Diagrams

PDIP, SOIC



SSOP



CMOS Enhanced FLASH/EEPROM Technology:

- Low power, high speed technology
- Fully static design
- Wide operating voltage range:
  - Commercial: 2.0V to 5.5V
  - Industrial: 2.0V to 5.5V
- Low power consumption:
  - < 2 mA typical @ 5V, 4 MHz
  - 15 µA typical @ 2V, 32 kHz
  - < 0.5 µA typical standby current @ 2V

FAIRCHILD SEMICONDUCTOR™ www.fairchildsemi.com

LM741

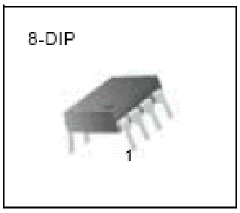
Single Operational Amplifier

Features

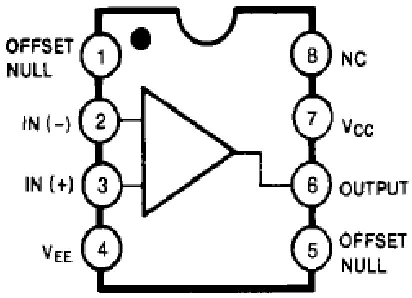
- Short circuit protection
- Excellent temperature stability
- Internal frequency compensation
- High Input voltage range
- Null of offset

Description

The LM741 series are general purpose operational amplifiers. It is intended for a wide range of analog applications. The high gain and wide range of operating voltage provide superior performance in intergrator, summing amplifier, and general feedback applications.



Internal Block Diagram



Rev. 5.0

FAIRCHILD SEMICONDUCTOR®

March 2008

LM78XX/LM78XXA 3-Terminal 1A Positive Voltage Regulator

Features

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

General Description

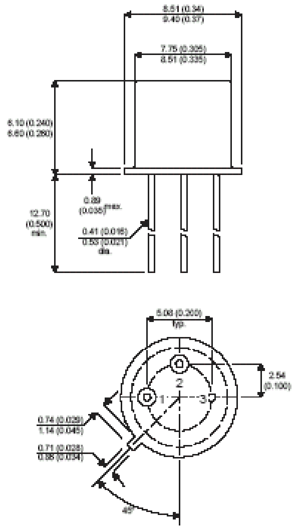
The LM78XX series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Ordering Information

Product Number	Output Voltage Tolerance	Package	Operating Temperature
LM7805CT	±4%	TO-220	-40°C to +125°C
LM7806CT			
LM7808CT			
LM7809CT			
LM7810CT			
LM7812CT			
LM7815CT			
LM7818CT			
LM7824CT			
LM7805ACT	±2%		0°C to +125°C
LM7806ACT			
LM7808ACT			
LM7809ACT			
LM7810ACT			
LM7812ACT			
LM7815ACT			
LM7818ACT			
LM7824ACT			

2N3053

MECHANICAL DATA
Dimensions in mm (inches)



TO39 PACKAGE (TO-205AD)

Underside View

Pin 1 = Emitter Pin 2 = Base Pin 3 = Collector

MEDIUM POWER SILICON NPN PLANAR TRANSISTOR

FEATURES

- V_{CEO} = 40V
- I_C = 0.7A
- P_{tot} = 5W

ABSOLUTE MAXIMUM RATINGS (T_{case} = 25°C unless otherwise stated)

V_{CBO}	Collector – Base Voltage	60V
V_{CEO}	Collector – Emitter Voltage	40V
V_{CER}	Collector – Emitter Sustaining Voltage	50V
V_{CEX}	Collector - Emiiter Voltage	60V
V_{EBO}	Emitter-Base Voltage	5V
I_C	Collector Current	0.7A
P_{TOT}	Power Dissipation T_{amb} = 25°C	1W
	T_{case} = 25°C	5W
T_j	Junction Temperature	200°C
T_{stg}	Storage Temperature	–65 to 200°C
$R_{th(jc)}$	Thermal Resistance Junction to Case	35°C / W
$R_{th(ja)}$	Thermal Resistance Junction to Ambient	175°C / W

Semelab plc. Telephone +44(0)1455 556565. Fax +44(0)1455 552612.
E-mail: sales@semelab.co.uk Website: http://www.semelab.co.uk

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