# Free Cooling Unit (FCU) Controller For A BTS Room

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## ABSTRACT

*Free Cooling Unit is a ventilation system dedicated to the tele-com BTS. The main objective of free cooling is to reduce AC run time and save electricity cost at the BTS sites.*

*It also can reduce the carbon emission as like as the IVS (Intelligent Ventilation System) .*

*A special feature is now added with this ventilation system which is data acquisition. Data acquisition systems, as the-name implies, are products and/or processes used to collect information to document or analyze some phenomenon.*

*So by using this data logger system we can store millions of data of BTS room temperature as well as outside temperature including the relevant date and time and also can collect those data for analysis and improvemen in future.*

*So Free Cooling Unit (FCU) controller is a microcontroller based electronic system that maintains the overall environment of a BTS room by controlling a Fan Unit, a Filter Unit and an AC by observing the room temperature and battery voltage level of a BTS room.*

**Keyword:** - *ADC,DAC,RTC,MAM,FIQ,GPIO,DLAB,CTS,RTS,etc….*

## 1. INTRODUCTION

In this project we required operating voltage for ARM controller board is 12V. The 12V 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. The rectified A.C. voltage is filtered using a 'C' filter. The rectified, filtered D.C. voltage is fed to the Voltage Regulator. Voltage regulator provides us to have a Regulated constant Voltage which is of +12V. The rectified, filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor. Now the output is fed to microcontroller board to supply operating voltage.

The project consists of micro controller, temperature sensors, motor, and fan. Here we monitor the room temperature with the help of sensors. The controller senses the room temperature and outdoor temperature using A/D converter. The controllers also maintain the room temperature under a predetermined value by controlling the Fan Unit. Processor gives command to Fan unit to ON if the BTS room temperature is not under a tolerant level. The temperature values are displayed with the help of LCD. If the values exceed beyond the threshold limit this information is messaged to user using GSM module. One of the major operations of this Project is to monitor the room temperature and outdoor temperature continuously.

## 2.LITERATURE SURVEY

The scarcity of electricity causing serious dislocation in all spheres of life, including production in agriculture and industries as well as in the section of cellular communication. To reduce the wastage of electricity in BTS room, cellular operators are using different ventilation systems instead of Air Conditioner (A C). In this paper a modern ventilation system FCU is designed interfacing with a Micro SD card for data acquisition especially for Bangla link BTS. FCU is an electronic instrument that records the temperature data and takes decision as per that

data. This research work deals with the PIC18F4520 which includes 10 bit ADC for data conditioning and 32K bytes of program memory used for interfacing a FAT-16 system with microprocessor. 4X20 LCD display is used for user interaction

**2.1 Proposed system**

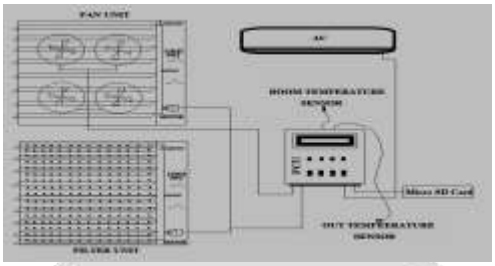

**Figure 2.1 : Free Cooling Unit (FCU) system**

- **Controller Unit:** Controller Unit monitors the whole environment of the BTS room and manages the room temperature by controlling the Fan Unit, Filter Unit and the Air Conditioner. It has a data logging section.
- **Fan Unit:** This equipment first opens the louver by using a 12V DC motor when a Fan Run Signal comes from the controller.
- **Filter Unit:** Filter Unit also opens the louver initially as same as the Fan Unit. It maintains a dust free air circulation in the BTS room.
- **Air Conditioner (AC):** Although it is not the part of a FCU but still its operation is maintained by the Controller Unit.

## 3. Design of Free Cooling Unit for BTS Room

### 3.1. FCU

Free Cooling Unit is a ventilation system dedicated to the telecom BTS . The main objective of free cooling is to reduce AC run time and save electricity cost at the BTS sites. A special feature is now added with this ventilation system which is data acquisition. Data acquisition systems, as the name implies, are products and/or processes used to collect information to document or analyze some phenomenon. So by using this data logger system we can store millions of data of BTS room temperature as well as outside temperature including the relevant date and time and also can collect those data for further analysis and improvement. Free Cooling Unit (FCU) controller is a microcontroller based electronic system that maintains the overall environment of a BTS room by controlling a Fan Unit, a Filter Unit and an AC by observing the room temperature and battery voltage level of a BTS room.

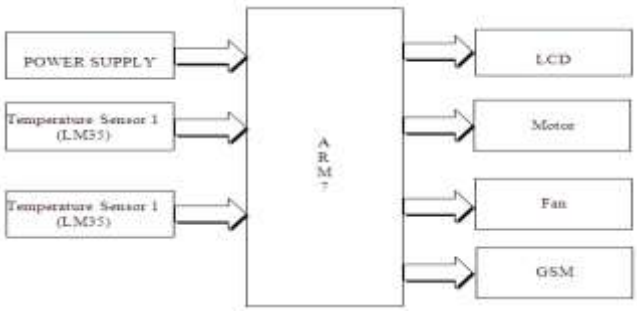


**Fig. 3.1.1 Block Diagram of FCU**

**Power Supply Section:**

This section is for supplying Power to all the remaining sections. It basically consists of a Transformer which is used to step down the 230V ac to 9V ac followed by diodes. After rectification the rippled dc is filtered using a capacitor Filter. A positive voltage regulator is used for regulating the obtained dc voltage.

**Microcontroller Section:**

This section basically consists of a Microcontroller with its associated circuitry like Pull up resistors, Crystal with capacitors, Reset circuitry and so on. The Microcontroller controls the devices being interfaced and communicates with the devices.

**GSM modem Section:**

It consists of a GSM modem. The modem will communicate with the microcontroller by serial communication. The modem is interfaced to microcontroller with the help of MAX 232.

**MAX 232 Sections:**

The microcontroller can communicate with the serial devices with the help of its single Serial Port. The logic levels at which this serial port operates is TTL logics. But some of the serial devices operate at RS 232 Logic levels. So in order to communicate the Microcontroller with either GSM modem or PC, a mismatch between the Logic levels occurs. To avoid this mismatch a Serial driver is used. And MAX 232 is a Serial Line Driver used to establish communication between microcontroller and PC or GSM.

**Motors:**

Motor is an output device. Its speed will be varied as per the speed set by the switches. The speed can be varied by varying the voltage given to the PWM converter. The speed of DC motor is inversely proportional to flux and directly proportional to armature voltage. By maintaining the flux constant, the speed can be varied by varying the armature voltage.

**3.2 ARM7**

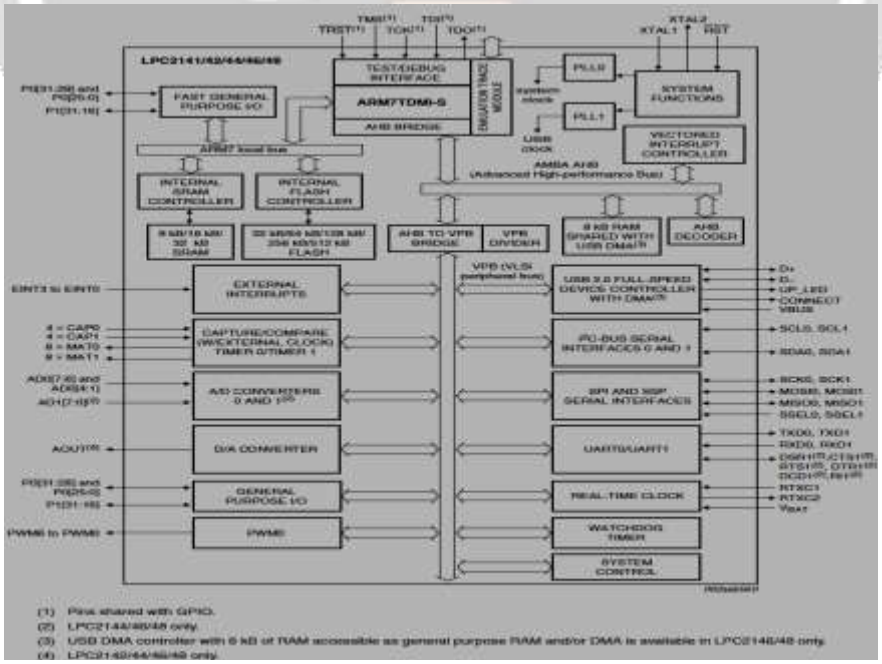


**Fig. 3.2.1 Block diagram of ARM7 LPC2142/44/46/48**

**Core Data path:**

- Architecture is characterized as Data path and control path.
- Data path is organized such that, operands are not fetched directly from memory locations. Data items are placed in register files. In memory locations no data processing takes place.
- Instructions typically use 3 registers i.e. 1 destination register and 2 source registers.
- Before entering into the ALU, Barrel Shifter preprocesses data
- Increment/Decrement logic can update register content.

**Pipeline:**

- In ARM 7, a 3 stage pipeline is used. A 3 stage pipeline is the simplest form of pipeline that does not affect from the problems such as read before write.
- In a pipeline, when one instruction is executed then second instruction is decoded and third instruction will be fetched.
- This executes only in a single cycle.

**Register Bank:**

- ARM7 uses load and store Architecture.
- Data has to be moved from memory location to a central set of registers.
- Data processing is done and is stored back into memory.
- Register bank contains the general purpose registers to hold the data or address.

**Interrupt Enable Bits**

I - IRQ, Interrupt Disable

F - FIQ, Disable Fast Interrupt

**T- Bit**

If

T=0, Processor in ARM Mode.

T=1, Processor in THUMB Mode

### 3.3 Universal Asynchronous Receiver/Transmitter 0

**Architecture:**

The VPB interface provides a communications link between the CPU/host and the UART0. The UART0 RX Shift Register (U0RSR) accepts valid characters with the help of RXD0. After a valid character is assembled, it is passed to the UART0 RX Buffer Register FIFO. The UART0 transmitter block, U0TX, accepts data written by the CPU or host and buffers the data in the UART0 TX Holding Register FIFO. The UART0 TX Shift Register reads the data stored in the U0THR and assembles the data to transmit via the serial output pin, TXD0 The UART0 Baud Rate Generator block, U0BRG, generates the timing enables used by the UART0 TX block. The U0BRG clock input source is the VPB clock (PCLK). The main clock is divided down per the divisor specified in the U0DLL and U0DLM registers. The interrupt interface receives several one clock wide enables from the U0TX and U0RX blocks Status information from the U0TX and U0RX is stored in the U0LSR. Control information for the U0TX and U0RX is stored in the U0LCR

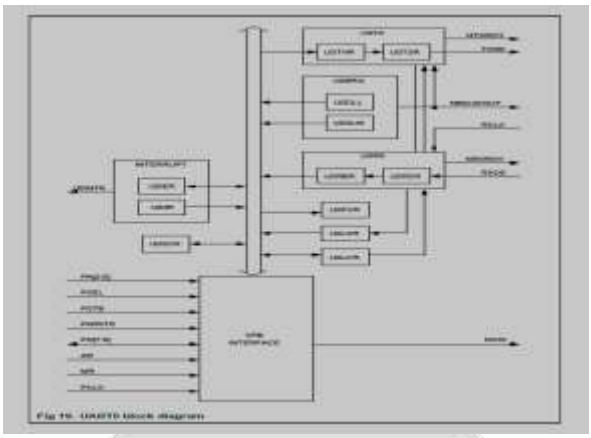

**Fig. 3.3.1 Block diagram of Universal Asynchronous Receiver/Transmitter 0**

### 3.4 Universal Asynchronous Receiver/Transmitter 1

**Architecture:**

The VPB interface provides a communication link between the UART1 and CPU or host. The UART1 RX Shift Register (U1RSR) accepts valid characters. It is passed to the UART1 RX Buffer Register FIFO to await access by the CPU or host via the generic host interface. The UART1 transmitter block, U1TX, accepts data written by the CPU or host and buffers the data in the UART1 TX. U1TSR reads the data stored in the U1THR and assembles the data to transmit. The U1BRG clock input source is the VPB clock (PCLK). The main clock is divided down per the divisor specified in the U1DLL and U1DLM registers. The modem interface contains registers U1MSR and U1MCR. This interface is responsible for handshaking between the UART1 and a modem peripheral. The interrupt interface contains registers U1IER and U1IIR. Status information from the U1TX and U1RX is stored in the U1LSR. Control information for the U1TX and U1RX is stored in the U1LCR.

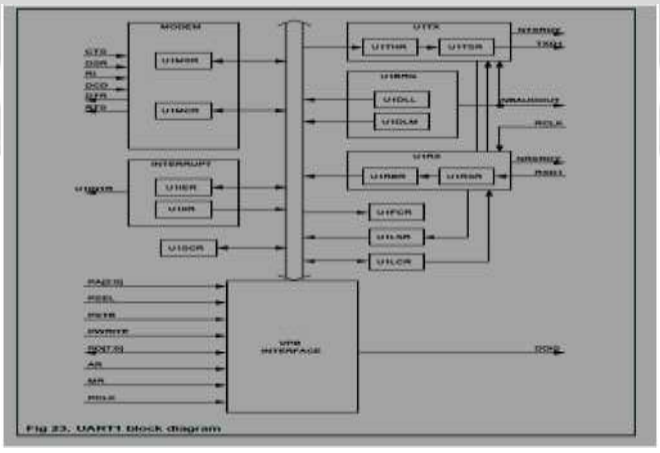

**Fig. 3.3.2 Block diagram of Universal Asynchronous Receiver/Transmitter 1**

### 3.5 Analog-to-Digital Converter (ADC):

**Description:**

Basic clocking for the A/D converters is provided by the VPB clock. A programmable divider is included in each

converter, to scale this clock to the 4.5 MHz (max) clock.

**3.6 Real Time Clock**

**Description:**

It uses little power in Power-down mode. On the LPC2141/2/4/6/8, the RTC can be clocked by a separate 32.768 KHz oscillator, or by a programmable prescale divider based on the VPB clock. Also, the RTC is powered by its , which can be connected to a battery or to the same 3.3 V supply used by the rest of the device.

**3.7 Power supply**

The power supplies are designed to convert high voltage AC to a suitable low voltage supply for electronics circuit. A power supply can by broken down into a series of blocks. A d.c power supply which maintains the output voltage constant irrespective of a.c mains fluctuations or load variations and it is known as "Regulated D.C Power Supply"

**3.8 Liquid Crystal Display**

In recent years the LCD is finding widespread use replacing LED s (seven-segment LED or other multi segment LED s). The reasons behind this are

1. The low prices of LCD s.
2. The ability to display numbers, characters and graphics.
3. Incorporation of a refreshing controller into the LCD, because of this controller, there by relieving the CPU of the task of refreshing the LCD.
4. Ease of programming for characters and graphics.

**3.9 GSM Technology**

Global System for Mobile Communication (GSM) is a set of ETSI standards specifying the infrastructure for a digital cellular service. The standard is used in approximately into many countries all over the world including such locations as Europe, Japan and Australia[1]. GSM security provides functions such as theft of service, privacy, and legal interception for raising the significant interest in the GSM community. The mobile communications has become one of the driving forces of the digital revolution. Now a days, daily millions of people are making phone calls by pressing a few buttons. General System for Mobile Communications i.e. GSM, is one of the many solutions out there. GSM has been dubbed the "Wireless Revolution" and it doesn't take much to realize why GSM provides a secure and confidential method of communication.

## 4.Implementation

**4.1 Introduction**

The project consists of micro controller, temperature sensors, motor, and fan. Here we can monitor the room temperature using sensors. The controller senses the room temperature and outdoor temperature with the help of A/D converter. By controlling the Fan Unit, the controllers maintain the room temperature under a predetermined value. Processor gives command to Fan unit to ON if the BTS room temperature is not under a tolerant level. The temperature values are displayed in LCD. If the values exceed beyond the threshold limit this information is messaged to user using GSM module. The main aim of the Project is to monitor the room temperature and outdoor temperature continuously.

**4.2 Schematic Explanation:**

In this project we required operating voltage for ARM controller board is 12V. This regulated 12V is generated by stepping down the voltage from 230V to 18V. Now this 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 us to have a Regulated constant Voltage which is of +12V. The rectified; filtered and regulated voltage is again filtered for ripples using an electrolytic capacitor. Now the output is fed to microcontroller board to supply operating voltage.

i. LCD is interfaced to the controller Port 1 of P1.16 to P 1.21.

ii. Temperature sensor is connected to pi n P0.28.

iii. Temperature sensor is connected to pi n P0.29.

iv. Fan is connected to pin P0.16.

v. Motor is connected to pin P0.17.

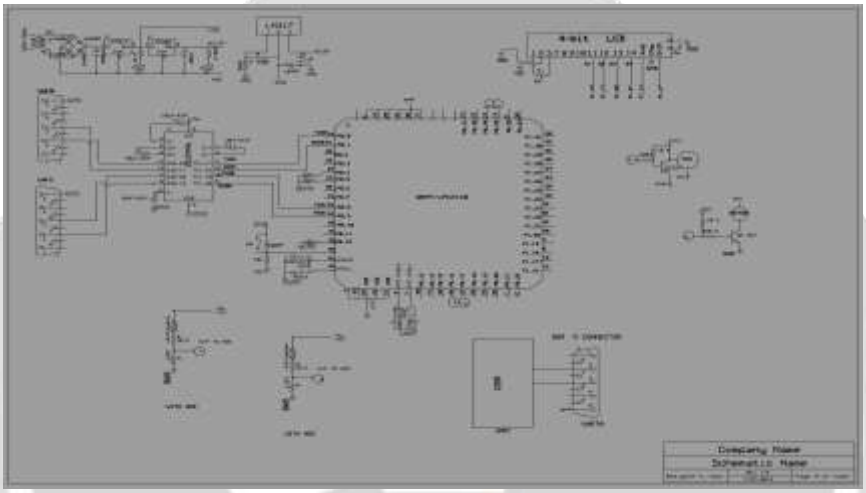

**Fig 4.2.1 Schematic explanation of FCU**

## 5.Experimental Result

### 5.1 Project Setup

Following image 5.1 shows the actual setup of project Free cooling unit for BTS room.

Here in this set up different major hardware blocks are like power supply, ARM7,LCD display,GSM modem, Fan unit, Motor etc.

**Image 5.1: Actual setup of Free cooling unit for BTS room**

By using this setup we can monitor the indoor and outdoor temperature of BTS room as well as we can reduce the run time of cooling unit so that we can reduce the electricity consumption.
With help LCD display we are able to visualize the present temperature of internal part of the BTS room as well as outdoor temperature. If temperature exceeds by there minimum value and maximum value which can be harmful to internal circuitries and devices situated inside the room, then FCU generate an message on LCD as well as send message to operator or to concern authority who can take appropriate measures to avoid and damage.

**5.2 Results.**

With the help of Keil software developer can define the maximum and minimum temperature value to the controller so that after any variation in to temperature by there predefine value it will intimate to operator through GSM modem and it will display on to LCD.

There are two different temperature need to monitor for faithful working of BTS room operation i.e. Indoor temperature and Outdoor temperature.

**Image 5.2: LCD screen showing Indoor (ITMP) temperature and Outdoor (OTMP) temperature**

## 6.Conclusion

The project "Design of Data Acquisition System Implemented with a Free Cooling Unit (FCU) Controller for a BTS Room" has been successfully designed and tested. Integrating features of all the hardware components used have developed it. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced IC's and with the help of growing technology the project has been successfully implemented. With the help this module power saving can be achieved with large amount.

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