International Journal of Emerging Engineering Research and Technology
Volume 2, Issue 7, October 2014, PP 153-156
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

Exploring Power Management Capability of 8051 Based Embedded System

V.A.Kulkarni[1], G.R.Udupi[2], Mrs. S.H.Shete[3]

[1]Research Scholar, Department of E&C Engineering, Gogte Institute of Technology, Belgaum, India, *vakulgit@gmail.com*
[2]Professor, Department of E&C Engineering, Gogte Institute of Technology, Belgaum, India
[3]Asst. Professor, AMGOI, Vathar, Kolhapur, India

Abstract: *Power Management plays vital role in embedded systems. While teaching 8051 microcontroller, power saving modes are often neglected. These modes, if used properly in embedded applications can save significant power. This is crucial for battery operated systems. It prolongs battery life, reduces heat dissipation which further results in less maintenance and has positive impact on environment. A typical 8051 based system is developed at Core Technology, Kolhapur for the study and experimentation. Results show that battery discharge can be reduced by proper application of power modes.*

Keywords: *Microcontroller, Power Management, Current, Measurement.*

1. INTRODUCTION

Microcontrollers are used in numerous battery-powered applications, ranging from smart meters to consumer medical devices to industrial devices that remotely transmit temperature, vibration, humidity and other parametric data. Battery lifetime in these applications is a critical parameter – the microcontroller plays a pivotal role in determining this length of time.

With the rapid growth of low-power and battery-operated embedded systems in the consumer and industrial markets, the energy consumed by systems using embedded processors has become a core attribute. Consumers’ new focus is on power efficiency. Despite the importance of balancing performance and energy in an embedded system, surprisingly, very few processor boards are available with a mechanism to measure these parameters.

An attempt has been made to implement an embedded application which can measure current drawn under various power mode operations. The rest of paper is organized as follows. In section 2 power saving modes of 8051is discussed. Section 3 explains experimental set up. Experimental results are given in section 4. Finally, we conclude the paper and describe future work in Section 5.

2. POWER SAVING MODES OF 8051

Power control register, PCON: Direct address 87H. Not bit addressable.

	0	X	X	X	0	0	0	0	Value after Reset
PCON	SMOD				GF1	GF0	PD	IDL	Bit name
	bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0	

The purpose of the Register PCON bits is:

- SMOD Baud rate is twice as much higher by setting this bit.
- GF1 General-purpose bit (available for use).

- GF1 General-purpose bit (available for use).
- GF0 General-purpose bit (available for use).
- PD By setting this bit the microcontroller enters the Power Down mode.
- IDL By setting this bit the microcontroller enters the Idle mode.

By making bit 0 or bit 1 of PCON, the processor can be placed in idle mode or power down mode.

2.1. Normal Working

Interrupt Control	Program Memory	RAM	Timer
CPU			
Oscillator	Bus Control	I/O Ports	Serial Port

Fig1. *Normal operation of 8051*

During normal operation, the oscillator clock is distributed to various parts of 8051. Fig1 shows various components of 8051. For the sake of convenience, buses and signals are not shown.

Idle Mode: 8051 can be put in idle mode by making bit 0 of PCON as 1.Input clock to CPU is stopped and CPU stops working. Shaded part of Fig2 indicates inactive part of 8051 in idle mode. Since clock pulse is not available to CPU, fetching and execution of instructions will not take place. The other components like Timer/Counter, Interrupts and serial ports remain active, since they receive clock input. To exit from idle mode, hardware reset input or an interrupt (external or timer or serial interrupt) to be applied.

Interrupt Control	Program Memory	RAM	Timer
CPU			
Oscillator	Bus Control	I/O Ports	Serial Port

Fig2. *Idle mode with CPU frozen.*

Power down Mode: When bit 1 of PCON is set, processor enters power down mode. On chip oscillator is frozen. Peripherals like Timer/Counters, serial and other interrupts along with CPU becomes inactive as shown in Fig3.

Interrupt Control	Program Memory	RAM	Timer
CPU			
Oscillator	Bus Control	I/O Ports	Serial Port

Fig3. *Power down mode*

In power down mode, all interrupts become non functional. Hence using interrupts it is not possible to bring processor back to normal operation. Using hardware reset, processor can be brought back to normal mode

3. EXPERIMENTAL SETUP

Experimental setup used is shown in Fig4.Its main components are 89c52, temperature sensor LM35, ADC 0808, 16x2 LCD, etc. It is developed at Core Technology, Kolhapur. Terminals with red and black color are used to measure voltage. The terminals with yellow color below voltage terminals are used to measure current drawn by the set up during different modes of operation.

The experimental set up used intended to measure ambient temperature and display the same on lcd along with mode of usage. Switches are used to generate interrupts.

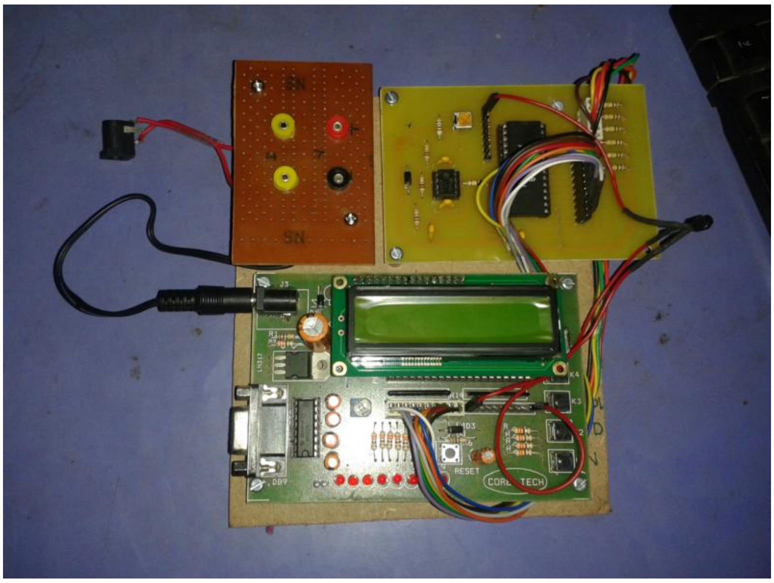

Fig4. *Experimental setup.*

4. Experimental Results and Discussion

Following readings were recorded during program execution.

Normal mode: 134 mA

Idle Mode: 132.6 mA

Power Down mode: 124 mA

One interesting observation made during measurement was that display draws large current. To substantiate this, same experiment was repeated without display and following readings were recorded.

Normal mode: 48.3 mA

Idle Mode: 44.5 mA

Power Down mode: 36.5 mA

Approximately 87 mA was the current drawn by display system.

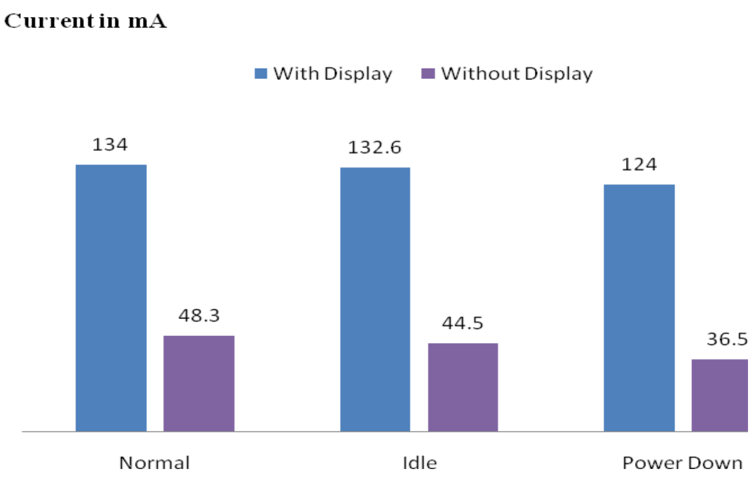

Fig5. *Measured Current*

From Fig5, it is clear that substantial current is drawn by LCD in all three modes. Thus more power saving can be achieved.

5. Conclusion and Future Work

This paper proposes to explore power management capability of 8051 based embedded system. The difference in current is 1.04% and 7.46% less in idle and power down mode respectively. Substantial power can be saved by proper selection of display device and by keeping display off for certain duration, which in turn depends on application. From Fig5, it can be seen that, a 63.95%, 66.44% and 70.56% reduction in current can be observed in three modes.

The future work of this paper is to find power consumed by individual components in a typical embedded system and suggest an optimum power solution.

References

[1] V.A.Kulkarni and G.R.Udupi, "Measurement of Power Consumption in Embedded Systems – Tools and Techniques – An overview", in Proc. ATEES 2014, paper atec-18.

[2] Naehyuck Chang, Kwanho Kim, Hyung Gyu Lee, "Cycle accurate energy measurement and characterization with a case study of the ARM7TDMI [microprocessors]" // IEEE Transactions on Very Large Scale Integration (VLSI) Systems, 2002. –Vol. 10, Iss. 2. –PP. 146–154.

[3] Mostafa Bazzaz, Mohammad Salehi and Alireza Ejlali "An Accurate Instruction-Level Energy Estimation Model and Tool for Embedded Systems", IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, VOL. 62, NO. 7, JULY 2013

[4] Liang-BI Chen, Yen-Ling chen and Ing-Jer Huang "A Real-Time Power Analysis Platform for Power-Aware Embedded System Development",JOURNAL OF INFORMATION SCIENCE AND ENGINEERING 27, 1165-1182 (2011).

[5] Shanq-Jang Ruan and Yi-Ruei Lai, " Development and Analysis of Power Behavior for Embedded System Laboratory", Dept. of Electronic Engineering, National Taiwan University of Sci. & Tech. No. 43, Sec. 4, Keelung Rd., Taipei 106, Taiwan.

Authors' Biography

V.A.Kulkarni is perusing his research in the area "Power Management in Embedded System". He is having 18 years of teaching experience. He has presented papers in conferences. His research interest includes embedded systems, system on chip and battery management. Presently he is working as Associate Professor and Head in Electrical Engineering Department, AMGOI, Vathar, Kolhapur, India

Dr. G.R.Udupi is working as Professor in Department of Electronics and Communication Engineering, GIT, Belgaum, India. He is having 33 years of teaching experience. His area of interest includes Fuzzy logic, ANN, Biomedical instrumentation, Power quality. He is having 20+ international journal papers to his credit. He has supervised the completion of 02 PhDs and is guiding 06 research scholars. He is member of IEEE, BMSI, IETE and IE(I).

Mrs. S.H.Shete is working as Assistant Professor Electrical Engineering Department, AMGOI, Vathar, Kolhapur, India. Her area of interest is control system and embedded controllers. She is having 08 years of teaching experience.