ABSTRACT

Intelligent Energy Saving System can be used in places like where lighting is very important. The libraries will be well illuminated with many lamps. When people are not present at a reading place the lighting can be made OFF and when they are present, the lighting made ON. All these can be done through by Dimming circuit and PIR sensor.

If a person entering to the monitored area, the PIR sensors activates and sense the person, gives to the micro controller. The Infrared energy emitted from the living body is focused by a Fresnel lens segment. Then only the PIR sensor activates. After sensing the person   LDR checks the light intensity of the monitored area, whether it is bright or dark. Depending on the LDR output, the lamp may be ON / OFF by using Dimmer circuit.

By using this system we can adjust the speed of Fan according to the room temperature measured by Thermostat, which is connected to the micro controller.

To display the room temperature of PIR mode operation we are using the LCD display.

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LIST OF FIGURES

CHAPTER 1
INTRODUCTION

1. INTRODUCTION

Intelligent Energy Saving System, the aim of the project is to save the energy. In this project we are using various sensors, controlling and display.

However, in this project work the basic signal processing of various parameters which are temperature, LDR, Smoke sensor. For measuring various parameters values, various sensors are used and the output of these sensors are converted to control the parameters. The control circuit is designed using micro-controller. The outputs of all the three parameters are fed to micro-controller. The output of the micro-controller is used to drive the LCD display, so that the value of each parameter can be displayed. In addition to the LCD display micro-controller outputs are also used to driver a relay independently. This relay energizes and de-energizes automatically according to the condition of the parameter.

1.1 OBJECTIVE OF THE PROJECT: -

The aim of the project is to save the energy or power, used in places like libraries where lighting is very important for the people who come to read books. So, the libraries will be well illuminated with many lamps.

At the same time when people are not present at a particular reading place the lighting can be made off by using Dimmer and when people come to that area, according to the LDR lighting can be made sufficiently brighter.

By using this system, we can also adjust the speed of the Fan according to the room temperature using Thermostat and Dimmer.

1.2 PRINCIPLE OF OPERATION

Consider a particular table in the library, which is connected with our experimental kit .When a person entering into that place the PIR sensor absorbs the black body radiation emitted by that person and activates it. The LCD display will displays the "PIR ON".

After some time delay the light will glows for some time by using the Dimmer circuit and with the help of LDR sensor it checks the room lightening , and it takes the condition when the light is sufficient the lamp will be in OFF state and when light is insufficient the lamp will be in ON state.

With the help of Thermostat sensor the room temperature is measured and the speed of the Fan varies according to the temperature of Thermostat. The LCD display will displays the room "temperature in degree centigrade".

When a person is leaving that place, the PIR sensor will activate again and firstly the Fan will be OFF and after some time delay the lamp also will be OFF. Now the LCD display is in stand by mode state. And the main supply power will be switched OFF.

1.3 BLOCK DIAGRAM:
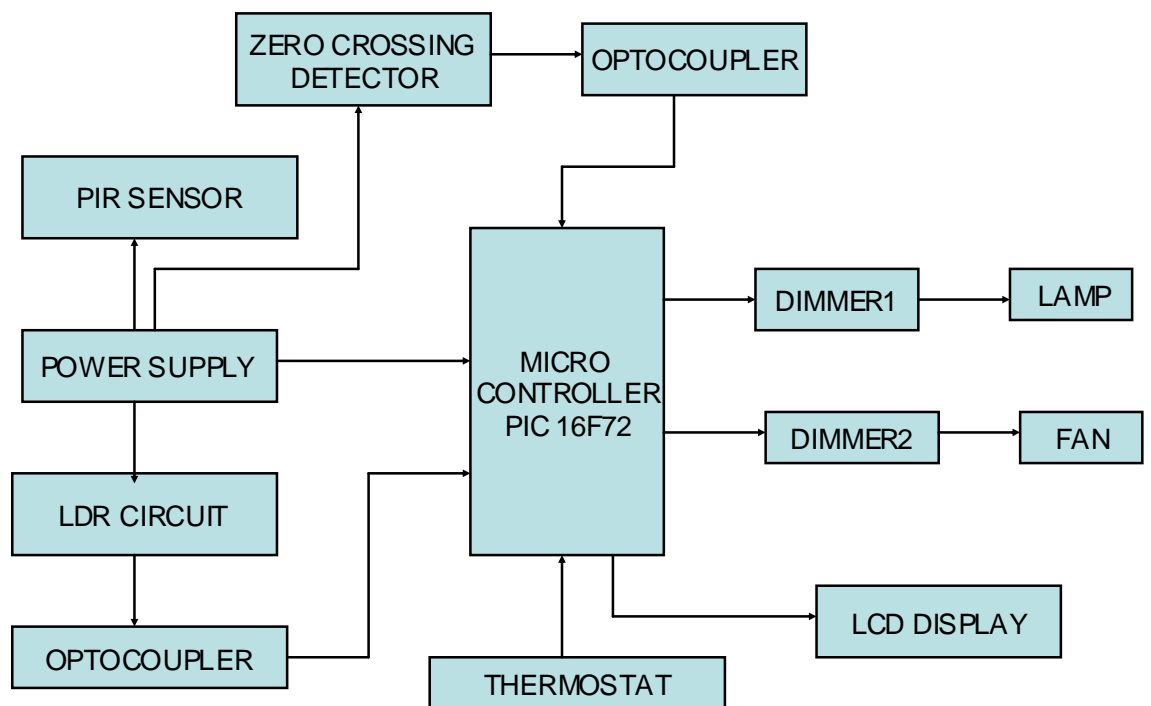
1.4 System Features:

- Easy operation
- Convenient
- Affordable

Required Skills:

- Understanding of Micro controller
- Embedded C Programming
- Understanding Interfacing Techniques
- Knowledge on Sensors
- Design and Fabrication of PCB

Project phase: -

- Schematic design and drawing of PCB
- Design and Interfacing Circuits for Micro controller
- Preparation of PCB
- Assembling and Testing of Interfacing Circuits
- Code for the Application
- Debugging and Testing
- Project Report

1.4 EQUIPMENTS: -

- ➢ Printed Circuit Board
- ➢ Micro controller → PIC 16F72
- ➢ 5V, 12V Dc Power supply
- ➢ IR sensor → Passive Infrared Sensor
- ➢ LDR → Light Dependent Resistor
- ➢ Thermostat
- ➢ LCD → Optrax, 2 line by 16 characters
- ➢ Zero Crossing Detector
- ➢ Lamp
- ➢ Fan

CHAPTER 2.

DESCRIPTION OF THE PROJECT

2. DESCRIPTION OF THE PROJECT: -

2.1 BLOCK DIAGRAM EXPLANATION: -

PIR SENSOR: -

A PIR detector is a motion detector that senses the heat emitted by a living body. These are often fitted to security lights so that they will switch on automatically if approached. They are very effective in enhancing home security systems.

The sensor is passive because, instead of emitting a beam of light or microwave energy that must be interrupted by a passing person in order to "sense" that person, the PIR is simply sensitive to the infrared energy emitted by every living thing. When an intruder walks into the detector's field of vision, the detector "sees" a sharp increase in infrared energy.

LDR: -

LDR's or Light Dependent Resistors are very useful especially in light/dark sensor circuits. These help in automatically switching ON /OFF the street lights and etc., normally the resistance of an LDR is very high, sometimes as very high as 1000000 ohms, but when they are illuminated with light, resistance drop dramatically. Electronic opto sensors are the devices that alter their electrical characteristics, in the presence of visible or invisible light. The best-known devices of these types are the light dependent resistor (LDR), the photo diode and the phototransistors.

ZCD: -

A zero crossing detector literally detects the transition of a signal waveform from positive and negative, ideally providing a narrow pulse that coincides exactly with the zero voltage condition.

THERMOSTAT: -

In this project we are making use DS 1621 thermostat, it's a non-contact digital type temperature transducer suitable for measuring room temperature. The word 'thermistor' is an acronym for thermal resistor, i.e., a temperature sensitive resistor. It is used to detect very small changes in temperature. The variation in temperature is reflected through appreciable variation of the resistance of the device.

LCD DISPLAY: -

A liquid crystal is a material (normally organic for LCD's) that will flow like a liquid but whose molecular structure has some properties normally associated with solids. The Liquid Crystal Display (LCD) is a low power device. The power requirement is typically in the order of microwatts for the LCD. However, an LCD requires an external or internal light source. We are making use of LCD in our project to display the PIR mode and room temperature.

OPTOCOUPLER: -

Optocoupler is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated. A common implementation involves a LED and a phototransistor, separated so that light may travel across a barrier but electrical current may not.

DIMMER: -

Dimmers are devices used to vary the brightness of a light. By decreasing or increasing the RMS voltage and hence the mean power to the lamp it is possible to vary the intensity of the light output. Although variable-voltage devices are used for various purposes, the term dimmer is generally reserved for those intended to control lighting.

2.2 SCHEMATIC DIAGRAM: -
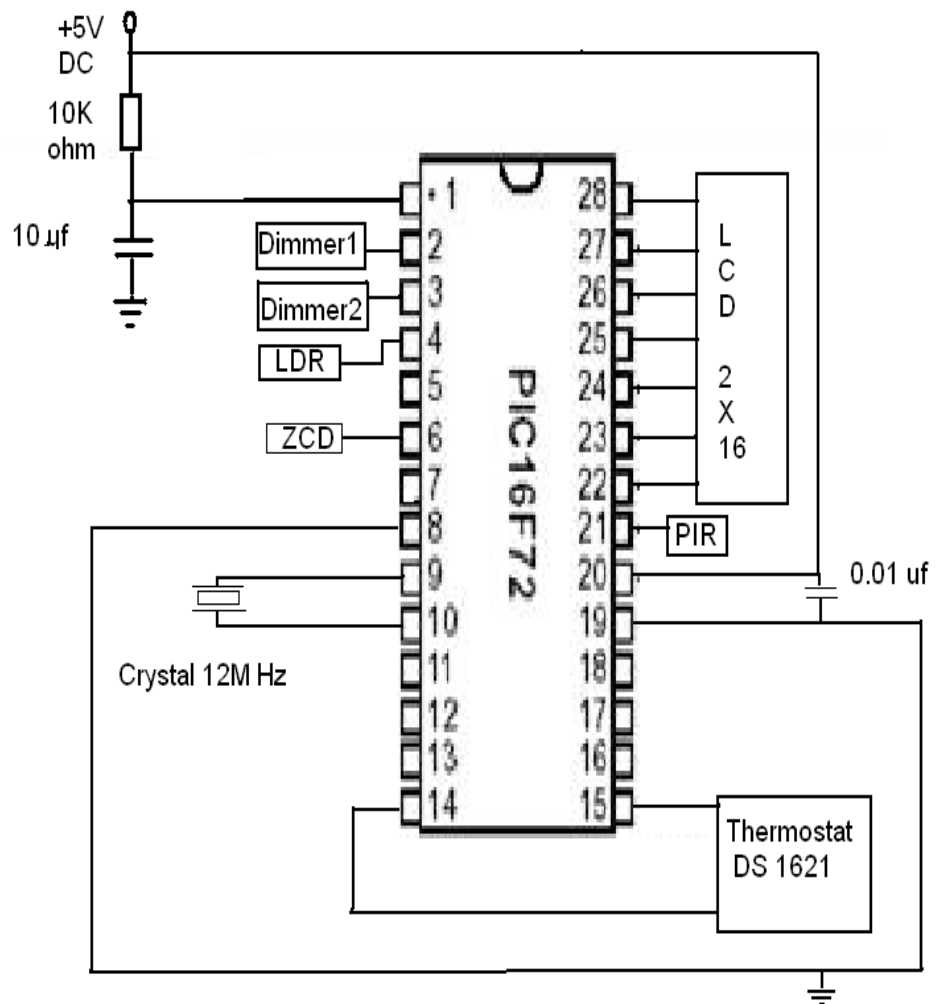
2.3 SCHEMATIC EXPLANATION: -

PORT A: -

Port A can acts as a both input as well as output port. It is having 6 pins (A0-A5). In these A0 is connected to Dimmer1, A1 is connected to Dimmer2 and A4 is connected to ZCD output.

PORT B: -

Port B can acts as a both input as well as output port. It is having 8 pins (B0-B7). In these B1 connected to register selection pin(R/S), B2 is connected to read/write(R/W) and B3 pin is connected to enable pin.

PORT C: -

Port C can acts as a both input as well as output port. It is having 8 pins (C0-C7). In these RC3 and RC4 connected to the thermostat pins.

12M Hz Crystal Oscillator is connected in between 9th and 10th pins of micro controller.

Reset pin is connected to the pin number1 i.e., MCLR/VPP.

8th and 19th pins are connected to ground (Vss).

CHAPTER 3.

HARDWARE DESCRIPTION

3. HARDWARE DESCRIPTION: -

3.1 MICRO CONTROLLER: -

INTRODUCTION: -

Microcontrollers these days are silent workers in many apparatus, ranging from the washing machine to the video recorder. Nearly all of these controllers are mask programmed and therefore are of very little use for applications that require the programs to be changed during the course of execution.

Even if the programs could be altered, the information necessary to do so an instruction set, an assembler language and description for the basic hardware is either very difficult to obtain or are in adequate when it came to the issue of accessibility.

A marked exception to the above category is the PICI6F72 micro controller belonging to the PIC family. This microcontroller has features that seem to make it more accessible than any other single chip microcontroller with a reasonable price tag.

The PICI6F72, an 8-bit single chip microcontroller has got a powerful CPU optimized for control applications. The PICI6F72 is an 8 – bit single chip microcontroller. The 16f7877A provides a significantly more powerful architecture, a more powerful instruction set and a full serial port.

The PICI6F72 is a complete micro controller. There are 40 pins needed by the five-bidirectional ports. Pins provide power, allow you to connect a crystal clock and provide a few timing and control signals.

The architecture includes the ALU, W register, the stack; a block of registers. All these devices are connected to via internal 8-bit data bus.

Each I/O port is also connected to the 8-bit internal data bus through a series of registers. These registers hold data during I/O transfers and control the I/O ports. The architectural block diagram also shows the PICI6F72 ROM and RAM

Comparison of microprocessor and microcontroller:

The difference between Microprocessor and Micro controller is Microprocessor can only process with the data, Micro controller can control external device. That is if you want switch "ON" or "OFF" a device, you need peripheral ICs to do this work with Micro controller you can directly control the device.

Like Microprocessor, Micro controller is available with different features. It is available with inbuilt memory, I/O lines, timer and ADC. The micro controller, which we are going to use.

Advantages of Microcontrollers:

1.   If a system is developed with a microprocessor, the designer has to go for external memory such as RAM, ROM or EPROM and peripherals and hence the size of the PCB will be large enough to hold all the required peripherals.

2.   But the microcontroller has got all these peripheral facilities on a single chip so development of a similar system with a microcontroller reduces PCB size and cost of the design.

3.   One of the major difference between a microcontroller and a microprocessor is that a controller often deals with bits, not bytes as in the real world application, for example switch contacts can only be open or close, indicators should be lit or dark and motors can be either turned on or off and so forth.

4.   The Microcontroller has two 8-bit timers/ counters built within it, which makes it more suitable to this application since we need to produce some accurate timer delays. It is even more advantageous that the timers also act as interrupt.

ABOUT PICI6F72:

The PICI6F72 is a low-power, high-performance CMOS 8-bit microcomputer with 2K bytes Flash programmable and erasable read only memory (PEROM). PICI 6F72 is a powerful microcomputer, which provides a highly flexible and cost-effective solution to many embedded control application.

FEATURES OF PIC 16F72: -

High performance RISC CPU:

- Only 35 single word instructions to learn
- All single cycle instructions except for program branches, which are two-cycle.
- Operating speed: DC-20 MHZ clock input
  - DC-200 ns instruction cycle
  - Up to 2k x 14 words of program Memory,
  - Up to 128 x 8 bytes of Data Memory (RAM)
- Pinout compatible to PIC 16C72/72A and PIC 16F872.
- Interrupt capability.
- Eight- level deep hard ware stack.
- Direct, Indirect and Relative Addressing modes.

Peripheral Features:

- High Sink/Source Current: 25 mA
- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during

Via External crystal/clock.

- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler

- Capture, Compare, PWM (CCP) module

    - Capture is 16-bit, max. resolution is 12.5 ns

- Compare is 16-bit, max. resolution is 200 ns

- PWM max. resolution is 10-bit

- 8-bit, 5-channel analog-to-digital converter

- Synchronous Serial Port (SSP) with SPI™ (Master/Slave) and I^{2}C™ (Slave)

- Brown-out detection circuitry for Brown-out Reset (BOR)

CMOS Technology:

- Low power, high speed CMOS FLASH technology

- Fully static design

- Wide operating voltage range: 2.0V to 5.5V

- Industrial temperature range

- Low power consumption:

    < 0.6 mA typical @ 3V, 4 MHz

    20 µA typical @ 3V, 32 kHz

    < 1 µA typical standby current

Special Microcontroller Features:

- 1,000 erase/write cycle FLASH program memory typical

- 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.

- RC oscillator for reliable operation

- Programmable code protection

- Power saving SLEEP mode

- Selectable oscillator options

- In-Circuit Serial Programming™ (ICSP™) via 2 pins

- Processor read access to program memory

ARCHITECTURE OF PIC 16F72 MICRO CONTROLLER: -

The PIC16F72 belongs to the Mid-Range family of the PIC micro devices. The program memory contains 2K words, which translate to 2048 instructions, since each 14-bit program memory word is the same width as each device instruction. The data memory (RAM) contains 128 bytes. There are 22 I/O pins that are user configurable on a pin-to-pin basis. Some pins are multiplexed with other device functions.

These functions include: -

- **External interrupt**

- **Change on PORTB interrupts**

- **Timer0 clock input**

- **Timer1 clock/oscillator**

- **Capture/Compare/PWM**

- **A/D converter**

- **SPI/I^{2}C**

- **Low Voltage Programming**

- **Incircuit Debuuger**

ARCHITECTURE DIAGRAM OF PIC 16F72:

PIN DIGRAM OF PIC 16F72:

$\overline{\text{MCLR}}$/VPP ⟶	1	28	⟷ RB7/PGD
RA0/AN0 ⟷	2	27	⟷ RB6/PGC
RA1/AN1 ⟷	3	26	⟷ RB5
RA2/AN2 ⟷	4	25	⟷ RB4
RA3/AN3/VREF ⟶	5	24	⟷ RB3
RA4/T0CKI ⟷	6	23	⟷ RB2
RA5/AN4/$\overline{\text{SS}}$ ⟶	7	22	⟷ RB1
Vss ⟶	8	21	⟷ RB0/INT
OSC1/CLKI ⟶	9	20	⟵ VDD
OSC2/CLKO ⟵	10	19	⟵ Vss
RC0/T1OSO/T1CKI ⟷	11	18	⟷ RC7
RC1/T1OSI ⟷	12	17	⟷ RC6
RC2/CCP1 ⟷	13	16	⟷ RC5/SDO
RC3/SCK/SCL ⟷	14	15	⟷ RC4/SDI/SDA

PIC16F72
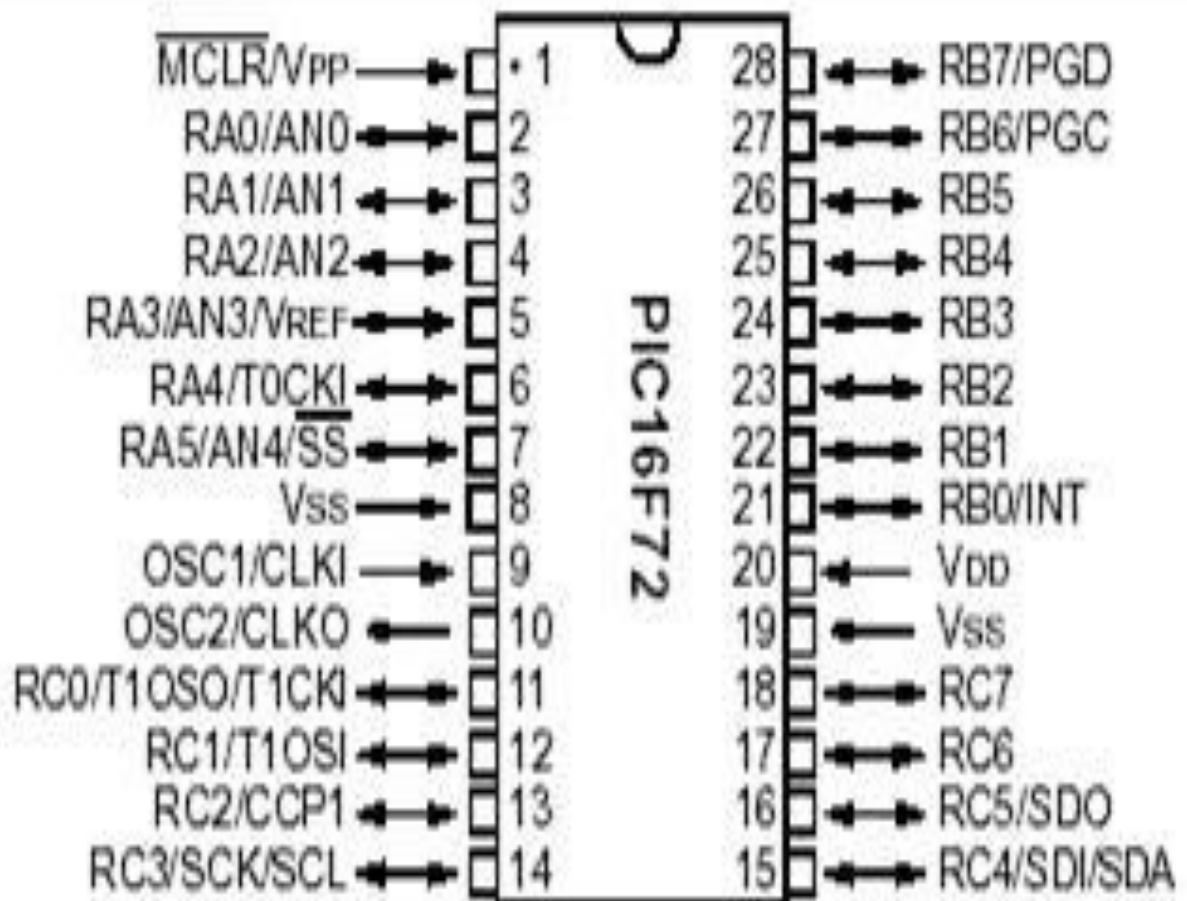
PIN DESCRIPTION:

MCLR/VPP:

Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.

RA0 - RA5:

These are the bi-directional Input / output PORTA pins.

RA1, RA2, are the analog inputs 1, analog input2.

RA3 can also be analog input3 or analog reference voltage.

RA4 can also be the clock input to the Timer0 module. Output is open drain type.

RA5 can also be analog input4 or the slave select for the synchronous serial port.

VSS:

Ground reference for logic and I/O pins.

OSC1/CLK1:

Oscillator crystal input / External clock source input.

OSC2/CLKO:

Oscillator crystal output. Connects to crystal or resonator in Crystal Oscillator mode. In RC mode, the OSC2 pin outputs CLKO, which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.

RC0 – RC7:

These are the bidirectional Input / Output PORTC pins.

RC0/T1OSO/ T1CK. RC0 can also be the Timer1 oscillator output or Timer1 Clock input.

RC1/T1OSI is the Timer1 oscillator input.

RC2/CCP is the Capture1 input/Compare1 output/ PWM1 output.

RC3/SCK/SCL. RC3 can also be the synchronous serial clock input/output for Both SPI and I2C modes.

RC4/SDI/SDA is the SPI Data In (SPI mode) or Data I/O (I2C mode).

RC5/SDO is e the SPI Data Out (SPI mode).

RC6

RC7.

VDD:

Positive supply for logic and I/O pins.

RB0 – RB7:

These are the bi-directional I/O PORTB pins. PORTB can be software

programmed for internal weak pull-up on all inputs.

RB0/IN is the external interrupt pin.

RB1, RB2, RB3 are the bi-directional pins.

RB4 is the Interrupt-on-change pin.

RB5 is the Interrupt-on-change pin.

RB6/PGC is the Interrupt-on-change pin. Serial programming clock.

RB7/PGD is the Interrupt-on-change pin. Serial programming data.

I / O PORTS:

Some pins for these I/O ports are multiplexed with an alternate function for the peripheral features on the device. In general, when a peripheral is enabled, that pin may not be used as a general purpose I/O pin. Additional information on I/O ports may be found in the PIC micro Mid-Range MCU Reference Manual, (DS33023).

PORTA and the TRISA Register:

PORTA is a 6-bit wide, bi-directional port. The corresponding data direction register is TRISA. Setting a TRISA bit (= 1) will make the corresponding PORTA pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISA bit (= 0) will make the corresponding PORTA pin an output (i.e., put the contents of the output latch on the selected pin

Reading the PORTA register, reads the status of the pins, whereas writing to it will write to the port latch. All write operations are read-modify-write operations. Therefore, a write to a port implies that the port pins are read, this value is modified and then written to the port data latch Pin RA4 is multiplexed with the Timer0 module clock input to become the RA4/T0CKI pin. The RA4/T0CKI pin is an Schmitt Trigger input and an open drain output.

All other RA port pins have TTL input levels and full CMOS output drivers. Other PORTA pins are multiplexed with analog inputs and analog VREF input. The operation of each pin is selected by clearing/setting the control bits in the ADCON1 register (A/D Control Register1).

Other PORTA pins are multiplexed with analog inputs and analog VREF input. The operation of each pin is selected by clearing/setting the control bits in the ADCON1 register (A/D Control Register1). Other PORTA pins are multiplexed with analog inputs and analog VREF input. The operation of each pin is selected by clearing/setting the control bits in the ADCON1 register (A/D Control Register1).

The TRISA register controls the direction of the RA pins, even when they are being used as analog inputs. The user must ensure the bits in the TRISA register are maintained set when using them as analog inputs.

PORTB and the TRISB Register:

PORTB is an 8-bit wide, bi-directional port. The corresponding data direction register is TRISB. Setting a TRISB bit (= 1) will make the corresponding PORTB pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISB bit (= 0) will make the corresponding PORTB pin an output (i.e., put the contents of the output latch on the selected pin).

Each of the PORTB pins has a weak internal pull-up. A single control bit can turn on all the pull-ups. This is performed by clearing bit RBPU (OPTION<7>). The weak pull-up is automatically turned off when the port pin is configured as an output. The pull-ups are disabled on a Power-on Reset.

Four of PORTB's pins, RB7:RB4, have an interrupt-on-change feature. Only pins configured as inputs can cause this interrupt to occur (i.e., any RB7:RB4 pin configured as an output is excluded from the interrupt on change comparison). The input pins (of RB7:RB4) are compared with the old value latched on the last read of PORTB. The "mismatch" outputs of RB7:RB4 are OR'd together to generate the RB Port Change Interrupt with flag bit RBIF (INTCON<0>).

PORTC and the TRISC Register:

PORTC is an 8-bit wide, bi-directional port. The corresponding data direction register is TRISC. Setting a TRISC bit (= 1) will make the corresponding PORTC pin an input (i.e., put the corresponding output driver in a Hi-Impedance mode). Clearing a TRISC bit (= 0) will make the corresponding PORTC pin an output (i.e., put the contents of the output latch on the selected pin). PORTC is multiplexed with several peripheral functions. PORTC pins have Schmitt Trigger input buffers.

When enabling peripheral functions, care should be taken in defining TRIS bits for each PORTC pin. Some peripherals override the TRIS bit to make a pin an out-put, while other peripherals override the TRIS bit to make a pin an input. Since the TRIS bit override is in effect while the peripheral is enabled, read-modify-write instructions (BSF, BCF, XORWF) with TRISC as destination should be avoided. The user should refer to the corresponding peripheral section for the correct TRIS bit settings.

Capture Mode:

In Capture mode, CCPR1H: CCPR1L captures the 16-bit value of the TMR1 register when an event occurs on pin RC2/CCP1. An event is defined as:
- Every falling edge
- Every rising edge
- Every 4th rising edge
- Every 16th rising edge

An event is selected by control bits CCP1M3:CCP1M0 (CCP1CON<3:0>). When a capture is made, the interrupt request flag bit CCP1IF (PIR1<2>) is set. It must be cleared in software. If another capture occurs before the value in register CCPR1 is read, the old captured value is overwritten by the new captured value.

Compare Mode:

In Compare mode, the 16-bit CCPR1 register value is constantly compared against the TMR1 register pair value. When a match occurs, the RC2/CCP1 pin is:

- Driven High
- Driven Low
- Remains Unchanged

The action on the pin is based on the value of control bits CCP1M3: CCP1M0 (CCP1CON<3:0>). At the same time, interrupt flag bit CCP1IF is set. The output may become inverted when the   mode of the module is changed from Compare/Clear on Match (CCPxM<3:0> = '1001') to Compare/Set on Match (CCPxM<3:0> = '1000'). This may occur as a result of any operation that selectively clears bit CCPxM0, such as a BCF instruction. When this condition occurs, the output becomes inverted when the instruction is executed. It will remain inverted for all following Compare operations, until the module is reset.

ANALOG-TO-DIGITAL CONVERTER (A/D) MODULE:

The analog-to-digital (A/D) converter module has five inputs for the PIC16F72. The A/D allows conversion of an analog input signal to a corresponding 8-bit digital number. The   output of the sample and hold is the input into the converter, which generates the result via successive approximation. The analog reference voltage is software selectable to either the device's positive supply voltage (VDD) or the voltage level on the RA3/AN3/VREF pin.

The A/D converter has a unique feature of being able to operate while the device is in SLEEP mode. To operate in SLEEP, the A/D conversion clock must be derived from the A/D's internal RC oscillator.

The A/D module has three registers:

- A/D Result Register ADRES
- A/D Control Register 0   ADCON0
- A/D Control Register 1   ADCON1

A device RESET forces all registers to their RESET state. This forces the A/D module to be turned off and any conversion is aborted. The ADCON0 register, shown in Register 10-1,   controls the operation of the A/D module. The ADCON1 register, shown in Register 10-2, configures the functions of the port pins. The port

pins can be configured as analog inputs (RA3 can also be a voltage reference) or a digital I/O.

OSCILLATOR CONFIGURATIONS:

The PIC16F72 can be operated in four different Oscillator modes. The user can program two configuration bits (FOSC1 and FOSC0) to select one of these four Modes:

- LP Low Power Crystal
- XT Crystal/Resonator
- HS High Speed Crystal/Resonator
- RC Resistor/Capacitor

RESET:

The PIC16F72 differentiates between various kinds of RESET:

- Power-on Reset (POR)
- MCLR Reset during normal operation
- MCLR Reset during SLEEP
- WDT Reset (during normal operation)
- WDT Wake-up (during SLEEP)
- Brown-out Reset (BOR)

Some registers are not affected in any RESET condition. Their status is unknown on POR and unchanged in any other RESET. Most other registers are reset to a "RESET state" on Power-on Reset (POR), on the MCLR and WDT Reset, on MCLR Reset during SLEEP, and Brown-out Reset (BOR). They are not affected by a WDT Wake-up, which is viewed as the resumption of normal operation. The TO and PD bits are set or cleared differently in different RESET situations, as indicated in Table 11-4. These bits are used in software to determine the nature of the RESET.

Power-on Reset (POR):

A Power-on Reset pulse is generated on-chip when VDD rise is detected (in the range of 1.2V - 1.7V). To take advantage of the POR, tie the MCLR pin to VDD, A maximum rise time for VDD is specified. When the device starts normal operation (exits the RESET condition), device-operating   parameters   (volt-age,   frequency,

temperature,) must be met to ensure operation. If these conditions are not met, the device must be held in RESET until the operating conditions are met.

Power-up Timer (PWRT):

The Power-up Timer provides a fixed 72 ms nominal time-out on power-up only

From the POR. The Power-up Timer operates on an internal RC oscillator. The chip is kept in RESET as long as the PWRT is active. The PWRT's time delay allows VDD to rise to an acceptable level.

A configuration bit is provided to enable/ disable the PWRT. The power-up time delay will vary from chip to chip due to VDD, temperature and process variation.

Oscillator Start-up Timer (OST):

The Oscillator Start-up Timer (OST) provides 1024 oscillator cycles (from OSC1 input) delay after the PWRT delay is over (if enabled). This helps to ensure that the crystal oscillator or resonator has started and stabilized. The OST time-out is invoked only for XT, LP and HS modes and only on Power-on Reset or wake-up from SLEEP.

Brown-out Reset (BOR):

The configuration bit, BOREN, can enable or disable the Brown-out Reset circuit. If VDD falls below VBOR (parameter D005, about 4V) for longer than TBOR (parameter #35, about 100 μs), the brown-out situation will reset the device. If VDD falls below VBOR for less than TBOR, a RESET may not occur. Once the brown-out occurs, the device will remain in Brown-out Reset until VDD rises above VBOR. The Power-up Timer then keeps the device in RESET for TPWRT (parameter #33, about 72 ms). If VDD should fall below VBOR during TPWRT, the Brown-out Reset process will restart when VDD rises above VBOR, with the Power-up Timer Reset. The Power-up Timer is always enabled when the Brown-out Reset circuit is enabled, regardless of the state of the PWRT configuration bit.

Power Control/Status Register (PCON):

The Power Control/Status Register, PCON, has two bits to indicate the type of RESET that last occurred. Bit0 is Brown-out Reset Status bit, BOR. Bit BOR is

unknown on a Power-on Reset. It must then be set by the user and checked on subsequent RESETS to see if bit BOR cleared, indicating a Brown-out Reset occurred. When the Brown-out Reset is disabled, the state of the BOR bit is unpredictable.

Bit1 is POR (Power-on Reset Status bit). It is cleared on a Power-on Reset and unaffected otherwise. The user must set this bit following a Power-on Reset.

Watchdog Timer (WDT):

The Watchdog Timer is a free running, on-chip RC oscillator that does not require any external components. This RC oscillator is separate from the RC oscillator of the SC1/CLKI pin. That means that the WDT will run, even if the clock on the OSC1/CLKI and OSC2/ CLKO pins of the device has been stopped, for example, by execution of a SLEEP instruction.

During normal operation, a WDT time-out generates a device RESET (Watchdog Timer Reset). If the device is in SLEEP mode, a WDT time-out causes the device to wake-up and   continue with normal operation (Watchdog Timer Wake-up). The TO bit in the STATUS register will be cleared upon a Watchdog Timer time-out.

Program Verification/Code Protection:

If the code protection bit(s) have not been programmed, the on-chip program memory can be read out for verification purposes.

ID Locations:

Four memory locations (2000h - 2003h) are designated as ID locations, where the user can store checksum or other code identification numbers. These locations are not accessible during normal execution, but are readable and writable during

program/verify. It is recommended that only the four Least Significant bits of the ID location are used.

In-Circuit Serial Programming:

PIC16F72 microcontrollers can be serially programmed while in the end application circuit. This is simply done with two lines for clock and data and three other lines for power, ground, and the programming voltage. This allows customers to manufacture boards with unprogrammed devices, and then program the micro controller just before shipping the product. This also allows the most recent firmware or a custom firmware to be programmed.

INSTRUCTION SET SUMMARY:

Each PIC16F72 instruction is a 14-bit word divided into an OPCODE that specifies the instruction type and one or more operands that further specify the operation of the instruction. The PIC16F72 instruction set summary in Table 12-2 lists byte-oriented, bit-oriented, and literal and control operations. Table 12-1 shows the opcode field descriptions. For byte-oriented instructions, 'f' represents a file register designator and 'd' represents a destination designator. The file register designator specifies which file register is to be used by the instruction.

The destination designator specifies where the result of the operation is to be placed. If 'd' is zero, the result is placed in the W register. If 'd' is one, the result is placed in the file register specified in the instruction.

For bit-oriented instructions, 'b' represents a bit field designator which selects the number of the bit affected by the operation, while 'f' represents the number of the file in which the bit is located. For literal and control operations, 'k' represents an eight or eleven-bit constant or literal value.

The instruction set is highly orthogonal and is grouped into three basic categories:

- Byte-oriented operations
- Bit-oriented operations
- Literal and control operations

All instructions are executed within one single instruction cycle, unless a conditional test is true or the program counter is changed as a result of an instruction. In this case, the execution takes two instruction cycles, with the second cycle executed as a NOP. One instruction cycle consists of four oscillator periods. Thus, for an oscillator frequency of 4 MHz, the normal instruction execution time is 1 µs. If a conditional test is true, or the program counter is changed as a result of an instruction, the instruction execution time is 2 µs.

I2C PROTOCOL

HISTORY OF THE I2C BUS

The I2C bus was developed in the early 1980's by Philips Semiconductors. Its original purpose was to provide an easy way to connect a CPU to peripheral chips in a TV-set. I²C is a multi-master serial computer bus used to attach low-speed peripherals to a motherboard, embedded system, or cell phone. The name stands for Inter-Integrated Circuit and is pronounced *I*-squared-*C* and also, *I-two-C*.

THE I2C BUS PROTOCOL

The I2C bus physically consists of 2 active wires and a ground connection. The active wires, called SDA and SCL, are both bi-directional. SDA is the Serial data line, and SCL is the Serial clock line.

Every device hooked up to the bus has its own unique address, no matter whether it is an MCU, LCD driver, memory, or ASIC. Each of these chips can act as a receiver and/or transmitter, depending on the functionality. Obviously, an LCD driver is only a receiver, while a memory or I/O chip can be both transmitter and receiver.

The I2C bus is a multi-master bus. This means that more than one IC capable of initiating a data transfer can be connected to it. The I2C protocol specification states that the IC that initiates a data transfer on the bus is considered the **Bus Master**. Consequently, at that time, all the other ICs are regarded to be **Bus Slaves**.

As bus masters are generally microcontrollers, let's take a look at a general 'inter-IC chat' on the bus. Let's consider the following setup and assume the MCU wants to send data to one of its slaves.
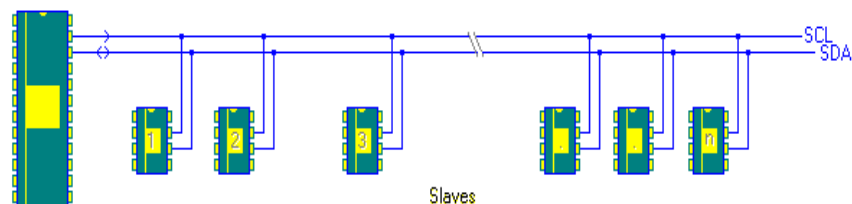
OPERATION:-

First, the MCU will issue a **START** condition. This acts as an 'Attention' signal to all of the connected devices. All ICs on the bus will listen to the bus for incoming data.

Then the MCU sends the **ADDRESS** of the device it wants to access, along with an indication whether the access is a Read or Write operation (Write in our example). Having received the address, all IC's will compare it with their own address. If it doesn't match, they simply wait until the bus is released by the stop condition (see below). If the address matches, however, the chip will produce a response called the **ACKNOWLEDGEMENT** signal.

Once the MCU receives the acknowledge, it can start transmitting or receiving **DATA**. In our case, the MCU will transmit data. When all is done, the MCU will issue the **STOP** condition. This is a signal that the bus has been released and that the connected ICs may expect another transmission to start any moment.

We have had several states on the bus in our example: START, ADDRSS, ACKNOWLEDGEMENT, DATA and STOP. These are all unique conditions on the

bus. Before we take a closer look at these bus conditions we need to understand a bit about the physical structure and hardware of the bus

THE I2C BUS HARDWARE STRUCTURE

As explained earlier, the bus physically consists of 2 active wires called **SDA** (data) and **SCL** (clock), and a ground connection.

Both SDA and SCL are initially bi-directional. This means that in a particular device, these lines can be driven by the IC itself or from an external device. In order to achieve this functionality, these signals use open collector or open drain outputs (depending on the technology).

The bus interface is built around an input buffer and an open drain or open collector transistor. When the bus is IDLE, the bus lines are in the logic HIGH state (note that external pull-up resistors are necessary for this which is easily forgotten). To put a signal on the bus, the chip drives its output transistor, thus pulling the bus to a LOW level. The "pull-up resistor" in the devices as seen in the figure is actually a small current source or even non-existent.
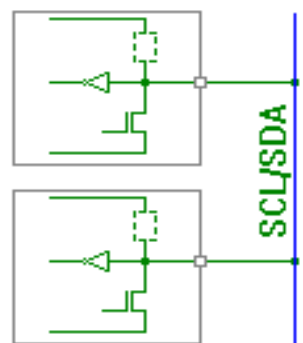

I2C Bus Events: The START and STOP conditions:

Prior to any transaction on the bus, a START condition needs to be issued on the bus. The start condition acts as a signal to all connected IC's that something is about to be transmitted on the bus. As a result, all connected chips will listen to the bus.

After a message has been completed, a STOP condition is sent. This is the signal for all devices on the bus that the bus is available again (idle). If a chip was

accessed and has received data during the last transaction, it will now process this information (if not already processed during the reception of the message).

START: The chip issuing the Start condition first pulls the SDA (data) line low, and next pulls the SCL (clock) line low.
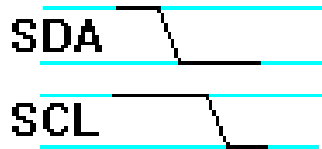
**STOP:** The Bus Master first releases the SCL and then the SDA line.
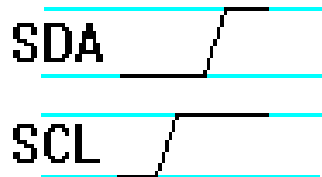
- A single message can contain multiple Start conditions. The use of this so-called "repeated start" is common in I2C.

- A Stop condition always denotes the END of a transmission. Even if it is issued in the middle of a transaction or in the middle of a byte. It is "good behavior" for a chip that, in this case, it disregards the information sent and resumes the "listening state", waiting for a new start condition.

I2C BUS EVENTS: TRANSMITTING A BYTE TO A SLAVE:

Once the **start** condition has been sent, a byte can be transmitted by the MASTER to the SLAVE.

This first byte after a start condition will identify the slave on the bus (address) and will select the mode of operation. The meaning of all following bytes depends on the slave.
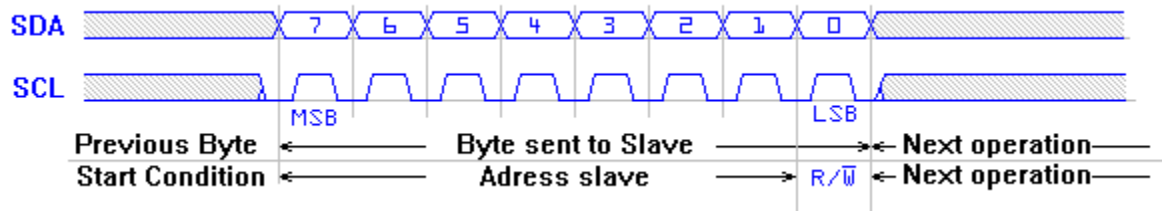

As the I2C bus gained popularity, it was soon discovered that the number of available addresses was too small. Therefore, one of the reserved addresses has been allocated to a new task to switch to 10-bit addressing mode. If a standard slave (not able to resolve extended addressing) receives this address, it won't do anything (since it's not its address).

If there are slaves on the bus that can operate in the extended 10-bit addressing mode, they will ALL respond to the **ACK** cycle issued by the master. The second byte that gets transmitted by the master will then be taken in and evaluated against their address.

I2C BUS EVENTS: RECEIVING A BYTE FROM A SLAVE:

Once the slave has been addressed and the **slave has acknowledged** this, a byte can be received from the slave if the R/W bit in the address was set to READ (set to '1').

The protocol syntax is the same as in **transmitting a byte to a slave**, except that now the master is not allowed to touch the SDA line. Prior to sending the 8 clock pulses needed to clock in a byte on the SCL line, the master releases the SDA line. The slave will now take control of this line. The line will then go high if it wants to transmit a '1' or, if the slave wants to send a '0', remain low.
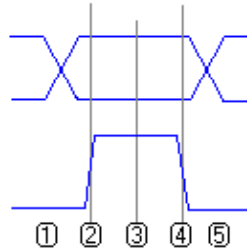
All the master has to do is generate a rising edge on the SCL line (2), read the level on SDA (3) and generate a falling edge on the SCL line (4). The slave will not change the data during the time that SCL is high. (Otherwise a **Start or Stop condition** might inadvertently be generated.)

During (1) and (5), the slave may change the state of the SDA line.

In total, this sequence has to be performed 8 times to complete the data byte. Bytes are always transmitted MSB first
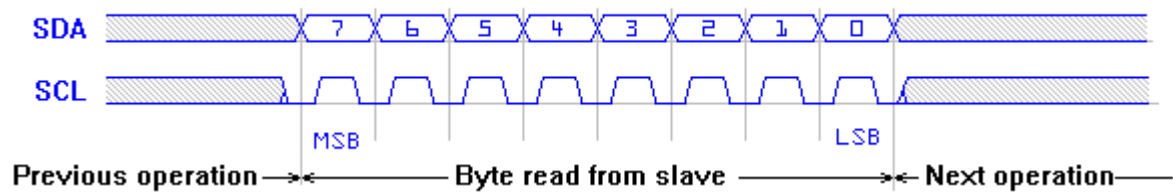
The meaning of all bytes being read depends on the slave. There is no such thing as a "universal status register". You need to consult the data sheet of the slave being addressed to know the meaning of each bit in any byte transmitted.

I2C BUS EVENTS: GETTING ACKNOWLEDGE FROM A SLAVE:

When an address or data byte has been transmitted onto the bus then this must be acknowledged by the slave(s). In case of an address: If the address matches its own then that slave and only that slave will respond to the address with an ACK. In case of a byte transmitted to an already addressed slave then that slave will respond with an ACK as well.

The slave that is going to give an ACK pulls the SDA line low immediately after reception of the 8th bit transmitted, or, in case of an address byte, immediately after evaluation of its address. In practical applications this will not be noticeable.
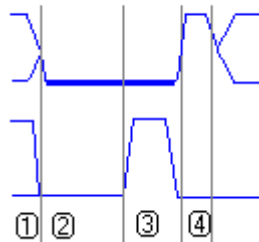
This means that as soon as the master pulls SCL low to complete the transmission of the bit (1), SDA will be pulled low by the slave (2).

The master now issues a clock pulse on the SCL line (3). The slave will release the SDA line upon completion of this clock pulse (4).

The bus is now available again for the master to continue sending data or to generate a stop condition.

In case of **data being written to a slave**, this cycle must be completed before a **stop condition** can be generated. The slave will be blocking the bus (SDA kept low by slave) until the master has generated a clock pulse on the SCL line.

I2C BUS EVENTS: GIVING ACKNOWLEDGE TO A SLAVE:

Upon **reception of a byte from a slave**, the master must acknowledge this to the slave device.

The master is in full control of the SDA and the SCL line.
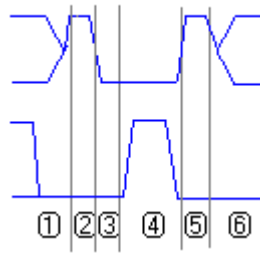
After transmission of the last bit to the master (1) the slave will release the SDA line. The SDA line should then go high (2). The Master will now pull the SDA line low (3) .

Next, the master will put a clock pulse on the SCL line (4). After completion of this clock pulse, the master will again release the SDA line (5).The slave will now regain control of the SDA line (6).

If the master wants to stop receiving data from the slave, it must be able to send a **stop condition.**

Since the slave regains control of the SDA line after the ACK cycle issued by the master, this could lead to problems.

Let's assume the next bit ready to be sent to the master is a 0. The SDA line would be pulled low by the slave immediately after the master takes the SCL line low. The master now attempts to generate a Stop condition on the bus. It releases the SCL line first and then tries to release the SDA line - which is held low by the slave. Conclusion: No Stop condition has been generated on the bus.

This condition is called a NACK: Not acknowledge.

I2C BUS EVENTS: NO ACKNOWLEDGE (FROM SLAVE TO MASTER):

This is not exactly a condition. It is merely a state in the data flow between master and slave.

If, after transmission of the 8th bit from the master to the slave the slave does not pull the SDA line low, then this is considered a No ACK condition.

This means that either:

- The slave is not there (in case of an address)
- The slave missed a pulse and got out of sync with the SCL line of the master.
- The bus is "stuck". One of the lines could be held low permanently.

In any case the master should abort by attempting to send a stop condition on the bus.

APPLICATIONS

I²C is appropriate for peripherals where simplicity and low manufacturing cost are more important than speed. Common applications of the I²C bus are:

- Reading configuration data from SPD EPROM's on SDRAM, DDR SDRAM, DDR2 SDRAM memory sticks (DIMM) and other stacked PC boards
- Supporting systems management for PCI cards, through a SMBus 2.0 connection.
- Accessing NVRAM chips that keep user settings.
- Accessing low speed DACs.
- Accessing low speed ADCs.
- Changing contrast, hue, and color balance settings in monitors (Display Data Channel).
- Changing sound volume in intelligent speakers.

- Controlling OLED/LCD displays, like in a cell phone.
- Reading hardware monitors and diagnostic sensors, like a CPU thermostat and fan speed.
- Reading real time clocks.
- Turning on and turning off the power supply of system components.

A particular strength of I²C is that a microcontroller can control a network of device chips with just two general-purpose I/O pins and software.

Peripherals can also be added to or removed from the I²C bus while the system is running, which makes it ideal for applications that require hot swapping of components.

3.2 PASSIVE INFRARED SENSOR (PIR): -

A PIR detector is a motion detector that senses the heat emitted by a living body. These are often fitted to security lights so that they will switch on automatically if approached. They are very effective in enhancing home security systems.

The sensor is passive because, instead of emitting a beam of light or microwave energy that must be interrupted by a passing person in order to "sense" that person, the PIR is simply sensitive to the infrared energy emitted by every living thing. When an intruder walks into the detector's field of vision, the detector "sees" a sharp increase in infrared energy.

A PIR sensor light is designed to turn on when a person approaches, but will not react to a person standing still. The lights are designed this way. A moving person exhibits a sudden change in infrared energy, but a slower change is emitted by a motionless body. Slower changes are also caused by gradual fluctuations in the temperature of the environment. If the light were sensitive to these slower changes, it would react to the sidewalk cooling off at night, instead of the motion of a burglar.

If you have a PIR light, you may notice that it is more sensitive on cold days than on warm days. This is because the difference in temperature between the ambient air and the human body is greater on cold days, making the rise in temperature easier for the sensor to detect. This has drawbacks, though; if the sensor is too sensitive, it will pick up things you don't want it to such as the movement of small animals.

Passive infrared sensor is an electronic device, which measures infrared light radiating from objects in its field of view. PIRs are often used in the construction of PIR-based motion detectors. Apparent motion is detected when an infrared source with one

temperature, such as a human, passes in front of an infrared source with another temperature, such as a wall.

All objects emit what is known as black body radiation. This energy is invisible to the human eye but can be detected by electronic devices designed for such a purpose. The term 'Passive' in this instance means the PIR does not emit energy of any type but merely accepts incoming infrared radiation.

Infrared radiation enters through the front of the sensor, known as the sensor face. At the core of a PIR is a solid state sensor or set of sensors, made from approximately 1/4 inches square of natural or artificial pyroelectric materials, usually in the form of a thin film, out of gallium nitride (GaN), caesium nitrate ($CsNO_3$), polyvinyl fluorides, derivatives of phenylpyrazine, and cobalt phthalocyanine. (See pyroelectric crystals.) Lithium tantalate ($LiTaO_3$) is a crystal exhibiting both piezoelectric and pyroelectric properties.

The sensor is often manufactured as part of an integrated circuit and may consist of one (1), two (2) or four (4) 'pixels' of equal areas of the pyroelectric material. Pairs of the sensor pixels may be wired as opposite inputs to a differential amplifier. In such a configuration, the PIR measurements cancel each other so that the average temperature of the field of view is removed from the electrical signal; an increase of IR energy across the entire sensor is self-cancelling and will not trigger the device. This allows the device to resist false indications of change in the event of being exposed to flashes of light or field-wide illumination. (Continuous bright light

could still saturate the sensor materials and render the sensor unable to register further information.)

At the same time, this differential arrangement minimizes common-mode interference; this allows the device to resist triggering due to nearby electric fields. However, a differential pair of sensors cannot measure temperature in that configuration and therefore this configuration is specialized for motion detectors.

In a PIR-based motion detector, the PIR sensor is typically mounted on a printed circuit board, which also contains the necessary electronics required to interpret the signals from the chip. The complete circuit is contained in a housing, which is then mounted in a location where the sensor can view the area to be monitored. Infrared energy is able to reach the sensor through the window because the plastic used is transparent to infrared radiation (but only translucent to visible light). This plastic sheet prevents the introduction of dust and insects, which could obscure the sensor's field of view.

OPERATION OF PIR SENSOR:

A few mechanisms have been used to focus the distant infrared energy onto the sensor surface. The window may have Fresnel lenses molded into it. Alternatively, sometimes PIR sensors are used with plastic segmented parabolic mirrors to focus the infrared energy; when mirrors are used, the plastic window cover has no Fresnel lenses molded into it. A filtering window (or lens) may be used to limit the wavelengths to 8-14 micrometers, which is most sensitive to human infrared radiation (9.4 micrometers being the strongest).

The PIR device can be thought of as a kind of infrared 'camera', which remembers the amount of infrared energy focused on its surface. Once power is applied to the PIR the electronics in the PIR shortly settle into a quiescent state and energize a small relay. This relay controls a set of electrical contacts, which are usually connected to the detection input of an alarm control panel. If the amount of infrared energy focused on the sensor changes within a configured time period, the

device will switch the state of the alarm output relay. The alarm output relay is typically a "normally closed (NC)" relay; also know as a "Form B" relay.

A person entering the monitored area is detected when the infrared energy emitted from the intruder's body is focused by a Fresnel lens or a mirror segment and overlaps a section on the chip, which had previously been looking at some much cooler part of the protected area. That portion of the chip is now much warmer than when the intruder wasn't there. As the intruder moves, so does the hot spot on the surface of the chip. This moving hot spot causes the electronics connected to the chip to de-energize the relay, operating its contacts, thereby activating the detection input on the alarm control panel. Conversely, if an intruder were to try to defeat a PIR perhaps
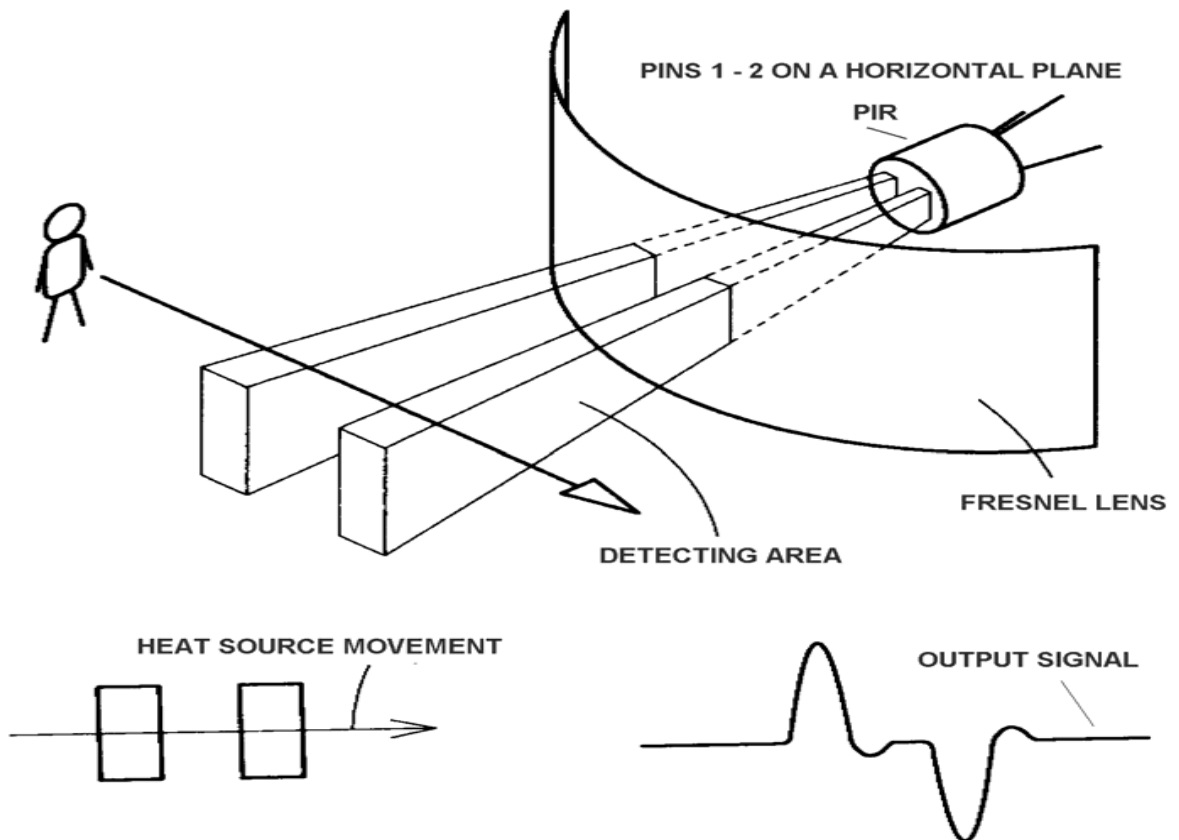
By holding some sort of thermal shield between himself and the PIR, a corresponding 'cold' spot moving across the face of the chip will also cause the relay to de-energize unless the thermal shield has the same temperature as the objects behind it.

Manufacturers recommend careful placement of their products to prevent false alarms. They suggest mounting the PIRs in such a way that the PIR cannot 'see' out of a window. Although the wavelength of infrared radiation to which the chips are sensitive does not penetrate glass very well, a strong infrared source (a vehicle headlight, sunlight reflecting from a vehicle window) can overload the chip with enough infrared energy to fool the electronics and cause a false (non-intruder caused) alarm. A person moving on the other side of the glass however would not be 'seen' by the PIR.

They also recommended that the PIR not be placed in such a position that an HVAC vent would blow hot or cold air onto the surface of the plastic, which covers the housing's window. Although air has very low emissivity (emits very small amounts of infrared energy), the air blowing on the plastic window cover could change the plastic's temperature enough to, once again, fool the electronics.

PIRs come in many configurations for a wide variety of applications. The most common used in home security systems has numerous Fresnel lenses or mirror segments and has an effective range of about thirty feet. Some larger PIRs are made with single segment mirrors and can sense changes in infrared energy over one hundred feet away from the PIR. There are also PIRs designed with reversible orientation mirrors, which allow either broad coverage (110° wide) or very narrow 'curtain' coverage.

PIRs can have more than one internal sensing element so that, with the appropriate electronics and Fresnel lens, it can detect direction. Left to right, right to left, up or down and provide an appropriate output signal.

3.3 LIGHT DEPENDENT RESISTOR: -

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as

1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

Electronic opto sensors are the devices that alter their electrical characteristics, in the presences of visible or invisible light. The best-known devices of this type are the light dependent resistor (LDR), the photo diode and the phototransistors.

Light dependent resistor as the name suggests depends on light for the variation of resistance.

- LDR are made by depositing a film of cadmium sulphide or cadmium selenide on a substrate of ceramic containing no or very few free electrons when not illuminated. The film is deposited in a zig zag fashion in the form of a strip. The longer the strip the more the value of resistance.

- When light falls on the strip, the resistance decreases. In the absence of light the resistance can be in the order of 10K ohm to 15K ohm and is called the dark resistance.

Depending on the exposure of light the resistance can fall down to value of 500 ohms. The power ratings are usually smaller and are in the range 50mw to .5w. Though very sensitive to light, the switching time is very high and hence cannot be used for high frequency applications. They are used in chopper amplifiers.

Light dependent resistors are available as discs 0.5cm to 2.5cm. The resistance rises to several Mega ohms under dark conditions.

The below figure shoes that when the torch is turned on, the resistance of the LDR falls, allowing current to pass through it is shown in figure.

LDR
Light Dependent Resistor
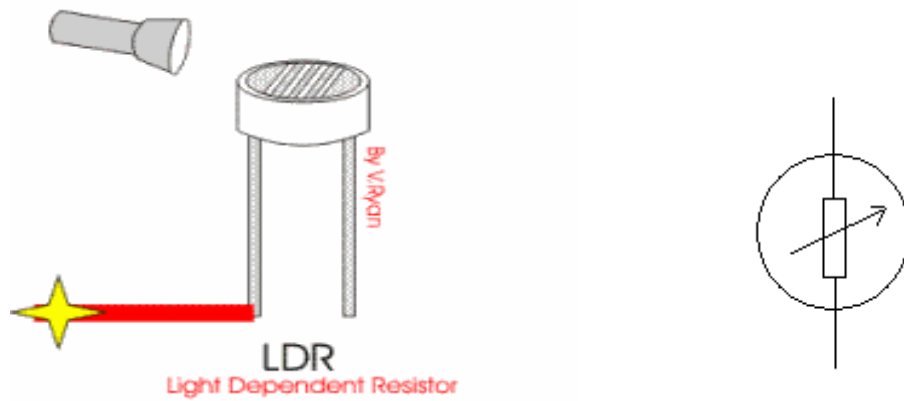
The basic construction and symbol for LDR are shown in above figures respectively. The device consists of a pair of metal film contacts. Separated by a snakelike track of cadmium sulphide film, designed to provide the maximum possible contact area with the two metal films. The structure is housed in a clear plastic or resin case, to provide free access to external light. Practical LDRs are available in variety of sizes and packages styles, the most popular size having a face diameter of roughly 10mm. practical LDR is shown in below figure.
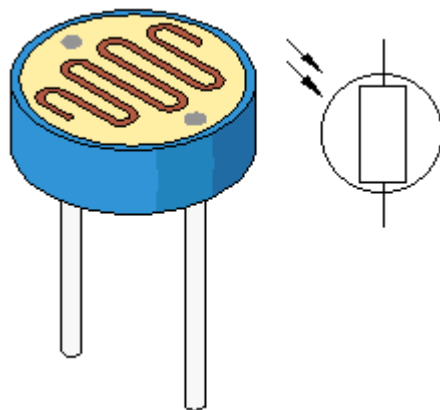
Spectral response:

The resistors are only light dependent over a limited range of wavelengths. LDRs have their maximum response at about 680nm.

Temperature dependency:

Electrons can be excited not only by photons but also by thermal agitation. The dark resistance is therefore not infinite at normal temperatures. It increases with the ambient temperature coefficient is, however, very small and can be neglected.

Recovery rate:

When an LDR is brought from a certain illuminating level into total darkness, the resistance does not increase immediately to the dark value. The recovery rate is specified in k ohm/second and for current LDR types it is more than 200k ohm/second. The recovery rate is much greater in the reverse direction, e.g. going from darkness to illumination level of 300 lux, it takes less than 10ms to reach a resistance which corresponds with a light level of 400 lux.

LDRs are sensitive, inexpensive, and readily available devices. They have good power and voltage handling capabilities, similar to those of a conventional resistor. Their only siginificant defect is that they are fairly low acting, taking tens or hundreds of LDR include light and dark-activated switches and alarms, light beam alarms and reflective smoke alarms etc. A LDR may be connected either way round and no special precautions are required when soldering.

- Darkness: Maximum resistance, about 1Mohm.
- Very bright light: Minimum resistance, about 100 ohm.

The LDR is a variable resistor whose resistance decreases with the increase in light intensity. Two cadmium sulphide (cds) photoconductive cells with spectral response similar to that of the human eye. The cell resistance falls with increasing light intensity.

LDR Circuit Diagram: -
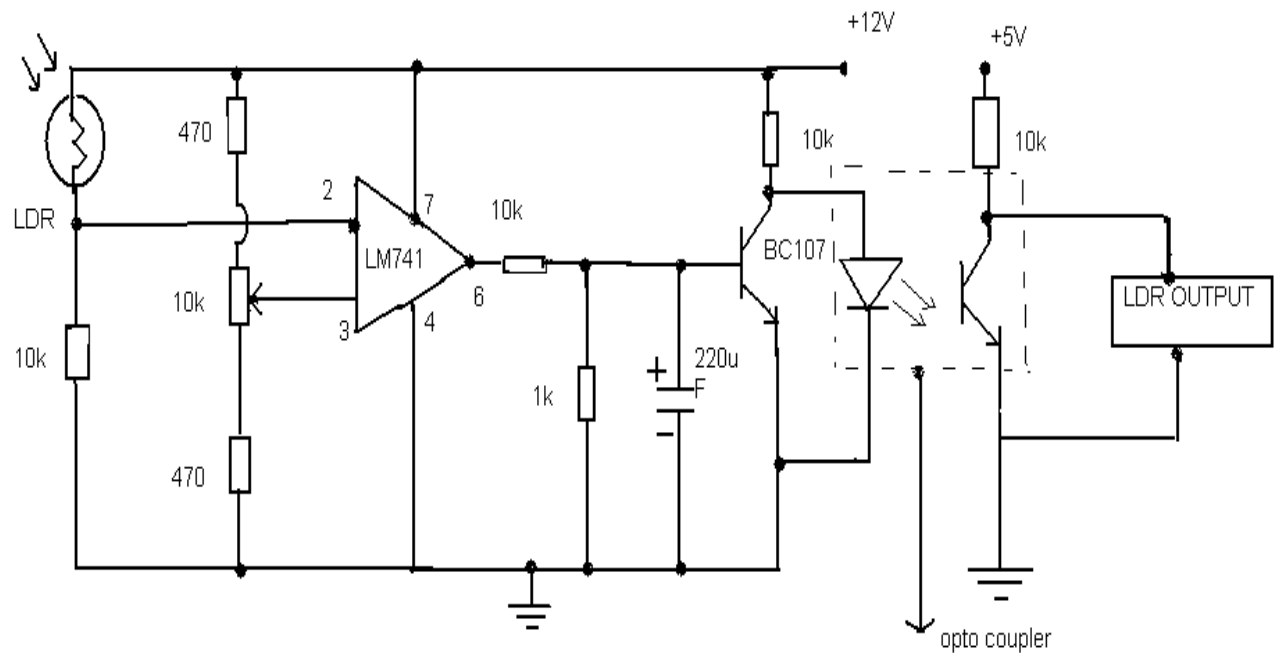
Features:

- High reliability
- Light weight
- Wide spectral response
- Wide ambient temperature range

Applications:

- Smoke detection
- Automatic lighting control
- Burglar alarm systems
- Camera (electronic shutter)
- Strobe (color temperature reading)

3.4 Digital Thermometer and Thermostat (DS1621): -

FEATURES: -

❖ Temperature measurements require no external components

❖ Measures temperatures from -55°C to +125°C in 0.5°C increments. Fahrenheit equivalent is -67°F to 257°F in 0.9°F increments

❖ Temperature is read as a 9-bit value (2-byte transfer)

❖ Wide power supply range (2.7V to 5.5V)

❖ Converts temperature to digital word in less than 1 second

❖ Thermostatic settings are user definable and nonvolatile

❖ Data is read from/written via a 2-wire serial interface (open drain I/O lines)

❖ Applications include thermostatic controls, industrial systems, consumer products, Thermometers, or any thermal sensitive system

❖ 8-pin DIP or SO package (150mil and 208mil)

ABSOLUTE MAXIMUM RATINGS:

Voltage on Any Pin Relative to Ground	-0.5V to +6.0V
Operating Temperature Range	-55_C to +125_C
Storage Temperature Range	-55_C to +125_C

DESCRIPTION:

The DS1621 Digital Thermometer and Thermostat provides 9-bit temperature readings, which indicate the temperature of the device. The thermal alarm output, TOUT, is active when the temperature of the device exceeds a user-defined temperature TH:- The output remains active until the temperature drops below user defined temperature TL, allowing for any hysteresis necessary.

User-defined temperature settings are stored in nonvolatile memory so parts may be programmed prior to insertion in a system. Temperature settings and

temperature readings are all communicated to/from the DS1621 over a simple 2-wire serial interface.

PIN DESCRIPTION:

PIN ASSIGNMENT

SDA - 2-Wire Serial Data Input/Output.

SCL - 2-Wire Serial Clock

GND - Ground

TOUT - Thermostat Output Signal

A0 - Chip Address Input
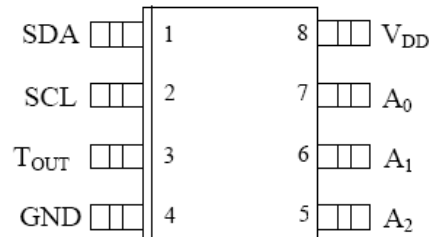
DS1621 8-PIN S0(150 mil)

A1 - Chip Address Input

A2 - Chip Address Input

VDD - Power Supply Voltage
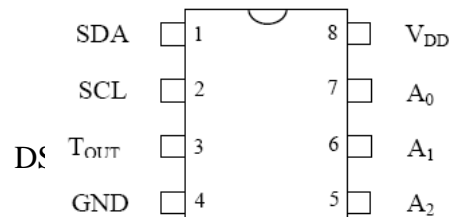
OPERATION:

Measuring Temperature:

The DS1621 measures temperature using a band gap-based temperature sensor. A delta-sigma analog-to digital converter (ADC) converts the measured temperature to a digital value that is calibrated in °C; for °F applications, a lookup table or conversion routine must be used.

The temperature reading is provided in a 9-bit, two's complement reading by issuing the READ TEMPERATURE command. Table 2 describes the exact relationship of output data to measured temperature. The data is transmitted through the 2-wire serial interface, MSB first. The DS1621 can measure temperature over the range of -55_C to +125_C in 0.5_C increments.

DS1621 FUNCTIONAL BLOCK DIAGRAM:
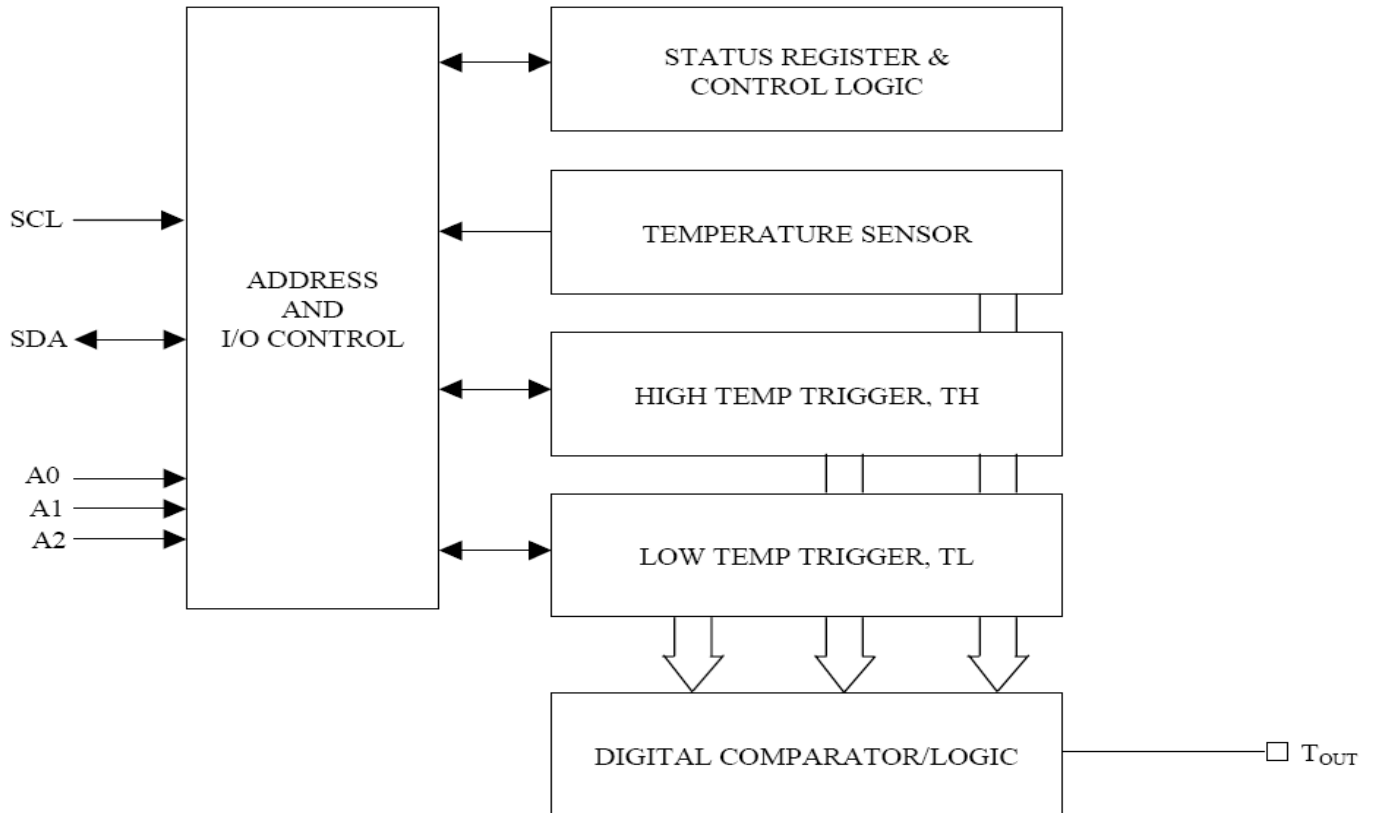
Thermostat Control: -

In its operating mode, the DS1621 functions as a thermostat with programmable hysteresis as shown in Figure 3. The thermostat output updates as soon as a temperature conversion is complete.

When the DS1621's temperature meets or exceeds the value stored in the high temperature trip register (TH), the output becomes active and will stay active until the temperature falls below the temperature stored in the low temperature trigger register (TL). In this way, any amount of hysteresis may be obtained.

The active state for the output is programmable by the user so that an active state may either be a logic "1" (VDD) or a logic "0" (0V). This is done using the POL bit in the configuration register as explained in the Operation and Control section of this datasheet.

THERMOSTAT OUTPUT OPERATION: -

DQ (Thermostat output, Active = High)
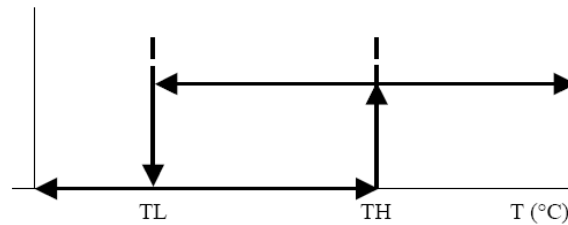
OPERATION AND CONTROL: -

The DS1621 must have temperature settings resident in the TH and TL registers for thermostatic operation. A configuration/status register also determines the method of operation that the DS1621 will use in a particular application, as well as indicating the status of the temperature conversion operation.

The configuration register is defined as follows:

MSb	Bit 6	Bit5	Bit 4	Bit 3	Bit 2	Bit 1	LSb
DONE	THF	TLF	NVB	X	X	POL	1SHOT

Where

DONE = Conversion Done bit. "1" = Conversion complete, "0" = Conversion in progress.

THF = Temperature High Flag. This bit will be set to "1" when the temperature is greater than or equal to the value of TH. It will remain "1" until reset by writing "0"

into this location or removing power from the device. This feature provides a method of determining if the DS1621 has ever been subjected to temperatures above TH while power has been applied.

TLF = Temperature Low Flag. This bit will be set to "1" when the temperature is less than or equal to the value of TL. It will remain "1" until reset by writing "0" into this location or removing power from the device. This feature provides a method of determining if the DS1621 has ever been subjected to temperatures below TL while power has been applied.

NVB = Nonvolatile Memory Busy flag. "1" = Write to an E2 memory cell in progress, "0" =nonvolatile memory is not busy. A copy to E2 may take up to 10 ms.

POL = Output Polarity Bit. "1" = active high, "0" = active low. This bit is nonvolatile.

1SHOT = One Shot Mode. If 1SHOT is "1", the DS1621 will perform one temperature conversion upon receipt of the Start Convert T protocol. If 1SHOT is "0", the DS1621 will continuously perform temperature conversions. This bit is nonvolatile.

X = Reserved.

For typical thermostat operation the DS1621 will operate in continuous mode. However, for applications where only one reading is needed at certain times or to conserve power, the one-shot mode may be used. Note that the thermostat output (TOUT) will remain in the state it was in after the last valid temperature conversion cycle when operating in one-shot mode.

The DS1621 may operate in the following two modes:

1.   Slave receiver mode: Serial data and clock are received through SDA and SCL. After each byte is received an acknowledge bit is transmitted. START and STOP conditions are recognized as the beginning and end of a serial transfer. Address

recognition is performed by hardware after reception of the slave address and direction bit.

2.   Slave transmitter mode: The first byte is received and handled as in the slave receiver mode. However, in this mode the direction bit will indicate that the transfer direction is reversed. Serial data is transmitted on SDA by the DS1621 while the serial clock is input on SCL. START and STOP conditions are recognized as the beginning and end of a serial transfer.

COMMAND SET:

To write to the DS1621, the master will issue the slave address of the DS1621 and the R/W bit will be set to "0". After receiving an acknowledge, the bus master provides a command protocol. After receiving this protocol, the DS1621 will issue an acknowledge and then the master may send data to the DS1621. If the DS1621 is to be read, the master must send the command protocol as before and then issue a repeated

START condition and the control byte again, this time with the R/W bit set to "1" to allow reading of the data from the DS1621. The command set for the DS1621 as shown in Table 3 is as follows:

Read Temperature [AAh]: -

This command reads the last temperature conversion result. The DS1621 will send 2 bytes, in the format described earlier, which are the contents of this register.

Access TH [A1h]: -

If R/W is "0" this command writes to the TH (HIGH TEMPERATURE) register. After issuing this command, the next 2 bytes written to the DS1621, in the same format as described for reading temperature, will set the high temperature threshold for operation of the TOUT output. If R/W is "1" the value stored in this register is read back.

Access TL [A2h]: -

If R/W is "0" this command writes to the TL (LOW TEMPERATURE) register. After issuing this command, the next 2 bytes written to the DS1621, in the

same format as described for reading temperature, will set the high temperature threshold for

operation of the TOUT output. If R/W is "1" the value stored in this register is read back.

Access Config [ACh]: -

If R/W is "0" this command writes to the configuration register. After issuing this command, the next data byte is the value to be written into the configuration register. If R/W is "1" the next data byte read is the value stored in the configuration register.

Read Counter [A8h]: -

This command reads the value Count_Remain. This command is valid only if R/W is "1".

Read Slope [A9h]: -

This command reads the value Count_Per_C. This command is valid only if R/W is "1".

Start Convert T [EEh]: -

This command begins a temperature conversion. No further data is required. In one-shot mode the temperature conversion will be performed and then the DS1621 will remain idle. In continuous mode this command will initiate continuous conversions.

Stop Convert T [22h]: -

This command stops temperature conversion. No further data is required. This command may be used to halt a DS1621 in continuous conversion mode. After issuing this command, the current temperature measurement will be completed and the DS1621

will remain idle until a Start Convert T is issued to resume continuous operation.

Table 3. DS1621 COMMAND SET

INSTRUCTION	DESCRIPTION	PROTOCOL	2-WIRE BUS DATA AFTER ISSUING PROTOCOL	NOTES
TEMPERATURE CONVERSION COMMANDS				
Read Temperature	Read last converted temperature value from temperature register.	AAh	<read 2 bytes data>	
Read Counter	Reads value of Count_Remain	A8h	<read data>	
Read Slope	Reads value of the Count_Per_C	A9h	<read data>	
Start Convert T	Initiates temperature conversion.	EEh	idle	1
Stop Convert T	Halts temperature conversion.	22h	idle	1
THERMOSTAT COMMANDS				
Access TH	Reads or writes high temperature limit value into TH register.	A1h	<write data>	2
Access TL	Reads or writes low temperature limit value into TL register.	A2h	<write data>	2
Access Config	Reads or writes configuration data to configuration register.	ACh	<write data>	2

3.5 ZERO CROSSING DETECTOR (ZCD): -

Zero crossing detectors as a group are not a well-understood application, although they are essential elements in a wide range of products. It has probably escaped the notice of readers who have looked at the lighting controller and the Linkwitz Cosine Burst Generator, but both of these rely on a zero crossing detector for their operation.

A zero crossing detector literally detects the transition of a signal waveform from positive and negative, ideally providing a narrow pulse that coincides exactly with the zero voltage condition. At first glance, this would appear to be an easy enough task, but in fact it is quite complex, especially where high frequencies are involved. In this instance, even 1 kHz starts to present a real challenge if extreme accuracy is needed.

The not so humble comparator plays a vital role - without it, most precision zero crossing detectors would not work, and we'd be without digital audio, PWM and a multitude of other applications taken for granted.

Basic low frequency: -

The zero crossing detector as used for the dimmer ramp generator. Although it has almost zero phase inaccuracy, that is largely because the pulse is so broad that any inaccuracy is completely swamped. The comparator function is handled by transistor Q1 - very basic, but adequate for the job.

The circuit is also sensitive to level, and for acceptable performance the AC waveform needs to be of reasonably high amplitude. 12-15V AC is typical. If the voltage is too low, the pulse width will increase. R1 is there to ensure that the voltage falls to zero - stray capacitance is sufficient to stop the circuit from working without it.
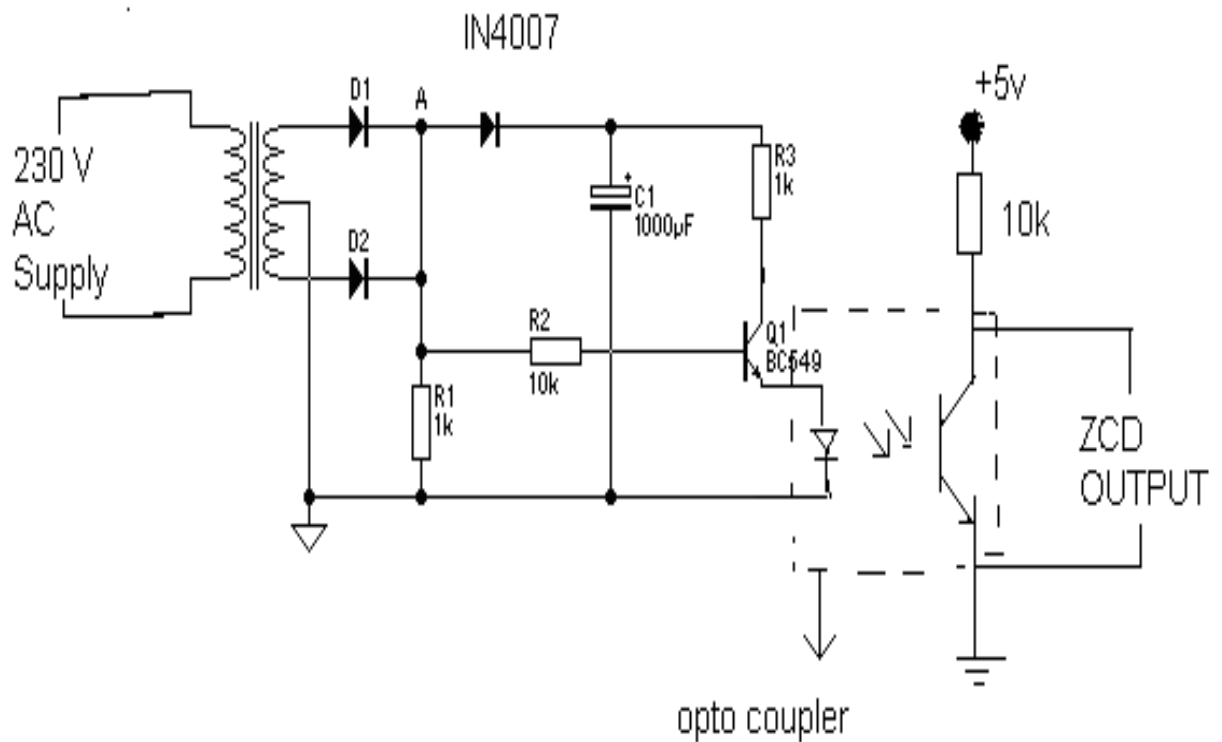
Basic 50/60Hz Zero Crossing Detector

The pulse width of this circuit (at 50Hz) is typically around 600us (0.6ms) which sounds fast enough. The problem is that at 50Hz each half cycle takes only 10ms (8.33ms at 60Hz), so the pulse width is over 5% of the total period. This is why most dimmers can only claim a range of 10%-90% - the zero crossing pulse lasts too long to allow more range.

While this is not a problem with the average dimmer, it is not acceptable for precision applications. For a tone burst generator (either the cosine burst or a 'conventional' tone burst generator), any inaccuracy will cause the switched waveform to contain glitches.

ZCD OUTPUT WAVEFORM: -
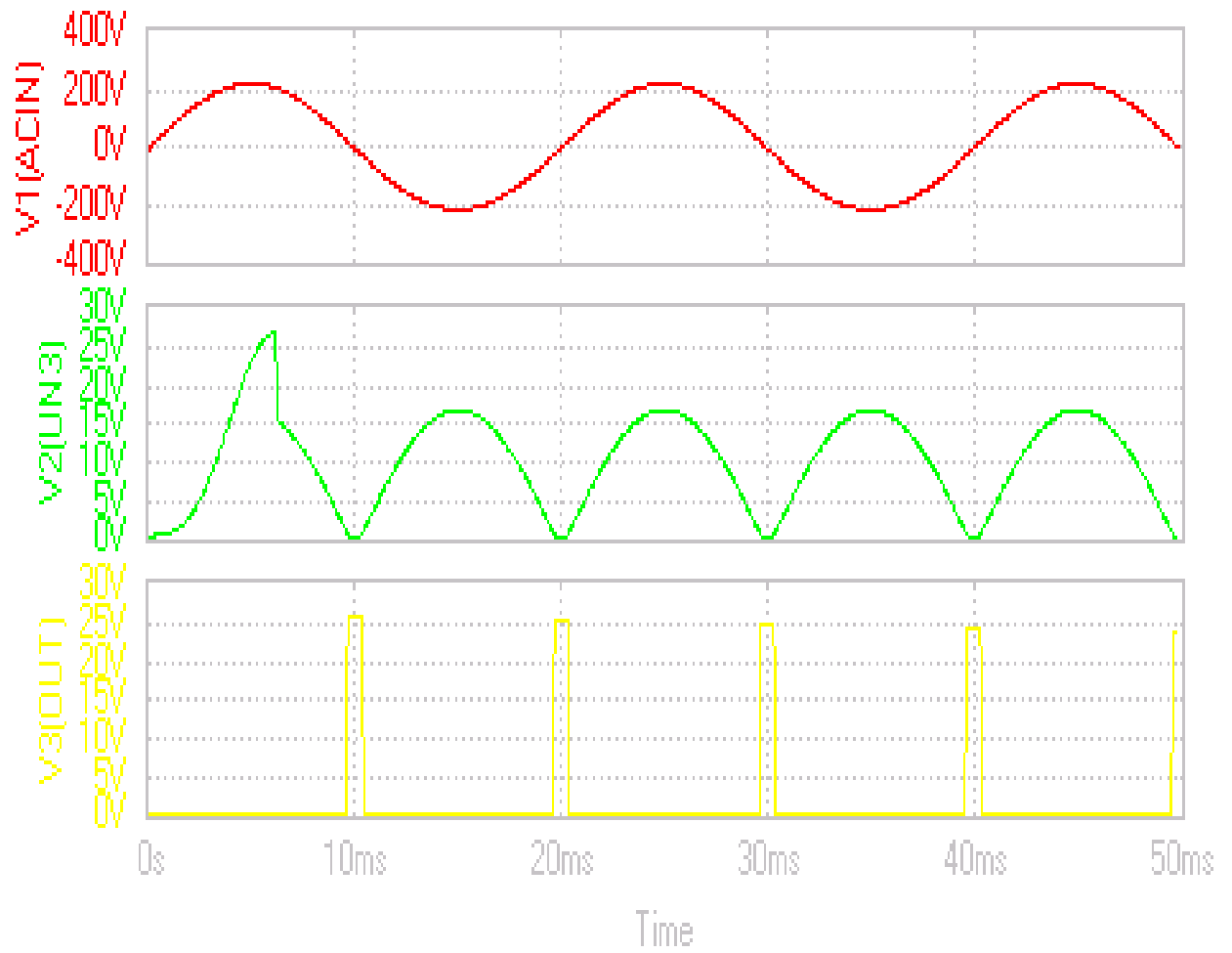
3.6 POWER SUPPLY:

Power supply block consists of following units:

- Step down transformer.
- Bridge rectifier circuit.
- Input filter.
- Voltage regulators.
- Output filter.
- Indicator unit.

Step down transformer:

The step-down transformer is used to step down the supply voltage of 230v ac from mains to lower values, as the various IC's used in this project require reduced voltages. The transformer consists of primary and secondary coils. To reduce or step down the voltage, the transformer is designed to contain less number of turns in its secondary core. The outputs from the secondary coil which is center tapped are the ac values of 0v, 15v and 15v. The conversion of these ac values to dc values to dc values is done using the full wave rectifier unit.

Rectifier Unit:

A diode bridge is an arrangement of four diodes connected in a bridge circuit. That provides the polarity of output voltage of any polarity of the input voltage. When used in its most common application, for conversion of alternating current (A.C) input into direct current (D.C) output, it is known as a bridge rectifier. The diagram describes a diode-bridge design known as a full wave rectifier. This design can be used to rectify single phase A.C. when no transformer center tap is available. A bridge rectifier makes use of four diodes in a bridge arrangement to achieve full wave rectification. This is a Widely used configuration, both with individual diodes wired as shown and with single component bridges where the diode bridge is wired internally.

For both positive and negative swings of the transformer, there is a forward path through the diode bridge. Both conduction paths cause current to flow in the same direction through the load resister, accomplishing full-wave rectification. While one set of diodes is forward biased, the other set is reverse biased and effectively eliminated from the circuit.

Input Filter: -

Capacitors are used as filters. The ripples from the dc voltages are removed and pure dc voltage is obtained. The primary action performed by capacitor is charging and discharging. It charges in positive half cycle of the ac voltage and it will discharge in negative half cycle. So it allows only ac voltage and does not allow the dc voltage. This filter is fixed before the regulator. Capacitors used here are of the value 1000uF

Regulator unit: -

Regulator regulates the output voltage to a specific value. The output voltage is maintained irrespective of the fluctuations in the input dc voltage. Whenever there are any ac voltage fluctuations, the dc voltage also changes, and to avoid this regulators are used.

Regulators can be classified as: -

1.   Positive regulator, which regulates the positive voltage(7805,7812)
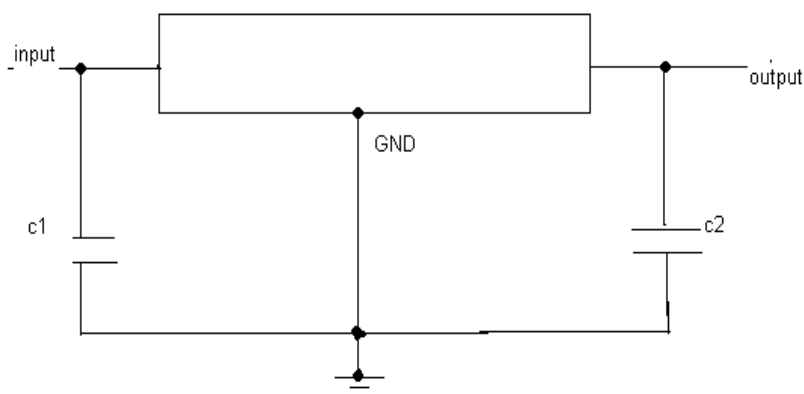
1.   > input pin
2.   > ground pin
3.   > output pin

2.   Negative regulator, which regulates the negative voltage (7912).

1.   > ground pin
2.   > input pin
3.   > output pin

Regulators used in this application are: -

7805 which provides 5v dc

7812 which provides 12v dc

7912 which provides -121v dc

Out put Filter: -

      This filter is fixed after the Regulator circuit to filter any of the possibly found ripples in the output received finally. Capacitors used here are of value 10F.

Power Supply Circuit Diagram:

3.7 LIQUID CRYSTAL DISPLAY (LCD): -

LCD is a type of display used in digital watches and many portable computers. LCD displays utilize to sheets of polarizing material with a liquid crystal solution between them. An electric current passed through the liquid causes the crystals to align so that light cannot pass through th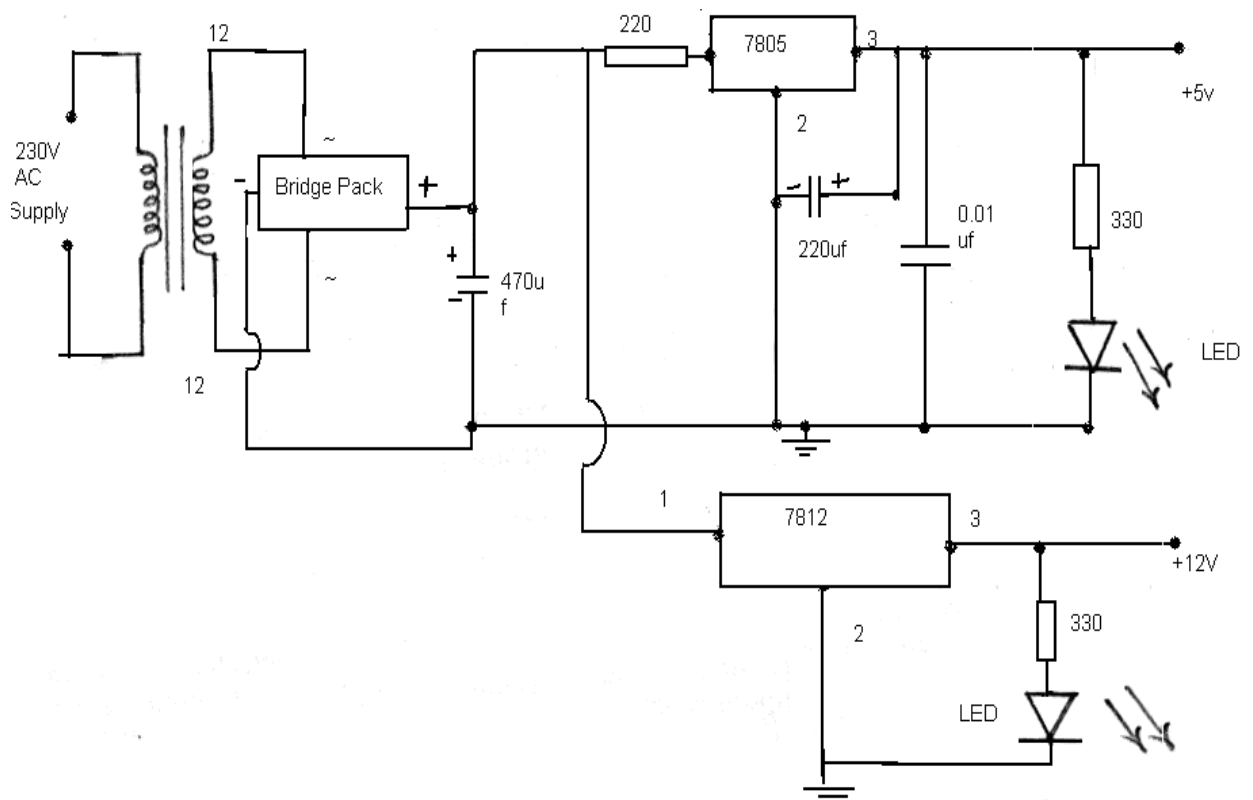em. LCD technology has advanced very rapidly since its initial inception over a decade ago for use in lap top computers. Technical achievements has resulted in brighter displace, higher resolutions, reduce response times and cheaper manufacturing process.

The liquid crystals can be manipulated through an applied electric voltage so that light is allowed to pass or is blocked. By carefully controlling where and what wavelength (color) of light is allowed to pass, the LCD monitor is able to display images. A backlight provides LCD monitor's brightness.

Over the years many improvements have been made to LCD to help enhance resolution, image, sharpness and response times.

One of the latest such advancement is applied to glass during acts as switch allowing control of light at the pixel level, greatly improving LCD's ability to display small-sized fonts and image clearly.

Other advances have allowed LCD's to greatly reduce liquid crystal cell response times. Response time is basically the amount of time it takes for a pixel to "change colors", in reality response time is the amount of time it takes a liquid crystal cell to go from being active to inactive.

This is due to following reasons:

- The declining prices of LCDs.
- The ability to display numbers, characters and graphics. This is in contrast to LEDs, which are limited to numbers and a few characters.

An intelligent LCD display of two lines, 20 characters per line that is interfaced to the pic16f72 microcontroller.

Incorporation of a refreshing controller into the LCD, thereby relieving the CPU to keep displaying the data. Ease of programming for characters and graphics.

Most of the LCD modules conform to a standard interface specification. A 14-pin access is provided having eight data lines, three control lines and three power lines. The connections are laid out in one of the two common configurations, either two rows of seven pins, or a single row of 14 pins.

One of these pins is numbered on the LCD's printed circuit board (PCB), but if not, it is quite easy to locate pin1. Since this pin is connected to ground, it often has a thicker PCB track, connected to it, and it is generally connected to metal work at same point.

PIN DIAGRAM OF LCD: -
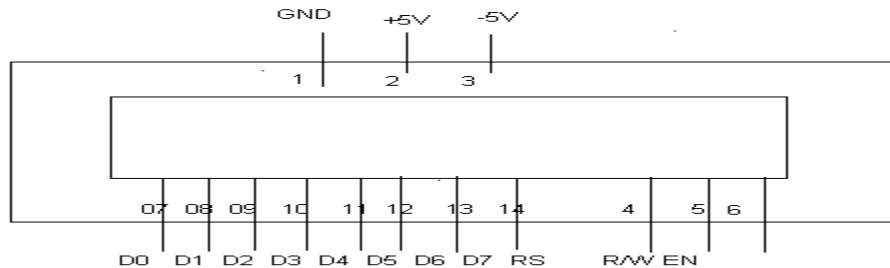
PIN DESCRIPTIONS: -

Vcc, Vss and Vee: -

While Vcc and Vss provide +5V and ground respectively, Vee is used for controlling LCD contrast.

RS Register Select: -

There are two very important registers inside the LCD. The RS pin is used for their selection as follows.

If RS=0, the instruction command code register is selected, allowing the user to send a command such as clear display, cursor at home, etc.

If RS=1, the data register is selected, allowing the user to send data to be displayed on the LCD.

R/W, read/write: -

R/W input allows the user to write information to the LCD or read information from it.

R/W = 1 for reading.

R/W= 0 for writing.

EN, enable: -

The LCD to latch information presented to its data pins uses the enable pin. When data is supplied to data pins, a high–to-low pulse must be applied to this pin in order for the LCD to latch in the data present at the data pins. This pulse must be a minimum of 450 ns wide.

D0 – D7: -

The 8–bit data pins, DO – D7, are used to send information to the LCD or read the contents of the LCD's internal registers.

To display letters and numbers, we send ASCII codes for the letters A–Z, a-z numbers 0-9 to these pins while making RS=1.

There are also instruction command codes that can be sent to the LCD to clear the display or force the cursor to home position or blink the instruction command codes.

We also use RS = 0 to check the busy flag bit to see if the LCD is ready to receive information. The busy flag is D7 and can be read when R/W=1 and RS=0, as follows: if R/W = 1, RS = 0. When D7= 1 (busy flag = 1), the LCD is busy taking care of internal operations and will not accept any information.

Prototype circuit: -

For a LCD module to be used effectively in any piece of equipment, a Microprocessor or Micro controller is usually, required to drive it. However, before attempting a series of switches to the pins of the module. This can be a quite benefical step, if even you are thoroughly conversant with the workings of microprocessors.

3.8   DIMMER: -

Dimmers are devices used to vary the brightness of a light. By decreasing or increasing the RMS voltage and hence the mean power to the lamp it is possible to vary the intensity of the light output. Although variable-voltage devices are used for various purposes, the term dimmer is generally reserved for those intended to control lighting.

Modern dimmers are built from silicon-controlled rectifiers (SCR) instead of potentiometers or variable resistors because they have higher efficiency. A variable resistor would dissipate power by heat (efficiency as low as 0.5). By switching on and off, theoretically a dimmer does not heat up (efficiency close to 1.0).

Thyristor (and briefly, thyratrom) dimmers were introduced to solve some of these problems. Because they use switching techniques instead of potential division there is almost no wasted power, dimming can be almost instantaneous and is easily controlled by remote electronics.

Triacs are used instead of SCR thyristors in lower cost designs, but do not have the surge handling capacity of back-to-back SCR's, and are only suitable for loads less than about 20 Amps. The switches generate some heat during switching, and can cause interference. Large inducors are used as part of the circuitry to suppress this interference. When the dimmer is at 50% power the switches are switching their highest voltage (>300 V in Europe) and the sudden surge of power causes the coils on the inductor to move, creating buzzing sound associated with some types of dimmer; this same effect can be heard in the filaments of the incandescent lamps as "singing". The suppression circuitry adds a lot of weight to the dimmer, and is often insufficient to prevent buzzing to be heard on audio systems that share the mains supply with the lighting loads. This development also made it possible to make dimmers small enough to be used in place of normal domestic light switches.

CIRCUIT DIAGRAM: -
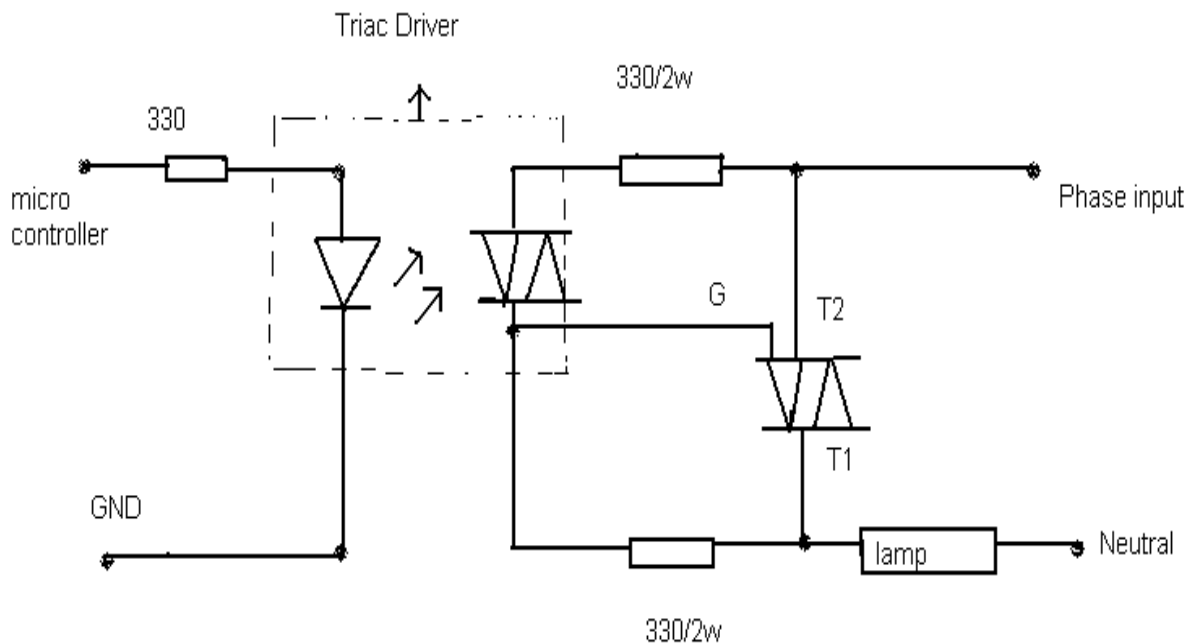
TRIAC DRIVER MOC 3021: -

DESCRIPTION: -

These devices consist of a AlGaAs infrared emitting diode optically coupled to a monolithic silicon detector performing the function of a zero voltage crossing bilateral triac driver.

They are designed for use with a triac in the interface of logic systems to equipment powered from 115 VAC lines, such as teletypewriters, CRTs, solid-state relays, industrial controls, printers, motors, solenoids and consumer appliances, etc.

APPLICATIONS: -

• Solenoid/valve controls

• Lighting controls

• Static power switches

• AC motor drives

• Temperature controls

• E.M. contactors

• AC motor starters

• Solid-state relays

FEATURES: -

• Simplifies logic control of 115 VAC power

• Zero voltage crossing

• dv/dt of 2000 V/□ s typical, 1000 V/□ s guaranteed

3.9 OPTOCOUPLER: -

Opto coupler is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated — since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken. A common implementation involves a LED and a phototransistor, separated so that light may travel across a barrier but electrical current may not.

When an electrical signal is applied to the input of the opto-isolator, its LED lights, its light sensor then activates, and a corresponding electrical signal is generated at the output. Unlike a transformer, the opto-isolator allows for DC coupling and generally provides significant protection from serious overvoltage conditions in one circuit affecting the other. With a photodiode as the detector, the output current is proportional to the amount of incident light supplied by the emitter.

The diode can be used in a photovoltaic mode or a photoconductive mode. In photovoltaic mode, the diode acts like a current source in parallel with a forward-biased diode. The output current and voltage are dependent on the load impedance and light intensity. In photoconductive mode, the diode is connected to a supply voltage, and the magnitude of the current conducted is directly proportional to the intensity of light.

An opto-isolator can also be constructed using a small incandescent lamp in place of the LED; such a device, because the lamp has a much slower response time than a LED, will filter out noise or half-wave power in the input signal. In so doing, it will also filter out any audio- or higher-frequency signals in the input. It has the further disadvantage, of course, (an overwhelming disadvantage in most applications) that incandescent lamps have relatively short life spans.

Thus, such an unconventional device is of extremely limited usefulness, suitable only for applications such as science projects. The optical path may be air or a dielectric waveguide. The transmitting and receiving elements of an optical isolator may be contained within a single compact module, for mounting, for example, on a circuit board; in this case, the module is often called an **optoisolator** or **opto-isolator**.

The photosensor may be a photocell, phototransistor, or an optically triggered SCR or Triac. Occasionally, this device will in turn operate a power relay or contactor.

FEATURES OF OPTOCOUPLER: -

- Interfaces with common logic families
- Input-output coupling capacitance < 0.5 Pf
- Industry Standard Dual-in line 6-pin package
- 5300 VRMS isolation test voltage

PIN DIAFRAM OF OPTOCOUPLER: -
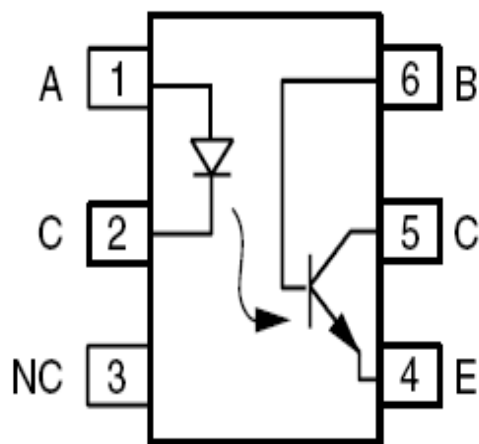
Applications:

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

3.10 LOADS: -

In this intelligent energy saving system we are using two loads, lamp and Fan. According to the light intensity of the particular room or cabin the LDR will senses, depending on the LDR output the lamp will be ON/OFF. This system is only applicable for lamps and not applicable for tube lights, because the starting voltage of the tube lights is high compared to lamps.

By using Thermostat and Dimmer we can adjust the speed of the Fan according to the changes of the room temperature.

4. SOFTWARE DESCRIPTION: -

4.1 FLOW CHART: -

```
                          ( Initialization )
                                 │
                                 ▼
                    ┌─────────────────────────┐
                    │  Dimmer1&dimmer2 off     │
                    └─────────────────────────┘
                                 │
                                 ▼
            False                ◇
                              ╱  Is   ╲
                             ◇ PIRon&LDR ◇────────┐
                              ╲  Low   ╱          │
                                ◇                 ▼
                                │        ┌──────────────────┐
                                │        │   Compliment     │
                                │        │   Dimmer 1 on    │
                                │        └──────────────────┘
                                ▼
                    ┌─────────────────────────┐
                    │    Read temperature      │
                    └─────────────────────────┘
                                 │
                                 ▼
                                ◇
                             ╱ Is temp. ╲
                            ◇ 28>t<30    ◇
                            ◇ 30>t<32    ◇
                            ◇ 32>t<34    ◇
                             ╲  36>t    ╱
                                ◇
                                │
                                ▼
                    ┌─────────────────────────┐
                    │ Set firing angle and     │
                    │ switch on dimmer 2       │
                    └─────────────────────────┘
```
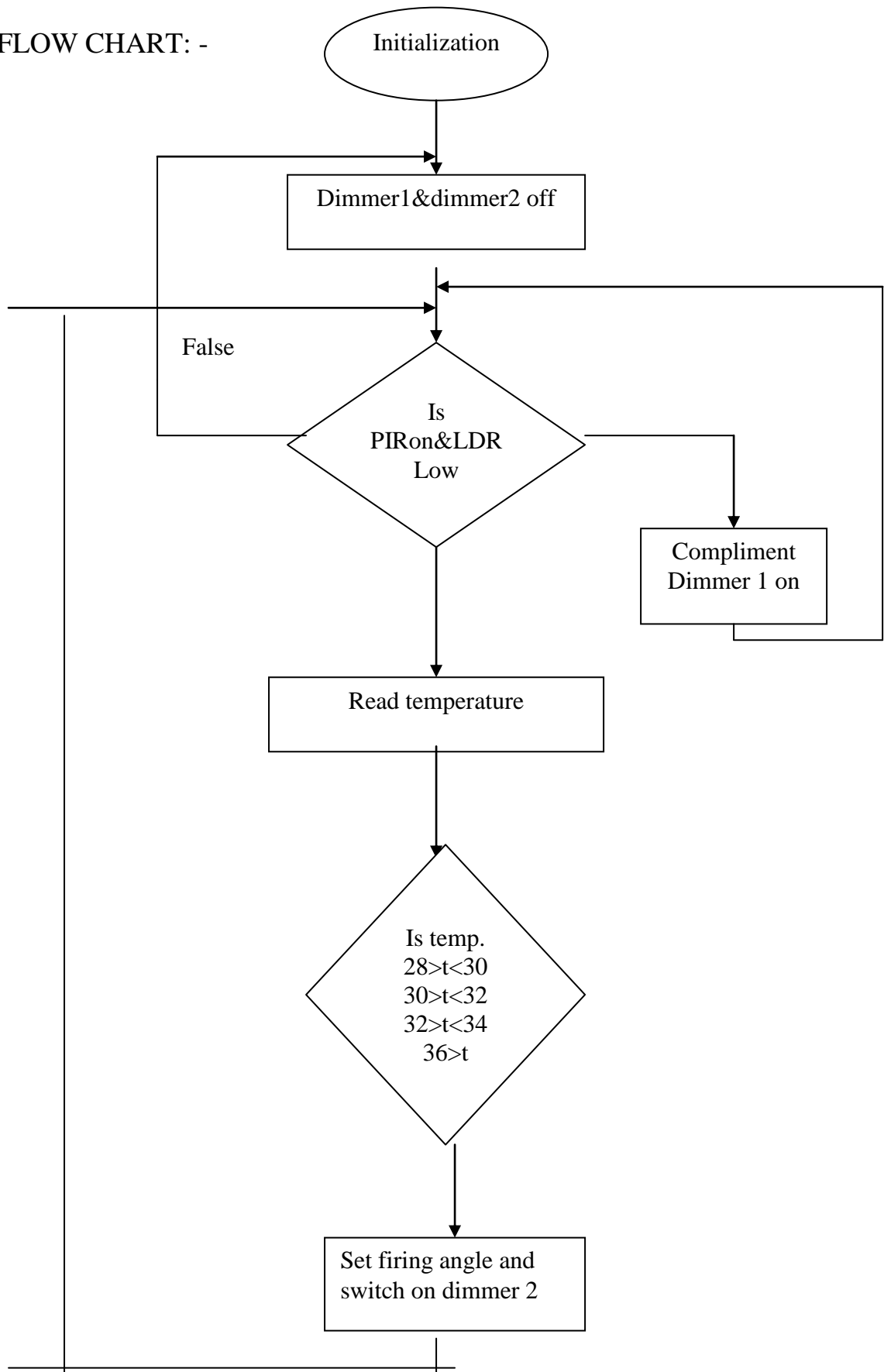
4.2   SOURCE CODE: -

Program for PIC16F72: -

```
# include<16f72.h>
# use delay (clock=12000000)
# fuses hs , nowdt , protect
# use  i2c(master,  sda=PIN_c4 , scl=PIN_c3)
# include  <lcdb.c>
int temph , templ ;
int1   x=0 , y=0 ;
int   m ;


# define   zcd    PIN_a4
# define   pir    PIN_B0
# define   ldr    PIN_a2
# define   dim1  PIN_a0
# define   dim2  PIN_a1
# include   <temperature.c>
# include   <dimmer1.c>
# include   <dimmer2.c>
# INT_EXT
 Void main( )
{
     Output_low(dim1) ;
     Output_low(dim2) ;
      X=0;   Y=0;


     Setup_adc_ports(   NO_ANALOGS    ) ;// All are digital only

     temp_intit( ) ;
     lcd_intit( ) ;
     LCD_PUTC("\f  POWER   SAVER") ;
```

```
delay_ms(2000) ;

While(1)
{

            If    (! input(pir) )
            {

                    output_high(dim1) ;
                    While(! input(pir) ){}
                    X=~x ;
LCD_PUTC("\n     PIR ON            ") ;
Delay_ms(5000) ;
}

if(x= =0)

    {

        If(y= =1)
{

        delay_ms(20000) ;
        Y=0 ;
    }


        output_low(dim1) ;
        output_low(dim2);

LCD_PUTC("\n     STAND   BY        ") ;
delay_ms (300);

    }
```

```
if(x= =1)
{

y=1;

temp_read ( );

                    if   (templ= =0x80) templ=5;
                    else   templ=0;
                    printf(lcd_putc, "\nTEMP:   %02d.%d  dc", temph,templ) ;

if(temph>=27  &&   temph<=28   )
                         {
back25:         if( ! input(zcd))goto back25;          / /waiting to get zero start

                          delay_ms(5);




                         output_high(dim2);

back26:          if( ! input(zcd))goto back26;          / /waiting to get zero start

                         output_low(dim2);

            delay_ms(5);

                         output_high(dim2);

back27:          if( ! input(zcd))goto back27;

                               output_low(dim2);
                         }
```

```
                    if   (temph>=29      &&   temph<=31   )
                    {

back20:        if( ! input(zcd))goto back20;          //waiting to get zero start

               delay_ms(5);    //     161

                output_high(dim2);

back30:        if( ! input(zcd))goto back30;          //waiting to get zero start

               output_low(dim2);

        delay_ms(5);

                output_high(dim2);

back32:         if( ! input(zcd))goto back32;
                  output_low(dim2);
                }

                  if   (temph>31      &&      temph<=33  )
                 {
back9:         if( ! input(zcd))goto back9;           //waiting to get zero start
                 delay_ms(5);    //     161
                 output_high(dim2);

back10:         if( ! input(zcd))goto back10;         //waiting to get zero start
                  output_low(dim2);
                  delay_ms(5);
                  output_high(dim2);

back11:          if( ! input(zcd))goto back11;
```

```
                        output_low(dim2);
                   }

           if    (temph>33    &&      temph<=35  )
             {

back12:        if( ! input(zcd))goto back12;        / /waiting to get zero start
               delay_ms(3);    / /    161
               output_high(dim2);

back13:         if( ! input(zcd))goto back10;        / /waiting to get zero start
                output_low(dim2);

               delay_ms(3);
                output_high(dim2);

back14:          if( ! input(zcd))goto back14;
                 output_low(dim2);

            }

            if    (temph>35      &&      temph<=37  )
              {

back15:        if( ! input(zcd))goto back15;        / /waiting to get zero start
               delay_ms(2);
               output_high(dim2);

back16:         if( ! input(zcd))goto back16;        / /waiting to get zero start
                output_low(dim2);
```

```
                        delay_ms(2);

                        output_high(dim2);



back17:            if( ! input(zcd))goto back17;

                        output_low(dim2);


                    }


                 if     (temph>37)   output_high(dim2) ;


                 if     (input(ldr) )output_high(dim1) ;


                 if     (! Input(ldr) )out_low(dim1) ;


            }
}
}
```

Program for thermostat:-

```
temp_init()
{
  i2c_start();
  i2c_write(0x90);// device address
  i2c_write(0xac);// control register
  i2c_write(00);// write mode
  i2c_stop();
  delay_ms(10);
  i2c_start();
  i2c_write(0x90);// device address
  i2c_write(0xee);// control register
  i2c_stop();
}
 temp_read()
{
  i2c_start();
  i2c_write(0x90);
  i2c_write(0xaa);
  i2c_start();
  i2c_write(0x91);
  temph=i2c_read();
  templ=i2c_read(0);
  i2c_stop();
}
```

CHAPTER 6.
CONCLUSION &
FUTURE DIRECTIONS

CONCLUSION:

Intelligent Energy Saving System is not limited for any particular application, it can be used any where in a process industries with little modifications in software coding according to the requirements. This concept not only ensures that our work will be usable in the future but also provides the flexibility to adapt and extend, as needs change.

In this project work we have studied and implemented a complete working model using a PIC microcontroller. The programming and interfering of PIC microcontroller has been mastered during the implementation. This work includes the study of energy saving system in many applications

FUTURE DIRECTIONS:

We except that our next generation will develop this energy saving system with wire less network.

In our project we connected all the sensors to micro controller with the wires. This can be developed with wire less such that we can place different sensors in different places. This sensor will activate the micro controller with the signals instead of using wires.

This system can also be applicable to various loads like pressure, force and etc. by increasing the number of ports of the micro controller.

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