

# Introduction to Single Board Heater System

**Talk to a Teacher**

**<http://spoken-tutorial.org>**

**National Mission on Education through ICT**

**<http://sakshat.ac.in>**

**Rupak Rokade  
IIT Bombay**

**04 June 2014**



# Objectives

- ▶ **Salient features**



# Objectives

- ▶ **Salient features**
- ▶ **Block diagram explanation**



# Introduction

- ▶ **Abbreviated as SBHS**



# Introduction

- ▶ **Abbreviated as SBHS**
- ▶ **Micro-controller based lab-in-a-box temperature control setup**



# Introduction

- ▶ **Abbreviated as SBHS**
- ▶ **Micro-controller based lab-in-a-box temperature control setup**
- ▶ **Designed to cater to the needs of undergraduate and postgraduate control courses**



# Introduction Contd..

**Revolves around the concepts of:**

- ▶ **Electronics**



# Introduction Contd..

**Revolves around the concepts of:**

- ▶ **Electronics**
- ▶ **Serial Port Communication**





# Introduction Contd..

**Revolves around the concepts of:**

- ▶ **Electronics**
- ▶ **Serial Port Communication**
- ▶ **Micro-Controller Programming**



# Introduction Contd..

**Revolves around the concepts of:**

- ▶ **Electronics**
- ▶ **Serial Port Communication**
- ▶ **Micro-Controller Programming**
- ▶ **Data Acquisition Interface**



# Introduction Contd..

**Revolves around the concepts of:**

- ▶ **Electronics**
- ▶ **Serial Port Communication**
- ▶ **Micro-Controller Programming**
- ▶ **Data Acquisition Interface**
- ▶ **Control Theory**



# Salient Features

- ▶ A Rs. 3000 device with its hardware design and codes released as open source



# Salient Features

- ▶ A Rs. 3000 device with its hardware design and codes released as open source
- ▶ An open source software is used to interface SBHS



# Salient Features

- ▶ A Rs. 3000 device with its hardware design and codes released as open source
- ▶ An open source software is used to interface SBHS
- ▶ More details can be sought from: [sbhs.os-hardware.in](http://sbhs.os-hardware.in)



# Salient Features Contd..

- ▶ The Time Constant is of the order of a minute



# Salient Features Contd..

- ▶ **The Time Constant is of the order of a minute**
- ▶ **Can do realistic experiment in 10 minutes**



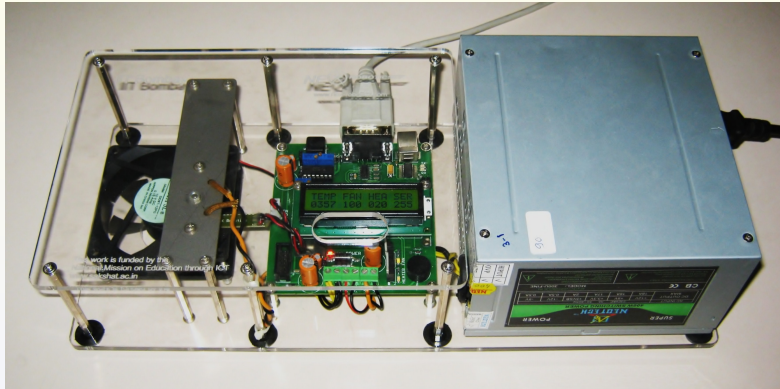


# Salient Features Contd..

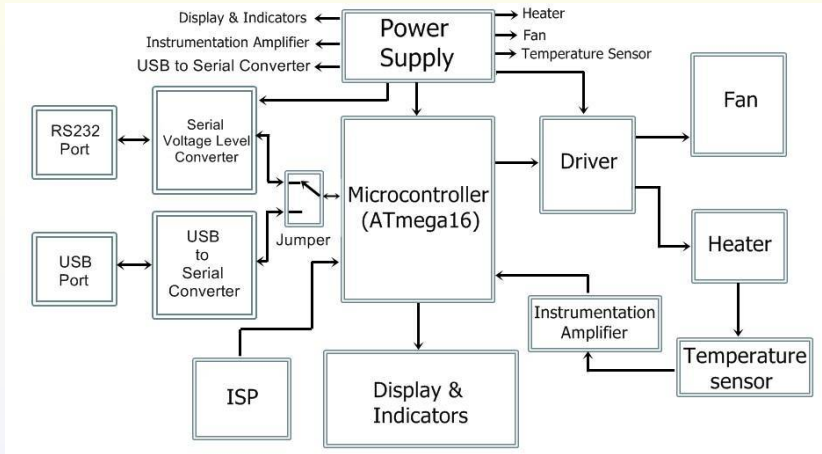
- ▶ **The Time Constant is of the order of a minute**
- ▶ **Can do realistic experiment in 10 minutes**
- ▶ **Available for remote access under Virtual Labs Project.**



# Single Board Heater System



# Block Diagram



# Power Supply



# Power Supply

- ▶ 12 volts 400 watt SMPS



# Power Supply

- ▶ 12 volts 400 watt SMPS
- ▶ 5 volts regulator is used wherever necessary

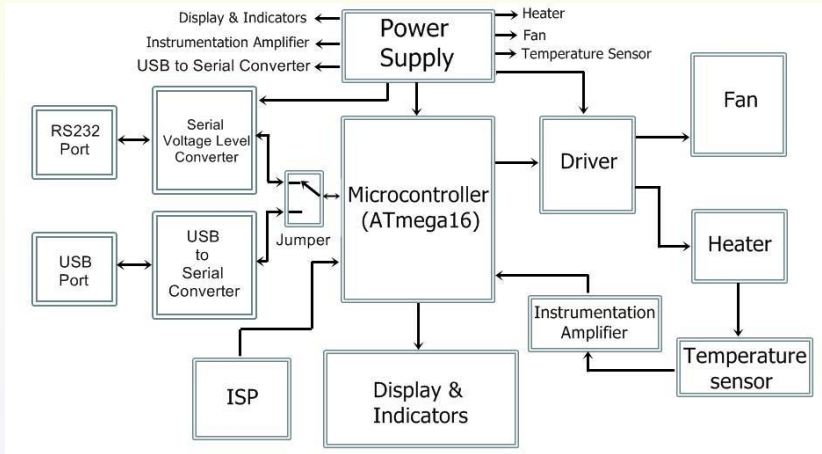


# Power Supply

- ▶ 12 volts 400 watt SMPS
- ▶ 5 volts regulator is used wherever necessary
- ▶ Separate voltage regulator for system and Temperature Sensor



# Block Diagram





# Micro-controller



# Micro-controller

- ▶ **ATmega16 8-bit micro-controller**



# Micro-controller

- ▶ **ATmega16 8-bit micro-controller**
- ▶ **Micro-controller plays a very important role**



# Micro-controller

- ▶ **ATmega16 8-bit micro-controller**
- ▶ **Micro-controller plays a very important role**
- ▶ **It controls most of the hardware on SBHS**



# Micro-controller

**Executes various tasks like**

- ▶ **Setting communication between computer and SBHS**



# Micro-controller

**Executes various tasks like**

- ▶ **Setting communication between computer and SBHS**
- ▶ **Controlling current passing through heater coil**



# Micro-controller

**Executes various tasks like**

- ▶ **Setting communication between computer and SBHS**
- ▶ **Controlling current passing through heater coil**
- ▶ **Controlling Fan speed**



# Micro-controller

**Executes various tasks like**

- ▶ **Setting communication between computer and SBHS**
- ▶ **Controlling current passing through heater coil**
- ▶ **Controlling Fan speed**
- ▶ **Reading temperature value**





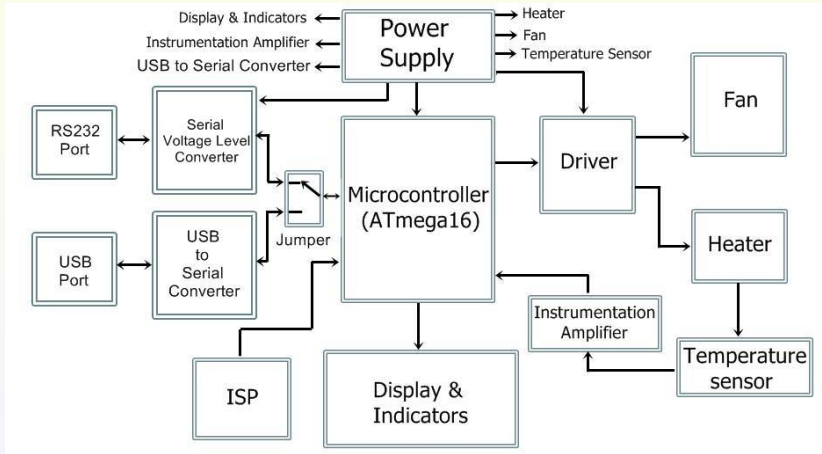
# Micro-controller

**Executes various tasks like**

- ▶ **Setting communication between computer and SBHS**
- ▶ **Controlling current passing through heater coil**
- ▶ **Controlling Fan speed**
- ▶ **Reading temperature value**
- ▶ **Displaying the parameter value**



# Block Diagram



# Heater and Fan



# Heater and Fan

## Heater assembly

- ▶ Metal plate placed about 3.5 mm away from nichrome coil



# Heater and Fan

## Heater assembly

- ▶ Metal plate placed about 3.5 mm away from nichrome coil
- ▶ Current passes through the coil, the coil gets heated



# Heater and Fan

## Heater assembly

- ▶ Metal plate placed about 3.5 mm away from nichrome coil
- ▶ Current passes through the coil, the coil gets heated
- ▶ Heat transfer to plate through convection



# Heater and Fan

## Heater assembly

- ▶ Metal plate placed about 3.5 mm away from nichrome coil
- ▶ Current passes through the coil, the coil gets heated
- ▶ Heat transfer to plate through convection
- ▶ Rises the plates temperature



# Heater and Fan

## Fan

- ▶ Computer Fan is used





# Heater and Fan

## Fan

- ▶ **Computer Fan is used**
- ▶ **Used to cool the heated metal plate**



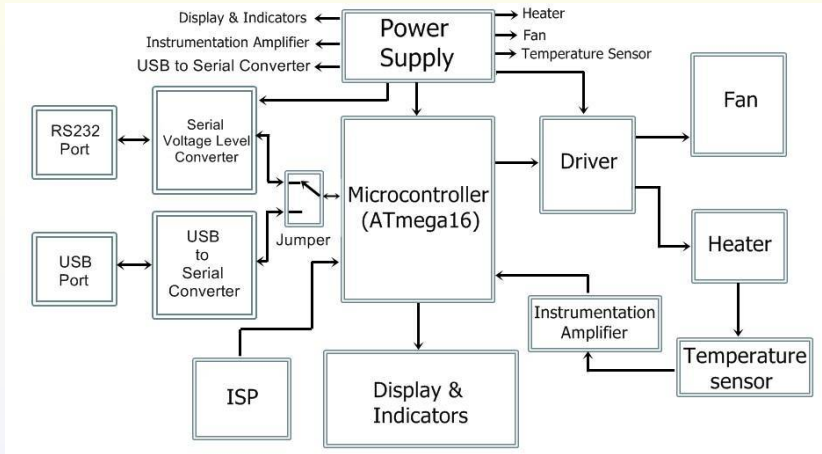
# Heater and Fan

# Fan

- ▶ **Computer Fan is used**
- ▶ **Used to cool the heated metal plate**
- ▶ **Fan is placed below the heater assembly**



# Block Diagram



# Driver

- ▶ Used for regulating power delivered to Fan and Heater assembly



# Driver

- ▶ **Used for regulating power delivered to Fan and Heater assembly**
- ▶ **MOSFET's are used to regulate power**



# Driver

- ▶ Used for regulating power delivered to Fan and Heater assembly
- ▶ MOSFET's are used to regulate power
- ▶ Commands are directly given by micro-controller to MOSFET's

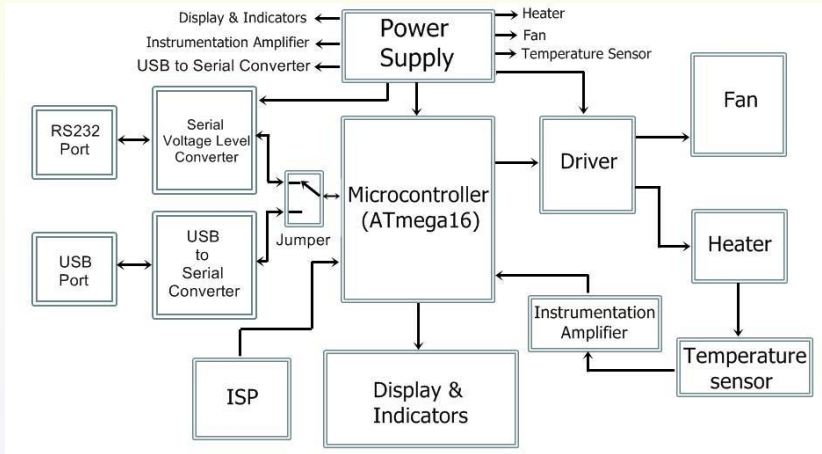


# Driver

- ▶ **Used for regulating power delivered to Fan and Heater assembly**
- ▶ **MOSFET's are used to regulate power**
- ▶ **Commands are directly given by micro-controller to MOSFET's**
- ▶ **MOSFET's are switched at some PWM frequency**



# Block Diagram





# Temperature Sensor

- ▶ **AD590 Temperature Sensor is used**



# Temperature Sensor

- ▶ **AD590 Temperature Sensor is used**
- ▶ **Output is in terms of  $\mu A/K$**



# Temperature Sensor

- ▶ **AD590 Temperature Sensor is used**
- ▶ **Output is in terms of  $\mu A/K$**
- ▶ **Operating Temperature ranges from -55 to 150°C**

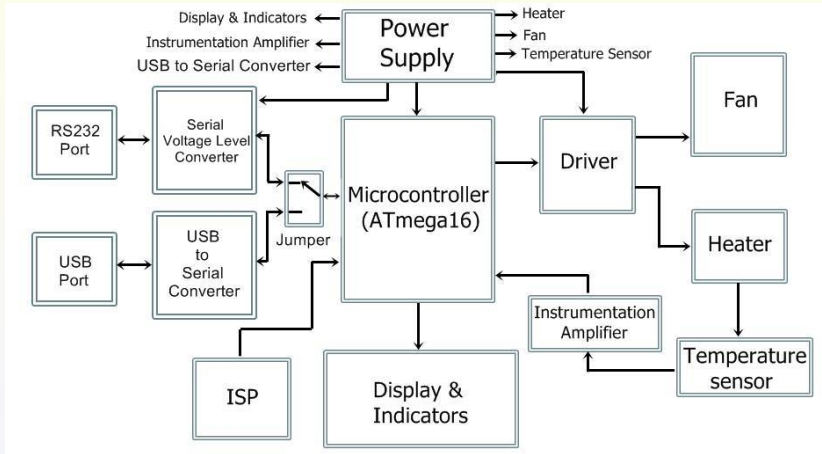


# Temperature Sensor

- ▶ **AD590 Temperature Sensor is used**
- ▶ **Output is in terms of  $\mu A/K$**
- ▶ **Operating Temperature ranges from -55 to 150°C**
- ▶ **Does not require Linearization Circuitry**



# Block Diagram



# Instrumentation Amplifier

- Used for signal conditioning



# Instrumentation Amplifier

- ▶ **Used for signal conditioning**
- ▶ **Provides good input impedance**



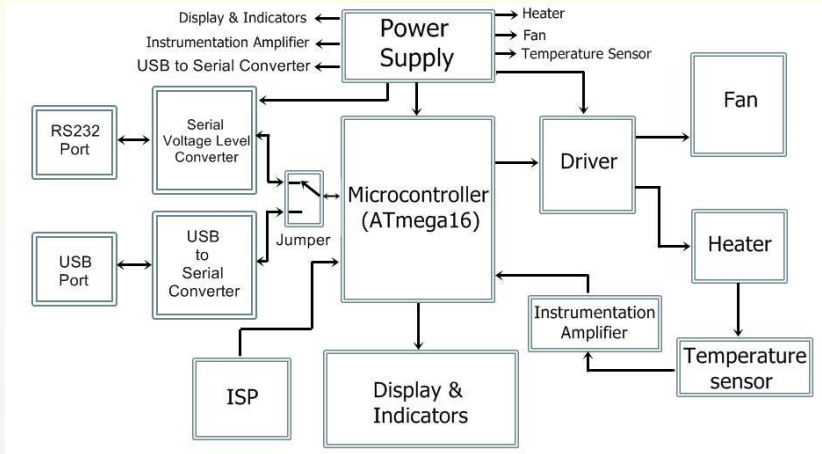
# Instrumentation Amplifier

- ▶ **Used for signal conditioning**
- ▶ **Provides good input impedance**
- ▶ **Avoids loading of Temperature Sensor**





# Block Diagram



# Display and Indicators

- ▶ 16x2 LCD display



# Display and Indicators

- ▶ **16x2 LCD display**
- ▶ **Has in-built controller**



# Display and Indicators

- ▶ **16x2 LCD display**
- ▶ **Has in-built controller**
- ▶ **Displays- Temperature, Fan & Heater in % of max value and Machine ID (MID)**



# Display and Indicators

- ▶ 16x2 LCD display
- ▶ Has in-built controller
- ▶ Displays- Temperature, Fan & Heater in % of max value and Machine ID (MID)
- ▶ Operated in 4-bit mode

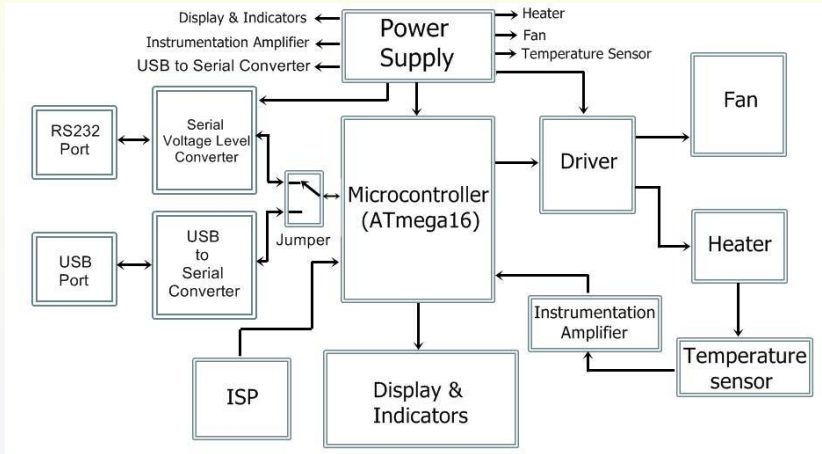


# Display and Indicators

- ▶ 16x2 LCD display
- ▶ Has in-built controller
- ▶ Displays- Temperature, Fan & Heater in % of max value and Machine ID (MID)
- ▶ Operated in 4-bit mode
- ▶ Indicators include various on-board LEDs



# Block Diagram



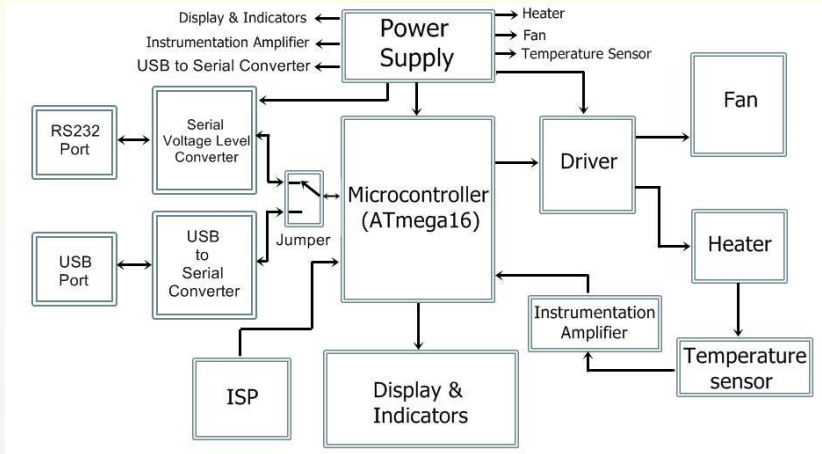
# Serial Voltage Level Converter

- ▶ Used for conversion of signals from serial to TTL and vice versa





# Block Diagram

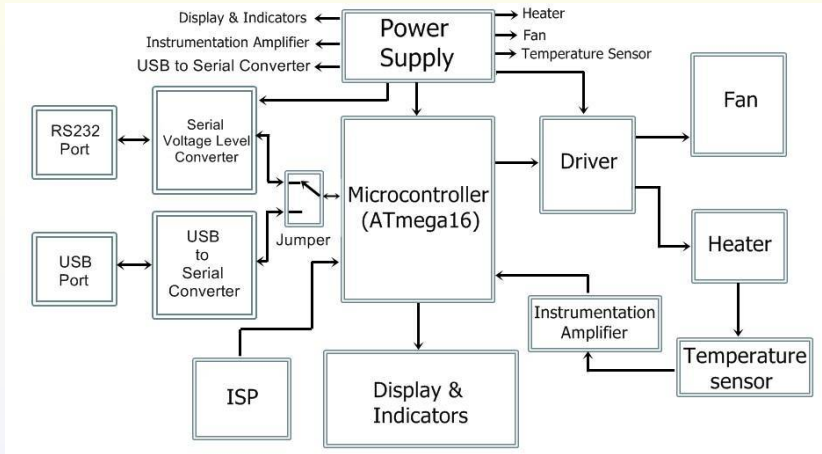


# USB to Serial Converter

- Used for conversion of signals from USB to serial and vice versa



# Block Diagram

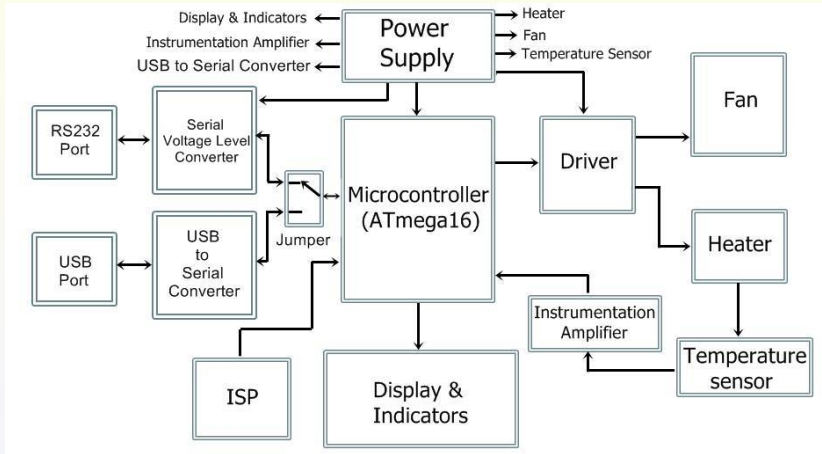


# USB and RS232 port

- Used to connect the USB and RS232 cable



# Block Diagram



# IN System Programming (ISP)

- ▶ ISP stands for In-System Programming



# IN System Programming (ISP)

- ▶ **ISP stands for In-System Programming**
- ▶ **10-pin male connector**



# IN System Programming (ISP)

- ▶ **ISP stands for In-System Programming**
- ▶ **10-pin male connector**
- ▶ **Used to program the micro-controller**





# Summary

1. Salient features
2. Block diagram explanation

- ▶ Power Supply
- ▶ Microcontroller
- ▶ Heater and fan
- ▶ Driver
- ▶ Temperature Sensor
- ▶ Instrumentation Amplifier
- ▶ Display
- ▶ USB & RS232 ports
- ▶ ISP



# About the Spoken Tutorial Project

- ▶ Watch the video available at [http://spoken-tutorial.org/What\\_is\\_a\\_Spoken\\_Tutorial](http://spoken-tutorial.org/What_is_a_Spoken_Tutorial)
- ▶ It summarises the Spoken Tutorial project
- ▶ If you do not have good bandwidth, you can download and watch it



# Spoken Tutorial Workshops

## The Spoken Tutorial Project Team

- ▶ Conducts workshops using spoken tutorials
- ▶ Gives certificates to those who pass an online test

For more details, please write to  
**[contact@spoken-tutorial.org](mailto:contact@spoken-tutorial.org)**



# Acknowledgements

- ▶ Spoken Tutorial Project is a part of the Talk to a Teacher project
- ▶ It is supported by the National Mission on Education through ICT, MHRD, Government of India
- ▶ More information on this Mission is available at:

<http://spoken-tutorial.org/NMEICT-Intro>

