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MICROCONTROLLER BASED OPTICAL MEASUREMENT FOR ABSORBANCE AND REFLECTANCE

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***Abstract*:- : The application specific paper describes a design approach for digital opto sensors and data acquisition systems. It is based on the Universal Frequency-to-Digital Converter (UFDC-1) working well with any frequency output sensors, for example, light- and color-to-frequency converter from TAOS. Such design approach lets significantly simplify the design process, reduce time to market and production price and produce digital opto (color and light) sensors and multi parameters sensors with high metrological performances. Practical examples of such digital sensors are given.**

Keywords: universal frequency-to-digital converter, intelligent opto sensor, data acquisition system, digital sensor, frequency output sensors, sensor interfacing, UFDC-1, light-to-frequency detector, color-to-frequency detector

I. INTRODUCTION

Due to many advantages of frequency as an informative parameter of sensors, more and more manufactures produce different sensors and transducers with frequency, period, time interval or duty cycle output.

These sensors combine a configurable silicon photodiode and a current-to-frequency converter on single monolithic CMOS integrated circuits. The output can be either a pulse train or a square wave (50% duty cycle) with frequency directly proportional to light intensity or irradiance and features a wide dynamic range.

Since the signal is in the form of a frequency, dynamic range is not limited by supply voltage and noise. Sensitivity of the device is maximized by a large detector area and precision input circuitry. Once converted to a frequency, the signal is virtually noise immune and may be transmitted over cables from remote sensors to other parts of system. Isolation is easily accomplished with optical couplers or transformers. Being a pulse data form, the signals of several sensors may be easily multiplexed into one microcontroller or counter using digital logic. Integration of the frequency signal is easily performed in order to eliminate low frequency interference or to measure long-term light exposure rates. When a very high resolution light measurement is required, and speed is not critical, frequency or pulse counting technique would be used (the standard counting technique). This can be accomplished by counting pulses for a defined gate time. Relatively fast light measurements can be made by measuring the output period (indirect counting technique), or alternatively, pulse width.

The frequency of a sine wave or square wave signal is expressed as the number of oscillations per second. In order to determine the frequency of a continuous signal one just needs to count those oscillations. This way we determine the frequency of the first harmonic of a continuously oscillating signal. To measure the frequencies that a non continuous "sound" is composed of, you need a spectrum analyser. This is however a different piece of hardware. What we design here is a frequency counter for continuously oscillating signal. We assume that the signal does not change its frequency during a given interval where we sample the signal.

II. LITERATURE SURVEY

Existing on the modern sensor market digital light sensors with embedded ADCs as usually have a slow conversion time, for example, the embedded 16-bit ADC of light sensor from Intersil (ISL29015) has the integration time 45-90 ms [2]; the ADC from Maxim MAX9635 has the conversion time 97-107 ms [3]. Such sensors can be used for proximity or ambient light applications, but it cannot be used for light sensing applications, in which a conversion speed is a critical parameter.

Modern light-to-frequency converters [1] have a broad frequency range: from part of Hz to 1.6 MHz. Nevertheless a simple frequency-to-digital conversion (based on classical methods for frequency measurements) can be performed by any low-cost microcontroller, a wide dynamic frequency range of such converters brings as usually, many design problems. In order to get reasonable or high metrological performances of designed optical sensor systems, the frequency-to-digital conversion should be based on advanced methods for frequency measurements. Such methods must have a constant quantization relative error in a whole broad frequency range, scalable resolution, non redundant conversion time and a possibility to measure frequency, which exceeds a reference frequency*:* $fx > f0$ in order to design a sensor systems with a reasonable power consumption. The main aim of these research and development was to propose a universal design solution for all existing light-to frequency converters in order to eliminate all mentioned above design problems, and introduce intelligent and smart features for various sensor systems, which can be realized in different technologies: hybrid, standard CMOS technology difference calculation for sorting purpose and storing reference image data[13].

III. PROPOSED SYSTEM

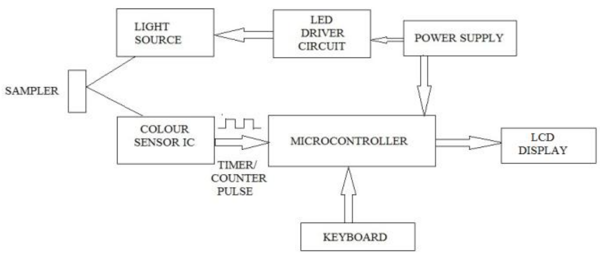

Fig **1:** Block diagram

Block diagram description: The block diagram consists of microcontroller AT89C51 as the main controller and other peripherals are connected to the different ports of microcontroller. Power supply, Colour Sensor IC TCS3200, LCD display, LED Driver circuit and Keyboard are connected to the microcontroller. The Sampler acts as a medium for the light to reflect and fall on the colour sensor IC.

a) LED Driver Circuit

An LED driver is an electrical device which regulates the power to an LED or a string (or strings) of LEDs. An LED driver is a self-contained power supply which has outputs that are matched to the electrical characteristics of the LED or LEDs. The power level of the LED is maintained constant by the LED driver as the electrical properties change throughout the temperature increases and decreases seen by the LED or LEDs.

b) Color Sensor IC TCS3200

Here the color sensor IC used is TCS3200. The TCS3200 programmable color light to frequency converters that combine configurable silicon photodiodes and a current to frequency converter on a single monolithic CMOS integrated circuits. The output is a square wave with frequency directly proportional to light intensity. In the TCS3200 the light to frequency converter reads an 8X8 array of photodiodes.16 photodiodes have blue filters, 16 photodiodes have green filters and 16 photodiodes have red filters and 16 photodiodes are clear.

c) Microcontroller AT89C51

The AT89C51 is a low-power, high-performance CMOS 8-bit microcomputer with 4K bytes of Flash programmable and erasable read only memory (PEROM). The device is manufactured using Atmel's high-density nonvolatile memory technology and is compatible with the industry-standard MCS-51 instruction set and pin out. The on-chip Flash allows the program memory to be reprogrammed in-system or by a conventional nonvolatile memory programmer. By combining a versatile 8-bit CPU with Flash on a monolithic chip, the Atmel AT89C51 is a powerful microcomputer which provides a highly-flexible and cost-effective solution to many embedded control applications.

d) LCD Display

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments LED and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data.

IV. WORKING

Working: A light source with different colour is present. The LED driver circuit drives the source. Light falls on the Sampler which is a device on which light can be reflected or absorbed. The state of sampler can be solid or liquid in nature. Sensor IC is basically analog to digital converter. Sensor IC senses the colour and gives input in form of pulses to the microcontroller. Microcontroller then counts these pulses and proportional to these pulses it gives frequency as output which is displayed on the LCD display. By comparing light intensities of original light and reflected light from sampler we can measure the reflection or absorption.

The basic principle of this project is light to frequency converter. When the light falls on the sampler it gets reflected and falls on the color sensor IC. The color sensor IC senses the color of the light beam and converts it in the form of pulses. This conversion is done by the timer counter circuit. The pulses are given to the microcontroller. The keyboard input is given to the microcontroller. The microcontroller senses the light color and through the keyboard interfacing it decides the frequency of the particular color and displays the intensity of the light accordingly to the seven segment LCD Display. The LCD display will display the intensity of the input light beam in the range of 1-100KHz.

The working can be explained in the following steps

- Keyboard (@ pin 25 26 27 28) select the colour of light (R G B W) (@ pin 1 2).
- Output from the colour sensor IC is fed to pin no. 15 of microcontroller (output of IC is a train of pulses)
- Timer is set for a fixed time. Pulses are then fed into the window of the counter of microcontroller. Then the counter is set and this gives the count of no. of pulses.
- This count is converted into a frequency range.
- The count is displayed on the LCD screen and we get the intensity of light.

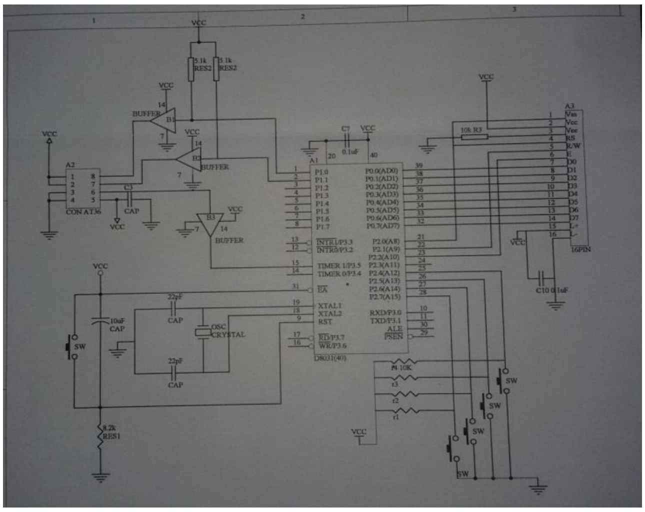

Fig 2. Circuit Diagram

SOFTWARE:

The software which will be used to implement this project will be Kiel MicroVision software. We will use this software as it is the most latest in the market and is very user friendly in comparison to its counterparts. The µVision IDE combines project management, run-time environment, build facilities, source code editing, and program debugging in a single powerful environment. µVision is easy-to-use and accelerates your embedded software development. µVision supports multiple screens and allows you to create individual window layouts anywhere on the visual surface.

The µVision Debugger provides a single environment in which you may test, verify, and optimize your application code. The debugger includes traditional features like simple and complex breakpoints, watch windows, and execution control and provides full visibility to device peripherals.

V. ADVANTAGES

1. high noise immunity
2. high reference accuracy
3. wide dynamic range
4. multi parametricity
5. simplicity of coding
6. multiplexing
7. interfacing and integration
8. low cost
9. low power consumption

VI. APPLICATIONS

1. Used in biomedicals.
2. Fluorescence for the sensing of chemicals.
3. Optical interconnects.
4. LED lighting and illumination.
5. Solar cells.

VII. FUTURE SCOPE

The proposed system will be a demo version of calculating amount of zinc in the given sample by reflecting frequency. It can be further modified to find various amount of zinc in samples by reflection and absorption. It can also be used as biomedical applications that use optoelectronic sensors include pulse oximetry, measuring the amount of oxygen in the blood heart-rate monitors; blood diagnostics, such as blood glucose monitoring; urine analysis; and dental color matching. Improving LED efficiency, this technique can also use for data transmission in short distance.

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