The Power Analysis Tool for an Embedded Systems Development Board

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Abstract

This project proposes a power analysis tool for an SoC development board. It can help us to analyze power consumption of the embedded systems design of each component between software and hardware.

1. Introduction

Power consumption is an important issue for embedded system designs, especially for today's portable applications, for example, cellular phones, video cams, digital cameras, etc. Due to the quality portable application design demands high performance with low power dissipation and longer battery life. Moreover, a portable application usually uses limited power supply by the battery. Hence, how to reduce power consumption becomes a critical issue of the development of portable devices. Therefore, power consumption related issues should be discussed. Owing to the most SoC embedded systems development boards and their development software tools did not support power analysis related functions such as power measurement, power analysis and power management. For this reason, the embedded systems experiments lack the related development platform that supports power consumption analysis. To meet the demand, we have consulted and closely collaborated with Microtime computer Inc. [1] to develop an SoC embedded systems development board, called PreSOCes. The PreSOCes is a prototyping platform for embedded systems development and the integration of development on system hardware and software with Linux OS. It consists of a Creator [1] hardware motherboard, a changeable daughter board, a dedicated in-circuit emulator (ICE) and a Domingo debugger for µClinux, Linux, etc. The ProSOCes supports several common embedded systems devices such as ARM CPU, SDRAM, FLASH, CF card reader, LCD, CCU, UART, etc., and these device provide measurement probe to measure electric current for each device. Although the PreSOCes supports electrical current measurement, developer can only measure a single channel electric current at the same time. Developer would like to analyze power consumption of the embedded system in order to design a power-awared embedded system. The platform must be supplied more than one channel of power measurement at the same time. The PreSOCes only supports a single channel measurement probe but defeated to the multi-channel function and just only provide electric current measurement probes. It lacks power analysis related hardware/software platform. Therefore, we have developed a power analysis tool in order to help developer to analyze power in the embedded systems experiments.

2. Description of Power Analysis Platform

Fig.1 shows the architecture of the proposed power analysis platfrom. It can be divided into two main parts. One is encircled by dotted line shows the prototyping of the embedded application. The other is outside the dotted line by the proposed tool for measurement, analysis and management. The photo of our prototype of the proposed platform is shown in Fig.2.

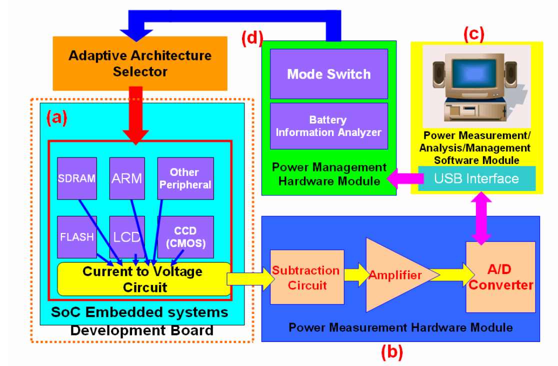

Figure 1: Proposed power analysis platform - (a) PreSOCes SoC embedded systems development board (b) power measurement hardware module (c) PC-based host with USB interface (d) power management hardware module

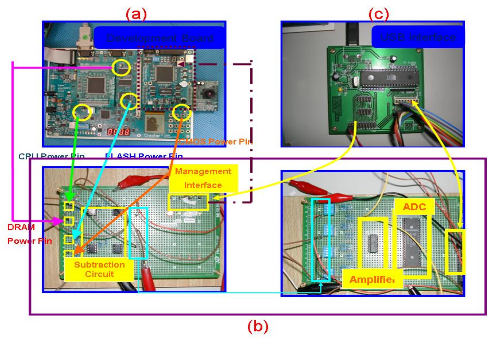

Figure 2: Prototype of proposed power analysis platform - (a) PreSOCes SoC embedded systems development board (b) power measurement/management hardware module (c) PC-based host with USB interface

2.1 Power Measurement Hardware Module

Fig.1 (b) is the power measurement hardware module. It consists of subtraction circuits, voltage amplifiers, and a multi-channel A/D converter, which is designed to measure real-time multi-channel power information at the same time. The subtraction circuits are used to solve the circuit short problem, which fails to support the multi-channel power measurement on the PreSOCes. The voltage amplifiers to amplify the expected analog signal are used by the Operation Amplifier (OPA). The different device needs different magnification in order to get better accurate requirement. Hence, the multi-magnification voltage amplifier has been used for different device. The multi-channel A/D converter transfers analog signals to digital signals, and receives the control signals from PC-based host to switch different channel. It measures the power information of each device simultaneously.

2.2 Power Management Hardware Module

Fig.1 (d) is the power management hardware module. In the power management hardware module, the control signal can control adaptived architecture selector to switch power management mode according to the battery information analyzer. Developer can set up different software algorithm and turn off some disuse hardware to control power consumption on the PreSOCes.

2.3 Power Measurement/Analysis/Management Software Interface

The power measurement software GUI interface on the PC-based host. The host sends control signals to the multi-channel A/D converter in order to switch different channels. Then, the host receives the value of power measurement by the USB interface. The power analysis software can gather the power statistics of each device and display the power measurement. The execution screens of our software GUI interface are shown in Fig.3 to Fig.5. The measurement results will be analyzed for SoC embedded systems development board. Fig.3 shows the measurement results of electric current, power, and energy for each device. The experimental result is conformed to actual operation of embedded systems because processors often have most complex computation. The result proves that developer can measure the change of real-time power consumption rapidly and dynamically. And, they can find out which is the most power consumption devices of the device. Fig.3 and Fig.4 show the information of power measurement. This project further takes care of the power management mode in Fig.5. Fig.5 shows the simulation results of power management. If the developer would like to design a power-awared application, they must be focused on different power management mode and how to reduce the power consumption in the designs.

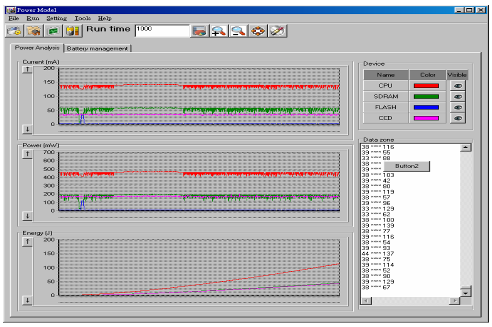

Figure 3: Power Measurement of each device

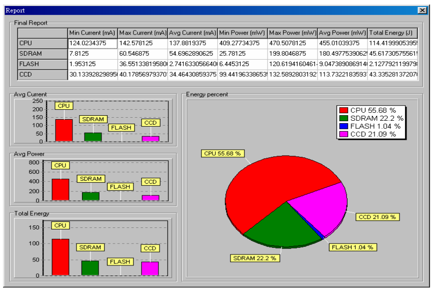

Figure 4: Power analysis of each device

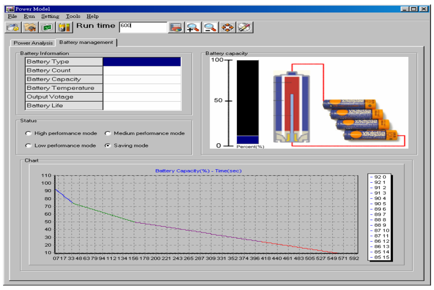

Figure 5: Simulation of power management of each device

3. Conclusion

In this project, we have designed a tool that supports power measurement, analysis, and management for an embedded systems development borad. The power measurement module provides real-time multi-channel probes to measure electric current of each device of the embedded application. The power analysis module can record and analyze electric current and power information statistics of each device of the embedded application. The power management module provides control signals. The hardware and software of the embedded application can be dynamically switched for designing low-power embedded application. This tool can help embedded systems developer to undertake practical power analysis for their embedded system designs.

4. References

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