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Hardware Demonstration of a Home Energy Management System forManaging End-use Appliances.

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***Abstract:* -- A Home Energy Management (HEM) system plays a crucial role in realizing residential Demand Response (DR) programs in the smart grid environment. It provides a homeowner the ability to automatically perform smart load controls based on utility signals, customer's preference and load priority. This paper presents the hardware demonstration of the proposed HEM system for managing end-use appliances. The Hem's communication time delay to perform load control is analyzed, along with its residual energy consumption. In general, an HEM unit comprises:a) an embedded device running a GUIsoftware application, which includes a DR algorithmthat serves as the brain of the HEM system. It makes a decisionto switch ON/OFF selected end-use appliances based onthe utility signal received, as well as homeowner's load priorityand preference settings. It is also responsible for collecting electricalconsumption data from all load controllers and providingan interface for homeowners to retrieve appliances' status andreview their power consumption; andb) An HEM communication module, which provides communication paths between theHEM unit and its load controllers. This module is attached tothe HEM unit and enables the HEM unit to send load controlcommands to all load controllers, and receive responses back.A Linux with a Zig Bee-enabled communicationmodule is used as the HEM unit for this demonstration. The concept will be implemented on a Single Board computer containing ARM 9 Processor an Embedded device with embedded Linux. The hardware components used in this project Friendly ARM Mini 2440 (Single-Board Computer) with 400 MHz Samsung S3C2440 ARM9 processor, Zigbee Modules, Light, Motor, 8051 microcontroller. The software's used OS: Embedded Linux2.6.32, Language: C++, IDE: Qt Creator2.1.0.**

***Keywords*:-- HEM, DR, SBC, MMU, AMBA Bus, HPNA, PnDAT, ULCONn, UERSTATn, UTRSTATn, UMCONn, RPSMA**

I. INTRODUCTION

Traditionally in the U.S. and in many parts of the world, there is a persist problem of inefficient use of electric power generation andtransmission assets. For Example in the dominion Virginia power's service area, roughly 20% of power generation are used 5% of the time. This problem has partially been tackled by the demand side management; with the introduction of smart grid it is now possible to perform demand response at customer premises to get a finer control of the available resources.

Demand Response is defined as the changes in electricity use by demand side resources from their normal consumption patterns in response to changes in the price of electricity, Or to incentive payments designed to induce lower electricity at times of high wholesale market prices or when system reliability is jeopardized".

FERC has also pointed out that almost 80% the total U.S. peak load reduction potential comes from incentive-based DR programs. Due to this reason, and the fact that there has not been a mature time-varying tariff for residential customers, the DR concept for our hardware demonstration is based on the incentive-based DR program which involves a customer receiving some sorts of load control signals from a service provider. This DR concept is thoroughly discussed in which we describe algorithm to manage multiple power-intensive loads in a house to meet certain peak reduction targets, taking into account homeowner preset load priority and comfort level preference.

Note that for this kind of DR programs, economic incentives should have already been writteninto the contract between consumer and the utility. In order to realize the proposed DR feature; it is necessary to deploy a fully automated DR solution, or auto-DR which can be made possible through the use of a Home Energy Management (HEM) system.

Various HEM systems are designed based on different communication schemes, such as ZigBee and power-line carriers, authors implement an HEM system using a task-scheduling approach, and authors propose an HEM system that can display energy usage information of individual appliances. In authors propose an in-home energy management (iHEM) system to reduce energy expenses and peak loads.

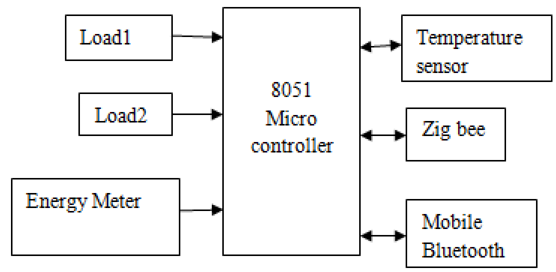
To manage multiple power intensive loads in a house to meet certain peak reduction targets taking in to account home owner preset load priority and comfort level preference. In this case home owners has freedom to choose what loads to manage and for how long. This is different from a preset load reduction target set by a local electric utility company in direct load control program.

In home energy management system reduces peak loads and energy expenses. Yet there is another implementation of a HEM that can manage power intensive loads to limit the household peak demand, while taking in to account house owners load priority and comfort preference.

II. BLOCK DIAGRAM:

***2.1. HEM Section*:**

2.2. Load Controller



2.3. Schematic Diagram Of HEM :

HEM Section:

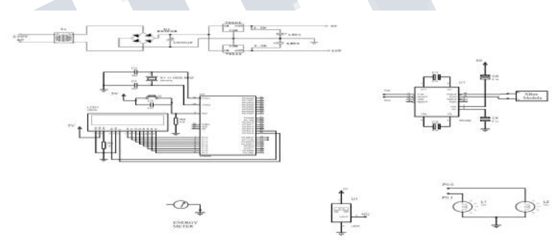
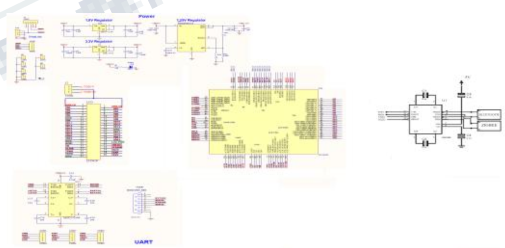


Fig1: HEM Schematic Diagram

Load Controller:



III. BLOCK DIAGRAM DESCRIPTION:

The Block diagram consists of a Zigbee transceiver, a Microcontroller, Bluetooth, energy meter, ADC and power supply. These hardware components will be discussed briefly as follows:

***3.1. Microcontroller Section*:**

This section forms the control unit of the whole project. This section basically consists of a Microcontroller with its associated circuitry like Crystal with capacitors, Reset circuitry, Pull up resistors (if

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needed) and so on. The Microcontroller forms the heart of the projectbecause it controlsthe devices being interfaced and communicateswith the devices according to the program being written.

3.2. Power Supply:

In this project we required operating voltage for ARM controller board is 5V. Hence the 5V D.C. power supply is needed for the ARM board. This regulated 12V is generated by stepping down the voltage from 230V to 18V now the step downed a.c. Voltage is being rectified by the Bridge Rectifier using 1N4007 diodes. The rectified a.c voltage is now filtered using a 'C' filter. Now the rectified, filtered D.C. voltage is fed to the Voltage Regulator. This voltage regulator provides/allows us to have a Regulated constant Voltage which is of +12V.

3.3. Zigbee transceiver:

Transceiver is a device which acts as both transmitter and receiver. This operates with 2.8-3.4V. Range of the transceiver module is 30-70m in urban areas and 1-1.5km in outdoor (LOS). The transceiver has an on-chip wire antenna and it operates at a frequency of 2.4GHz.The data received from the microcontroller is organized based on the ZIGBEE protocol standards and then modulated. Along with the data, source address and destination address are added and sent.

3.4. Bluetooth:

The art of connecting things is becoming more and more complex every day. In this article, we will look at a method of connecting devices, called Bluetooth that can streamline the process. A Bluetooth connection is wireless and automatic, and it has a number of interesting features that can simplify our daily lives.

3.5. ADC (Analog to Digital Converter):

In order to manipulate the data using a microprocessor, we need to convert the analog signals to the digital signals, so that the microprocessor will be able to read, understand and manipulate the data.

3.6. Energy meter:

An electric meter or energy meter is a device that measures the amount of electrical energy supplied to or produced by a residence, business or machine. The most common type is a kilowatt hour meter. When used in electricity retailing, the utilities record the values measured by these meters to generate an invoice for the electricity. They may also record other variables including the time when the electricity was used.Modern electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) and finding the product of these to give instantaneous electrical power (watts) which is then integrated against time to give energy used (joules, kilowatt-hours etc). The meters fall into two basic categories, electromechanical and electronic.

3.7. LM 35:

A sensor can be defined as a device which can convert one form of energy into electrical energy. Here we are using a sensor to sense the temperature around us. For this purpose we will be taking help of LM 35 which is a temperature sensor.

IV. HARDWARE COMPONENTS:

4.1. ARM Processor:

The mini2440 is a practical low-cost ARM9 Single Board Computer (SBC) with a very high performance/cost ratio. With the Samsung S3C2440 microprocessor and the use of professional layout and quality peripheral chips, it is very robust. The Mini2440 uses a four-layer board design with gold immersion processing, and has high quality equal-length bus routing in timing critical areas. The S3C2440A (450 MHz) offers outstanding features with its CPU core, a 16/32-bit ARM920T RISC processor designed by Advanced RISC machine ltd. The ARM920T implements MMU, AMBA BUS, and Harvard cache architecture with separate 16KB instruction and 16KB data caches, each with an 8 –word line length. The S3C2440A minimizes overall system costs and eliminates the need to configure additional components.

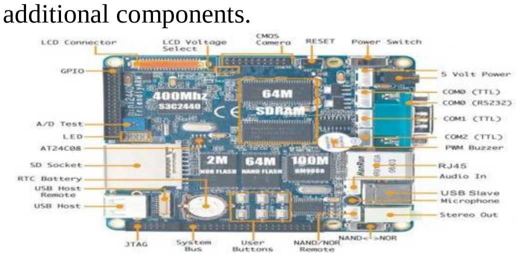

Fig 2: ARM 2440

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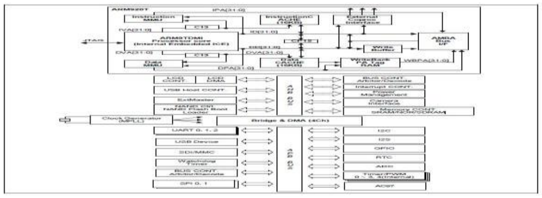
4.2 Functional Diagram:



4.3. Mini 2440 Memory Organization:

The Mini2440 two external SDRAM chips with a total of 32M bytes each or 64M bytes of with a full 32-bit data bus width for maximum speed. CPU chip select nGCS6 is used for the SDRAM which places it at address 0x3000 0000 (8 zeroes).

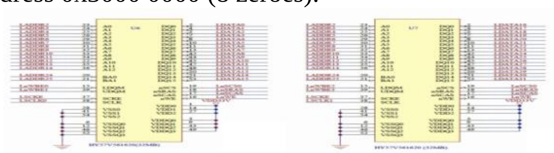


Fig 3: SDRAM storage system

4.4. Address Space Allocation:

The S3C2440 supports two modes: Boot from NAND Flash or boot from NOR Flash. When the NOR/NAND switch is in the NOR position, the system conforms to the memory map on the left. In the NAND position, the memory map on the right represents the start configuration. The SFR area is for special control register addresses. In NAND Flash boot mode, the internal 4K Byte Boot SRAM section is mapped to the nGCS0 space. In Nor Flash start mode nGCS0 is connected to external memory. Nor Flash has been mapped to the chip select space nGCS0. The SDRAM address space: 0x30000000 ~ 0x34000000. The boot mode determines the configuration of the memory map.

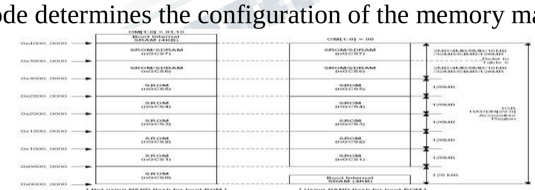


Fig 4: Address space location of MINI2440

4.5. Flash Storage Systems:

The Mini2440 has two kinds of Flash, one is the neither 2MByte Nor Flash, model SST39VF1601 (For programming with JTAG you must check the Flash on your board. Manufacturers and model numbers can vary). The other is the 64 (128, 256) MByte NAND Flash model K9F1208 (again, check before Flash with JTAG).The S3C2440 supports starting from either Flash. The slide switch, S2, chooses NAND or Nor. The Nor Flash uses A1-A22 for a total of 22 address lines. We won't choose address line A0. Because the memory is 1 word or two bytes (16 bits) wide and all access is on even numbered addresses. The smallest unit read is two bytes. According to the figure below, the design could use a total of neither 8 MByte of Nor Flash. On the SST39V1601 chips, A20 and A21 have no connection, 2 Mbytes of NOR flash. The NAND circuit allows up to 256 MByte chips without a design change.

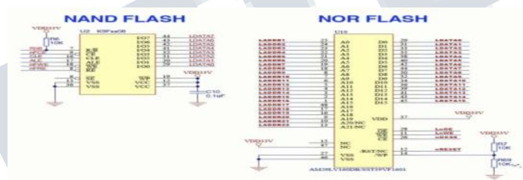


Fig5: Flash storage system

4.6. MINI2440 Power Supply Section:

The Mini2440's power supply system is rather simple and requires an external 5V power supply. Three regulators are used to generate: 3.3V, 1.8V, 1.25V.The Mini2440 is not designed for handheld mobile devices, so it does nothave full power management circuitry. The S1 DIP switchcontrols the system power and there is no provision for power control through software.

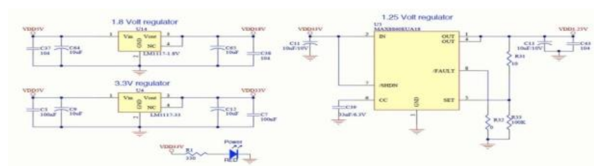


Fig 6: Power supply section

4.7. MINI2440 USB Interface:

As we are running a Linux system, there is no corresponding driver and application. Ethernet is usually preferred for data transfer in Linux. The USB Slave can be controlled with a GPC5 register bit to set USB_EN or disable. It can be disabled to conserve CPU resources.

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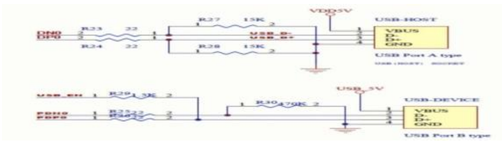


Fig 7: USB Interface

4.8. MINI2440 LCD Interface:

The Mini2440 LCD interface has a 41 Pin 0.5mm pitch white connector, which contains common LCD control signals (line-field scanning, the clock, enable, etc.) and complete RGB output of 8:8:8, supporting a maximum of 16 million colors. The LED backlight can be turned on or off or modulated with GPB1. The backlight signal is called LCD_PWRthrough Depositors configuration for PWM), and reset signals (nRESET), one of backlight control signals are LCD_PWR. In addition, pins 37, 38, 39, 40 are for the four-wire touch screen interface. They can be directly connected to a Touch Panel. See figure J2 for the LCD driver.

Fig 8: LCD Interface

4.9.MINI2440 Network Interface:

The Mini2440 uses a DM9000 10/100M LAN chip with network transformers and an RJ-45 connector. The DM 900 is a fully integrated and cost effective single chip fast Ethernet MAC controller with a general processor interface, a 10/100M PHY and a 4K DM word SRAM. It is designed with low power and high performance process that support 3.3V with 5V tolerance.The DM900 also provides a MI interface to connect the HPNA device or other Tran's receiver that support MI interface. This chip also support 8 bit,16 bit and 32 bit microprocessor interfaces to internal memory access for different processors. The programming of DM900 is very simple so user can port the software drivers to any system easily.

4.10. MINI2440 EEPROM Interface:

The Mini2440 has a direct connection from the S3C2440 I^2C signal pin to an AT24C08 EEPROM with a capacity of 256 bytes. This is mainly used to test.

Fig 9: MINI2440 EEPROM Interface

4.11. NAND Flash Controller:

S3C2440A boot code can be executed on an external NAND flash memory. In order to support NAND flash boot loader, the S3C2440A is equipped with an internal SRAM buffer called 'Steppingstone'. When booting, the first 4 Kbytes of the NAND flash memory will be loaded into Steppingstone and the boot code loaded into Steppingstone will be executed.Generally, the boot code will copy NAND flash content to SDRAM. Using hardwareECC, theNAND flash data validity will be checked. Upon the completion of the copy, the main program will be executed on the SDRAM.

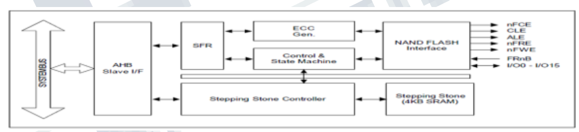


Fig10: NAND Flash Controller

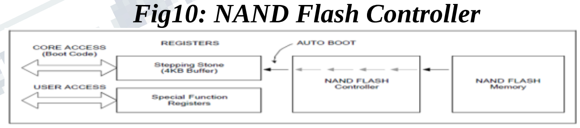
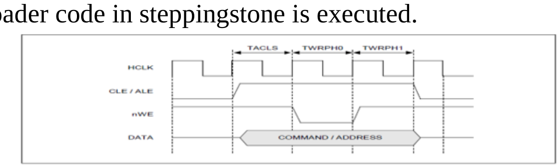


Fig11: NAND Boot Loader

During reset, Nand flash controller will get information about the connected NAND flash through Pin status (NCON (Adv flash), GPG13(Page size), GPG14(Address cycle), GPG15(Bus width). After power-on or system reset is occurred, the NAND Flash controller loads automatically the 4-KBytes boot loader codes. After loading the boot loader codes, the boot loader code in steppingstone is executed.



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Data Register Configuration

1. 16-bit NAND Flash Memory Interface

A. Word Access

Register	Endian	Bit [31:24]	Bit [23:16]	Bit [15:8]	Bit [7:0]
NFDATA	Little	2nd I/O[15:8]	2nd I/O[7:0]	1st I/O[15:8]	1st I/O[7:0]
NFDATA	Big	1st I/O[15:8]	1st I/O[7:0]	2nd I/O[15:8]	2nd I/O[7:0]

A. Half-word Access

Register	Endian	Bit [31:24]	Bit [23:16]	Bit [15:8]	Bit [7:0]
NFDATA	Little/Big	Invalid value	Invalid value	1st I/O[15:8]	1st I/O[7:0]

1. 8-bit NAND Flash Memory Interface

A. Word Access

Register	Endian	Bit [31:24]	Bit [23:16]	Bit [15:8]	Bit [7:0]
NFDATA	Little	4th I/O[7:0]	3rd I/O[7:0]	2nd I/O[7:0]	1st I/O[7:0]
NFDATA	Big	1st I/O[7:0]	2nd I/O[7:0]	3nd I/O[7:0]	4th I/O[7:0]

A. Half-word Access

Register	Endian	Bit [31:24]	Bit [23:16]	Bit [15:8]	Bit [7:0]
NFDATA	Little	Invalid value	Invalid value	2nd I/O[7:0]	1st I/O[7:0]
NFDATA	Big	Invalid value	Invalid value	1st I/O[7:0]	2nd I/O[7:0]

A. Byte Access

Register	Endian	Bit [31:24]	Bit [23:16]	Bit [15:8]	Bit [7:0]
NFDATA	Little/Big	Invalid value	Invalid value	Invalid value	1st I/O[7:0]

Table1: Data Register Configuration

4.12. Stepping stone (4K-BYTE SRAM):

The NAND Flash controller uses Steppingstone as the buffer on booting and also you can use this area for another purpose.

4.13. ECC (Error Correction Code):

NAND Flash controller consists of four ECC (Error Correction Code) modules. The two ECC modules (one for data[7:0] and the other for data[15:8]) can be used for (up to) 2048 bytes ECC Parity code generation, and the others(one for data[7:0] and the other for data[15:8]) can be used for (up to) 16 bytes ECC Parity code generation. — 28-bit ECC Parity Code = 22-bit Line parity + 6bit Column Parity — 14-bit ECC Parity Code = 8-bit Line parity + 6bit Column Parity

2048 BYTE ECC PARITY CODE ASSIGNMENT TABLE

	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0
MECCn_0	P64	P64'	P32	P32'	P16	P16'	P8	P8'
MECCn_1	P1024	P1024'	P512	P512'	P256	P256'	P128	P128'
MECCn_2	P4	P4'	P2	P2'	P1	P1'	P2048	P2048'
MECCn_3	P8192	P8192'	P4096	P4096'	–	–	–	–

16 BYTE ECC PARITY CODE ASSIGNMENT TABLE

	DATA7	DATA6	DATA5	DATA4	DATA3	DATA2	DATA1	DATA0
SECCn_0	P16	P16'	P8	P8'	P4	P4'	P2	P2'
SECCn_1	P1	P1'	P64	P64'	P32	P32'	–	–

Table2: ECC Parity Code

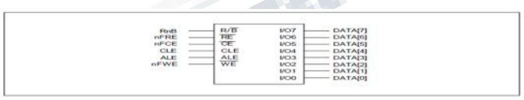

Fig12: 8-Bit NAND Flash Configuration

When you write the address, the same address is issued from data[7:0] and data[15:8]

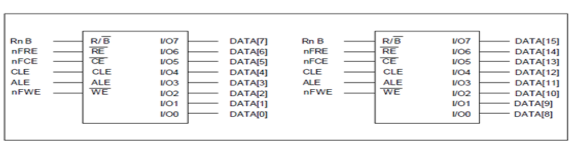

Fig13: Two 8- Bit NAND Flash Configuration

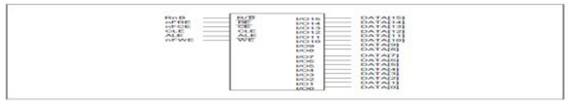

Fig14: 16-bit NAND Flash Interface

NAND FLASH CONFIGURATION REGISTER

Register	Address	R/W	Description	Reset Value
NFCONF	0x4E000000	R/W	NAND flash configuration register	0x0000100X

NFCONF	Bit	Description	Initial State
Reserved	[15:14]	Reserved	–
TACLS	[13:12]	CLE & ALE duration setting value (0~3) Duration = HCLK x TACLS	01
Reserved	[11]	Reserved	0
TWRPH0	[10:8]	TWRPH0 duration setting value (0~7) Duration = HCLK x (TWRPH0 + 1)	000
Reserved	[7]	Reserved	0
TWRPH1	[6:4]	TWRPH1 duration setting value (0~7) Duration = HCLK x (TWRPH1 + 1)	000
AdvFlash (Read only)	[3]	Advance NAND flash memory for auto-booting 0: Support 256 or 512 byte/page NAND flash memory 1: Support 1024 or 2048 byte/page NAND flash memory This bit is determined by NCON0 pin status during reset and wake-up from sleep mode.	H/W Set (NCON0)
PageSize (Read only)	[2]	NAND flash memory page size for auto-booting AdvFlash PageSize When AdvFlash is 0, 0: 256 Word/page, 1: 512 Bytes/page When AdvFlash is 1, 0: 1024 Word/page, 1: 2048 Bytes/page This bit is determined by GPG13 pin status during reset and wake-up from sleep mode. After reset, the GPG13 can be used as general I/O port or External interrupt.	H/W Set (GPG13)
AddrCycle (Read only)	[1]	NAND flash memory Address cycle for auto-booting AdvFlash AddrCycle When AdvFlash is 0, 0: 3 address cycle 1: 4 address cycle When AdvFlash is 1, 0: 4 address cycle 1: 5 address cycle This bit is determined by GPG14pin status during reset and wake-up from sleep mode. After reset, the GPG14can be used as general I/O port or External interrupt.	H/W Set (GPG14)
BusWidth (R/W)	[0]	NAND Flash Memory I/O bus width for auto-booting and general access. 0: 8-bit bus 1: 16-bit bus This bit is determined by GPG15 pin status during reset and wake-up from sleep mode. After reset, the GPG15 can be used as general I/O port or External interrupt. This bit can be changed by software.	H/W Set (GPG15)

4.14. Port Configuration Register (GPACON-GPJCON):

In S3C2440A, most of the pins are multiplexed pins. So, It is determined which function is selected for each pins. The PnCON(port control register) determines which function is used for each pin.If PE0 – PE7 is used for the wakeup signal in power down mode, these ports must be configured in interrupt mode.

4.15. Port Data Register (GPADAT-GPJDAT):

If Ports are configured as output ports, data can be written to the corresponding bit of PnDAT. If Ports are configured as input ports, the data can be read from the corresponding bit of PnDAT.

4.16. Port Pull-Up Register(GPBUP-GPJUP):

The port pull-up register controls the pull-up resister enable/disable of each port group. When the corresponding bit is 0, the pull-up resister of the pin is enabled. When 1, the pull-up resister is disabled.If the port pull-up register is enabled then the pull-up resisters work without pin's functional setting(input, output, DATAn, EINTn and etc)

4.17. Miscellaneous Control Register:

This register controls DATA port pull-up resister in Sleep mode, USB pad, and CLKOUT selection.

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4.18. External Interrupt Control Register:

The 24 external interrupts are requested by various signaling methods. The EXTINT register configures the signaling method among the low level trigger, high level trigger, falling edge trigger, rising edge trigger, and both edge trigger for the external interrupt request Because each external interrupt pin has a digital filter, the interrupt controller can recognize the request signal that is longer than 3 clocks. EINT are used for wakeup sources.

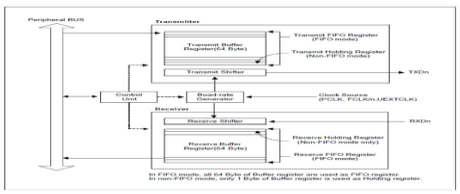

Fig15: UART Operation

V. UART OPERATION:

The following sections describe the UART operations that include data transmission, data reception, interrupt generation, baud-rate generation, Loopback mode, Infrared mode, and auto flow control.

5.1Data Transmission:

The data frame for transmission is programmable. It consists of a start bit, 5 to 8 data bits, an optional parity bit and 1 to 2 stop bits, which can be specified by the line control register (ULCONn). The transmitter can also produce the break condition, which forces the serial output to logic 0 states for one frame transmission time. This block transmits break signals after the present transmission word is transmitted completely. After the break signal transmission, it continuously transmits data into the Tx FIFO (TX holding register in the case of Non-FIFO mode).

5.2 Data Reception:

Like the transmission, the data frame for reception is also programmable. It consists of a start bit, 5 to 8 data bits, an optional parity bit and 1 to 2 stop bits in the line control register (ULCONn). The receiver can detect overrun error parity error, frame error and break condition, each of which can set an error flag. The overrun error indicates that new data has overwritten the old data before the old data has been read. The parity error indicates that the receiver has detected an unexpected parity condition. The frame error indicates that the received data does not have a valid stop bit. The break condition indicates that the RxDn input is held in the logic 0 states for duration longer than one frame transmission time Receive time-out condition occurs when it does not receive any data during the 3 word time (this interval follows the setting of Word Length bit) and the Rx FIFO is not empty in the FIFO mode.

5.3Auto Flow Control (AFC):

The S3C2440A's UART 0 and UART 1 support auto flow control with nRTS and nCTS signals. In case, it can be connected to external UARTs. If users want to connect a UART to a Modem, disable auto flow control bit inUMCONn register and control the signal of nRTS by software. InAFC,nRTS depends on the condition of the receiver and nCTS signals control the operation of the transmitter. The UART's transmitter transfers the data in FIFO only when nCTS signals are activated (in AFC, nCTS means that other UART's FIFO is ready to receive data). Before the UART receives data, nRTS has to be activated. When its receive FIFO has a spare more than 32-byte and has to be inactivated when its receive FIFO has a spare under 32-byte (in AFC, nRTS means that its own receive FIFO is ready to receive data).

***5.3 RS-232C interface*:**

If the user wants to connect the UART to modem interface (instead of null modem), nRTS, nCTS, nDSR, nDTR, DCD and NRI signals are needed. In this case, the users can control these signals with general I/O ports by software because the AFC does not support the RS-232C interface.

5.4 Interrupt/DMA Request Generation:

Each UART of the S3C2440A has seven status (Tx/Rx/Error) signals: Overrun error, Parity error, Frame error, Break, Receive buffer data ready, Transmit buffer empty, and Transmit shifter empty, all of which are indicated by the corresponding UART status register (UTRSTATn / UERSTATn).The overrun error, parity error, frame error and break condition are referred to as the receive error status. Each of which can cause the

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receive error status interrupt request, if the receive-error-status-interrupt-enable bit is set to one in the control register, UCONn. When a receive-error-status-interrupt-request is detected, the signal causing the request can be identified by reading the value of UERSTSTn. When the receiver transfers the data of the receive shifter to the receive FIFO register in FIFO mode and the number of received data reaches Rx FIFO Trigger Level, Rx interrupt is generated. If the Receive mode is in control register (UCONn) and is selected as 1 (Interrupt request or pollingmode). In the Non-FIFO mode, transferring the data of the receive shifter to receive holding register will cause Rx interrupt under the Interrupt request and polling mode. When the transmitter transfersdata from its transmit FIFOregister to its transmit shifter and the number of data left in transmit FIFO reaches Tx FIFO Trigger Level, Tx interrupt is generated, if Transmit mode in control register is selected as Interrupt request or polling mode. In the Non-FIFO mode, transferring data from the transmit holding register to the transmit shifter will cause Tx interrupt under the Interrupt request and polling mode. If the Receive mode and Transmit mode in control register are selected as the DMAn request mode then DMAn request occurs instead of Rx or Tx interrupt in the situation mentioned above.

5.5 UART Error Status FIFO:

UART has the error status FIFO besides the Rx FIFO register. The error status FIFO indicates which data, among FIFO registers, is received with an error. The error interrupt will be issued only when the data, which has an error, is ready to read out. To clear the error status FIFO, the URXHn with an error and UERSTATn must be read out.

5.6 Baud-rate Generation:

Each UART's baud-rate generator provides the serial clock for the transmitter and the receiver. The source clock for the baud-rate generator can be selected with the S3C2440A's internal system clock or UEXTCLK. In other words, dividend is selectable by setting Clock Selection of UCONn. The baud-rate clock is generated by dividing the source clock (PCLK, FCLK/n or UEXTCLK) by 16 and a 16-bit divisor specified in the UART baud-rate divisor register (UBRDIVn). The UBRDIVn can be determined by the following expression:

UBRDIVn = (int)(UART clock / (buad rate x 16)) –1

(UART clock: PCLK, FCLK/n or UEXTCLK) Where, UBRDIVn should be from 1 to (216-1), but can be set 0 (bypass mode) only using the UEXTCLK which should be smaller than PCLK.

5.7 Baud-Rate Error Tolerance:

UART Frame error should be less than 1.87 %(3/160).
tUPCLK = (UBRDIVn + 1) x 16 x 1Frame / PCLK
tUPCLK: Real UART Clock
tUEXACT = 1Frame / baud-rate tUEXACT: Ideal UART Clock
UART error = (tUPCLK – tUEXACT) / tUEXACT x 100%

5.8 Loopback Mode:

The S3C2440A UART provides a test mode referred to as the Loopback mode, to aid in isolating faults in the communication link. This mode structurally enables the connection of RXD and TXD in the UART. In this mode, therefore, transmitted data is received to the receiver, via RXD. This feature allows the processor to verify the internal transmit and to receive the data path of each channel. This mode can be selected by setting the loopback bit in the UART control register (UCONn).

5.9 Infrared (IR) Mode:

The S3C2440A UART block supports infrared (IR) transmission and reception, which can be selected by setting the Infrared-mode bit in the UART line control register (ULCONn).In IR transmit mode, the transmit pulse comes out at a rate of 3/16, the normal serial transmit rate (when the transmit data bit is zero); In IR receive mode, the receiver must detect the 3/16 pulsed period to recognize a zero value.

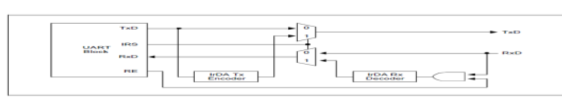

Fig16: Irda Functional Block Diagram

5.10ADC & Touch Screen Interface:

The 10-bit CMOS ADC (Analog to Digital Converter) is a recycling type device with 8-channel analog inputs. It converts the analog input signal into 10-bit binary digital codes at a maximum conversion rate of

500KBPS with 2.5MHz A/D converter clock. A/D converter operates with on-chip sample-and-hold function and power down mode is supported. Touch Screen Interface can control/select pads (XP, XM, YP, and YM) .Touch Screen for X, Y position conversion. Touch Screen Interface contains Touch Screen Pads control logic and ADC interface logic with an interrupt generation logic.

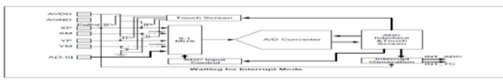

Fig17: ADC & Touch Screen Interface

VI. ENERGY METER:

An electric meter or energy meter is a device that measures the amount of electrical energy supplied to or produced by a residence,business or machine. The most common type is a kilowatt hour meter. When used in electricity retailing, the utilities record the values measured by these meters to generate an invoice for the electricity. They may also record other variables including the time when the electricity was used.

Fig19: Energy Meter

Modern electricity meters operate by continuously measuring the instantaneous voltage (volts) and current (amperes) and finding the product of these to give instantaneous electrical power (watts) which is then integrated against time to give energy used (joules, kilowatt-hours etc). Means to record and store the analog signals in NUMBERS.

VII. LED INTERFACING WITH 8051:

Microcontroller port pins cannot drive these LEDs as these require high currents to switch on. Thus the positive terminal of LED is directly connected to Vcc, power supply and the negative terminal is connected to port pin through a current limiting resistor. This current limiting resistor is connected to protect the port pins from sudden flow of high currents from the power supply. Thus in order to glow the LED, first there should be a current flow through the LED. In order to have a current flow, a voltage difference should exist between the LED terminals. To ensure the voltage difference between the terminals and as the positive terminal of LED is connected to power supply Vcc, the negative terminal has to be connected to ground. Thus this ground value is provided by the microcontroller port pin. This can be achieved by writing an instruction "CLR P1.0". With this, the port pin P1.0 is initialized to zero. Voltage difference is established between the LED terminals and accordingly, current flows and therefore the LED glow. LED and switches can be connected to any one of the four port pins.

VIII.TEMPERATURE SENSOR:

Here we are using a sensor to sense the temperature around us. For this purpose wewill be taking help of LM 35 which is a temperature sensor.

IX. LM 35:

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 lineartemperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The LM35 is rated to operate over a −55° to +150°C temperature range.

X. DEMONSTRATION OF HEM

10.1 Proposed HEM system

Most of the HEM implementations discussed in the literature are designed to schedule appliance operation based on price signals. There is yet another implementation of an HEM system that can manage power-intensive loads to limit the household peak

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demand, while taking into account homeowner's load preload and comfort preference. This topic is the subject of this paper. It presents the HEM hardware demonstration in a laboratory environment using the previously developed DR algorithm. Emphasis is placed on the HEM system setup and electrical measurements of the loads that are controlled by the HEM unit, together with measurements of communication time delays between theHEMunit and load controllers, along with theHEM system's residual power consumption.

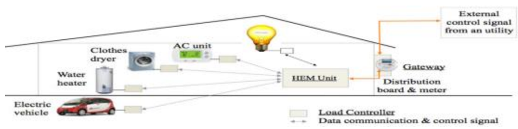


Fig20: Overview of HEM System

The overall system comprises an HEM unit that provides monitoring and control functionalities for a homeowner, and *that* gather electrical consumption data fromselected appliances and perform local control based on command signals from the HEMsystem. A gateway, such as a smart meter, can be used to provide an interface between a utility and a homeowner in a real-life HEM deployment.In such a scenario, the gateway receives a DR signal from a utility, which is used as an input for our HEM unit we focus on controlling power-intensive household appliances, namely water heaters, air conditioners, clothes dryers and electric vehicles. Other household loads,such as TVs, computers, and other plug loads, will not be controlled because turning OFF these loads will result in noticeable impacts on customer's lifestyle.

10.2Architecture OF HEM Unit:

In general, an HEM unit comprises:

a) An embedded PC running a GUI software application, which includes a DR algorithmthat serves as the brain of the HEM system. It makes a decisionto switch ON/OFF selected end-use appliances based onthe utility signal received, as well as homeowner's load priorityand preference settings. It is also responsible for collecting electricalconsumption data from all load controllers and providingan interface for homeowners to retrieve appliances' status andreview their power consumption; and

b) An HEM communication module, which provides communication paths between theHEM unit and its load controllers. This module is attached tothe HEM unit and enables the HEM unit to send load controlcommands to all load controllers, and receive responses back.A laptop computer with a ZigBee-enabled communication module is used as the HEM unit for this demonstration.

10.3.Architecture of Load Controller:

A load controller provides an interface between the HEM unit and a selected appliance. It provides basic power management functions (i.e., monitor, control, communicate) via a standard electrical outlet. Architecture-wise, it contains: a) A datacapturing and processing module, which collects and calculates real-time electrical consumption data, such as voltage, current,apparent power, real power, and powerfactor from appliances.b) A control module, which is simply an electronic relay circuitthat provides the capability to switch a selected applianceON/OFF, depending on the command sent by the HEM unit.

c) A communication module, which is responsible for providing communication paths between a load controller and the HEM unit. This is to allow the collected electrical consumption data from a load controller to be sent to the HEM unit; commands from the HEM unit to be received by a load controller; and response signals from a load controller to be sent to the HEM unit.A commercial off-the-shelf load controller product is selected for the proposed HEM demonstration. This product is capable of controlling power-intensive loads (up to 276 V).

10.4.**Communications within the HEM System:**

In any HEM systems, two types of communication modules are needed. One is integrated with the HEM unit and the other is built-in in each load controller. The type of communication modulesselected will impact the overall system's data communication rate, range, cost, and its residual power consumption. Under a typical home area network/smart-device platform, one or a combination of the following communication technologies may be deployed: Wi-Fi (802.11/n), Bluetooth (802.15.1), ZigBee (802.15.4), and Power Line Carrier (PLC). According to the evaluation study of various communication technologies, we select ZigBee to demonstrate the proposed HEM system.

10.5.Embedded HEM Algorithm:

For this HEM hardware demonstration as

presented, we used the previously published DR algorithm that is designed to allow a homeowner to operate his/her appliances when needed as long as the total household consumption remains below the specified limit during a DR event. At the same time, it takes into account load priority and customer comfort preference for power-intensive appliances. Here, we provide only the brief description of this DR algorithm.In this demonstration, we assume that a utility's DR event signal sent to a home comprises the demand limit amount (kW) and the duration of a DR event(hours). The demand limit specifies the maximum electric power consumption that is allowed by a house for the entire DRevent duration. Theembedded HEM algorithm considers that controllable loads in a house are of four types: water heater (WH), air conditioner (AC), clothes dryer and electric vehicle (EV).

Step 1:The HEM load management algorithm starts by gathering system information: 1) the demand limit in *kW* and its duration; 2) appliance power consumption in *kW*; 3) room, ambient and hot water temperatures in F; and 4) load priorities and customer preference settings.

Step 2:

The HEM algorithm then checks for both demands limit and comfort level violations. For the demand limit violation, the HEM algorithm checks if the total household consumption exceeds the specified demand limit level. For the comfort level violations.

for example the HEM algorithm checks: a) for WH, if the hot water temperature falls outside the preset threshold; b) for AC, if the room temperature falls outside thepreset threshold; c) for a clothes dryer, if the clothes dryer can finish its job before the specified completion time; and d) for EV, if the EV can be fully charged before the specified charging completion time.

Step 3:

If there is any comfort level violation, the HEM unit decides on the status of each appliance based on the requested demand limit level. With the demand limit violation, the HEM unit sends command signal(s) to turn OFF selected appliances according to their priority, as necessary.With any comfort level violations, selected appliances will be turned ON in order to keep their comfort levels within their pre-specified ranges. In this case, the HEM unit will go through a decision-making process to ensure that the total household power consumption-with additional appliances turning ON—will not exceed the demand limit.

10.6.The Demonstration oftheHEM:

The HEM system installation in our laboratory environment with four commercial load controllers and five actual loads: a hair dryer, a portable air conditioning unit,bulbsand two electric baseboard heaters.As discussed earlier, our DR algorithm focuses on controlling power-intensive loads, which are a water heater (WH), an AC unit, a clothes dryer, and an electric vehicle (EV). Due to limitations in using an actual WH, a clothes dryer and an EV in our laboratory environment, selected appliances are used that have similar operating characteristics as follows: A hair dryer is used to represent the clothes dryer. Both loads have a motor load and heating coils. Instead of completely shutting OFF the clothes dryer, we have designed the DR algorithm to turn OFF its heating coils during a DR event if required, while the motor part is still in operation. This approach will allow the clothes dryer to resume its operation after the DR event ends. For our experiment, the hair dryer's electrical circuit is modified by inserting a relay circuit to allow switching OFF the hair dryer's heating coils. This will allow turning OFF the hair dryer's heating coils, while the hair dryer motor keeps on running during a simulated DR event.Two electric baseboard heaters are used to represent the water heater and EV loads. Electric baseboards consume relatively constant power during their operation, which is quite similar to that of the water heater and EV loads. The power ratings, together with the electrical measurement data, Note that the power consumption of the hair dryer islower than its rating because the low heat setting is used in the experiment.

10.7The HEM Graphical User Interface (GUI):

The HEM GUI is developed in a visual C++ developmentenvironment, i.e., C++ Builder. It is embedded in the laptopcomputer. The HEM GUI provides a dashboard for a homeowner to monitorappliance status, appliance power consumption, total householdpower consumption, the requested demand limit, as well as room. The dashboard is configured to update these parameters in 1-min intervals. A homeowner can also change his/her load priority and preference settings from the HEM screen.

10.8The Load Controller:

Four identical load controllers are used in this demonstration. These are general-purpose load controllers for DR and sub-metering applications suitable for controlling 85-276 loads. The selected load controller includes a microcontroller unit (MCU) with an analog front end that can measure voltage, current and provide power factor, real and apparent power in real-time. It also has a built-in ZigBee communication module and a 30 A power relay for switching ON/OFF its connected load.

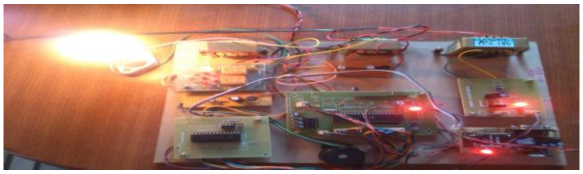
10.9The HEM Communication Module:

Two identical ZigBee modules in our HEMsystem: a) the ZigBee module in the HEM unit; and b) theZigBee module in each load controller.When the HEM unit requests its electrical power consumptiondata.The “Received Data” contains voltage, current, power factor, real and apparent power data. The electrical data in the message body of the “Received Data” can be interpreted as per the load controller’s specifications, the voltage and current data in Hex are to be divided by 10; the apparent and real power data is simply a conversion from Hex to Decimal and the power factor data in Hex are to be divided by 1000.To evaluate the operation of the HEM algorithm, an 8 kW demand limit level is imposed on this hypothetical house between 17:00 and 20:00. The demonstrated HEM system monitors household consumption and performs load control to keep the total consumption below the specified 8 kW limit during this DR event.For the clothes dryer, the purpose of this demonstration is to simulate the 4.0 kW clothes dryer operation (modeled by a hair dryer) in this hypothetical house and use the HEM to control the status of the heating coils of the hair dryer in our laboratory environment. In this demonstration, the ON/OFF status of the clothes dryer’s heating coils is represented by that of the hair dryer’s heating coils.

XI. RESULTS

***HEM Section*:**

Load Controller Section:



Future Enhancement

By using TCP/IP (transmission Control Protocol/Internet Protocol) we can operate the HEM Section. By using Wi-Fi also we can control the HEM Section. Transmission Control Protocol/Internet Protocol is the basic communication language or protocol of the internet.It can also be used as a communication protocol in a private network when you are set up with directaccess to the internet your computer is provided with a copy of TCP/IP program just as every other computer that you may send message to or get information from also has a copy of TCP/IP.

XII. CONCLUSION

In this paper, the demonstration of the proposed HEM system based on ZigBee is presented for residential DR applications, along with the analysis of the communication time delay and the evaluation of the overall HEMsystem’s residual power consumption. The objective of this demonstration is to evaluate the HEM operation performance, in particular how each load performs when being controlled by the HEM unit. Electrical measurements of the four loads under study are presented, including voltage, current, real power, apparent power and power factor. The HEM hardware demonstration comprises a laptop computer that runs GUI software with the embedded HEM algorithm, four identical commercial off-the-shelf load controllers and four loads. This demonstration indicates that the proposed HEM system can monitor and control actual loads according to the designed DR algorithm. The measured electrical measurements of the loads confirm that the system performed satisfactorily during the entire experiment. The average communication time delay between the HEM unit and load controllers is in millisecond scale and increases slightly with communication distances. The residual energy of the proposed HEM system is estimated at 189 kWh per year.It is expected that this paper will provide an insight into the overall HEM system operation, in particular providing adetailed look at the implementation of an HEM system for automated residential DR applications.

The real-world implementation of the proposed system will benefit electric power distribution companies by helping to avoid distributiontransformer overloads with the presence of new power-intensive loads, like electric vehicles. We can use Wi-Fi Technology also in the control of home appliances.Now a day'sWI- Fi is becoming over world so in every there is wifi technology by using wifi technology also we can control laptops, bulbs, electric vehicles etc.

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REFERENCES

[1]. M.A. Mazidi, 8051 Microcontroller and embedded systems.
[2]. David Flynn , ARM 9
[3]. B.W Williams, Power Electronics
[4]. http:/www.brymercreative.com
[5]. http:/www.analog.com/librarly
[6]. http:/www.mychevroletvolt.com
[7]. http:/www.ferc.gov/legal/staff reports
[8]. http:/www.onlocationinc.com

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