Developing a Functional Light-emitting Diode (LED) Indicator in a Heat Controlled Environment

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ABSTRACT

The LED Temperature indicator uses the technology of converting environmental temperature to electronic signal. The operation of the LED temperature Indicator is based around a precision temperature sensing Integrated Circuit (IC), the LM35Z and the Dot/Bar Graph Display Driver, a monolithic Integrated circuit (LM3914) and other discrete electronic components. This work presented the performance/ sensitivity of the most active component (LM35) at changes in a heat controlled flask temperatures. The result obtained affirms that the linearity of the sensor component, has been set as a guide on how to use this component for heat sensing in similar applications.

Keywords: *Ambient, sensing, driver, environmental, LM35,*

INTRODUCTION

As the world advances in technology, the measurement of temperature has been simplified and more accurate with the use of digital electronics as a means of conversion (Andrew Skipor, nd), for instance, the digital thermometers, senses temperature with the use of a sensor such as thermistor, thermocouple, e.t.c. The experimental project demonstrating the operation of Precision Celsius Temperature Sensor and a Dot/Bar Graph LED Displays. The LM35 series are precision integrated-circuit, LM35 temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) with - 55°C to + 150°C temperature range (LM35 Sensor, LM35 Datasheet and National Semiconductor Corporation DS005516). The project uses an LM35DZ Precision Celsuis Temperature Sensor, an LM3914 Dot/Bar Graph Driver and Ten LEDs and few other electronics components like the Resistors, Potentiometer and Capacitors. The project is a low frequency, low voltage DC operated device, with a power supply of 9V. Current drain is about 33 milliamperes, which is mostly the LED current. The Driver IC and the Sensor Circuit requires about 100 microamperes. For a visual check of the heat changes, the LED Indicator happens to be the best monitoring Instrument used in checking heat changes. According to national Semiconductor datasheet, the common features of LM35 temperature sensor are: calibrated directly in °Celsius (Centigrade), linear + 10.0 mV/°C scale factor, 0.5°C accuracy guaranteed (at + 25°C), rated for full -55° to +150°C range; suitable for remote applications, low cost due to wafer-level trimming, operates from 4 to 30 volts, less than 60 µA current drain, low self-heating, 0.08°C in still air; nonlinearity only ± $^{1}/_{4}$°C typical, low impedance output, 0.1   for 1 mA load. The objective of this work is to build a functional LED temperature Indicator as a prototype system. The system monitors the sensitivity of the LM35 temperature sensor in control of other subsystems.

Table 1: Electrical Characteristics (www.national.com)

Electrical Characteristics
(Notes 1, 6)

Parameter	Conditions	LM35A			LM35CA			Units (Max.)
		Typical	Tested Limit (Note 4)	Design Limit (Note 5)	Typical	Tested Limit (Note 4)	Design Limit (Note 5)	
Accuracy (Note 7)	T_A=+25°C	±0.2	±0.5		±0.2	±0.5		°C
	T_A=−10°C	±0.3			±0.3		±1.0	°C
	$T_A=T_{MAX}$	±0.4	±1.0		±0.4	±1.0		°C
	$T_A=T_{MIN}$	±0.4	±1.0		±0.4		±1.5	°C
Nonlinearity (Note 8)	$T_{MIN}\leq T_A\leq T_{MAX}$	±0.18		±0.35	±0.15		±0.3	°C
Sensor Gain (Average Slope)	$T_{MIN}\leq T_A\leq T_{MAX}$	+10.0	+9.9, +10.1		+10.0		+9.9, +10.1	mV/°C
Load Regulation (Note 3) $0\leq I_L\leq 1$ mA	T_A=+25°C	±0.4	±1.0		±0.4	±1.0		mV/mA
	$T_{MIN}\leq T_A\leq T_{MAX}$	±0.5		±3.0	±0.5		±3.0	mV/mA
Line Regulation (Note 3)	T_A=+25°C	±0.01	±0.05		±0.01	±0.05		mV/V
	$4V\leq V_S\leq 30V$	±0.02		±0.1	±0.02		±0.1	mV/V
Quiescent Current (Note 9)	V_S=+5V, +25°C	56	67		56	67		µA
	V_S=+5V	105		131	91		114	µA
	V_S=+30V, +25°C	56.2	68		56.2	68		µA
	V_S=+30V	105.5		133	91.5		116	µA
Change of Quiescent Current (Note 3)	$4V\leq V_S\leq 30V$, +25°C	0.2	1.0		0.2	1.0		µA
	$4V\leq V_S\leq 30V$	0.5		2.0	0.5		2.0	µA
Temperature Coefficient of Quiescent Current		+0.39		+0.5	+0.39		+0.5	µA/°C
Minimum Temperature for Rated Accuracy	In circuit of *Figure 1*, I_L=0	+1.5		+2.0	+1.5		+2.0	°C
Long Term Stability	$T_J=T_{MAX}$, for 1000 hours	±0.08			±0.08			°C

Ω

MATERIALS AND PROCEDURE

Table 2: Materials Used

S/N	MATERIAL	DESCRIPTION
1	Temperature sensor	LM35DZ
2	Thermometer	350°C scale
3	Resistors	
4	Capacitors	
5	Multimeter	DMM Mastech MY64
6	LM3914	Dot/Graph Driver
7	Bar Indicators	LED
8	Power supply	9V
9	Connector Wires	
10	Bread Board	
11	Heat Controlled Flask	

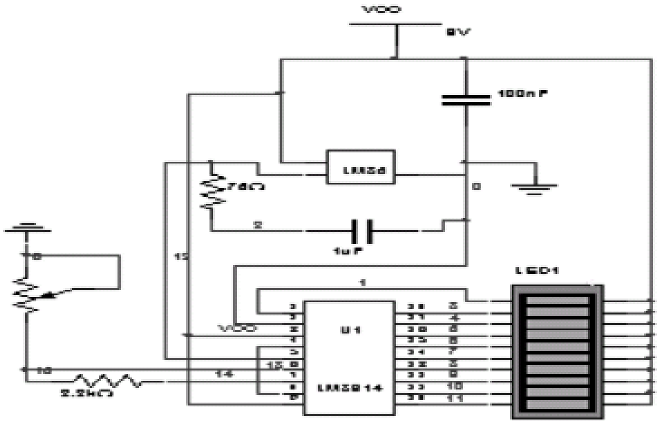

Fig 1: Temperature sensor circuit

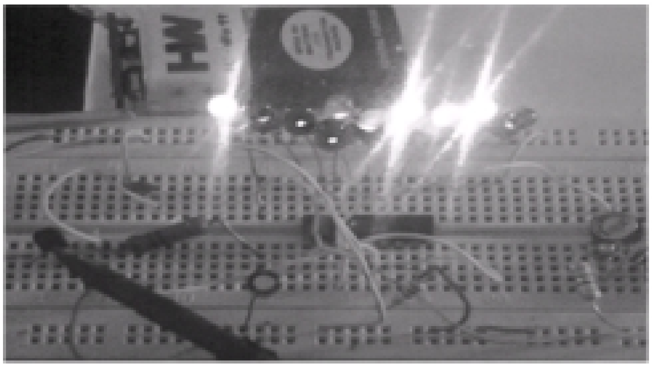

Fig 2: Prototype Implementation

Experimental Procedure

Step One: The circuit was setup in a breadboard as shown in fig 1 a pictorial view of the prototype is also shown in fig 1.

Step Two: The sensor IC was glued to the heat controlled flask with the thermometer.

Step Three: With the Digital Multimeter (DMM) connected, the circuit was powered.

Step Four: Initial condition was set at 19^{o}C

Step Five: As the heat in the system is increased, the voltage temperature readings were noted as shown in table 1.2.

Step Six: When unstable state was noticed, the experiment was stopped and performance interpolation was determined.

The result obtained from the experiment were presented on tables using MATLAB software, the performance sequence is shown diagramatically.

RESULTS AND DISCUSSION

Table 3: Experimental results

Temperature	Voltage
19	0.22
35	0.45
48	0.59
55	0.69
59	0.71

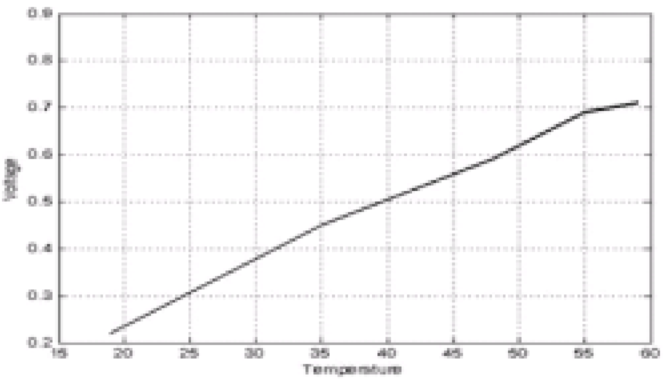

Fig 4: Performance analysis

From the above results, a linear stable relationship between temperature (in Celsius) and voltage was measured to the range of 55^{o}C. Recorded sensitivity between 19^o to 55^{o}C (stable state condition) gave an average voltage sensitivity difference of 0.15V. Hence, the system could be said to have an average sensitivity of 0.15V/12^{o}C or 0.0125/^{o}C. The subsystem control could be the activation of internal fan motor or heating elements. It can also serve as data source for programmed circuits (Wikipedia 2011, LM35 Application Circuit Diagram and LM35 Application Circuit Diagram). A completely developed system can be used in monitoring temperature at homes, hospitals, breweries, industries, electronic circuits etc (Andrew Skipor, nd).

CONCLUSION

This work has analyzed the performance and characteristics of the temperature sensing component LM35. From the result obtained, LM35 sensor has been seen to have good heat sensitivity at low temperatures. This unique characteristics makes it suitable for low heat, low power devices or for control of subsystems which handles higher power and heat conditions.

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