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Neonatal Intensive Care Unit Temperature Controller with GSM Connectivity

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Abstract - The main objective of this project was to design a temperature controller for controlling the temperature of a NICU (Neonatal Intensive Care Unit). We have tried to achieve both of these objectives in our project. For temperature control we have used a temperature sensor in conjunction with a microcontroller to create a temperature controller. This controller controls a relay circuit which trips the heater element once the set range is crossed. We have also interfaced a GSM module with the microcontroller to inform the user in case the threshold has been crossed.
Keywords: Temperature, NICU, temperature Sensor, Microcontroller, Relay, Heater, GSM Module.

1. INTRODUCTION

Temperature is one of the main parameter to control in most of the manufacturing industries like chemical, food processing, pharmaceutical etc. In these industries, some products need the required temperature to be maintained at highest priority or the product will fail. So the temperature controller is most widely used in almost all the industries. As the topic suggests, we have tried to incorporate the automatic temperature control mechanism into NICU. The idea behind this project is the proper temperature regulation which is important for the survival of a newborn. The infant has several disadvantages in terms of thermal regulation. The infant's body responds differently to hot and cold temperatures. In the case of hotter environmental temperatures, the infant's body produces sweat through the sweat glands. In the case of cold environmental temperatures, the infant may produce heat by shivering and other muscular activity. But in case of premature birth, health related problems, neonate i.e. 28 days post-delivery problems etc. the child is not able to maintain its own temperature with clothing and wrapping or it is acutely unwell due to which close observation is required to avoid health problems. This needs intensive care units like the incubator to regulate the temperature with intelligent monitoring system to avoid human errors and cost of monitoring.

2. COMPONENTS

Table-2.1 List of Components

S. No.	Name of Component		Type	Ratings	Quantity
1	ATmega328P		-PU Microcontroller (28P3 Package)	Operating Voltage: 1.8V to 5.5V Temperature range: -40°C to +85°C	x1
2	SIM900a GSM Module		Quad-band GSM/GPRS Module, SMT type suit	Supply Voltage: 3.4V to 5V Temperature range: -30°C to +80°C	x1
3	LM35 Temperature Sensor		Semiconductor based	Supply Voltage: 4V to 30V Temperature range: -55°C to +150°C	x1
4	Transformer		Step-down	220-230V, 50Hz to 12V	x1
5	LCD: JHD162a		16x2 LED Backlight COB	Operating Voltage: -0.3V to +7V Temperature Range: 0°C to +60°C	x1
6	Transistor: BC547		NPN	V_{CBO} = 50V, V_{EBO} = 6V V_{CEO} = 45V, I_c = 100mA	x2
7	Voltage Regulator	A: LM7805	Fixed	Input Voltage: 7V to 20V Output Voltage: 4.8V to 5.2V	x1
		B: LM7812	Fixed	Input Voltage: 14.5V to 27V Output Voltage: 11.5V to 12.5V	x1

8	Potentiometer		Passive	10KΩ	x1
9	Relay: JQC-3FC/T73		SPDT	Max. Switching Current: 7A, 10A Max. Switching Voltage: 28V DC/250V AC	x1
10	Resistors	Resistor A	Passive, Through hole	10KΩ	x1
		Resistor B		220Ω	x2
		Resistor C		220KΩ	x1
		Resistor D		4.7KΩ	x1
11	Diodes: 1N4007		Through hole	V_{RRM} = 1000V V_{RMS} = 700V I_F = 1A	x5
12	Capacitors	Capacitor A	Passive, Through hole	2200µF	x1
		Capacitor B		0.1µF	x3
		Capacitor C		10µF	x2
13	Light Emitting Diode (LED)		---	Min. Supply Voltage: > 3.0V	x1
14	Water Heater		---	Supply Voltage: 220V-230V AC	x1

2.1 ATmega328P Microcontroller

The ATmega328P is a low-power CMOS 8-bit microcontroller based on the AVR enhanced RISC architecture. By executing powerful instructions in a single clock cycle, the ATmega328P achieves throughputs approaching 1 MIPS per MHz allowing the system designer to optimize power consumption versus processing speed.

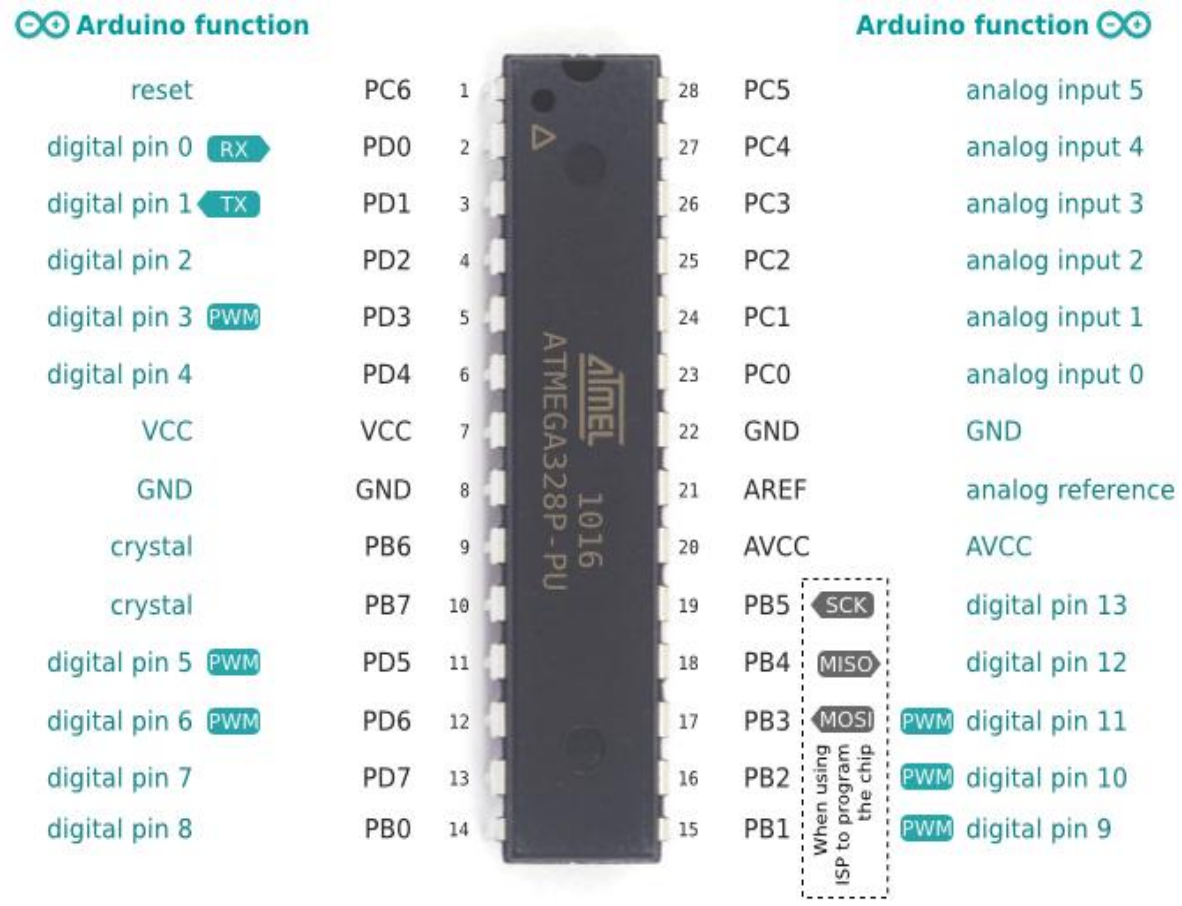

Fig. 2.1 ATmega328P Pin Configurations

2.2 GSM Module (SIM900a)

The SIM900 is a complete Quad-band GSM/GPRS solution in a SMT module which can be embedded in the customer applications.

Featuring an industry-standard interface, the SIM900 delivers GSM/GPRS 850/900/1800/1900MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. With a tiny configuration of 24mm x 24mm x 3 mm, SIM900 can fit almost all the space requirements in your M2M application, especially for slim and compact demand of design.

- SIM900 is designed with a very powerful single-chip processor integrating AMR926EJ-S core
- Quad - band GSM/GPRS module with a size of 24mmx24mmx3mm
- SMT type suit for customer application
- An embedded Powerful TCP/IP protocol stack
- Based upon mature and field-proven platform, backed up by our support
- service, from definition to design and production

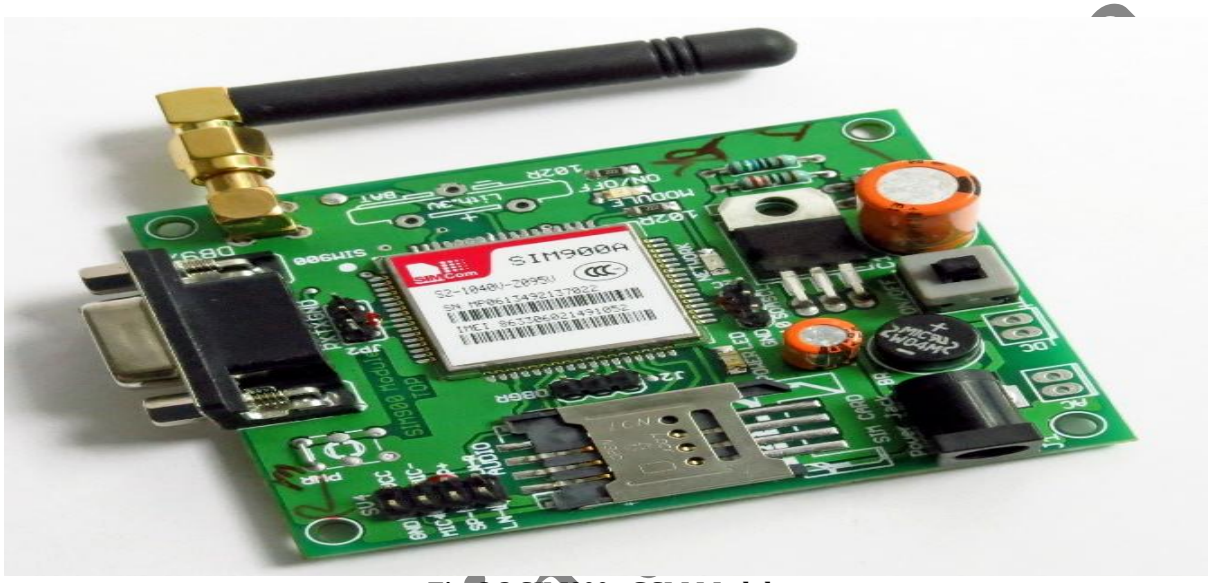

Fig. 2.2 SIM900a GSM Module

2.3 LM35 Temperature Sensor

The LM35 series are precision integrated-circuit temperature devices with an output voltage linearly-proportional to the Centigrade temperature.

The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling.

The LM35 device does not require any external calibration or trimming to provide typical accuracies of ±¼°C at room temperature and ±¾°C over a full −55°C to 150°C temperature range.

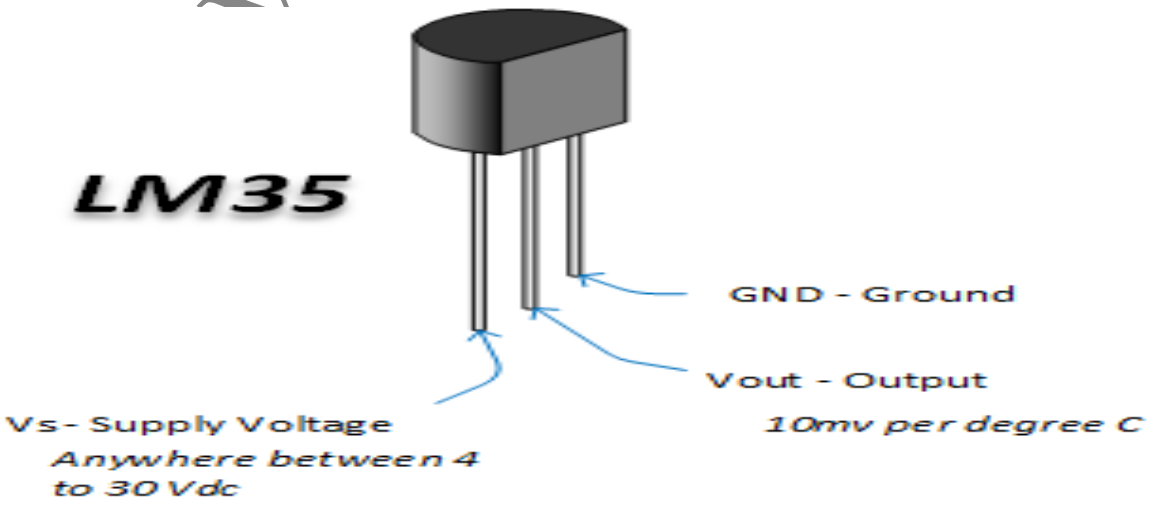

Fig. 2.3 LM35 Pin Configuration

3. CIRCUIT DIAGRAM

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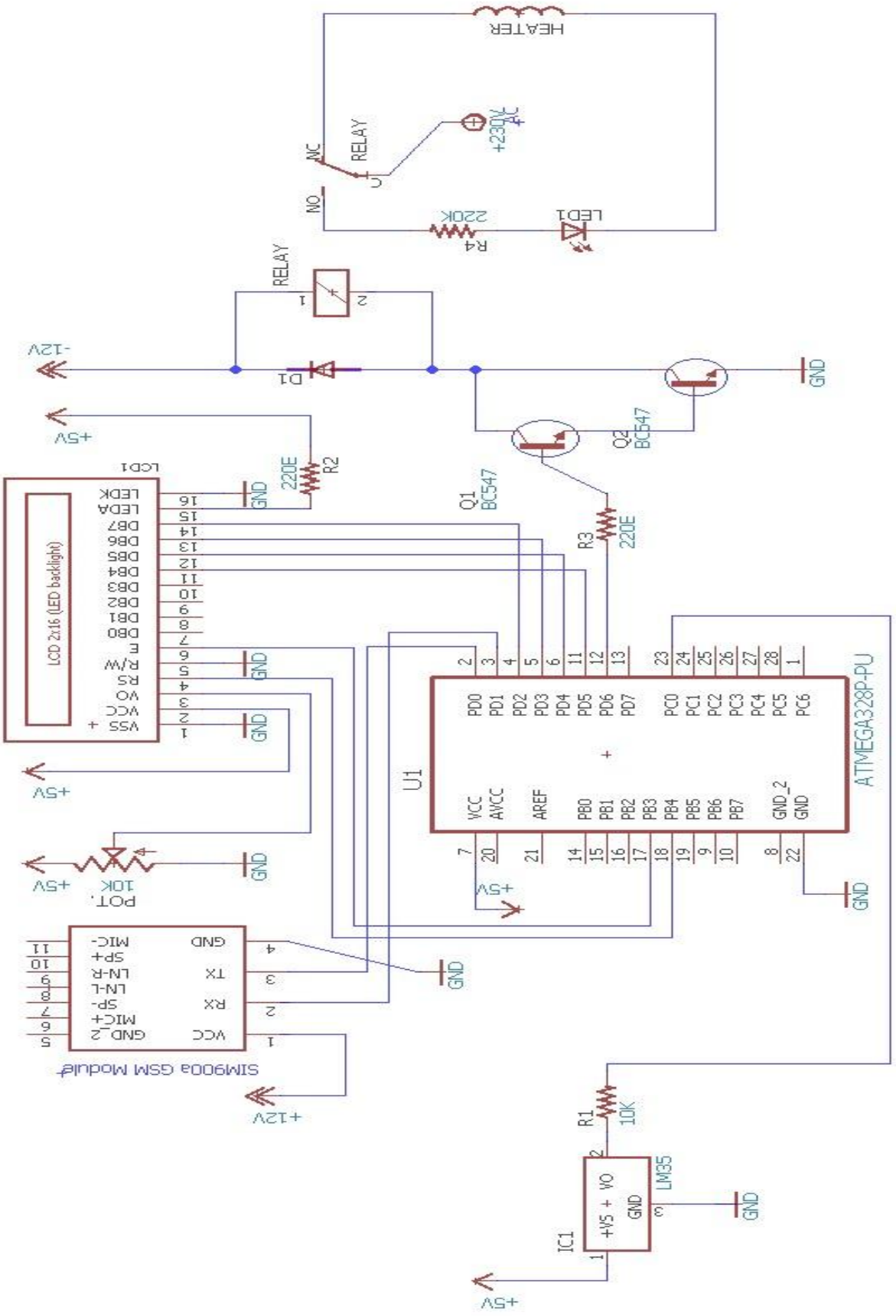

Fig. 3.1 NICU Temperature Controller Circuit Diagram

4. FLOW CHART

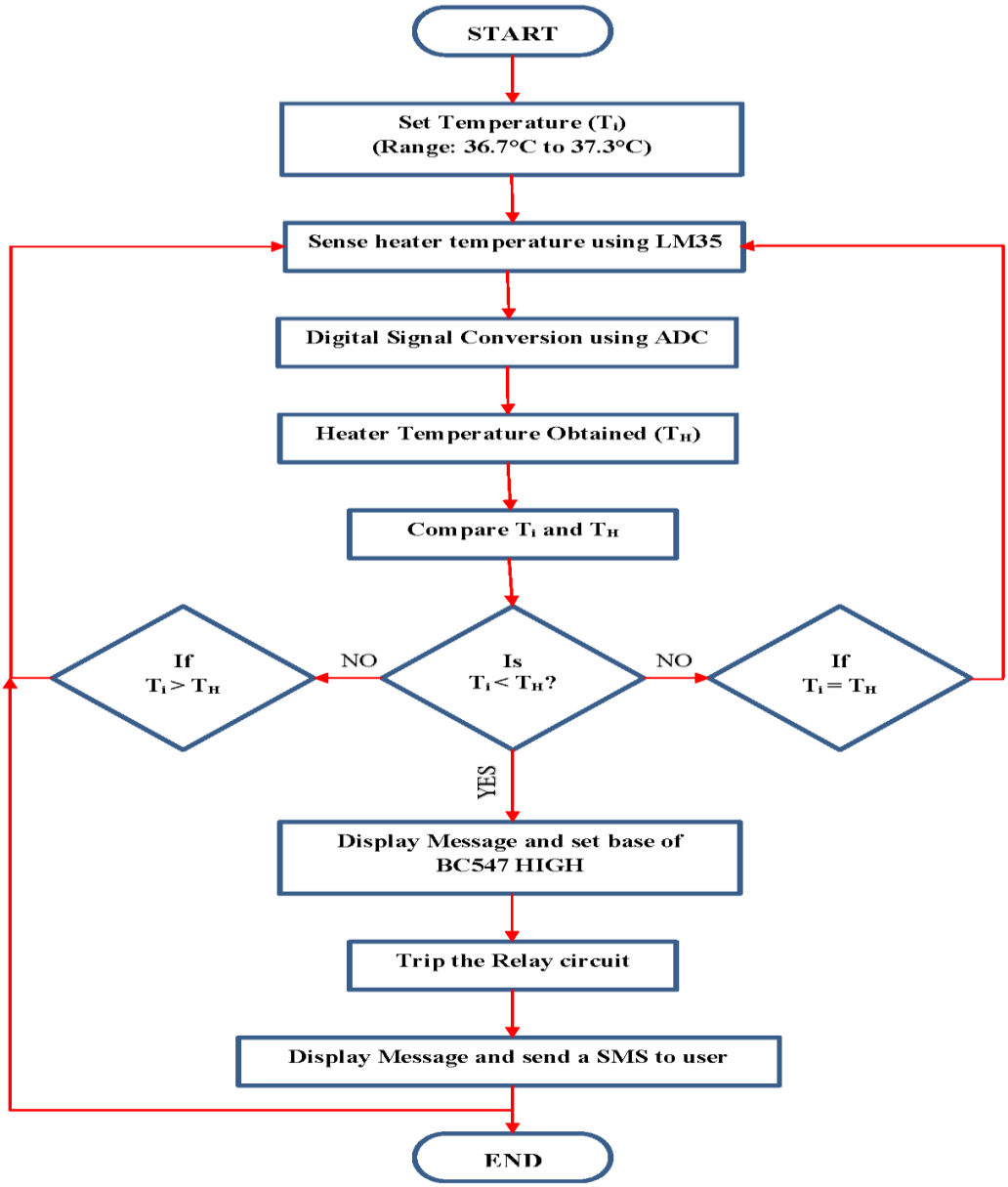

Fig. 4.1 Flow Chart of System Operation

5. WORKING

The project uses a precision centigrade temperature sensor LM35 which is capable of sensing the temperature. It gives the output in millivolts. This output is converted into corresponding digital data using inbuilt ADC of the ATmega328P microcontroller.

LCD is interfaced with the microcontroller & the value of the actual temperature is displayed on the LCD.

The LCD displays the present temperature and LOW, IDEAL or HIGH range of temperature.

If the temperature crosses the maximum value, the heater is switched off, which is connected through a relay driven by a transistor interfaced with a microcontroller.

Additionally, as soon as the maximum temperature limit is crossed by the heater, a message will be sent to the user, notifying him/her of the same, with the help of GSM Module.

CONCLUSIONS

The goal of this project from the onset was to design a temperature measurement and control unit. We achieved this objective with the help of software tools such as Proteus, Eagle, and Arduino IDE etc. Through the use of these software we were able to successfully integrate the LM35 temperature sensor with the Arduino Uno based microcontroller to obtain the desired specification.

Another objective of this project was to establish a connection between this circuit and a remote terminal. This is done with the help of SIM900a GSM Module. This module when interfaced with the microprocessor is able to send and receive data from remote terminals and pass this data onto the microcontroller in the form of interrupt signals.

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