

Designing Of Time and Power Efficient Model for Controlling Of Critical Process

T. Menaka¹, S. Vanila², F. Agi Lydia Prizzi³

¹M.E Control & Instrumentation SRM Valliammai Engineering College, Kattankulathur

²Asst. prof (S.G) SRM Valliammai Engineering College, Kattankulathur

³Asst. prof (O.G) SRM Valliammai Engineering College, Kattankulathur

Abstract: Over the recent years, time analysis and power efficient has become a desirable property in many critical processes of the industries like chemical industry, petrochemical industry etc. in the time analysis concept, we deal about priorities for critical and noncritical parameters based upon time scheduling and controlling the parameters under the pre-set values stipulated for the processes example: even a low priority parameter is given the highest priority some time due to drastic change in the outputs value against the set point. Power efficient factor allows us to lower the power consumption of the instruments for continuous operation. In this paper, we have used many critical parameters namely temperature sensor, level sensor, current sensor, viscosity sensor, pressure sensor for time-analysis, controlling and as an input for the serial interface protocol. Here power efficient is calculated using three different serial interface protocols namely I²C, UART, and SPI between two microcontrollers

Index Terms: digital serial interface; embedded systems; power efficiency; time analysis

I. INTRODUCCION

Power minimization is an important design criteria for embedded system used in many applications because due to less power consumed by the instruments, it's life time increase and energy minimizes. Here we have evaluated the most power efficient serial protocol by comparing the three different protocols namely UART, SPI and I2C which are interfaced between two microcontroller. The power efficient is calculated based upon on the rate of Data been transmitted. The serial interface protocol has been used instead of parallel protocol because of following advantages that are serial interface uses only one input and output pin for the data transfers but parallel protocol needs eight or more pins, serial interface supports all kind of embedded peripheral but not parallel protocol and others. The time analysis concept is based on time scheduling of critical and non-critical parameter and controlling the values of the parameter against the stipulated set points. The controlling of the parameters is done with the help of microcontroller.

II. SERIAL INTERFACES

A. UART

The interfaces based on universal asynchronous receivers/transmitters (UART) are often used for implementing such standards as electronic industries alliance (EIA) recommended standards RS-232, RS-422 and RS-485. UART are nowadays one of the most commonly used methods for communication between an embedded system and an external device. UARTs provide full-duplex asynchronous serial peer-to-peer communication. The data transmission over UART usually starts with a start bit(s), that alerts the receiver that a word of data is about to be sent and allows the receiver to synchronize clocks with the transmitter. After the start-bit, the actual data is transmitted starting with the least-significant bit. Once a data word has been sent, transmitter may issue the parity bit (PR) to provide a simple error checking and/or a stop bit (p) to signalize the end of data word transmission in fig 1.

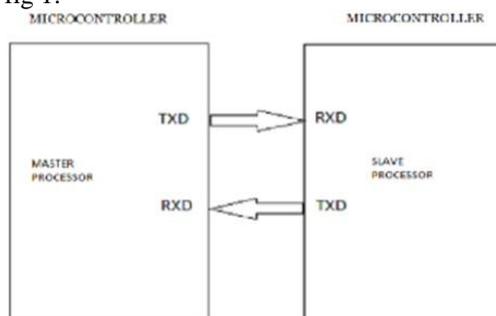


Fig1. UART INTERFACE

b. SPI

The serial peripheral interface (SPI) that has been popularized by Motorola is a synchronous serial interface that operates in full duplex mode the typical method for connecting several SPI slave devices to a master is presented in fig. 2. As the figure re shows, SPI bus utilizes three common lines for all slave devices: clock (SCLK); master output, slave input (MOSI); master input, slave output (MISO); and a separate chip select (CS) line for each slave device. Therefore, before starting the communication, the SPI master device pulls down CS line of the required slave device to select it in The SPI specification does not define neither any maximum data rate nor any particular addressing scheme or acknowledgment mechanism

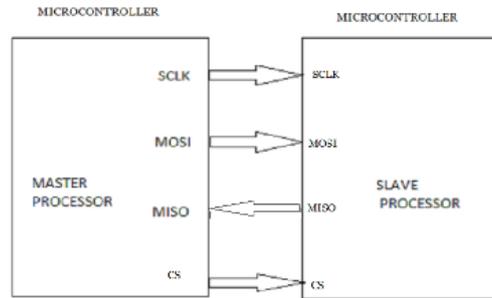


Fig 2. SPI INTERFACE

c. I²C

The developed by Philips inter-integrated circuit (I²C) interface and its data format are presented in fig. 3 as this figure reveals, the i2c interface uses two common physical lines for clock (SCLK) and data (SDA), which are pulled-up with resistors (Rp). The I2C interface supports multiple slave and master devices; therefore, the master device starts the communication by sending the start bit(s) and the device address. Together with the slave device’s address, the master transmits the 1-bit read/write (r/w) for defining the communication direction, which would be used until the stop bit (p) closes the current session. The i2c communication protocol implements per-byte acknowledgments (a/a). the standardized data rates for i2c devices are 10 k-bit/s, 100kbit/s and 400 k-bit/s, although most recent i2c revision also supports the rates of 1 m-bit/s and 3.4 m-bit/s.

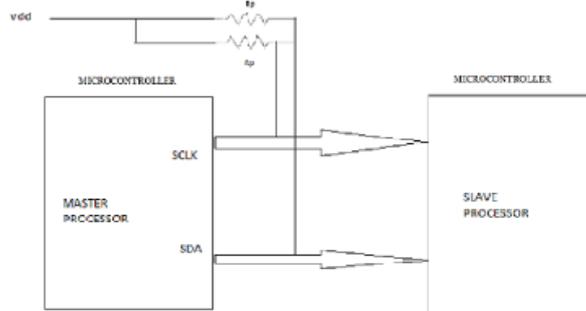


Fig3. I²C

III. CRITICAL PARAMETER

A. Temperature sensor

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (centigrade) temperature .the LM35 thus has an advantage over linear temperature sensors calibrated in ° kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient centigrade scaling in fig.4

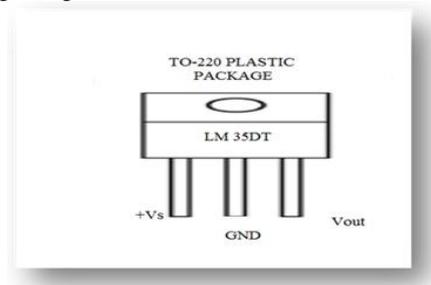


Fig 4. Temperature sensor

The lm35 does not require any external calibration or trimming to provide typical accuracies of $\pm 1/4^\circ\text{C}$ at room temperature and $\pm 3/4^\circ$ cover a full -55 to $+150^\circ$ temperature range. It can be used with single power supplies.

B. PRESSURE SENSOR

The sensor used in my project is hand pressure /force/ touch sensor . Pressure is an expression of the force required to stop a fluid from expanding, and is usually stated in terms of force per unit area. Pressure, P, is defined as force, F, per unit area, A:

$$P = F/A$$

When external force is applied onto the sensor, the resistive element is deformed against the substrate. Air from the spacer opening is pushed through the air vent in the tail, and the conductive material on the substrate comes into contact with parts of the active area. The more of the active area that touches the conductive element, the lower the resistance. All FSRs exhibit a “switch like response”, meaning some amount of force is necessary to break the sensor’s resistance at rest and push it into the measurement range. It can be used to provide a 0-5vdc output that is proportional to the amount of force applied in it.



Fig 4. Pressure sensor

C. IR TRANSMITTER AND RECEIVER SENSOR

An IR transmitter and receiver is a device that can both emit and receive infrared signals. This sensor consists of LED, Variable resistor IR photodiode, LM 358 IC and resistor. The infra-red rays ranges from 30 to 250 kHz. This kit transmits a 38 KHz modulated IR signal to a distance of 6 to 8 feet.

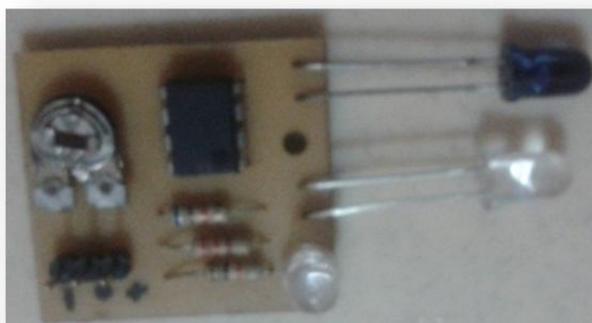


Fig 5 I.R sensor Diagram

Place the transmitter on one side and the receiver on the other side to see if an object passes through. When any obstacle is in between during the transmission of the IR radiation, the radiation gets deviated. The amount of IR radiation which gets deviated is received by the receiver. From the deviations, we can come to know the distances at which the obstacle is present and how much of the rays have been deviated.

In this project, IR sensor is present in the master microcontroller. As soon as the obstacle comes in front of IR rays, the LCD of the master microcontroller displays that “IR DETECTED”. The same sentence format is transmitted to slave microcontroller’s LCD display. It can be also used as a remote switch to turn objects OFF and ON by infrared radiations.

IV. EXPERIMENTAL SETUP

For evaluating the power consumption for I2C, SPI and UART interfaces in real-life conditions we have used the test-bed build around two pick it 3 development boards from microchip with pic16F788A microcontrollers on-board. The microcontroller of the first board was programmed to transmit the data over the

serial interface, while the microcontroller of the second board was used to receive the data. the pins of the microcontrollers that were required for implementing the serial interfaces have been connected together using 10 cm long wires in fig.9.the input values were of various parameters which are critically important including temperature, pressure and IR sensor etc. For evaluating the power consumptions for I²C, SPI and UART in real time conditions, we used PIC16F877A microcontroller on board .In the first (TX) board of the microcontroller, known as master was programed to transmit the data and the second board (RX) i.e. slave was used to receive the data.

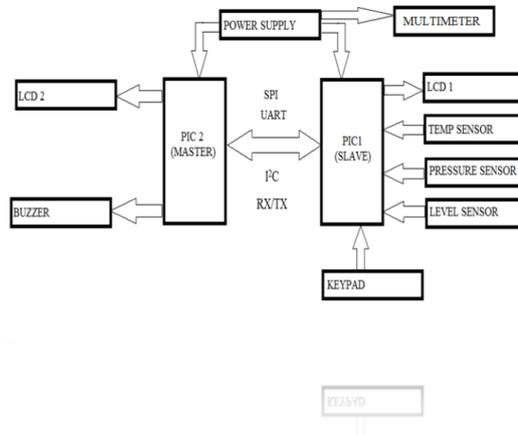


FIG 9. Experimental setup

For both the transmitting and receiving of the data, all the three protocol have been used. The digitally converted data received from various sensors through ADC is transmitted to slave microcontroller and the analog values are displayed in the LCD

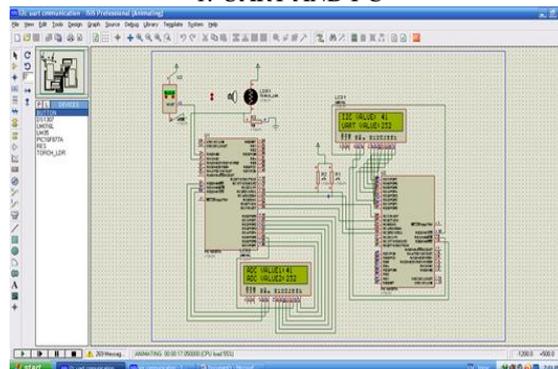
The power consumption measurement was done in three stages. First of all, power consumption for TX and RX boards were measured when the serial interfaces on both boards were initialized, but no transmission was on-going. The second measurements were made when the transmission was on- going: during the second measurement the RX board was selected as data target, during the third measurement - RX board was not selected as target .The power consumption during the second and third stages was measured for two cases: single byte transmission and transmission of eight data bytes in single packet. This is how the power efficient was calculated in real time in my project with the help of suitable hardware kit.

For time analysis, different type of sensors are used in which prioritises are given depending upon process been done at that point of time .But sometimes even a low priority parameter is given the highest priority some time due to drastic change in the outputs value against the set point value. The output of the sensors is in the analog form which has to convert into a digital form. For the conversion, we use analog to digital converter. The digitalized output is sent to the microcontroller for controlling each and every parameter in case of large variation in the parameter value or sends the data as an input for serial protocol.

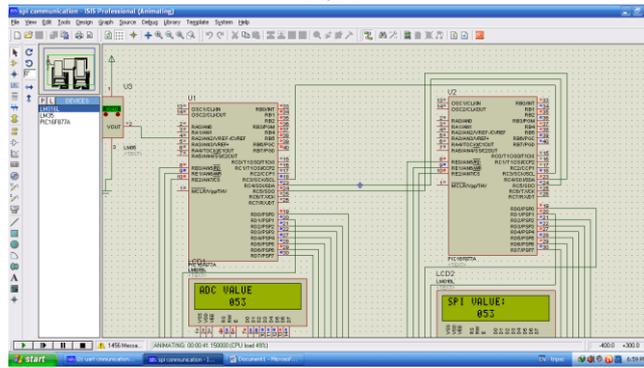
V. RESULTS

A.SIMULATION RESULT

1. UART AND I²C



2.SPI



B. HARDWARE RESULT

This is result is for 1 bytes and 8 bytes datum

1. Pressure sensor

| CURRENT RATING | | | POWER CONSUMED | | |
|------------------|------|------|------------------|------|------|
| I ² C | SPI | UART | I ² C | SPI | UART |
| A | A | A | mV | mV | mV |
| 0.08 | 0.09 | 0.10 | 0.4 | 0.45 | 0.5 |
| 0.12 | 0.14 | 0.15 | 0.6 | 0.7 | 0.75 |

2. I.R SENSOR

| CURRENT RATING | | | POWER CONSUMED | | |
|------------------|------|------|------------------|------|------|
| I ² C | SPI | UART | I ² C | SPI | UART |
| A | A | A | mV | mV | mV |
| 0.09 | 0.12 | 0.13 | 0.45 | 0.6 | 0.65 |
| 0.16 | 0.17 | 0.18 | 0.8 | 0.85 | 0.9 |

3. TEMPERATURE SENSOR

| CURRENT RATING | | | POWER CONSUMED | | |
|------------------|------|------|------------------|------|------|
| I ² C | SPI | UART | I ² C | SPI | UART |
| A | A | A | mV | mV | mV |
| 0.07 | 0.09 | 0.11 | 0.35 | 0.45 | 0.55 |
| 0.13 | 0.14 | 0.16 | 0.65 | 0.7 | 0.8 |

VI. DISCUSSION AND CONCLUSION

We have discussed and evaluated the most digital serial interfacing protocols that are to be used by different embedded systems namely SPI, UART and I²C . Ideally among all three interfaces used here , I²C had the lowest power consumption during data exchanges for the same data rate .

The interface based on UART consumed 22 to 23 % more power for transferring the same amount of data compare to I²C. However, using SPI interface consumed more than 2 times more energy comparing to I²C at single byte transmission and for packet over 8 bytes so it rated as more efficient than UART.

Although the implementation of the serial interface in software requires same amount of resource as implementation in hardware .In our experiment, we used only one hardware platform that is PIC microcontroller with assumption that the result can be expanded to the same extent for other platform of hardwares. In our project, we evaluated the serial interface for one particular data rate and estimated that maximum data rates can be achieved at next implementation stage.

Additionally, we explored the way and means for time-scheduling of the data of critical parameter. Nevertheless, all the three protocols used here are having certain advantages over each other, for the transmission of data pretending to the critical parameters I²C is rated to be the most ideally one.

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