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ELECTRONICALLY REFRIGERATOR TEMPERATURE CONTROL

Sana Naikwadi[1], Prof. Mrs. Sayali Rawat [2]

Department of Electronics & Telecommunication Engineering,
Bhivarabai Sawant Institute Of Technology & Research,
Wagholi. Savitribai Phule Pune University (India)

ABSTRACT

There is an enormous future for efficient microcontrollers (MCUs) within the appliance trade because the worth of little pin count; little memory devices reach antecedent unachievable levels. a mixture of increased shopper demand for a lot of refined appliances and therefore the demand for competitive differentiation is driving the adoption of natural philosophy inside the appliance trade. Some refrigerators still have a basic mechanical device circuit that controls the temperature. Mechanical device are less energy economical, the govt norms for the energy potency rating are getting rigorous conjointly the client expectation regarding energy consumption of appliance are lower, thus there's want of energy economical icebox temperature management. MCUs supply cheap thanks to add innovative differentiating options and improve the potency of the appliance whereas continued to scale back system value. Within the past this evolution had not been potential for prime volume merchandise owing to the comparatively high worth of little MCUs and mechanical device controllers. Several appliances nowadays still solely use distinct parts to supply terribly basic management inside the system. this can be blessings to the appliance trade of employing a little extremely integrated MCU over distinct based mostly management solutions, and thence the electronic icebox temperature controller are often the answer.

Keywords: MC9RS08KA2 (Freescale MCU), One Potentiometer, Thermister, Codewarrior 6.3 Tool

I. INTRODUCTION

Some refrigerators still have a basic electromechanical circuit that controls the temperature. Electromechanical are less energy efficient, the government norms for the energy efficiency rating are becoming stringent also the customer expectation about energy consumption of home appliance are lower, so there is need of energy efficient refrigerator temperature control. Current electromechanical controllers have limitations for the efficient control. The electronic refrigerator temperature controller can be the solution. The existing electromechanical refrigerator temperature controllers are not cost effective, so there is need of low cost electronic refrigerator temperature controller to improve the energy efficiency of refrigerator.

1.1 Basic Refrigeration Cycle

- Liquids absorb heat ones modified from liquid to gas
- Gases offer heat ones modified from gas to liquid.

For Associate degree air con system to control with economy, the refrigerant should be used repeatedly. For this reason, all air conditioners use the similar cycle of compression, condensation, expansion, and evaporation during a loop. A similar refrigerant is employed to maneuver the warmth from one space, and to expel this heat in another space. The refrigerant comes into the mechanical device as a unaggressive gas, it's compressed so moves out of the mechanical device as a aggressive gas.

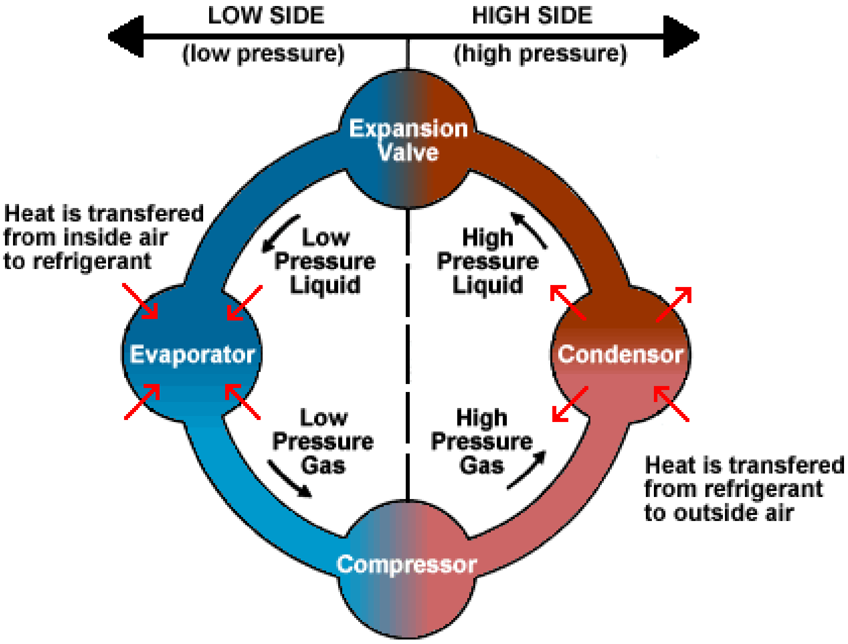

Fig.1 Principles of Refrigeration

- The gas then flows to the condenser. Here the gas condenses to a liquid, and offers off its heat to the skin air.
- The liquid then moves to the enlargement valve beneath air mass. This valve restricts the flow of the fluid, and lowers its pressure because it leaves the enlargement valve.
- The unaggressive liquid then moves to the evaporator, wherever heat from the within air is absorbed and changes it from a liquid to a gas.
- As a hot unaggressive gas, the refrigerant moves to the mechanical device wherever the whole cycle is continual.

Note that the four-part cycle is split at the middle into a high aspect and a coffee aspect side this refers to the pressures of the refrigerant in all sides of the system.

II. PROPOSED SYSTEM

The DC voltage is needed for operational the relay coil management electronic equipment is generated from AC solely by employing a standard AC/DC power offer. As there should always be a minimum of 3v differential between the inputs and controlled output during3 terminal regulator to keep up regulation. A basic resistance with one resistance and one thermoresistor is employed to implement the temperature detector. The thermister resistance depends on the temperature. For every temperature, we've a special voltage within the divider. This price is effectively measured with the ADC enforced by computer code that uses one resistance, one electrical condenser, and therefore the analog comparator enclosed within the MC9RS08KA2 MCU.

The icebox temperature management has four positions. The management switches on the relay once the temperature is over vary. It switches it off once the temperature reaches at a nominal position.

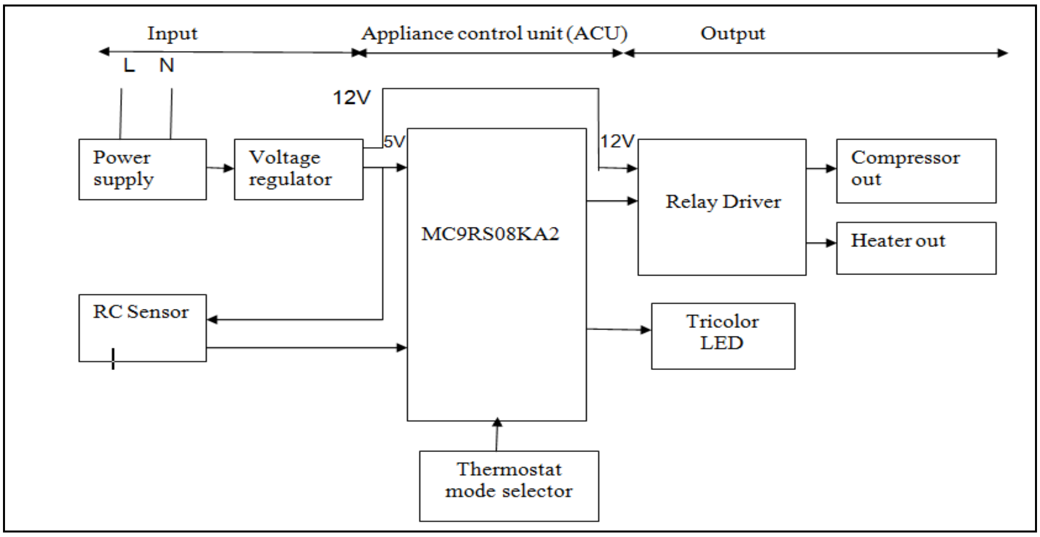

Fig. 2 Block Diagram

For example, the refrigerator's temperature management has four positions, the vary of everyone is:

• Position 4: zero °C – one °C

• Position 3: one °C – two °C

• Position two: 2 °C – three °C

• Position 1: three °C – four °C

When the temperature position is one, if the temperature is beyond four °C, the relay is closed, and therefore the icebox mechanical device is on. Next, once the temperature reaches two.5 °C, the applying opens the relay and therefore the mechanical device stops.

III. IMPLEMENTATION & RESULT

The temperature management is enforced with one potentiometer and a electrical condenser connected to 1 MC9RS08KA2 MCU I/O pin. The temperature detector may be a basic resistance fashioned by a resistance and a thermister. The output is associate I/O pin connected to a relay that switches the availability of the icebox. The flow of the program consists of reading the management wheel price followed by reading the detector voltage and, finally, change the output ON or OFF per the management and detector values.

3. 1 Management Price

The icebox temperature management may be a basic RC network connected to associate I/O pin. By measurement the charging time of the RC network, we are able to verify the potentiometer resistance, and thus, the worth you entered. The charge curve of the RC network is employed to see the time the curve takes to travel from zero V to the input-high voltage (VIH). This technique is employed as a result of the MC9RS08KA2 MCU doesn't have associate integrated analog-to digital device (ADC).

The first step is configuring the management pin as output. Set the pin price to zero to discharge the capacitance. After the capacitance is absolutely discharged, modification the management pin direction to associate degree input. The capacitance starts charging to VDD. When the voltage of the capacitance gets to VIH, the pin state changes from zero to one. A resistance (potentiometer) is employed to change the time the capacitance takes to achieve VIH. Adjusting its resistance varies that point.

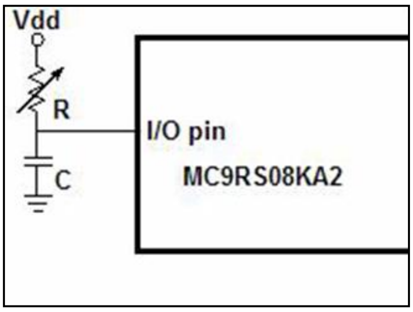

Fig. 3 Temperature Control Implementation

The electrical device voltage is given by the subsequent equation:

VCC=VDD (1-$e^{\frac{-t}{rc}}$)…………………………………………………………………………………..…….. (1)

Solving for time

T = - rc In (1-$\frac{vcc}{vdd}$)……………………………………………………………………………..………. (2)

• Vc — Voltage of the electrical device

• VDD — offer voltage of RC network

• t — Time (seconds)

• r — Resistance

• c – Electrical device

A 220 kΩ potentiometer and ten nF electrical devices were utilized in this application note. From the MC9RS08KA2 datasheet, we all know that once VDD > two.3 V, the VIH for the inputs is zero.70 x VDD.

If the MC9RS08 MCU is equipped 5 V then:

VIH = 0.70 x VDD = (0.70 x 5) = 3.5 V

Table one show the distinction in time victimisation the on top of with totally different resistance industrial values

Table 1 Time Result According Resistance Value

VDD(V)	R (Ω)	C(F)	VIH	TIME(s)
5	10000	0.00000001	3.5	0.000120397
5	20000	0.00000001	3.5	0.000240795
5	40000	0.00000001	3.5	0.000481589
5	60000	0.00000001	3.5	0.000722384
5	80000	0.00000001	3.5	0.000963178
5	100000	0.00000001	3.5	0.001203973
5	120000	0.00000001	3.5	0.001444767
5	140000	0.00000001	3.5	0.001685562
5	160000	0.00000001	3.5	0.001926356
5	180000	0.00000001	3.5	0.002167151
5	200000	0.00000001	3.5	0.002407946
5	220000	0.00000001	3.5	0.00264874

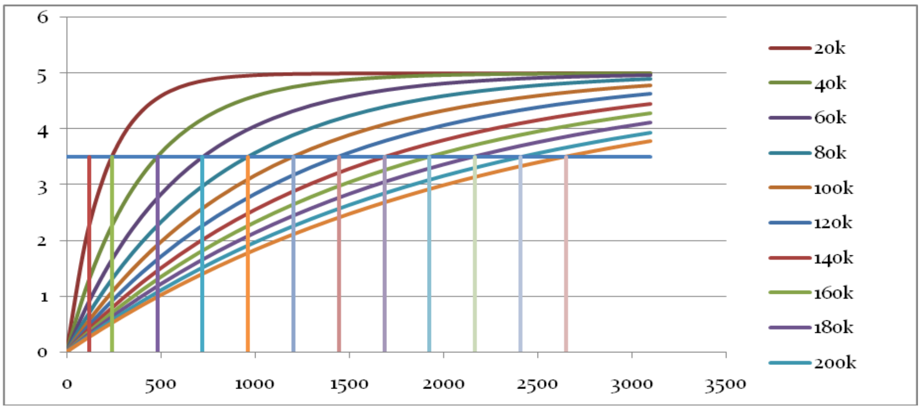

Fig. 4 Curve with different resister

3.2 Temperature Detector

A basic resistance with one electrical device and one thermoresistor is employed to implement the temperature sensor. The thermoresistor resistance depends on the temperature. For every temperature, we have a different voltage within the divider. This price is effectively measured with the ADC enforced by software package that uses one electrical device, one electrical device, and therefore the analog comparator enclosed within the MC9RS08KA2 MCU.

The resistance consists of the thermoresistor NCP18WB333J03RB and a one kilo ohms electrical device. It is better to own a giant variation within the output voltage of the detector with somewhat variation within the temperature.

The supply voltage of the RC network during this application note is five V and therefore the output voltage of the detector can be calculated with consequent equation.

Vout = Vdd (NTC/ (NTC+R)) =5(NTC/ (NTC+1k))…………………………………………………..… (3)

According to the thermoresistor specifications, the resistance vary is between eighty nine.61 Ω to 116.16 Ω in a range of four °C to –0.5 °C.

Table 2 Sensor Output Voltage

Temperature Sensor (°C)	NTC Value	Resister (Ω)	VDD (V)	Sensor Output (V)
-1	119.11	1000	5	0.5321
-0.5	116.16	1000	5	0.5203
0	113.21	1000	5	0.5084
0.5	110.26	1000	5	0.4965
1	107.31	1000	5	0.4845
1.5	104.36	1000	5	0.4724
2	101.41	1000	5	0.4603
2.5	98.46	1000	5	0.4481
3	95.51	1000	5	0.4359
3.5	92.56	1000	5	0.4235
4	89.61	1000	5	0.4112

Instead of having associate ADC module, the MC9RS08KA2 MCU includes a basic ADC enforced by package using the analog comparator module. This package ADC is essentially composed by a RC network and also the analog voltage to be measured. The package measures the time taken by the RC network to succeed in the sensor input voltage.

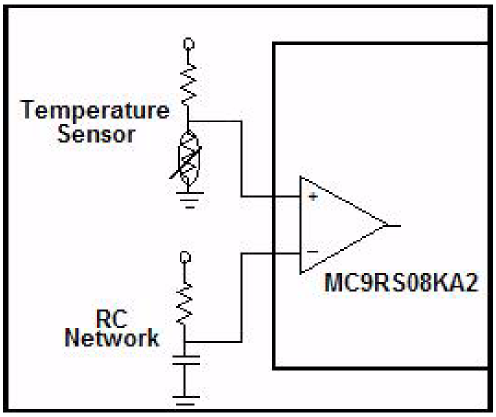

Fig. 5 Sensor Value Input (ADC by Software)

The formula to calculate the time taken for the capacitance to charge is that the same because the temperature management formula:

VC =Vdd (1- e^ (-1/rc))………………..………………………………………………………….. (4)

Solving for time

t= - rc ln (1 - $\frac{Vc}{Vdd}$)……………………………………………………………………………..… (5)

But, for the ADC by computer code the RC network is fastened. During this case, the resistance price is ten kΩ. The capacitor is zero.1 µF.

Based on the bus speed (8 MHz for this application), it is effective to build a table with the timer value according the sensor voltage.

To calculate the timer counts of each sensor voltage the next formula must be applied:

Timer Counts = VIH time (BusClock/prescaler)……………………………………………………… (6)

Table 3 Temperature, Sensor Output, and Microcontroller Counts

VDD	TEMPRETURE SENSOR (V)	R(Ω)	C(F)	VIH TIME	TIMER COUNT(BUS/32)
5	1.93444	10000	0.0000001	0.0004892	61.151
5	1.9138	10000	0.0000001	0.0004825	60.312
5	1.89253	10000	0.0000001	0.0004756	59.453
5	1.8706	10000	0.0000001	0.0004686	58.574
5	1.84797	10000	0.0000001	0.0004614	57.674
5	1.82462	10000	0.0000001	0.0004540	56.751
5	1.8005	10000	0.0000001	0.0004464	55.805
5	1.77558	10000	0.0000001	0.0004387	54.835
5	1.74982	10000	0.0000001	0.0004307	53.841
5	1.72317	10000	0.0000001	0.0004226	52.820

3.3 Temperature Management Application

The refrigerator's temperature management has four positions, that vary of everyone is:

• Position 4: zero °C – one °C

• Position 3: one °C – two °C

• Position 2: two °C – three °C

• Position 1: three °C – four °C

The management switches on the relay once the temperature is over vary. It switches it off once the temperature reaches the window worth. Because of temperature inertia, the window temperature is one.5 °C. Figure half dozen shows the window and also the values from it.

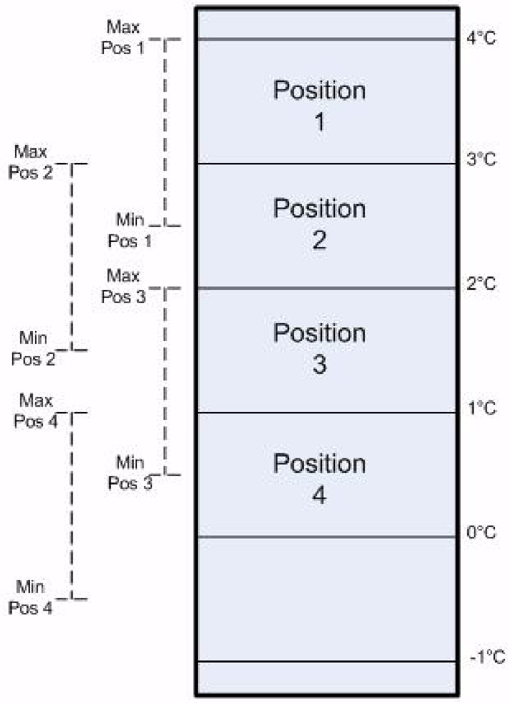

Fig. 6 Temperature Control Range

For example, once the temperature position is one, if the temperature is beyond four °C, the relay is closed, and the icebox mechanical device is on and at the same time heater is off. Next, once the temperature reaches two.5 °C, the applying opens the relay and therefore the mechanical device stops and hence heater start working. This guarantees that the temperature is stable for long periods of your time between the ranges and, no matter what; the temperature isn't quite four °C. Each temperature limit may be simply modified within the definition a part of the most code.

V. CONCLUSION

This paper shows a way to implement a straightforward on-off system with a low-end 8-bit microcontroller. The wants for associate MCU-based answer, providing intelligence, potency and complicated options, have become a lot of necessary within the appliance business, due to:

• The client exacting a lot of options and higher potency,

• The competition within the marketplace augmentative,

• Markets changing into progressively international,

• Governments introducing a lot of tight legislation on environmental problems.

For economical cooling and power saving white goods is been adopted by company to fulfil client demand.

MCUs provide reasonable thanks to add innovative options and cut back power consumption of the appliance whereas continued to cut back the general system price.

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