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Temperature Controlled In Infant Incubator

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Abstract: **Present design of an incubator uses microprocessor as main controller in digital signal processing combined with complex combinational logic circuit are redundant and needs to be improved in the sense of functionality. Replacement of microcontroller with an PIC controller is prudent action due to its efficiency and reliability especially in an incubator where the life of an infant relies on. A PIC controller has least complex circuitry has to be designed so that it saves space and be more reliable for an incubator. Therefore, it is highly recommended that the PIC controller has reduced circuit complexity and increase the control system action time response. PIC controller is the solution to all the problems since PIC controller offers more efficient, reliable and accurate control.**

Keywords: **Incubator, PIC Controller, RTD Sensor, Temperature Control, Data Logging.**

I. INTRODUCTION

This project is to design a temperature controller to be used to control temperature of a small environment such as an infant incubator. The incubator is considered as an air conditioned room with special specification which we can control it with respect to the condition of infant incubator which case the air flowing to upper area so dismiss the CO_2 from the special upper windows. Incubators are designed to provide an optimal environment for new-born babies with growth problems (premature baby) or with illness problems.

Premature infants are unable to keep themselves sufficiently warm. They are also very weak and prone to infections. An incubator is a special type of a cot which provides an ideal environment for the infant. It tries to stimulate the conditions as inside the mother's womb. Current studies relate infant death in some cases while being cared in incubator due to suffocation and malfunction of an incubator. This happen when the temperature in the incubator increases and causes the level of CO_2 to increase too.

Beside, current incubator design uses combinational logic circuits which have more complicated connection involving analog signal processing to microprocessor and controlling system. This type of circuit will cause problems such as:

SPACE LIMITATIONS: Lots of resistors, capacitors, and other electrical components are being soldered onto one circuit plus with controller system. This circuit certainly consumes large space in the interior part of the incubator.

HIGH POWER CONSUMPTION: The big conventional combinational logic circuit consume large amount of power to run the incubator due to its component characteristic. So, this circuit is not power efficient.

HIGH HEAT DISSIPATION: Consuming large amount of power certainly leaves effects to heat dissipation by the electrical component in the combinational logic circuit. The high heat dissipation would affect the performance of electronic components especially diodes in the forward and reverse bias region according to the equation below:

$$I_D = I_S \left(e^{kv_0/T_k} - 1 \right)$$

SLOW RESPONSE FOR ACTUATION: The complex connections in the combinational logic circuit furthermore impose on the signal transmission due to lots of electronic component the signal must go through before it reaches the control

system. This slow and long signal procedure effectuate the suppose response and furthermore might bring fatality to the infant in the incubator.

Therefore, it is highly recommended that the controller has reduced circuit complexity and increase the control system action time response. PIC controller is the solution to all the problems since PIC controller offers more efficient, reliable and accurate control.

Block Diagram:

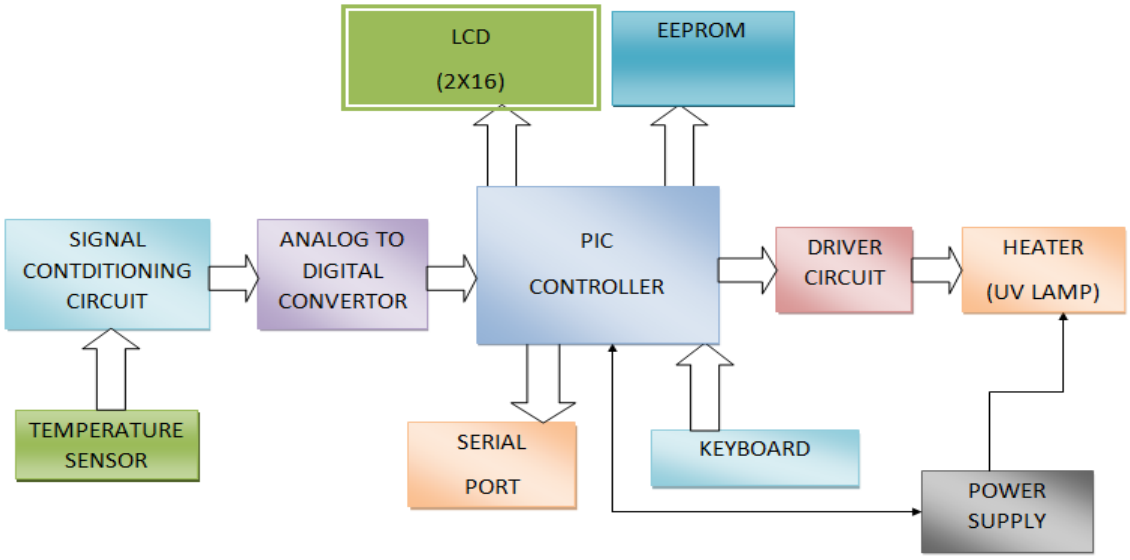

FIGURE 1: BLOCK DIAGRAM

II. HARDWARE COMPONENTS

A. List of Components:

1) Power Supply
2) PIC 16f1936 Controller
3) Temperature sensor (RTD)
4) 16*2 LCD
5) Optoisolator (MOC3042)
6) Constant current source (LM334)

B. Description of Component:

PIC 16f1936 Controller

Features:

- Enhanced mid-range core with 49 instruction, 16 stack levels
- Flash program memory with self read/write capability
- Internal 32MHz oscillator
- Integrated temperature indicator

- Comparators with selectable voltage reference
- 11 Channel 10bit ADC with voltage reference
- Four 8-bit timers (TMR0/TMR2/TMR4/TMR6)
- One 16-bit timer (TMR1)
- Enhanced power-On/Off-Reset
- In Circuit Serial Programming (ICSP)
- Wide operating voltage (1.8V – 5.5V)
- Low power PIC16F1936 variant (1.8V – 3.6V)

Pin Diagram:

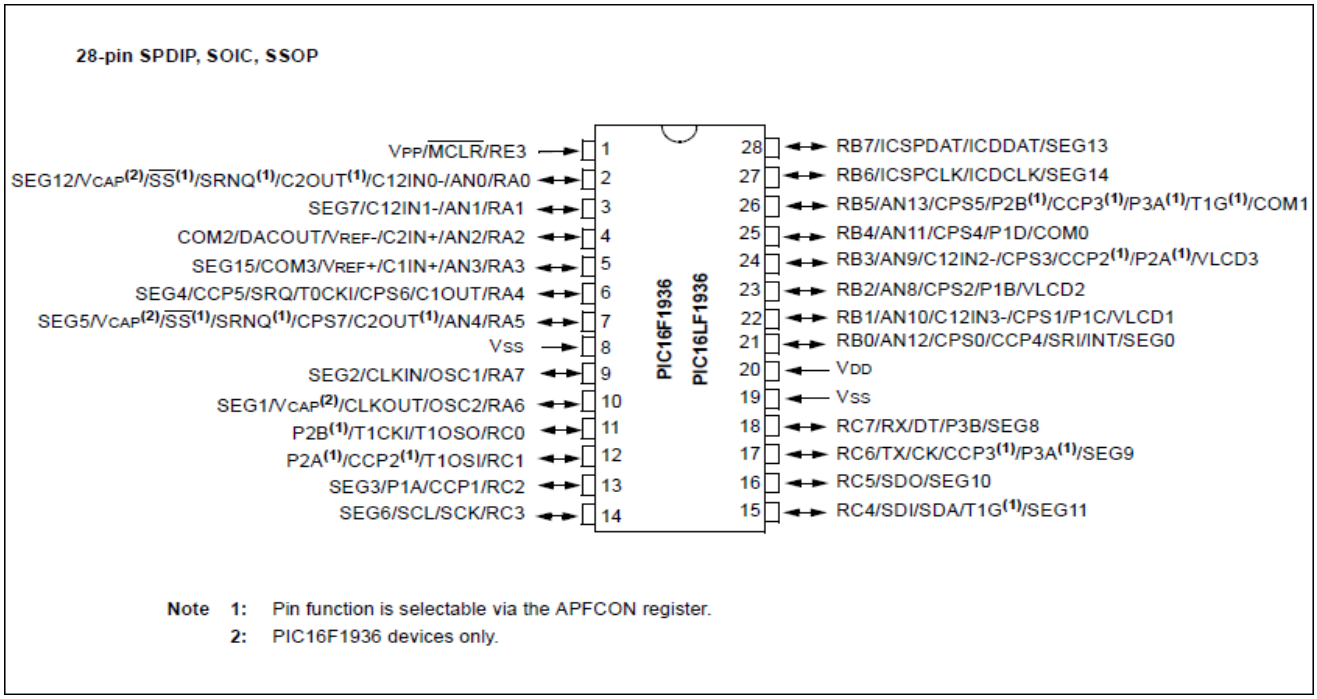

FIGURE 2: PIN DIAGRAM OF PIC16F1936 CONTROLLER

TABLE 1: PARAMETER OF PIC16F1936

No.	Parameter	Value
1	Program Memory Type	Flash
2	Program Memory (KB)	14
3	CPU Speed (MIPS)	8
4	RAM Bytes	512
5	Data EEPROM (bytes)	256
6	Timers	4*8bit, 1*16bit
7	ADC	11 channel – 10bit
8	Comparators	2
9	Segment LCD (pixels)	60
10	Temperature Range (°C)	-40 to 125
11	Operating Voltage Range (V)	1.8 to 5.5
12	Pin Count	28

Resistance Temperature Detector (RTD) Sensor:

Resistance Temperature Detector is temperature sensors that contain a resistor that changes resistance value as its temperature changes.

The RTD element is made from a pure material whose resistance at various temperatures has been documented.

The material has a predictable change in resistance as the temperature changes; it is this predictable change that is used to determine temperature.

Common resistance materials for RTD:

Platinum,

Nickel,

Copper,

Tungsten

Advantages of RTD:

A wide temperature range (-50 to 500°C for thin-film and -200 to 850°C for wire-wound)

Good accuracy

Good interchangeability

Long-term stability

Power Supply:

Transformer:

A transformer steps down high voltage AC mains to low voltage AC. Here we are using a centre-tap transformer whose output will be sinusoidal with 36volts peak to peak value. The low voltage AC output is suitable for lamps, heaters and special AC motors. It is not suitable for electronic circuits unless they include a rectifier and a smoothing capacitor. The transformer output is given to the rectifier circuit.

Rectifier:

A rectifier converts AC to DC, but the DC output is varying. There are several types of rectifiers; here we use a bridge rectifier. The Bridge rectifier is a circuit, which converts an ac voltage to dc voltage using both half cycles of the input ac voltage. The circuit has four diodes connected to form a bridge. The ac input voltage is applied to the diagonally opposite ends of the bridge. The load resistance is connected between the other two ends of the bridge.

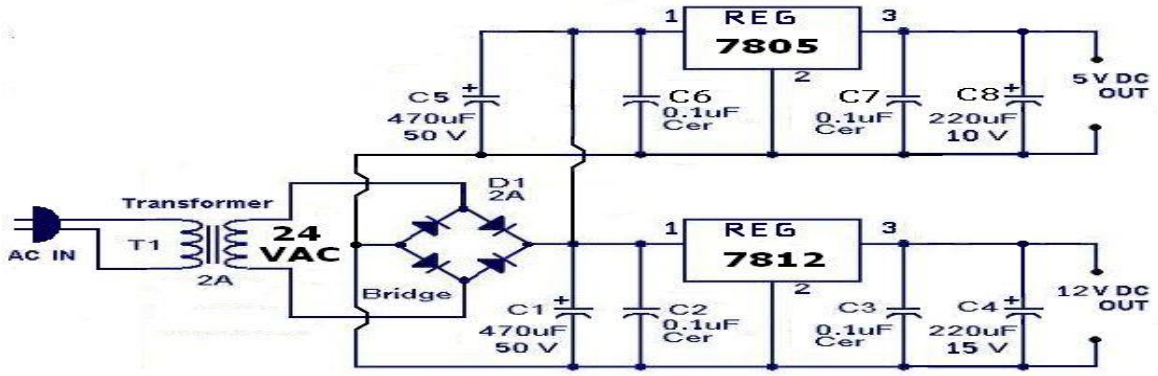

FIGURE 3: CIRCUIT DIAGRAM OF +5V AND +12V POWER SUPPLY

Smoothing or filtering:

The smoothing block smoothes the DC from varying greatly to a small ripple and the *ripple voltage* is defined as the deviation of the load voltage from its DC value. Smoothing is also named as filtering.

Filtering is frequently effected by shunting the load with a capacitor. The action of this system depends on the fact that the capacitor stores energy during the conduction period and delivers this energy to the loads during the no conducting period.

Regulator:

Regulator eliminates ripple by setting DC output to a fixed voltage. Voltage regulator ICs are available with fixed (typically 5V, 12V and 15V) or variable output voltages. Many of the fixed voltage regulator ICs has 3 leads (input, output and high impedance). They include a hole for attaching a heat sink if necessary.

16*2 LCD:

LCD (Liquid Crystal Display) screen is an electronic display module. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special custom characters.

TABLE 2: FUNCTION PINS OF 16*2 LCD

Pin No.	Symbol	Function
1	Vss	Power supply (GND)
2	Vdd	Power supply (+5v)
3	Vo	Contrast Adjust
4	RS	Register select signal
5	R/W	Data read/write
6	E	Enable signal
7	DB0	Data bus line
8	DB1	Data bus line
9	DB2	Data bus line
10	DB3	Data bus line
11	DB4	Data bus line
12	DB5	Data bus line
13	DB6	Data bus line
14	DB7	Data bus line
15	A	Power supply for LED B/L (+)
16	K	Power supply for LED B/L (-)

Optoisolator:

An **Optocoupler**, also known as an **Opto-isolator** or **Photo-coupler**, is an electronic component that interconnects two separate electrical circuits by means of a light sensitive optical interface. The basic design of an optocoupler consists of an LED that produces infra-red light and a semiconductor photo-sensitive device that is used to detect the emitted infra-red beam. Both the LED and photo-sensitive device are enclosed in a light-tight body or package with metal legs for the electrical connections.

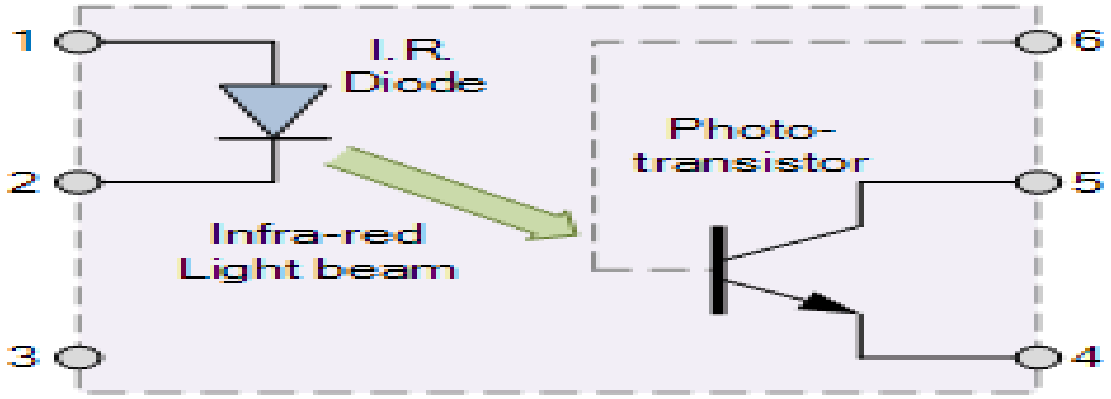

FIGURE 4: CONSTRUCTION OF OPTOCOUPLER

Constant Current Source (LM334):

The LM334 is a three-terminal current source designed to operate at current levels from 1mA to 10mA, as set by an external resistor. The device operates as a true two terminal current source, requiring no extra power connections or input signals. Regulation is typically 0.02%/V and terminal-to-terminal voltage can range from 800mV to 40V. Because the operating current is directly proportional to absolute temperature in degrees Kelvin, the device will also find wide applications as a temperature sensor. The temperature dependence of the operating current is 0.336%/°C at room temperature.

Features of LM334:

- 1mA to 10mA operation
- 0.02%/v Regulation
- Can be used as a linear temperature sensor
- Supplied in standard transistor packages

III. CONCLUSION

The hardware of "Temperature Controlled in Infant Incubator" has been successfully designed and tested. Integrating features of all the hardware components used have developed. The controller makes use of a RTD sensor to sense the temperature and provide warmth and prevent heat loss to significantly improve survival rates.

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