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A Compact Circuit for Room Temperature Indicator

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Abstract:

This paper presents a simple use of Voltage/Frequency converter in monitoring temperature in degrees (^{0}F).The proposed circuit is a multifunction and a multi-useful device that can be widely applicable, easily installed and handled by an ordinary person. Unlike thermometer, we used electronics components and display the temperature output digitally on a seven segment display, so that people can easily read the temperature.

Keywords — **V/F converter, temperature sensor, dual op-amp, timers, NAND gate, three-digit BCD counter.**

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I. INTRODUCTION

We have designed an interesting and cheap room temperature indicator system i.e. A Compact circuit for Room Temperature. This Gadget helps us to monitored room temperature very easily. The system is composed of a temperature sensor, amplifier, V/F converter, three-digit binary-coded-decimal (BCD) counter, time base, and LED display. In addition to the 9400 V/F converter, other ICs needed for this project include the 'AD590' temperature sensor, LF353 dual op-amp, NE555 timers, 74LS00 NAND gate, MC 14553 three-digit BCD counter. HEFA543BD (Equivalent to MC14543) BCD-to-seven-segment decoder/driver/latch and three seven-segment (common anode or common cathode) LED displays with three PNP switching transistors.

II. BLOCK DIAGRAM

The block diagram of the system using V/F converter is shown below:

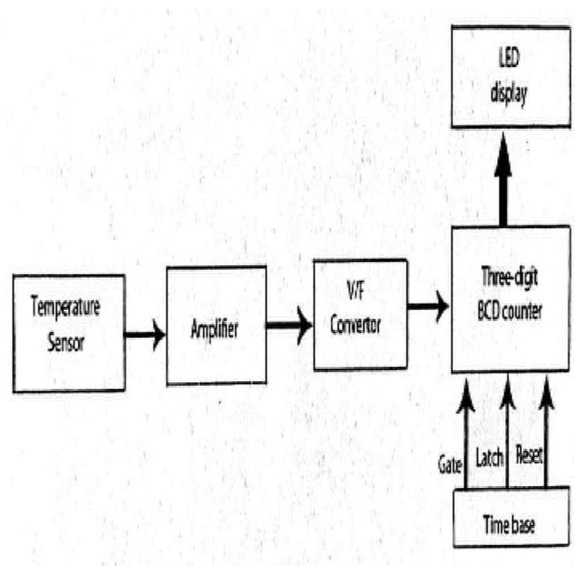

Figure 1. Block diagram of the system

The temperature sensor converts room temperature into a corresponding analog voltage. This analog voltage is amplified by the amplifier section to meet the requirement in the V/F converter and for the calibration purposes. Now, the output frequency from the V/F converter becomes a function of temperature. As the temperature increases, the analog voltage also increases, thus the frequency in the output signal of V/F also increases. The output of V/F converter is connected to the clock input of the 3 digit BCD counter which counts the frequency corresponding to a particular room temperature. Therefore, the frequency now become the value of the room temperature and is displayed in decimal number by using driver/decoder and 3 numbers, seven segment display.

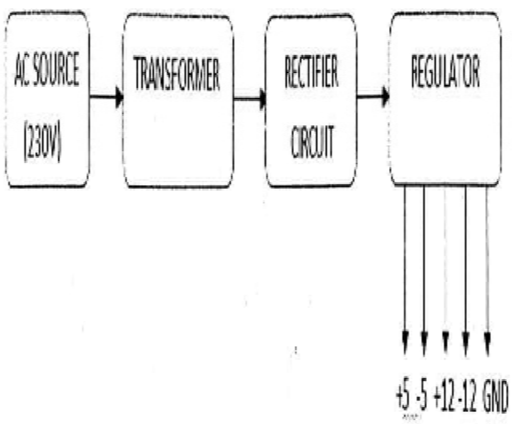

Figure 2. Block diagram of the power supply.

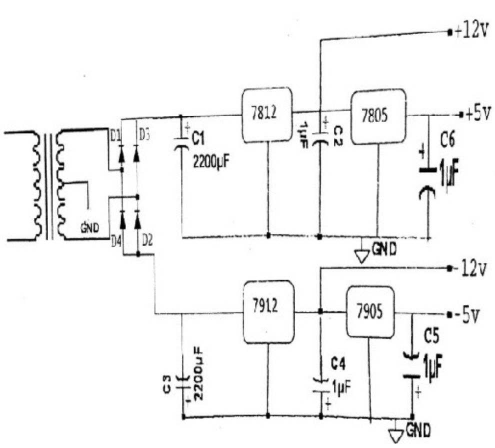

Figure 3. Schematic diagram of the power supply.

The block diagram and the schematic diagram of the power supply are shown in figure2 and figure3. This power supply consist of 4 regulator IC namely 7805,7905,7812 and 7912. These regulators provides an output of +5V,-5V,+12V,-12V respectively.

III.CIRCUIT DIAGRAM OF THE SYSTEM:

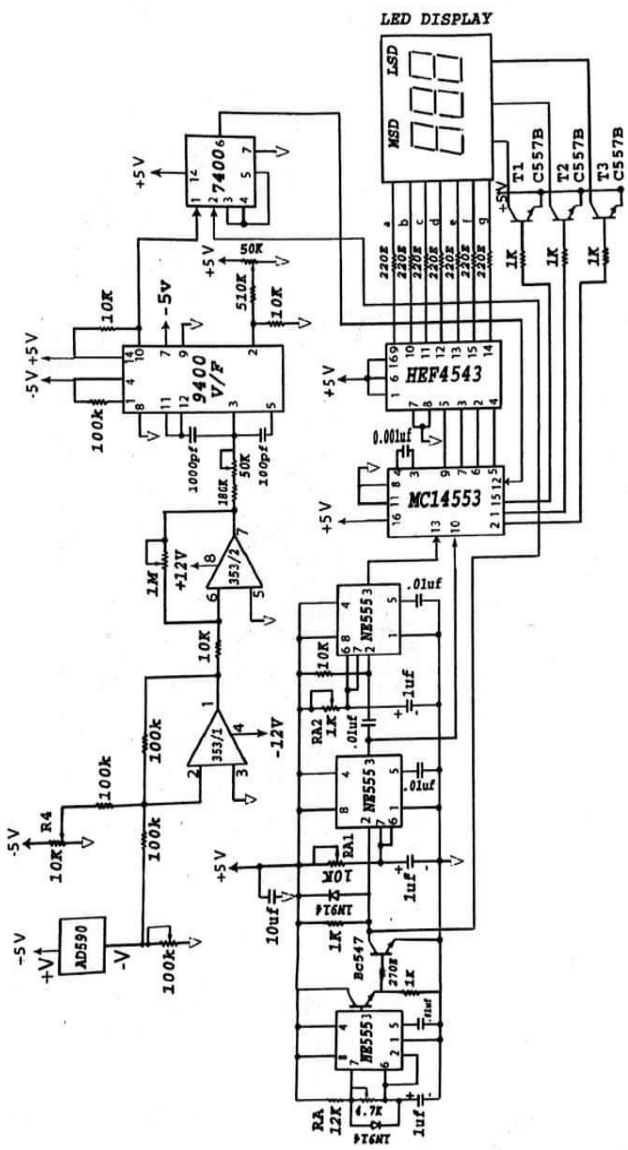

Figure 4. Schematic diagram of the proposed system.

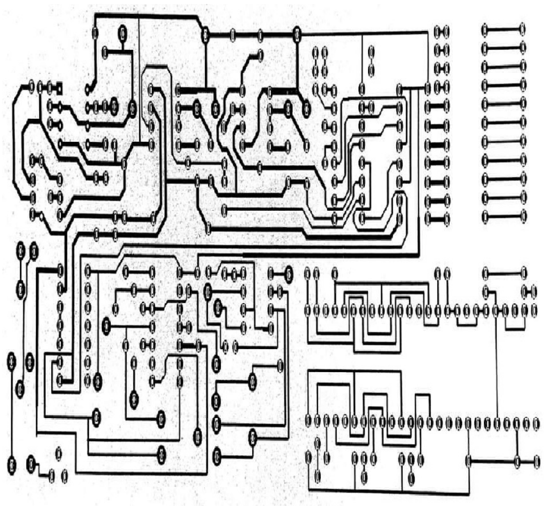

Figure 5. PCB layout of the proposed system.

IV.WORKING OF THE SYSTEM:

Figure4 shows the schematic diagram of the proposed system, which is designed to display temperatures from 0^0 to 100^0F. The output of the temperature sensor changes linearly as a function temperature (10mV/K). This output is an input to the summing amplifier, which is used to calibrate the output of the temperature sensor for a desired temperature type (K, ^{0}C, or ^{0}F) and an intended range. That is, to display the temperature in either K, ^{0}C, or ^{0}F, potentiometer R_4 is adjusted accordingly so that a suitable voltage appears at the output of the summing amplifier. Since the output of the temperature sensor is directly proportional to temperature changes-, R_4 needs to be adjusted at only one temperature. The output of the summing amplifier then drives the inverting amplifier. The purpose of the inverting amplifier is twofold:

1) To invert the input so that its output voltage is positive,which is necessary for the V/F converter.
2) To provide a suitable gain, which depends on the voltage-to-frequency scaling used for the V/F converter.

The output of the inverting amplifier is the input to the V/F converter; therefore, the output frequency of the converter is directly proportional to the output voltage of the inverting amplifier. For example, as the temperature goes up the output voltage of the summing amplifier increases in the negative direction, whereas that of the inverting amplifier increases in the positive direction, which in turn causes the frequency of the V/F to increase in the positive direction.

The output frequency of the converter is then ANDed with the gating signal to produce the clock signal for the three-digit BCD counter. The BCD output of the counter drives the three LED displays sequentially via the BCD-to-seven segment decoder/latch/driver stage, and the temperature is displayed on the LEDs, depending on the relationship between the frequency of the V/F converter and the gate signal. The gate, latch, and reset signals are generated by the time-base circuit, which consists of a free-running multivibrator and two one-shot multivibrators.

V. CIRCUIT DESCRIPTION:

For the values indicated in figure4, the output of the AD590 changes 10mV/K. This means that at 0^0F=255.22K the output of the sensor will be 2552.2mV, which must be scaled down to 0V so that the temperature displayed will be in degrees Fahrenheit. This is accomplished by the use of the summing amplifier. Specifically, potentiometer R_4 of the summing amplifier is adjusted so that the output is 0V. The same procedure is used to calibrate the output of the summing amplifier at any other value of ^{0}F. Table1 shows the relationship between K, ^{0}C, ^{0}F, and the output of the temperature sensor and the summing amplifier at corresponding values of temperature. Because the output of the sensor is directly proportional to the temperature, the output of the summing amplifier needs to be calibrated at the temperature at which the circuit is initially started up (table1).

Relationship between different temperature units and outputs of the sensor and summing amplifier:

Table: 1

Kelvin(K)	Degrees Celsius	Degrees Fahrenheit	Output of the temperature sensor(mV)	Output of the summing amplifier(mV) to be adjusted to
255.22	-17.78	0	2552.2	0
273	0	32	2730	-177.8
298	25	77	2980	-427.8
310.78	37.78	100	3107.8	-555.6

Note that the output of the summing amplifier is a negative dc voltage since the net input voltage is always positive for temperatures $>0^0$ (table1). However, the 9400 V/F requires a positive input voltage. The summing amplifier must be therefore be followed by an inverting amplifier. The gain of the inverting amplifier, however, depends on the voltage-to-frequency scaling of the converter. The V/F converter of figure4 is calibrated for the maximum frequency of 50 KHz, which represents a temperature 0f 100^0F when the input voltage is 10V maximum. Since the output of the summing amplifier is -555.6mV at 100^0F, the gain of the inverting amplifier must be equal to

$$10V/555.6mV=17.9985$$

The output frequency of the V/F converter is then ANDed with the output frequency (called the gate signal) of the 555 IC free-running multivibrator to produce the clock signal for the three-digit BCD counter must be clocked 100 times to display 100^0F. To accomplish this, the pulse width of the free-running multivibrator must be 100/50 K=2 ms so that 100 pulses will be produced in 2ms. At the end of 2ms, the count of the counter is latched and displayed on the LED display. After the count is displayed as a temperature on the LEDs, the BCD counter is reset and the cycle repeats. In other words, the counter continuously cycles through three states: count, latch and reset. Therefore, the free-running multivibrator (gate signal) must provide for the time period required to count, latch and reset the BCD counter. The latch enable and master reset pulses for the BCD counter MC14553 are produced by using two 555 IC one-shot multivibrators. Figure.6 indicates the timing diagram for the BCD counter MC14553, Where the time period of the free-running multivibrator is approximately 12.5 ms with a pulse width of 2ms. The pulse width of the latch enable pulse is approximately 10 ms, and the master reset pulse width is approximately 0.5ms. To accomplish 2-, 10-, and 0.5- ms pulse widths, adjust potentiometers R_A, R_{A1} and R_{A2} respectively (figure4).

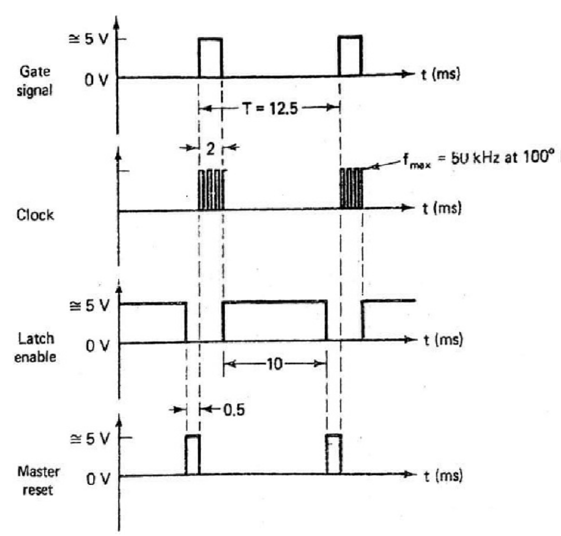

Figure 6.Timing diagram.

Finally, since the accuracy of the temperature displayed depends mainly on the frequency stability of the free running multivibrator, all resistors must be of 1% to 5% or better tolerance, and capacitor must be either Mylar of tantalum types.
Also remember that the temperature indicator must be calibrated at a temperature at which it is initially turned on.

VI. COMPONENTS REQUIRED:

- Seven-segment common Anode LEDs (3 nos.)
- C557B PNP switching transistors (3 nos.)
- MC14553 Three Digit BCD Counter (1 nos.)
- DM7400 NAND Gate (1 nos.)
- NE555 Timers (3 nos.)
- Teledyne 9400 V/F converter (1 nos.)
- BC547 NPN transistors (2 nos.)
- AD590 temperature sensor (1 nos.)
- 1N914 signal diodes (2 nos.)
- HEF4543BD BCD-to-seven segment decoder/diver/latch (1 nos.)
- LF353 Dual Op-amp (1 nos)

Resistors:

- 220Ω (7 nos.)
- 270Ω (1 nos.)
- 1KΩ (5 nos.)
- 1KΩ potentiometer (1 nos.)
- 4.7KΩ potentiometer (1 nos.)
- 10KΩ potentiometer (1 nos.)
- 10KΩ (5 nos.)
- 100KΩ potentiometer (1 nos.)
- 12KΩ potentiometer (1 nos.)
- 50KΩ potentiometer (1 nos.)
- 50KΩ (1 nos.)
- 100KΩ (4 nos.)
- 180KΩ (1 nos.)
- 510KΩ (1 nos.)
- 1MΩ potentiometer (1 nos.)

Capacitors:

- 1µf (3 nos.)
- 1000pf (1 nos.)
- 0.1µf (4 nos)
- 100pf (1 nos.)
- 0.01µf (1 nos.)

VII. CONCLUSION:

Nowadays, many manufacturers produced various type of temperature indicator and this paper is also one of them. So with this paper people can easily know the temperature of the room. Unlike thermometer we used electronics components and display the temperature output digitally on a seven segment display, so that people can easily read the temperature. We used very simple active and passive electronic components which a beginner can easily understand. It can be used in various application temperature sensor is necessary and to control those devices from damage/over heating.

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