International Online Conference on Advanced Research in Biology, Ecology, Science and Technology (ICARBEST'15)
Organized by
International Journal of Advanced Research in Biology, Ecology, Science and Technology (IJARBEST)
19th November 2015

A Novel Automatic Electric Billing system

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***Abstract*— In this project we design and implement an automatic meter reading system using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This controller reads the data from the meter output and transfers that data to GSM Module through the serial port. The embedded micro controller has the knowledge of sending message to the system through the GSM module. Another system is placed in EB office, which is the authority office. They send "unit request" to the microcontroller which is placed in home. Then the unit value is sent to the EB office PC through GSM module. According to the readings, the authority officer will send the information about the bill to the customer. If the customer doesn't pay bill on-time, the power supply to the corresponding home power unit is cut, by sending the command through to the microcontroller. Once the payment of bill is done the power supply is given to the customer. Power management concept is introduced, in which during the restriction mode only limited amount of power supply can be used by the customer.**

***Index Terms*—GSM module, Home Power unit, Microcontroller**

I. INTRODUCTION

In the power management concept, two modes are being used, one is the normal mode and the other is the restricted mode. During normal mode, the customer can consume the power as much as it is required. During the power demand, the authority officer will select the restricted mode which limits the power supply to the each customer's house and sends the message to each customer's microcontroller via GSM. By receiving this message, the microcontroller alerts the customer with an alarm and controls the usage of power. If the customer tends to consume more power, then the controller automatically disconnects the whole power supply to that particular customer's house. The reconnection is made only after paying the fine to the government.

II. PROPOSED SYSTEM

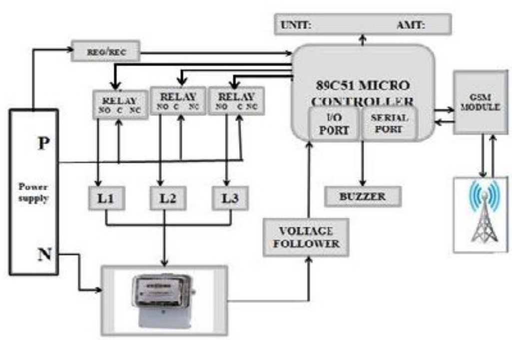

FIG.1. BLOCK DIAGRAM OF AMR SYSTEM PLACED AT HOME

Microcontroller is interfaced with the GSM module and energy meter. According to the power consumption, the meter reading continuously gets incremented. For the implementation of this system, a SIM card is required for the GSM module and an identification (ID) number is allotted to each customer. According to the requirement of the data, electricity department can send a message to the particular customer's energy meter. When microcontroller receives the message, its respective port bits are high and an interrupt signal occurs. Microcontroller starts to execute to the interrupt service subroutine until it reaches last instruction of the subroutine. After the execution of RET instruction, microcontroller returns to the main program and continues incrementing. Every one month, the data will be sent to the electricity board automatically and also the electricity board can access the system at any time on request. Receiving this meter reading every month, the bill amount is calculated and sent to the microcontroller which displays the unit consumed and the bill amount. Notifying this message on the LCD display, the customer has to pay the bill on time that can be done through credit card, debit card or even by net banking. A separate database is followed by the authority that stores all the information about each customer and their bill statement. Failing to pay the bill will lead to the power disconnection that is again done by the microcontroller by receiving the message from the electricity board. In the power management concept, two modes are being used, one is the normal mode and the other is the restricted mode. During normal mode, the customer can consume the power as much as it is required. During the power demand, the authority officer will select the restricted mode which limits the power supply to the each customer's house and sends the message to each customer's microcontroller via GSM. By receiving this message, the microcontroller alerts the customer with an alarm and controls the usage of power. If the customer tends to consume more power, then the controller automatically disconnects the whole power supply to that particular customer's house. The reconnection is made only after paying the fine to the government.

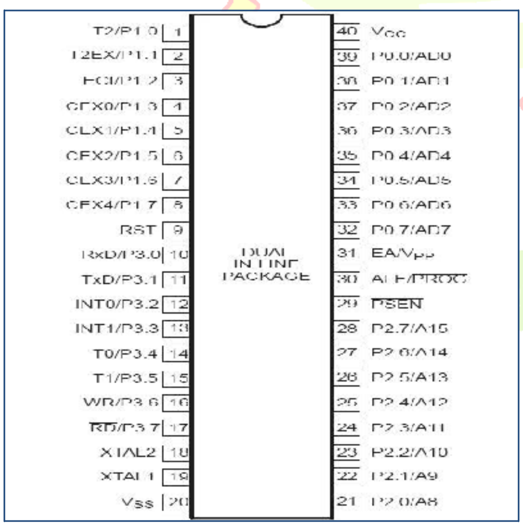

FIG.2. DIAGRAM OF 89C51 MICROCONTROLLER

1–8: P1.0 to P1.7 (Port 1)

Each of these pins can be used as either input or output according to your needs. Port 1 is an 8-bit bi-directional I/O port with internal pull-ups on all pins. Port 1 pins that have 1s written to them are pulled high by the internal pull-ups and can be used as inputs. As inputs, port 1 pins that are externally pulled low will source current because of the internal pull-ups. Each pin of Port1 has an alternate function

- Pin 1: T2 (P1.0) - Clock input of counter 0
- Pin 2: T2EX (P1.1) - Timer/Counter 2 Reload / Capture /Direction ControlPin 3: ECI (P1.2) - External Clock Input to the PCA
- Pin 4: CEX0 (P1.3) - External I/O for PCA module 0
- Pin 5: CEX1 (P1.4) - External I/O for PCA module 1
- Pin 6: CEX2 (P1.5) - External I/O for PCA module 2
- Pin 7: CEX3 (P1.6) - External I/O for PCA module 3
- Pin 8: CEX4 (P1.7) - External I/O for PCA module 4

A. 9: RST (Reset Signal)

High logical state on this input halts the MCU and clears all the registers. Bringing this pin back to logical state zero starts the program a new as if the power had just been turned on. In another words, positive voltage impulse on this pin resets the MCU. Depending on the device's purpose and environs, this pin is usually connected to the push-button, reset-upon-start circuit or a brown out reset circuit.

B. 10-17: P3.0 to P3.7 (Port 3)

As with Port 1, each of these pins can be used as universal input or output. However, each pin of Port 3 has an alternative function:

- Pin 10: RxD(P3,0) - Serial input for asynchronous communication
- Pin 11: TxD(P3.1) - Serial output for asynchronous communication
- Pin 12: INT0(P3.2) - Input for interrupt

0

- Pin 13: INT1(P3.3) - ~~Input for~~ interrupt 1
- Pin 14: T0(P3.4) - Clock input of counter 0
- Pin 15: T1(P3.5) - Clock input of counter 1
- Pin 16: WR(P3.6) - Signal for writing to external RAM memory
- Pin 17: RD(P3.7) - Signal for reading from external RAM memory
- 18-19: XTAL2 and XTAL1 (Crystal input and output)

Input and output of internal oscillator. Quartz crystal controlling the frequency commonly connects to these pins.

20: V_{SS}: Ground

C. 21- 28: P2.0 to P2.7 (Port 2)

If external memory is not present, pins of Port 2 act as universal input/output. If external memory is connected, this is the location of the higher address byte, i.e. addresses A8 – A15. It is important to note that in cases when not all the 8 bits are used for addressing the memory (i.e. memory is smaller than 64kB), the rest of the unused bits are not available as input/output.

D. 29: PSEN (Program Store Enable)

MCU activates this bit (brings to low state) upon each reading of byte instruction from program memory. If external ROM is used for storing the program, PSEN is directly connected to its control pins.

E. 30: ALE (Address Latch Enable)

Before each reading of the external memory, MCU sends the lower byte of the address register (addresses A0 – A7) to port P0 ,and activates the output ALE. External Chip (eg: 74HC373), memorizes the state of port P0 upon receiving a signal from ALE pin, and uses it as part of the address for memory chip. During the second part of the MCU cycle, signal on ALE is off, and port P0 is used as Data Bus. In this way, by adding only one integrated circuit, data from port can be multiplexed and the port simultaneously used for transferring both addresses and data.

31: EA (External Access Enable)

Bringing this pin to the logical state zero designates the ports P2 and P3 for transferring addresses regardless of the presence of the internal memory. This means that even if there is a program loaded in the MCU it will not be executed, but the one from the external ROM will be used instead. Conversely, bringing the pin to the high logical state causes the controller to use both memories, first the internal, and then the external (if present).

F. 32-39: P0.7 to P0.0 (Port 0)

Similar to Port 2, pins of Port 0 can be used as universal input/output, if external memory is not used. If external memory is used, P0 behaves as address output (A0 – A7) when ALE pin is at high logical level, or as data output (Data Bus) when ALE pin is at low logical level.

40: V_{CC}: Power +5V

The architecture of the 8051 family of microcontrollers (8051 derivatives) is referred to as the MCS-51 architecture (Micro Controller Series – 51), or sometimes simply as MCS-51. The block diagram of 89C51 microcontroller is shown below.

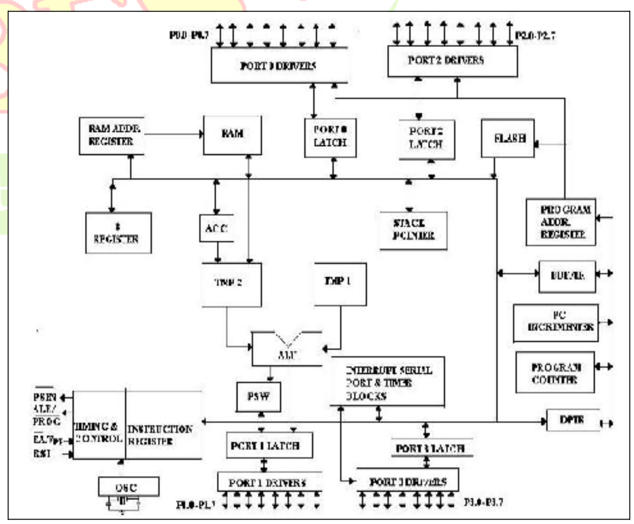

FIG.3. ARCHITECTURE OF 89C51 MICROCONTROLLER

A. ACCUMULATOR (ACC)

Accumulator is a general-purpose register, which stores runtime results. Before performing any operation upon an operand, operand has to be stored in the accumulator. Results of arithmetical operations are also stored in the accumulator. When transferring data from one register to another, it has to go through the accumulator. Due to its versatile role, this is the most frequently used register, essential part of every MCU.

B. B REGISTER

B Register is used along with the Accumulator for multiplication and division. This B register provides temporary storage space for the result of multiplication & division operation. Instructions of multiplication and division can be applied only to operands located in registers A and B. Other instructions can use this register as a secondary accumulator (A).

a. PORTS

Term "port" refers to a group of pins on a microcontroller which can be accessed simultaneously, or on which we can set the desired combination of zeros and ones, or read from them an existing status. Ports represent physical connection of Central Processing Unit with an outside world. Microcontroller uses them in order to monitor or control other components or devices. 89C51 has 4 ports; with each port have 8-bit length. All the ports are bit and byte addressable.

Port 0 (P0)

Port 0 has two-fold role: If external memory is used, P0 behaves as address output (A0 – A7) when ALE pin is at high logical level, or as data output (Data Bus) when ALE pin is at low logical level, otherwise all bits of the port are either input or output. Another feature of this port comes to play when it has been designated as output. Unlike other ports, Port 0 lacks the "pull up" resistor (***resistor*** with +5V on one end). This seemingly insignificant change has the following consequences:

- When designated as input, pin of Port 0 acts as high impedance offering the infinite input resistance with no "inner" voltage.
- When designated as output, pin acts as "open drain". Clearing a port bit grounds the appropriate pin on the case (0V). Setting a port bit makes the pin act as high impedance. Therefore, to get positive logic (5V) at output, external "pull up" resistor needs to be added for connecting the pin to the positive pole. Therefore, to get one (5V) on the output, external "pull up" resistor needs to be added for connecting the pin to the positive pole.

b. Port 1 (P1)

Port 1 is I/O port. Having the "pull up" resistor, Port 1 is fully compatible with TTL circuits. The alternate functions of Port1 are

TABLE I
89C51 PIN DESCRIPTION

PIN	ALTERNATE NAME	ALTERNATE FUNCTION
P1.0	T2	Serial input
P1.1	T2EX	Serial output
P1.2	ECI	External interrupt 0
P1.3	CEX0	External interrupt 1
P1.4	CEX1	Timer 0 external input
P1.5	CEX2	Timer 1 external input
P1.6	CEX3	Signal **write** to external
P1.7	CEX4	memory.

c. Port 2 (P2)

When using external memory, this port contains the higher address byte (addresses A8–A15), similar to Port 0. Otherwise, it can be used as universal I/O port.

d. Port 3 (P3)

Beside its role as universal I/O port, each pin of Port 3 has an alternate function. In order to use one of these functions, the pin in question has to be designated as input, i.e. the appropriate bit of register P3 needs to be set. By selecting one of the functions the other one is disabled. From a hardware standpoint, Port 3 is similar to Port 0. The alternate functions of Port 3 is given below

e. Data Pointer (DPTR)

The Data pointer register is made up of two 8 bit registers, named DPH (Data Pointer High) and DPL (Data Pointer Low). These registers are used to give addresses of the internal or external memory. The DPTR is under the control of program. DPTR is also manipulated as one 16 bit register, DPH & DPL are each assigned an address. The 89C51 microcontroller has additional DPTR. The dual DPTR structure is a way by which the chip will specify the address of an external data memory location. There are two 16-bit DPTR registers that address the external memory, and a single bit called DPS (bit0 in AUXR1) that allows the program code to switch between them.

f. Stack Pointer (SP)

The stack refers to an area of internal RAM that is used in conjunction with certain opcodes to store and retrieve data quickly. The register used to access the stack is called Stack Pointer. The 8 bit stack pointer register is used by the 89C51 to hold an internal RAM address that is called then top of the stack. The stack pointer increments before storing the data on the stack. As retrieved from the stack the SP is decremented by one. The number in Stack Pointer points to the location of the last "valid" address within the Stack. With the beginning of every new routine, Stack Pointer increases by 1; upon return from routine, SP decreases by 1. Upon reset (or turning the power on), the stack pointer contains the value 07h.

g. Program Counter (PC)

Used to access code memory. Program counter always points to the address of the next instruction in memory to be executed. Upon reset (or turning the power on), the program counter resets to the starting location of the program.
Instruction Register: When an instruction is fetched from the Flash memory, it is loaded in the instruction register.

h. Timing & Control unit

The timing and control unit synchronizes the operation of the microcontroller and generates control signals necessary for communication between the microcontroller and the peripherals.

i. Program Status Word (PSW)

The Program Status Word (PSW) register is an 8 bit register. It is also referred to as the flag register. It contains the math flags, user program flag F0, and the register select bits that identify which of the four general purpose register banks is currently in use by the program.

j. Oscillator

Oscillator circuit is used for providing a microcontroller with a clock. Clock is needed so that microcontroller could execute a program or program instructions. Stable pace provided by the oscillator allows harmonious and synchronous functioning of all other parts of MCU. The manufacturers make available 89C51 designs that can run at specified maximum and minimum frequencies, typically 1 megahertz to 33 megahertz. Minimum frequencies imply that some internal memories are dynamic and must always operate above a minimum frequency or data will be lost.

k. Interrupts

An interrupt is a signal from a device attached to a computer or from a program within the computer that causes the main program that operates the computer to stop and points out what to do next. In general, there are hardware interrupts and software interrupts. A hardware interrupt is related to the hardware of the system. For example, when an I/O operation is completed such as reading some data into the computer from a keyboard interrupt the main program. As the name implies the software interrupts related to the software of the system. It occurs when an application program terminates or requests certain services from the operating system.

l. Timers/Counters

Timers are usually the most complicated parts of a microcontroller. Physically, timer is a register whose value is continually increasing to FFFFh, and then it starts all over again: 0h, 1h, 2h, 3h, 4h...FFFFh....0h, 1h, 2h, 3h......etc. The 89C51 MCU clock employs a quartz crystal. As this frequency is highly stable and accurate, it is ideal for time measuring. Since one instruction takes 12 oscillator cycles to complete, the math is easy. 89C51 has three Timers/Counters marked as T0, T1 & T2. Their purpose is to measure time and count external occurrences, but can also be used as clock in serial communication purpose called as, Baud Rate.

m. Serial Port

Serial port is used to provide communication among two devices. Serial because of the ease and the economy of using only one wire to transmit data. Serial port is also referred as RS232 port. RS232 is a asynchronous way of communication. Asynchronous transmission allows data to be transmitted without the sender having to send a clock signal to the receiver. Instead, the sender and receiver must agree on timing parameters in advance and special bits are added to each word, which are used to synchronize the sending and receiving units.

When a word is given to the UART for Asynchronous transmissions, a bit called the "Start Bit" is added to the beginning of each word that is to be transmitted. The Start Bit is used to alert the receiver that a word of data is about to be sent, and to force the clock in the receiver into synchronization with the clock in the transmitter.

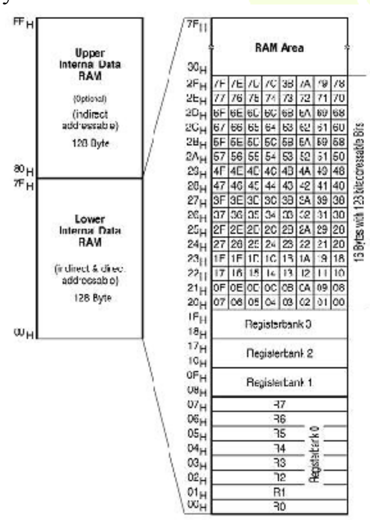

FIG.4. INTERNAL RAM ARCHITECTURE

89C51 have built-in 64-kilo bytes of Flash memory. The P89C51RD2BN Flash memory augments EPROM functionality with in-circuit electrical erasure and programming. The Flash can be read and written as bytes. The Chip Erase operation will erase the entire program memory. The Block Erase function can erase any Flash block. In-system programming and standard parallel programming are both available. On-chip erase and write timing generation contribute to a user-friendly programming interface. The P89C51RD2BN Flash reliably stores memory contents even after 10,000 erase and program cycles. The cell is designed to optimize the erase and programming mechanisms. In addition, the combination of advanced tunnel oxide processing and low internal electric fields for erase and programming operations produces reliable cycling. The P89C51RD2BN uses a +5 V VPP supply to perform the Program/Erase algorithms.

Global system for mobile communication (GSM) is a globally accepted standard for digital cellular communication.GSM is the name of a standardization group established in 1982 to create a common European mobile telephone standard that would formulate specifications for a pan-European mobile cellular radio system operating at 900 MHz. It is estimated that many countries outside of Europe will join the GSM partnership.

C. Mobile Station

It consist of Mobile Equipment (ME) such as hand portable and vehicle mounted unit Subscriber Identity Module (SIM), which contains the entire customer related information (identification, secret key for authentication, etc.)

D. Base Station Subsystem

It consist of Base Transceiver Station (BTS) defines a cell and is responsible for radio link protocols with the Mobile Station

Base Station Controller (BSC) controls multiple BTSs and manages radio channel setup, and handovers. The BSC is the connection between the Mobile Station and Mobile Switching Center.

E. GSM ADVANTAGE

- Better voice quality
- Low-cost alternatives to making calls, such as the Short message service
- Ease of deploying equipment from any vendors that implement the standard
- Offer roaming services so that subscribers can use their phones on GSM networks all over the world

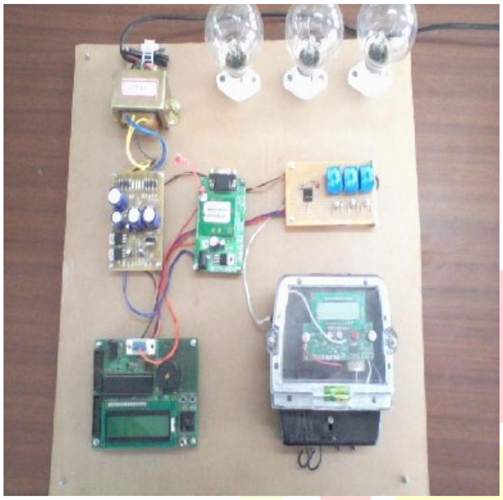

FIG.5.LAYOUT OF SYSTEM PLACED AT HOME

III.CONCLUSION

In this project we design and implement an automatic meter reading system using GSM Technology. The embedded micro controller is interfaced with the GSM Module. This setup is fitted in home. The energy meter is attached to the micro controller. This controller reads the data from the meter output and transfers that data to GSM Module through the serial port. The embedded micro controller has the knowledge of sending message to the system through the GSM module. Another system is placed in EB office, which is the authority office. They send "unit request" to the microcontroller which is placed in home. Then the unit value is sent to the EB office PC through GSM module. According to the readings, the authority officer will send the information about the bill to the customer. If the customer doesn't pay bill on-time, the power supply to the corresponding home power unit is cut, by sending the command through to the microcontroller. Once the payment of bill is done the power supply is given to the customer. Power management concept is introduced, in which during the restriction mode only limited amount of power supply can be used by the customer.

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