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Development of portable single phase power energy meter using PIC module (software) / Norfaiz Alias.

DEVELOPMENT OF PORTABLE SINGLE PHASE POWER ENERGY METER USING PIC MODULE (SOFTWARE)

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Bekp

July 2009

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"I hereby declared that I have read through this report entitle "Development of Portable Single Phase Power Energy Meter Using PIC Module (Software)"and found that it has comply the partial fulfillment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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DEVELOPMENT OF PORTABLE SINGLE PHASE POWER ENERGY METER USING PIC MODULE (SOFTWARE)

NORFAIZ BIN ALIAS

A report submitted in partial fulfillment of requirement for the degree of Bachelor in Electrical Engineering (Industry Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

July 2009

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I hereby declared that this report is of my own work except as cited clearly in the references.

Signature : .....

Name : NORFAIZ BIN ALIAS

Date : 8 JULY 2009

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I would like to take this opportunity to express my deepest regards to Mr. Azhar Bin Ahmad as my supervisor for final year project. Because his attention, helpful and his encouragement, I success to finish this report on time.

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ABSTRACT

This Final Year Project report is to design and construct the portable single phase power energy meter. The major components of this project are microcontroller 8051 IAR Embedded Workbench System and energy metering IC ADE7169. This programmed find used in devices that needs some intelligence but not a huge amount of processing power. The ADE7169 is use because it capability to give an output pulse of energy (KWh).This analog devices also provide excellent performance with an error of less than 0.1%. Lesser the error on meter, it will give the efficient measurement of the power usage. After finished built this meter, this circuit needed to test whether the design software suitable for the IC or not. If the IC can function after installed with the software, then it need to test with the load and make sure LCD will display the measured value. When LCD display the measured value, check the accuracy of the meter. Repair the design if error is more than 0.1% accuracy. The information process in ADE7169 will be read by IAR Embedded Workbench System than display at LCD (liquid crystal display). The program using Basic language are develop is C programming for IAR Embedded Workbench to make sure that the programmed can read data from ADE7169 and display the data at LCD. The energy data display by LCD is in digitally.

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ABSTRAK

Projek Semester Akhir ini melaporkan berkenaan rekabentuk dan pembangunan sebuah meter digital tenaga bagi litar satu fasa. Projek ini menggunakan mikro pengawal 8051 IAR Embedded Workbench System dan litar bersepadu tenaga (*energy metering IC*) ADE7169 sebagai komponen utamanya. Pengaturcaraan ini digunakan dalam peranti-peranti yang memerlukan beberapa kepandaian tetapi bukan dalam satu jumlah yang sangat besar kuasa pemprosesannya. ADE7169 digunakan kerana ia berkesanggupan bagi memberi satu denyut keluaran tenaga (KWh).Alat-alat analog ini juga menyediakan prestasi cemerlang dengan kesalahanan kurang daripada 0.1%. Kurang ralat pada meter, ia akan memberi ukuran yang cekap bagi penggunaan tenaga. Selepas sudah membina meter, litar ini perlu diuji sama ada perisian reka bentuk sesuai untuk IC atau tidak. Jika IC dapat berfungsi selepas diaturcarakan dengan perisian, kemudian ia perlu diuji dengan beban dan memastikan LCD akan memaparkankan nilai yang diukur. Apabila LCD memaparkan nilai yang diukur, periksa ketepatan bagi meter. Reka bentuk perisian perlu diperbaiki jika ralat adalah lebih daripada 0.1% ketepatan. Proses maklumat di ADE7169 akan dibaca oleh IAR Embedded Workbench System daripada paparan pada LCD (paparan hablur cecair). Program menggunakan bahasa Basic iaitu pengaturcaraan C untuk IAR Embedded Workbench untuk pastikan bahawa perisian itu boleh membaca data daripada ADE7169 dan memaparkankan data pada LCD. Paparan data pada LCD adalah secara digital.

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CHAPTER I

INTRODUCTION

1.1 Introduction

In this chapter, the problem statement related to single phase power energy meter will be describe. Also the objective overcomes for energy meter. This chapter also will describe the project scope.

1.2 Problem Statement

The energy meter (kWh) was meter find used in single phase. Thereby, the produce and developing of energy meter (kWh) with digital display in Malaysia still not wide enough. The old energy meter used electromechanical counter. Because of that the old meter can display the output only in energy (kWh) form.

There are many integrated circuit (energy metering IC). But the explored of this energy metering IC still in low level. If this exploring can enhance the system of energy meter, this can easier the operation of energy meter.

We can see, at this time energy meter could not display other different power like real power (P), reactive power (Q) and apparent power (S) at one time. If this problem can be solve, the used of this meter can be more practical to consumer.

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1.3 Objective

From the problem statement above, for this reason we need to build the hardware and developed the program. The objective of this project target state below:

1. To produce local single phase power energy meter.
2. To developed the C language using IAR Embedded Workbench System.
3. To analysis the basic operation of this programmed of power energy meter.
4. This power energy meter can measured and display the energy (kWh).

1.4 Project Scope

In order to fulfill this project, there is some scope need to take clearly such as:

1. The single phase power energy meter in digital can display and give value based on load from the circuit.
2. To used the IAR Embedded Workbench System software and assemble with the C language program.
3. This digital meter also can display the three powers like apparent power (S), real power (P), and reactive power (Q).
4. Also the energy meter can display the voltage, the current and other extra application.

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CHAPTER II

LITERATURE REVIEW / THEORIES

2.1 Digital power energy meter characteristic

This project about portable single phase power energy meter (KWh). This power energy meter operates at single phase circuit. The designs of this meter were based on energy metering IC ADE7169. The value of this meter will be displayed in digital, the current unit is (kWh) and displayed at LCD (*liquid crystal display*).

2.2 ADE 7169

The Analog Devices IC (ADE) family combines industry-leading data conversion technology with a fixed function digital signal processor (DSP) to perform the calculations essential to an electronic energy meter.

2.2.1 ADE Product Family

i. High accuracy exceeds IEC and ANSI standards
ii. Proprietary 16-bit ADCs and DSP provide high accuracy over large variations in current, environmental conditions, and time.
iii. Reliability proven with over 175 million units deployed in the field.
iv. On-chip reference with low temperature drifts (20 ppm to 30 ppm typ).
v. On-chip power supply monitoring.
vi. On-chip creep protection (no-load threshold).
vii. Single 5 V supply.

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viii. Low power consumption.

ix. Instantaneous active power output for calibration or interface to an MCU

x. Miswiring or reverse power indication.

xi. Tamper detection options

2.3 Value of ADE products

2.3.1 Proven Technology

Analog Devices is the market leader in sales of energy metering ICs with over 175 million meters deployed worldwide with ADE products.

i. Quality: Strict quality and test standards applied to ADE products throughout design and manufacturing stages ensure low meter production failure rate and uniform part-to-part characteristics.

ii. Reliability: Accelerated life expectancy tests on ADE products, representing more than 60 years of field usage, reduce probability of meter failure due to IC failure.

iii. Performance: Provide excellent performance with an error of less than 0.1% over an extended current dynamic range.

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2.4 Energy Meter System Diagram

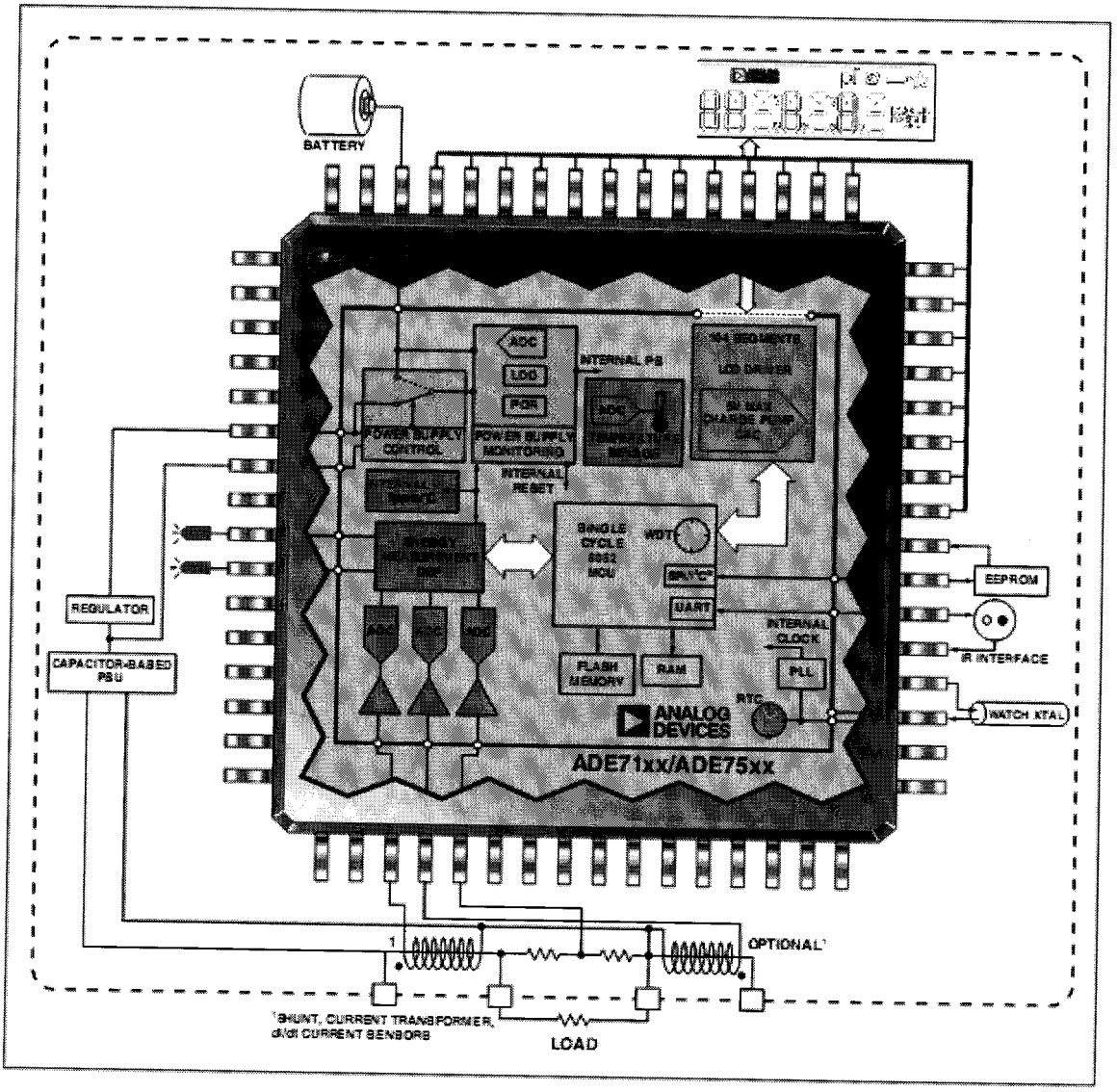

Figure 2.1: Energy meter system diagram

2.5 ADE developments tool

The ADE7169 family of products share a common set of tools designed to minimize design time while improving the part understanding. These tools are comprised of:

i. Energy meter reference design

ii. 1-pin emulator with isolated USB interface

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iii. Isolated USB to UART debugger interface
iv. Downloader software
v. Evaluation software
vi. Integrated development environment from well-known vendor
vii. Firmware libraries for common and part specific functions

The energy meter reference design integrates the main functions of an LCD meter with communication, battery backup, two current sensors, antitamper interface, and EEPROM interface while using the features of the ADE7169 such as battery management, antitamper detection, and temperature compensated real-time clock, and LCD driver contrast.

The reference design is accompanied by code libraries and an example of system integration code allowing easy evaluation and further development of solution. Isolated USB communication boards for debugging and emulation provide a safe solution for code development when the meter is connected to the line.

The ADE7169 can be used with integrated development environments (IDE) from open market vendors to simulate, compile, debug, and download assembly or C code. A free of charge IDE with unlimited assembly code capability and 4 kB limited C code capability is included in the evaluation kit. In addition, the part can be evaluated with a UART and a PC by using the versatile evaluation tools and downloader.

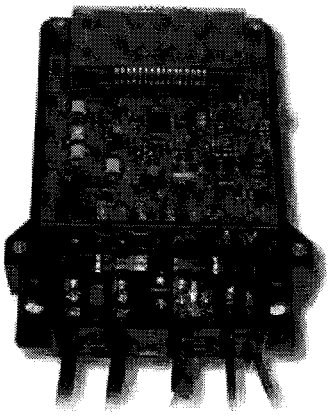

Figure 2.2: Evaluation board meter

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2.6 Micro's C (programming language)

C is a general-purpose computer programming language developed in 1972 by Dennis Ritchie at the Bell Telephone Laboratories to implement the Unix operating system. C is an imperative (procedural) systems implementation language. It was designed to be compiled using a relatively straightforward compiler, to provide low-level access to memory, to provide language constructs that map efficiently to machine instructions, and to require minimal run-time support. C was therefore useful for many applications that had formerly been coded in assembly language. Despite its low-level capabilities, the language was designed to encourage machine-independent programming. A standards-compliant and portably written C program can be compiled for a very wide variety of computer platforms and operating systems with little or no change to its source code, while approaching highest performance. The language has become available on a very wide range of platforms, from embedded microcontrollers to supercomputers.

2.7 Program Construction for Circuit

Program for circuit are the process to programming the microcontroller so it can control or manipulate the data obtained. By performed this process then the microcontroller can operate and control the circuit automatically. The first process need to take attention is make the flow chart program, choose the software that want to used and design the program, but the important process is understand the used of this software.

2.8 IAR Embedded Workbench System

To read the energy (kWh) data from energy metering IC ADE7169 as microcontroller, IAR Embedded Workbench is choosing as programming assembly. The IAR Embedded Workbench Kickstart Edition is designed for starter kits. The maximum code size handled by this toolset is 4 Kbytes. It will not generate any assembly code output. Now it is possible to use the kickstart edition for assembler projects without any code size

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limitation. This is possible since the debugger does not count code generated by the assembler when downloading the code. Figure 2.3 show the window of the software. The program will start from here.

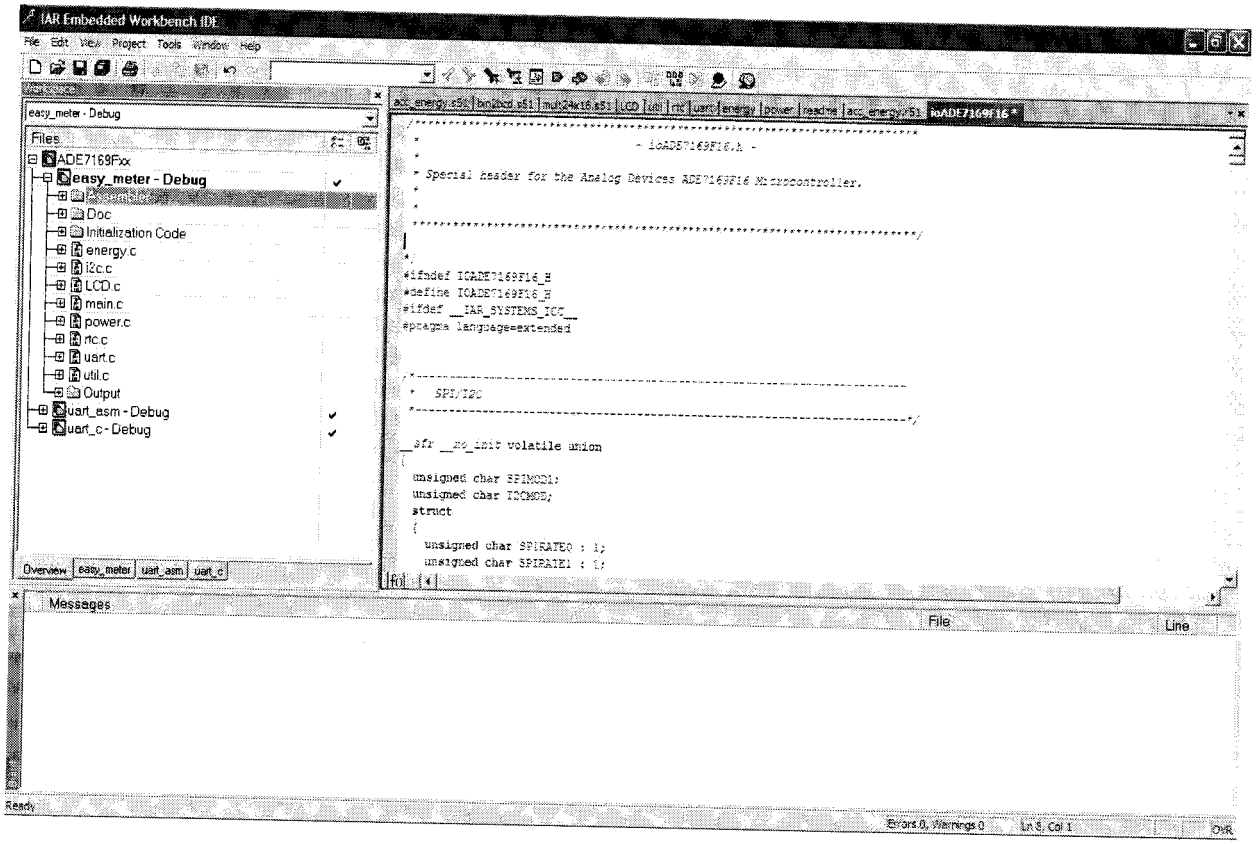

Figure 2.3: Software main window

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CHAPTER III

METHODOLOGY

3.1 Methodology Overview

Methodology is a method to explain how this project is satisfied. This method is use to get more information from collection the data, analysis the data and process the data. Methodology is important because it report the work will be executed in developing the project. The contents of methodology include the method and technique is used to design and implementation of project. Methodology also can be explained about justification using the method and software requirement.

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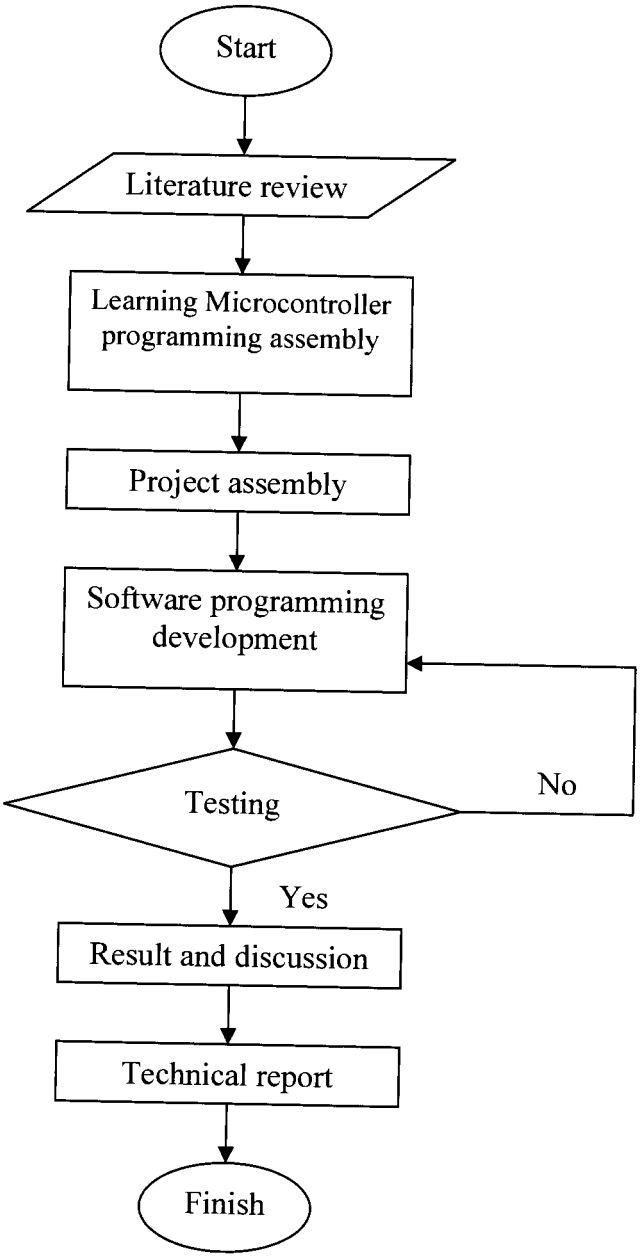

Figure 3.1: Project Flowchart

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3.2 Method Of Collecting Data

For collecting the data, the methodology is used such as literature review, learned microcontroller programming assembly, meter design (hardware), software programming, testing, LCD displayed, and progress report.

i. Literature review

This method is to study the assembly programming and analog devices ADE7169 integrated circuit (IC) and the programming assembly (IAR Embedded Workbench). Find and study journals, application notes, and data from internet, book and application notes that related to this project.

ii. Learning microcontroller programming assembly

To learned the command by using IAR Embedded Workbench System assembly.

iii. Project assembly

Development of the programming start

iv. Software programming

Development of the programming to measured the value of active energy like power (P), voltage and current.

v. Result and discussion

The programmed success when the LCD can display the output.

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vi. Technical report and presentation

Carry out analysis and testing on the project. Documented project report form and presenting end of the project report.

3.3 ADE 7169 Based Energy Meter Program Structure

This section contains a description of the C language program assembly used to implement an energy meter based on ADE7169 controller.

3.4 Main Structure of the Program

The program contains an initialization stage and a never ending loop. In order to minimize the time spent in the interrupts as much as possible, only 2 interrupts are enabled. The structure of the program is presented in Figure 3.2.

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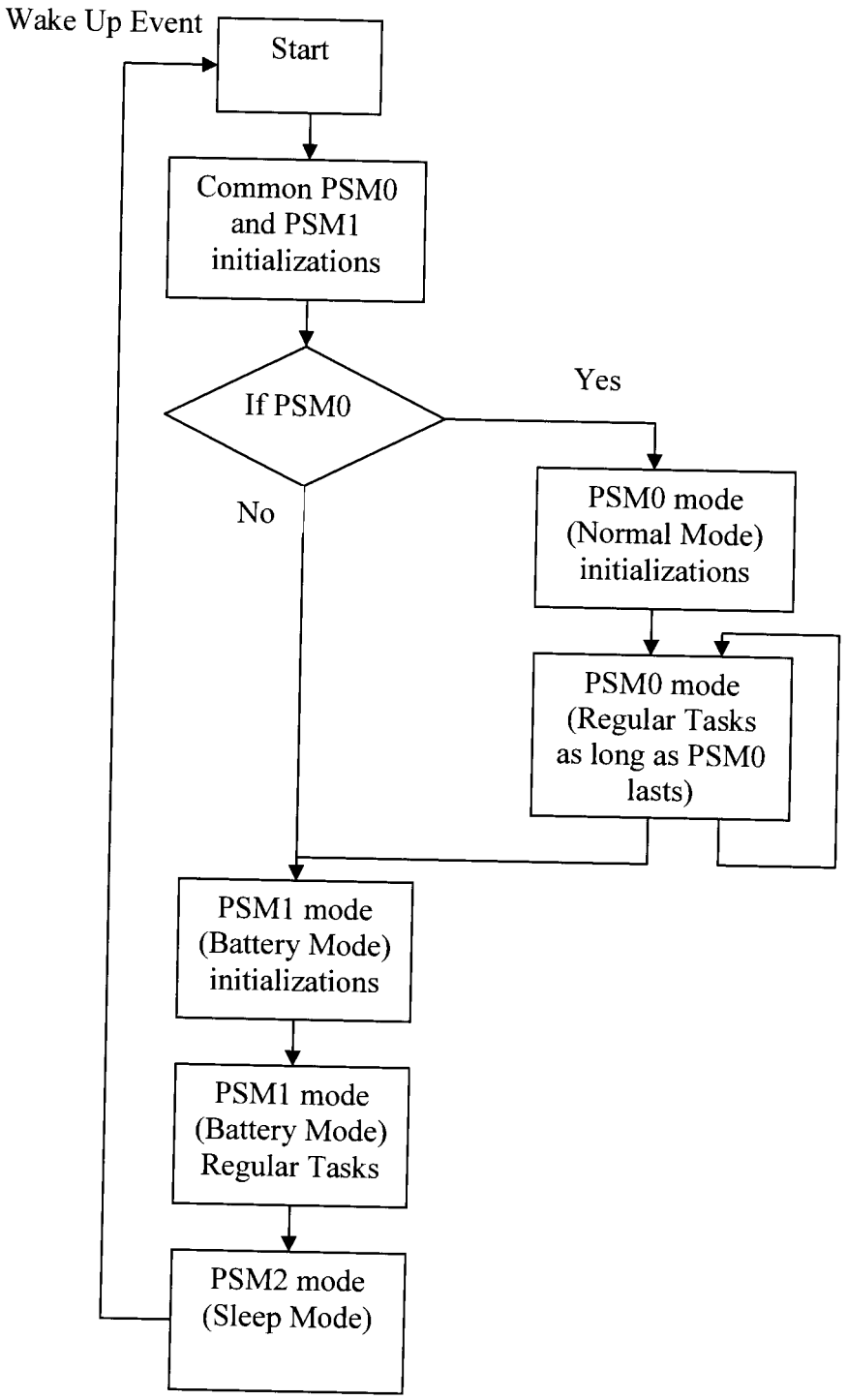

Figure 3.2: Program Structure

After reset, various initializations are executed based on the operating mode of the controller: PSM0, the normal mode, and PSM1, the battery mode. The tasks executed during this period are presented in Figure 3.3. Then, the never ending loop is executed only

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