PATIENT MONITORING SYSTEM USING PIC 16F877

C O N T E N T S

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SYNOPSIS

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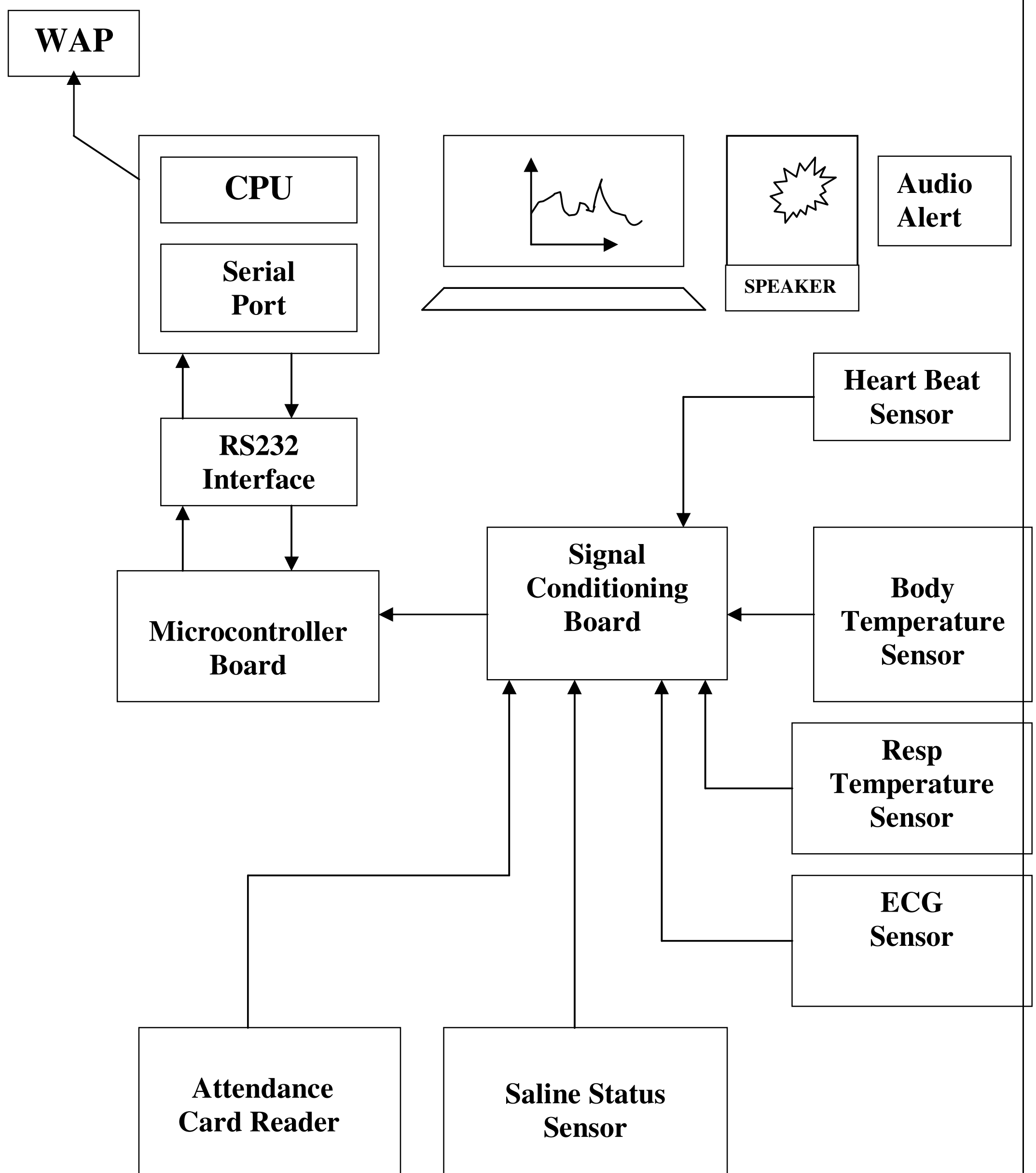
Our project is a working model which incorporates sensors to measure parameters like body temperature, heart beat rate, respiratory temperature and ECG; and transfer it to the computer so that the patient's health condition can be analyzed by doctors in any part of the hospital. Thus, it reduces the doctor's workload and also gives accurate results. Further this system uses WAP technology which enables the viewing of all parameters on the mobile phone. A micro-controller board is used for analyzing the inputs from the patient and any abnormality felt by the patient causes the monitoring system to give an alarm. Also all the process parameters within an interval selectable by the user are recorded online. This is very useful for future analysis and review of patient's health condition.

For more versatile medical applications, this project can be improvised, by incorporating blood pressure monitoring systems, dental sensors and annunciation systems, thereby making it useful in hospitals as a very efficient and dedicated patient care system.

BLOCK DIAGRAM

BLOCK DIAGRAM



INTRODUCTION

INTRODUCTION

Measurement of Body Temperature and Respiratory Temperature:

Thermistor is used for the measurement of body temperature and respiratory temperature. This Thermistor is a passive transducer and it's resistance depends on the heat being applied on it. We have arranged the thermistor in the potential divider circuit. This thermistor exhibits a large change in resistance with a change in the body temperature. The respiratory temperature is determined by holding the thermistor near the nose. Initially the thermistor is calibrated to normal body temperature. The thermistor part is attached to the patient whose temperature has to be measured, which changes the resistance value and thus the corresponding change in the temperature is displayed on the monitor graphically . Also all temperature measurements are updated in the patients database. Here in our project we use bead thermistor.

Electro Cardiogram (ECG):

This is a four lead ECG monitoring system. Four sensors are kept at various parts of the body ; the two arms and the two legs. All the signal outputs from the sensors are conditioned by an external circuit consisting of an instrumentation amplifier and a trimpot and is given to the PC through a PIC controller. An interactive program in Visual Basic is developed to read the voltage signals and display a waveform pattern. The four leads used are of silver electrode.

Saline Monitoring System:

For saline monitoring the infrared emitter and detector are placed in a position such that the saline bottle passes between them . They are placed near the neck of the saline bottle.

As long as saline is present, the path of the infrared rays is blocked and the infrared detector is blocked from collecting infrared rays from the infrared emitter. And so the output will indicate normal saline status. The software is written to give an audio alert when the saline level falls below the safe level.

Patient Calling System:

The patient calling system consists of four switches which when pressed gives display on the screen and activates an audio alert indicating that a patient is calling. These switches are placed in the vicinity of the patient to enable medical access in an emergency.

Heart Beat Monitor:

The patient's heart beat rate is monitored using a photoelectric sensor which can sense the patient's pulse rate . This method of tracking the heart rate is more efficient than the traditional method which derives the same from the ECG graph.

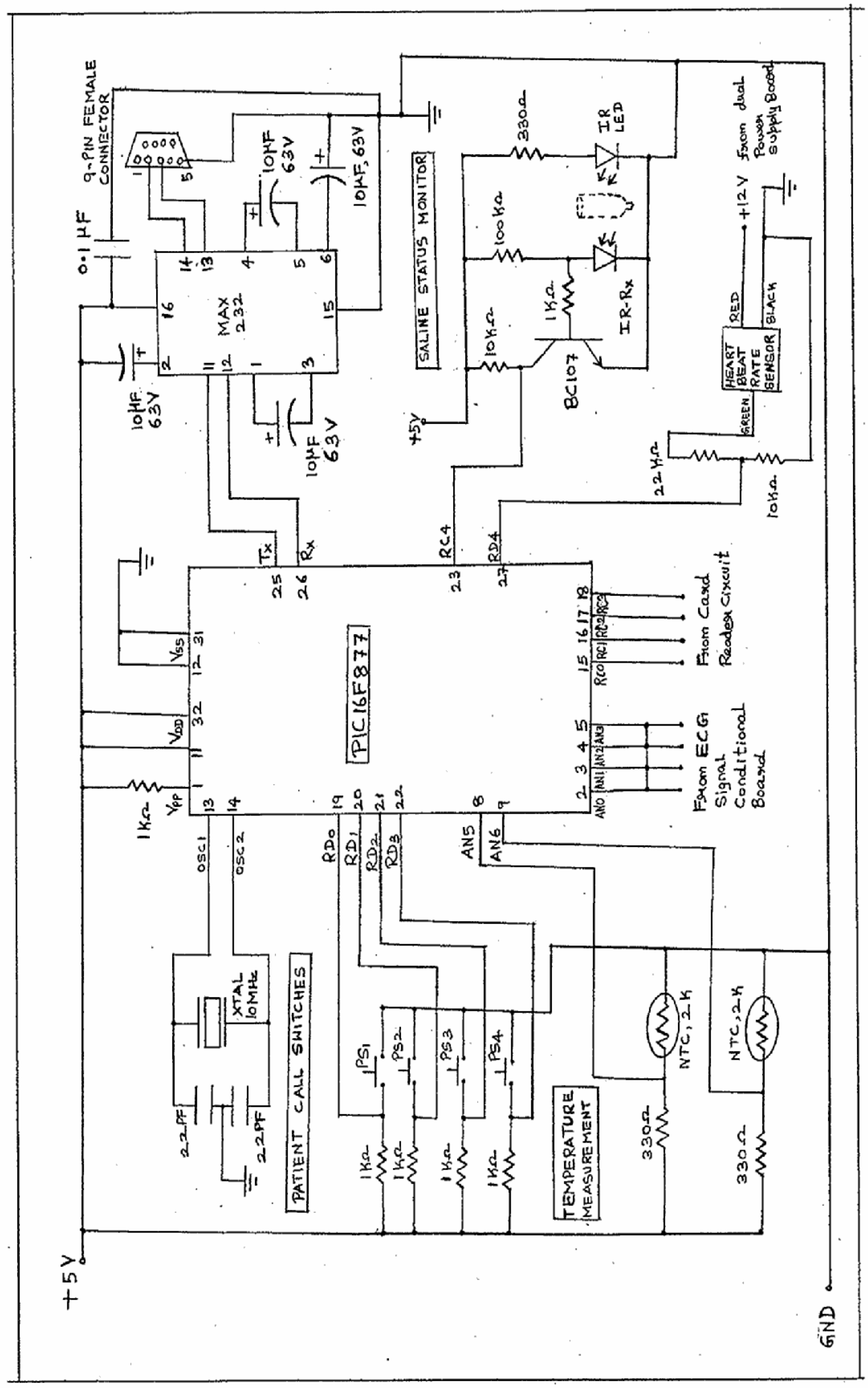
Attendance Card Reader:

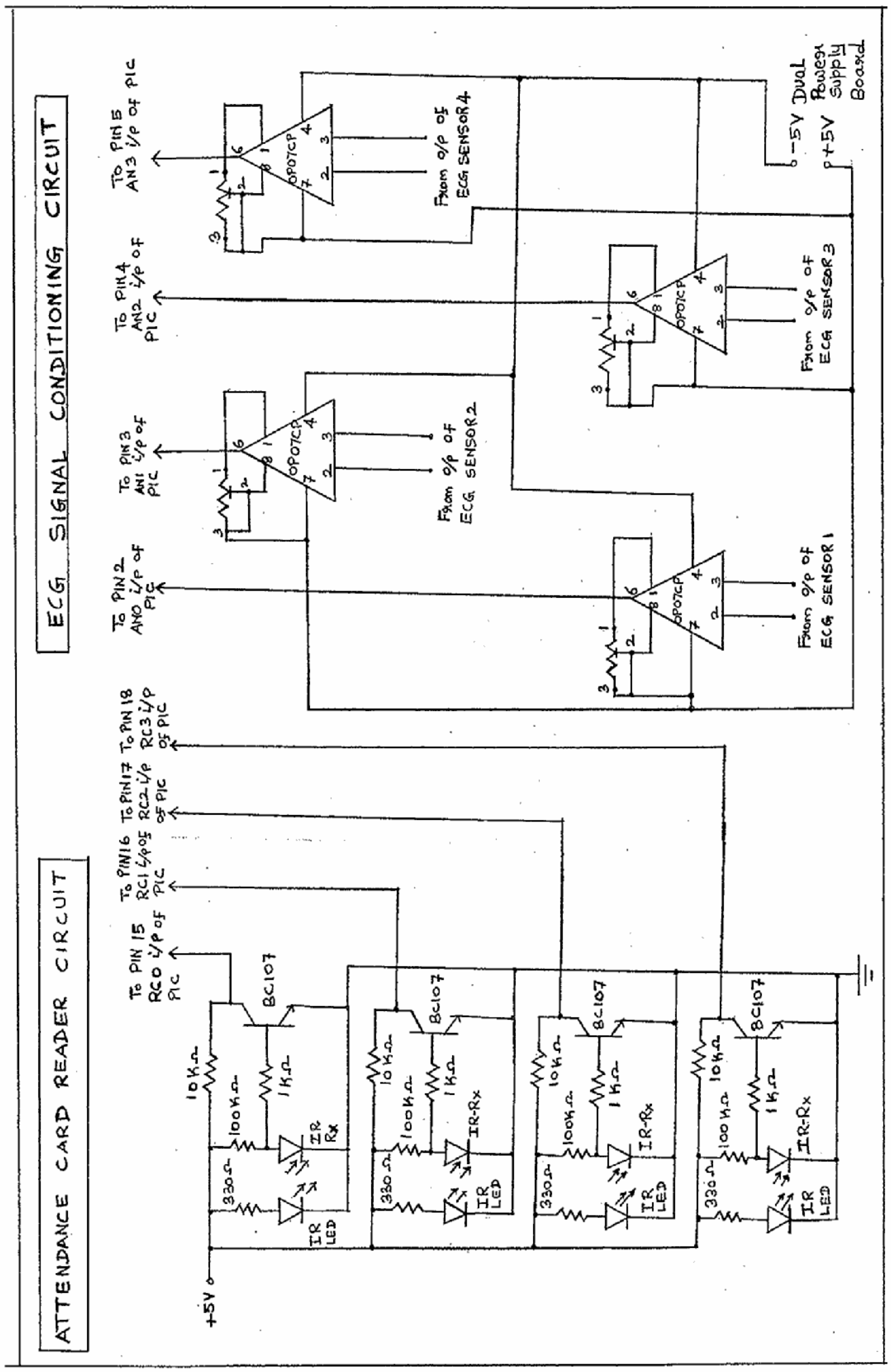
In order to facilitate easy maintenance and verification of the patient's medical record due knowledge is required regarding the staff interacting with the patient. This is achieved by using a punched identity card and it's associated card reader. The card reader uses photo-electric sensors to recognise 16 different medical ward members.

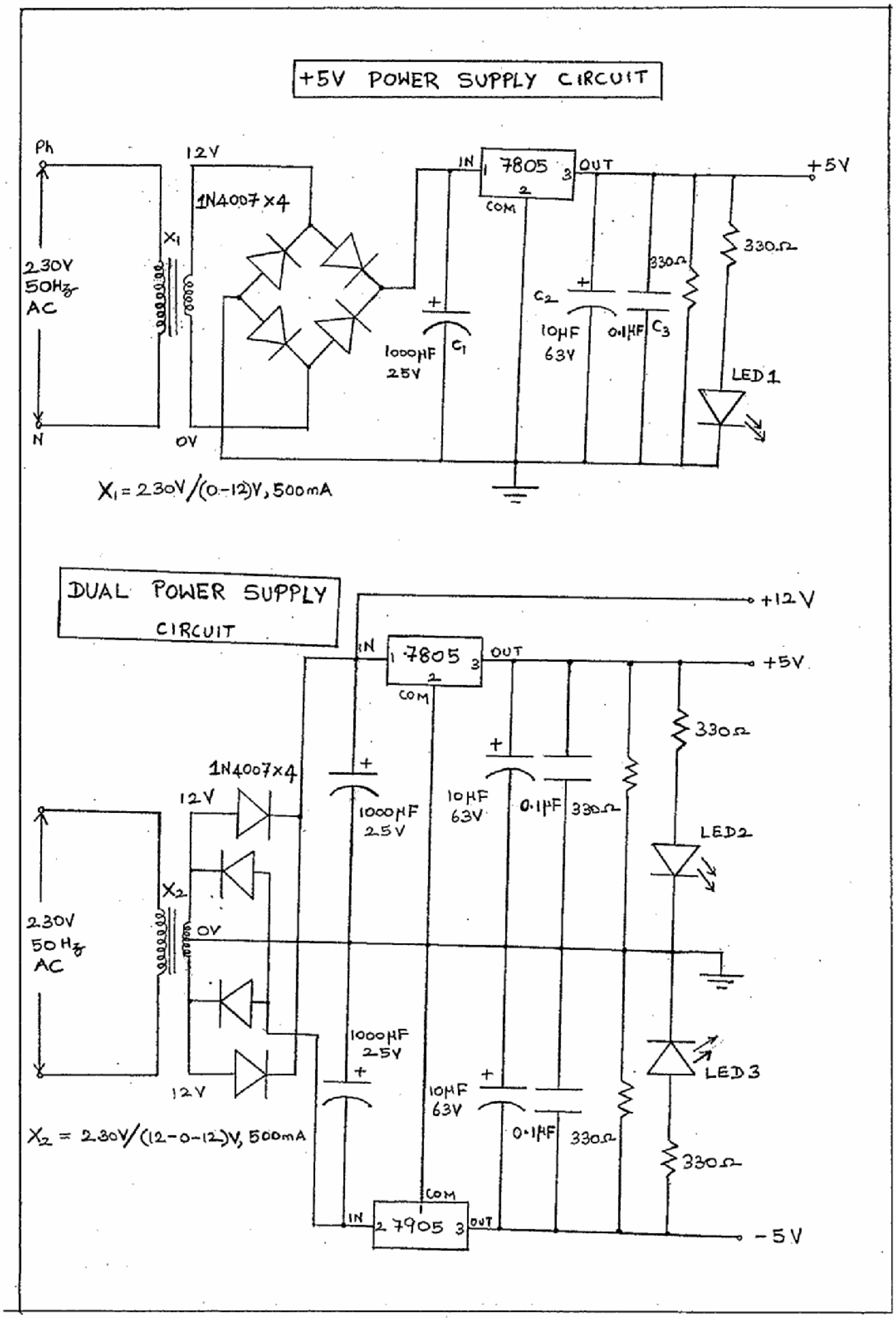
WAP and Audio Alert:

Whenever the temperature or the heart beat rate exceed the normal range of values; whenever the saline falls below the preset level and when any patient presses the emergency call switch , provision has been made for an audio alert and also short text messaging the concerned doctor through Wireless Application Protocol.

CIRCUIT DIAGRAM


9-PIN FEMALE CONNECTOR
0·1 μF
MAX 232
10μF 63V
10μF, 63V
SALINE STATUS MONITOR
330Ω
IR LED
100KΩ
1KΩ
10KΩ
IR-Rx
BC107
+5V
+12V From dual Power supply Board
HEART BEAT RATE SENSOR
RED
BLACK
GREEN
22KΩ
10KΩ
PIC16F877
From Card Reader Circuit
From ECG Signal Conditional Board
OSC1
OSC2
XTAL 10MHz
22PF
PATIENT CALL SWITCHES
PS1
PS2
PS3
PS4
TEMPERATURE MEASUREMENT
NTC, 2K
330Ω
GND


ATTENDANCE CARD READER CIRCUIT
ECG SIGNAL CONDITIONING CIRCUIT
BC107
IR LED
IR-Rx
OP07CP
From o/p of ECG SENSOR 1
From o/p of ECG SENSOR 2
From o/p of ECG SENSOR 3
From o/p of ECG SENSOR 4
-5V Dual Power supply Board
+5V


+5V POWER SUPPLY CIRCUIT
Ph
N
230V 50Hz AC
X1
12V
0V
1N4007 x4
IN
7805
OUT
COM
+5V
1000µF 25V
C1
C2
10µF 63V
0.1µF
C3
330Ω
330Ω
LED 1
X1 = 230V/(0-12)V, 500mA
DUAL POWER SUPPLY CIRCUIT
+12V
7805
+5V
1N4007x4
12V
1000µF 25V
10µF 63V
0.1µF
330Ω
330Ω
LED2
X2
230V 50Hz AC
0V
LED3
12V
X2 = 230V/(12-0-12)V, 500mA
COM
IN
7905
OUT
-5V

CIRCUIT DESCRIPTION

1. Power Supply Circuit:

All the electronic components only work with a DC supply ranging from –12V to +12V. We are using the commonly available energy source of 230v-50Hz and stepping down , rectifying, filtering and regulating the voltage.

Step Down Transformer:

When AC is applied to the primary winding of the power transformer it can either be stepped down or up depending on the value of DC needed. In our circuit the transformer of 230v/12-0-12v is used to perform the step down operation where a 230V AC appears as 12V AC across the secondary winding. The current rating of the transformer used in our project is 250mA.. Apart from stepping down AC voltages, it gives isolation between the power source and power supply circuitries.

Rectifier Unit:

In the power supply unit, rectification is normally achieved using a solid state diode. Diode has the property that will let the electron flow easily in one direction at proper biasing condition. As AC is applied to the diode, electrons only flow when the anode and cathode is negative. Reversing the polarity of voltage will not permit electron flow.

A commonly used circuit for supplying large amounts of DC power is the bridge rectifier. A bridge rectifier of four diodes (4*IN4007) are used to achieve full wave rectification. Two diodes will conduct during the negative cycle and the other two will conduct during the positive half cycle. The DC voltage appearing across the output terminals of the bridge rectifier will be somewhat lass than 90% of the applied rms value. Normally one alteration of the input voltage will reverse the polarities. Opposite ends of the transformer will therefore always be 180 deg out of phase with each other.

For a positive cycle, two diodes are connected to the positive voltage at the top winding and only one diode conducts. At the same time one of the other two diodes conducts for the negative voltage that is applied from the bottom winding due to the forward bias for that diode. In this circuit due to positive half cycle D1 & D2 will conduct to give 10.8v pulsating DC. The DC output has a ripple frequency of 100Hz. Since each altercation produces a resulting output pulse, frequency = 2*50 Hz. The output obtained is not a pure DC and therefore filtration has to be done.

Filtering Unit:

Filter circuits which usually capacitor is acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to 'short' the ripple with frequency of 100Hz to ground but also to leave the frequency of the DC to appear at the output. A load resistor R1 is connected so that a reference to the ground is maintained.

1000µf/25v : for the reduction of ripples from the pulsating.

10µf/63v : for maintaining the stability of the voltage at the load side.

O.01µf : for bypassing the high frequency disturbances.

Voltage Regulators:

The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without regulators have an inherent problem of changing DC voltage values due to variations in the load or due to fluctuations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output. IC7805 and IC7905 is used in this project for providing +5v and –5v DC supply.

2. <u>ECG Section:</u>

The muscular contractions necessary to maintain the hearts' pumping action are initiated by depolarization and repolarization of the SA node and then the depolarization and subsequent repolarization of the AV node. This electrical activity of the heart generates external action potentials. Hence by measuring these potentials at the surface of the body the electrical activity of the heart can be alalyzed end the technique used for this is called Electrocardio Graphy.

This is achieved by applying electrodes to certain positions on the body and record the potentials generated between various combinations of these electrodes with an amplifier and the computer screen display. We have used 4 electrodes for the Left Arm, Left Leg, Right Arm and Right Leg. Silver electrodes are preferred as they do not irritate the body and also the contact impedance of Silver is Minimum.

The output from the ECG electrodes are fed to a signal conditioning circuit. This circuit uses high gain amplifiers OP07 to achieve required signed gain. The gain of amplifier is set to meet the minimum input signed requirement of the PLC microcontroller. The OP07 belongs to the family of differentiate amplifiers which can very efficiently reject the interference of signals which are of a non biological origin. The offset voltage is overcome by using a 500KΩ trim pot connected for offset balancing of the OP07. The output from each of the four amplifiers are connected to the analog channel inputs ANO-AN3 of the microcontroller. The controller is programmed to process the ECG signals from a minimum of 3 electrodes.

3. Heart Beat Rate Sensor Cirtuit:

Monitoring the heart beat rate of the patient can be easily accomplished by analyzing the ECG pulse . Here, the ECG pulse is amplified and the average time interval or the instantaneous time interval between two successive R peaks is measured, from which the heart beat rate is derived. But this method fails to indicate heart blocks immediately and so photo electric pulse transducers are used.

The pulse rate monitoring method indicates a heart block immediately by sensing the cessation of blood circulation in the limb terminals. This technique uses photoelectric transducers which are easy to apply then the 3 ECG electrodes. Also the output signal amplitude is large with better signal to noise ratio.

The finger probe used for pulse pick up consists of a Ga As infrared LED and a silicon NPN phototransistor mounted in an enclosure that fits over the tip of the patients' finger. The peak spectral emission of the LED is at 0.94 mm with a 0.707 peak bandwidth of 0.04mm. The silicon phototransistor is sensitive to radiation between 0.4 and 1.1.mm. Due to the narrow bond of the spectrum involved the radiation heat output is minimized. The photo transistor is used as an emitter follower configuration. The IR signal from the LED is transmitted through the finger tip of the patient's finger and the conductivity of the phototransistor depends on the amount of radiation reaching it with each contraction of the heart, blood is forced to the extremities and amount of blood in finger increases. This alters the optical density and so the IR signal transmission through the finger reduces, causing a correspondence variation in phototransistor output. The phototransistor is connected as part of a voltage divider circuit, with 10KΩ and 22 KΩ carbon resistors and produces a voltage pulse that closely follows the heart beat rate. This pulse output is given to the bit 4 of the Port D of the microcontroller for signal processing.

4. Saline Status Monitoring Circuit:

The Saline water injection plays a key role in the treatment and recovery of many a patient that it requires constant monitoring. This condition can be easily fulfilled by using IR sensors which can detect a drop in the saline below the quantity. By means of annunciation systems, the hospital staff can be informed and an action of replacing the saline can be easily accomplished before the bottle becomes empty. Also the usage of WAP facilities sending of the saline status to the doctor concerned for any further action required.

The circuit uses an IR emitter and an IR detector which are placed in a straight line with the saline bottle in between, at the point representing the preset saline level. The presence of saline water, in a full bottle, refacts the emitted radiation, thus generating no output at the IR detector. When the saline level falls below the preset value ; the emitted IR radiation causes an photoelectric current output from the detector. The detector output is an analog quantity which is made to drive a switching NPN transistor BC107 to get a binary output from the collector of the transistor. This digital output is fed to the pin 23 of the PIC micro controller, corresponding to Port bit 4 . The signal is processed and the saline status is displayed on the screen. In case of the saline becoming empty the annunciation systems are activated.

5. Attendance Card Reader:

A patient's medical record is never complete without the data regarding the doctors who treated him/her. In our bid to automate the entire patient care system, this requirement is also accomplished by using an unique attendance card reader for the medical staff interacting with the patient.

This device is placed along side the patient in his/her ward. It uses an IR emitter- IR detected circuit to read a medical attendant's punched card. The project uses a 4 hole card with four emitter – detector pairs. Thus, a maximum $2^4 = 16$ staff can be identified using this circuit. Each staff is allotted his punched card and the details of each of the 16 staff is uploaded into the patient's database. Thus, details regarding the date and time of a medical attendant's visit, along with his identity is available for any further reference.

The circuit uses IR detectors which give analog outputs according to the card they read. A set of NPN switching transistors BC107 translate the analog output of the photoelectric card reader in to binary digital signals. These signals are connected to the bits 0 to 3 of Port C (i.e. pin 15 to pin 18) of the PIC micro controller.

6. Patient Call Switches Circuit:

The patient calling system consists of four switches when pressed gives display on the screen and activates an audio alert indicating that a patient is calling. These switches are placed in the vicinity of the patient to enable medical access in an emergency.

7. Body Temperature Measurement Circuit:

The temperature measuring circuit uses a thermistor each for the body temperature and the respiratory temperature.

A thermistor is a ceramic semiconductor which exhibits a large change in resistance with a change in its body temperature. The thermistors have much better sensitivity than RTD's and are therefore better suited for precision temperature measurements. The availability of high resistance values allows the thermistors to be used with long extension leads since the lead resistance or contact resistance effects can be greatly diminished. The non-linearity of the thermistor resistance-temperature characteristics outs a practical limit on the temperature span over which a thermistor can be operated in measurement or control circuit. RTD's have lower sensitivity and are more linear and can therefore be used in applications, where the temperature spans are very wide. Thermistors has other important advantages over RTD's in that they are available in smaller sizes, with faster response times, at lower costs and with greater resistance to shock and vibration effects.

In this circuit we have arranged thermistor in the form of potential divider when thermistor is R1 and a potentiometer is acting as a R2 which forms potential divider network and produces an output from potential divider network which is given to analog input channel of the microcontroller.

In general to obtain clear and constant o/p with respect to the input change, the sensor must be low power consumer. If we draw a lowest current sensitivity the thermistor will improve and provides better performance. Due to the above grounds we have constructed the thermistor circuits to produce low milli volts which can be easily digitized by the PIC. If not the thermistor will to drive large o/p voltage may cause self heating of the device. Self heating means large current flows through the thermistor create heat on it without accepting the body temperature.

8. Respiratory Temperature Measurement Circuit:

The air is warmed during its passage through the lungs and the expiratory tract and hence there is a detectable difference of temperature between the inhaled air and exhaled air. This difference in the temperature of the exhaled air is the respiratory temperature and it can be sensed by using a thermistor placed in front of the nostrils by means of a suitably holding device. In case the different of temperature of outside air and that of exhaled air is small, the thermistor can be initially heated to an appropriate temperature and the variation of its resistance in synchronism with the respiration rate, as a result of the cooling effect of the air stream can be detected.

The thermistors with dissipations of about 5 mw to 25 m w are used. It is placed as put of a voltage dividing circuit with a 330Ω resistance in series with the +5V supply. The output from the voltage divider is given as input to the analog channel of the microcontroller.

9. PIC Microcontroller Circuit:

The PIC 16F 877 microcontroller used has a high performance RISC CPU. It is a 40 pin DIP package with many efficient and application friendly features.

We have used a 10 MHz external crystal in crystal oscillator mode during two 22pf capacitors. The crystal output is given to pins 13 and 14 of the DIP.

The microcontroller operates over a voltage range from 2.0v to 5.5v. The +5V input is given to pins 11 and 32 as the positive supply for logic and I10pms, and pin 12, 31 are connected to the ground reference of the +EV regulated power supply board.

The PIC 16F877 has 8 analog channels and out of these analog channels AN0- AN3 are used for input from the ECG signal conditioning circuit, channels AN5 and AN6 are used for the temperature measurement circuits.

The port pins RDO-RD3 are used by the patient call switch circuit and the port pins RCO-RC3 are used by the attendance card reader circuit.

The output from the heart beat sensor is given to bit 4 of port D and output from the saline status monitoring circuit is given to bit 4 of Port C.

Pin number 25 is used in USART asynctmonous transmit mode and is connected to the pin 11 of the MAX232 driver.

Pin 26 is used in USART asynchmonous receive mode and is connected to in 12 of MAX 232 IC.

10. MAX 232:

The MAX 232 power supply section has 2 charge pumps ,the first uses external capacitors C1 to double the +5V input to +10V with input impedance of approximately 200Ω. The second charge pump uses external capacitor to invert +10V to –10V with an overall output impedance of 45Ω.

The best circuit uses 22µF capacitors for C1 and C4 but the value is not critical. Normally these capacitors are low cost aluminium electrolyte capacitors or tantalum ifsize is critical. Increasing the value of C1 and C2 to 47µF will lower the output impedance of +5V to +10V doubler by about 5Ω and +10V to -10V inverter by about 10Ω. Increasing the value of C3 and C4 lowers the ripple on the power supplies thereby lowering the 16KHz ripple on the RS 232 output. The value of C1 and C4 can be lowered to 1µF in systems where size is critical at the expense of an additional 20Ω impedance +10V output and 40Ω additional impedance at –10V input.

Transmitter Section:

Each of the two transmitters is a CMOS inverter powered by + 10V internally generated supply. The input is TTL and CMOS compatible with a logic threshold of about 26% of V_{cc}. The input if an unused transmitter section can be left unconnected: an internal 400KΩ pull up resistor connected between the transistor input and V_{cc} will pull the input high forming the unused transistor output low.

The open circuit output voltage swing is guaranteed to meet the RS232 specification + 5V output swing under the worst of both transmitter driving the 3KΩ. Minimum load impedance, the V_{cc} input at 4.5V and maximum allowable ambient temperature typical voltage with 5KΩ and V_{cc}= +9 V. The slew rate at output is limited to less than 30V/µs and the powered done output impedance will be a minimum of 300Ω with +2V applied to the output with V_{cc} = 0V.The outputs are short circuit protected and can be short circuited to ground indefinitely.

Reciever Section:

The two receivers fully conform to RS 232 specifications. Their input impedance is between 3KΩ either with or without 5V power applied and their switching threshold is within the +3V of RS232 specification. To ensure compatibility with either RS232 or TTL/CMOS input. The MAX232 receivers have V_{IL} of 0.8V and V_{IH} of 2.4V the receivers have 0.5V of hysterisis to improve noise rejection.The TTL/CMOS compatible output of receiver will be low whenever the RS232 input is greater than 2.4V. The receiver output will be high when input is floating or driven between +0.8V and –30V.

11. RS 232:

The most common communication interface for short distance is RS-232. RS-232 defines serial communication for one device to one computer communication port, with speeds upto 19,200 baud. Typically 7 or 8 bits (on/off) signal are transmitted to represent a character or digit. 9 pin connector is used .

PIN NAME	25 PIN	9 PIN	I/O DIRECTION
TxD	2	3	Output (“O”)
RxD	3	2	Input (“I”)
Gnd	7	5	
RTS	4	7	O
CTS	5	8	I
DTR	20	4	O
DSR	6	6	I
RI	22	9	I
DCD	8	1	I

HARDWARE DETAILS

MICROCHIP

PIC16F87X

28/40-Pin 8-Bit CMOS FLASH Microcontrollers

Devices Included in this Data Sheet:

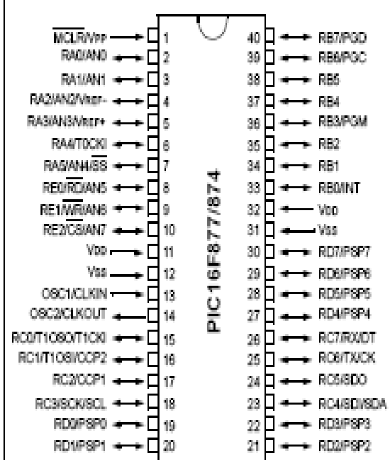
- PIC16F873
- PIC16F874
- PIC16F876
- PIC16F877

Microcontroller Core Features:

- High performance RISC CPU
- Only 35 single word instructions to learn
- All single cycle instructions except for program branches which are two cycle
- Operating speed: DC - 20 MHz clock input
  DC - 200 ns instruction cycle
- Up to 8K x 14 words of FLASH Program Memory,
  Up to 368 x 8 bytes of Data Memory (RAM)
  Up to 256 x 8 bytes of EEPROM Data Memory
- Pinout compatible to the PIC16C73B/74B/76/77
- Interrupt capability (up to 14 sources)
- Eight level deep hardware stack
- Direct, indirect and relative addressing modes
- Power-on Reset (POR)
- Power-up Timer (PWRT) and
  Oscillator Start-up Timer (OST)
- Watchdog Timer (WDT) with its own on-chip RC oscillator for reliable operation
- Programmable code protection
- Power saving SLEEP mode
- Selectable oscillator options
- Low power, high speed CMOS FLASH/EEPROM technology
- Fully static design
- In-Circuit Serial Programming™ (ICSP) via two pins
- Single 5V In-Circuit Serial Programming capability
- In-Circuit Debugging via two pins
- Processor read/write access to program memory
- Wide operating voltage range: 2.0V to 5.5V
- High Sink/Source Current: 25 mA
- Commercial, Industrial and Extended temperature ranges
- Low-power consumption:
  - < 0.6 mA typical @ 3V, 4 MHz
  - 20 µA typical @ 3V, 32 kHz
  - < 1 µA typical standby current

Pin Diagram

PDIP



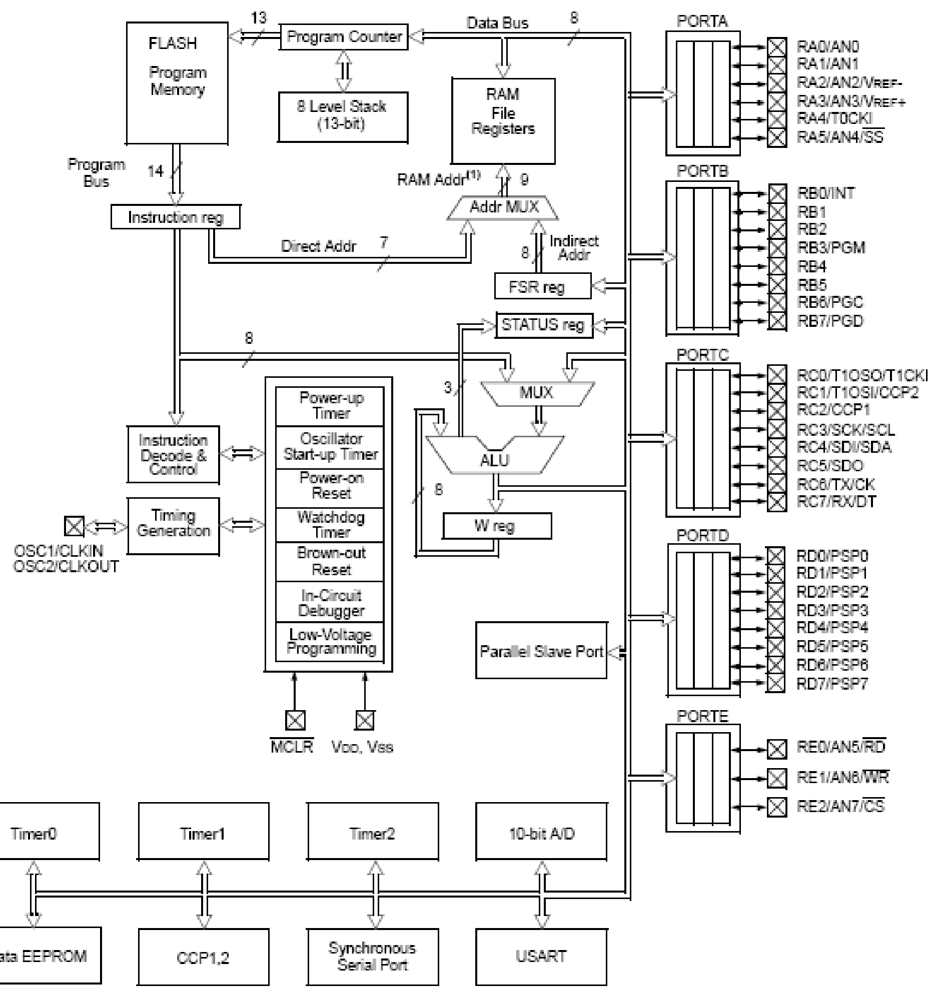
Peripheral Features:

- Timer0: 8-bit timer/counter with 8-bit prescaler
- Timer1: 16-bit timer/counter with prescaler, can be incremented during SLEEP via external crystal/clock
- Timer2: 8-bit timer/counter with 8-bit period register, prescaler and postscaler
- Two Capture, Compare, PWM modules
  - Capture is 16-bit, max. resolution is 12.5 ns
  - Compare is 16-bit, max. resolution is 200 ns
  - PWM max. resolution is 10-bit
- 10-bit multi-channel Analog-to-Digital converter
- Synchronous Serial Port (SSP) with SPI™ (Master mode) and I^2C™ (Master/Slave)
- Universal Synchronous Asynchronous Receiver Transmitter (USART/SCI) with 9-bit address detection
- Parallel Slave Port (PSP) 8-bits wide, with external RD, WR and CS controls (40/44-pin only)
- Brown-out detection circuitry for Brown-out Reset (BOR)

PIC16F87X

FIGURE 1-2: PIC16F874 AND PIC16F877 BLOCK DIAGRAM

Device	Program FLASH	Data Memory	Data EEPROM
PIC16F874	4K	192 Bytes	128 Bytes
PIC16F877	8K	368 Bytes	256 Bytes



Note 1: Higher order bits are from the STATUS register.

PIC16F87X

TABLE 1-2: PIC16F874 AND PIC16F877 PINOUT DESCRIPTION

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
OSC1/CLKIN	13	14	30	I	ST/CMOS(4)	Oscillator crystal input/external clock source input.
OSC2/CLKOUT	14	15	31	O	—	Oscillator crystal output. Connects to crystal or resonator in crystal oscillator mode. In RC mode, OSC2 pin outputs CLKOUT which has 1/4 the frequency of OSC1, and denotes the instruction cycle rate.
$\overline{MCLR}$/VPP	1	2	18	I/P	ST	Master Clear (Reset) input or programming voltage input. This pin is an active low RESET to the device.
						PORTA is a bi-directional I/O port.
RA0/AN0	2	3	19	I/O	TTL	RA0 can also be analog input0.
RA1/AN1	3	4	20	I/O	TTL	RA1 can also be analog input1.
RA2/AN2/VREF-	4	5	21	I/O	TTL	RA2 can also be analog input2 or negative analog reference voltage.
RA3/AN3/VREF+	5	6	22	I/O	TTL	RA3 can also be analog input3 or positive analog reference voltage.
RA4/T0CKI	6	7	23	I/O	ST	RA4 can also be the clock input to the Timer0 timer/counter. Output is open drain type.
RA5/$\overline{SS}$/AN4	7	8	24	I/O	TTL	RA5 can also be analog input4 or the slave select for the synchronous serial port.
						PORTB is a bi-directional I/O port. PORTB can be software programmed for internal weak pull-up on all inputs.
RB0/INT	33	36	8	I/O	TTL/ST(1)	RB0 can also be the external interrupt pin.
RB1	34	37	9	I/O	TTL	
RB2	35	38	10	I/O	TTL	
RB3/PGM	36	39	11	I/O	TTL	RB3 can also be the low voltage programming input.
RB4	37	41	14	I/O	TTL	Interrupt-on-change pin.
RB5	38	42	15	I/O	TTL	Interrupt-on-change pin.
RB6/PGC	39	43	16	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming clock.
RB7/PGD	40	44	17	I/O	TTL/ST(2)	Interrupt-on-change pin or In-Circuit Debugger pin. Serial programming data.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as an external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured as general purpose I/O and a TTL input when used in the Parallel Slave Port mode (for interfacing to a microprocessor bus).
4: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

TABLE 1-2: PIC16F874 AND PIC16F877 PINOUT DESCRIPTION (CONTINUED)

Pin Name	DIP Pin#	PLCC Pin#	QFP Pin#	I/O/P Type	Buffer Type	Description
						PORTC is a bi-directional I/O port.
RC0/T1OSO/T1CKI	15	16	32	I/O	ST	RC0 can also be the Timer1 oscillator output or a Timer1 clock input.
RC1/T1OSI/CCP2	16	18	35	I/O	ST	RC1 can also be the Timer1 oscillator input or Capture2 input/Compare2 output/PWM2 output.
RC2/CCP1	17	19	36	I/O	ST	RC2 can also be the Capture1 input/Compare1 output/PWM1 output.
RC3/SCK/SCL	18	20	37	I/O	ST	RC3 can also be the synchronous serial clock input/output for both SPI and I^2C modes.
RC4/SDI/SDA	23	25	42	I/O	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	24	26	43	I/O	ST	RC5 can also be the SPI Data Out (SPI mode).
RC6/TX/CK	25	27	44	I/O	ST	RC6 can also be the USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	26	29	1	I/O	ST	RC7 can also be the USART Asynchronous Receive or Synchronous Data.
						PORTD is a bi-directional I/O port or parallel slave port when interfacing to a microprocessor bus.
RD0/PSP0	19	21	38	I/O	ST/TTL(3)	
RD1/PSP1	20	22	39	I/O	ST/TTL(3)	
RD2/PSP2	21	23	40	I/O	ST/TTL(3)	
RD3/PSP3	22	24	41	I/O	ST/TTL(3)	
RD4/PSP4	27	30	2	I/O	ST/TTL(3)	
RD5/PSP5	28	31	3	I/O	ST/TTL(3)	
RD6/PSP6	29	32	4	I/O	ST/TTL(3)	
RD7/PSP7	30	33	5	I/O	ST/TTL(3)	
						PORTE is a bi-directional I/O port.
RE0/$\overline{RD}$/AN5	8	9	25	I/O	ST/TTL(3)	RE0 can also be read control for the parallel slave port, or analog input5.
RE1/$\overline{WR}$/AN6	9	10	26	I/O	ST/TTL(3)	RE1 can also be write control for the parallel slave port, or analog input6.
RE2/$\overline{CS}$/AN7	10	11	27	I/O	ST/TTL(3)	RE2 can also be select control for the parallel slave port, or analog input7.
VSS	12,31	13,34	6,29	P	—	Ground reference for logic and I/O pins.
VDD	11,32	12,35	7,28	P	—	Positive supply for logic and I/O pins.
NC	—	1,17,28, 40	12,13, 33,34		—	These pins are not internally connected. These pins should be left unconnected.

Legend: I = input O = output I/O = input/output P = power
— = Not used TTL = TTL input ST = Schmitt Trigger input

Note 1: This buffer is a Schmitt Trigger input when configured as an external interrupt.
2: This buffer is a Schmitt Trigger input when used in Serial Programming mode.
3: This buffer is a Schmitt Trigger input when configured as general purpose I/O and a TTL input when used in the Parallel Slave Port mode (for interfacing to a microprocessor bus).
4: This buffer is a Schmitt Trigger input when configured in RC oscillator mode and a CMOS input otherwise.

TABLE 3-1: PORTA FUNCTIONS

Name	Bit#	Buffer	Function
RA0/AN0	bit0	TTL	Input/output or analog input.
RA1/AN1	bit1	TTL	Input/output or analog input.
RA2/AN2	bit2	TTL	Input/output or analog input.
RA3/AN3/VREF	bit3	TTL	Input/output or analog input or VREF.
RA4/T0CKI	bit4	ST	Input/output or external clock input for Timer0. Output is open drain type.
RA5/SS/AN4	bit5	TTL	Input/output or slave select input for synchronous serial port or analog input.

Legend: TTL = TTL input, ST = Schmitt Trigger input

TABLE 3-2: SUMMARY OF REGISTERS ASSOCIATED WITH PORTA

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
05h	PORTA	—	—	RA5	RA4	RA3	RA2	RA1	RA0	--0x 0000	--0u 0000
85h	TRISA	—	—	PORTA Data Direction Register						--11 1111	--11 1111
9Fh	ADCON1	ADFM	—	—	—	PCFG3	PCFG2	PCFG1	PCFG0	--0- 0000	--0- 0000

Legend: x = unknown, u = unchanged, - = unimplemented locations read as '0'.
Shaded cells are not used by PORTA.

TABLE 3-5: PORTC FUNCTIONS

Name	Bit#	Buffer Type	Function
RC0/T1OSO/T1CKI	bit0	ST	Input/output port pin or Timer1 oscillator output/Timer1 clock input.
RC1/T1OSI/CCP2	bit1	ST	Input/output port pin or Timer1 oscillator input or Capture2 input/ Compare2 output/PWM2 output.
RC2/CCP1	bit2	ST	Input/output port pin or Capture1 input/Compare1 output/ PWM1 output.
RC3/SCK/SCL	bit3	ST	RC3 can also be the synchronous serial clock for both SPI and I^2C modes.
RC4/SDI/SDA	bit4	ST	RC4 can also be the SPI Data In (SPI mode) or data I/O (I^2C mode).
RC5/SDO	bit5	ST	Input/output port pin or Synchronous Serial Port data output.
RC6/TX/CK	bit6	ST	Input/output port pin or USART Asynchronous Transmit or Synchronous Clock.
RC7/RX/DT	bit7	ST	Input/output port pin or USART Asynchronous Receive or Synchronous Data.

Legend: ST = Schmitt Trigger input

TABLE 3-6: SUMMARY OF REGISTERS ASSOCIATED WITH PORTC

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
07h	PORTC	RC7	RC6	RC5	RC4	RC3	RC2	RC1	RC0	xxxx xxxx	uuuu uuuu
87h	TRISC	PORTC Data Direction Register								1111 1111	1111 1111

Legend: x = unknown, u = unchanged

TABLE 3-7: PORTD FUNCTIONS

Name	Bit#	Buffer Type	Function
RD0/PSP0	bit0	ST/TTL(1)	Input/output port pin or parallel slave port bit0.
RD1/PSP1	bit1	ST/TTL(1)	Input/output port pin or parallel slave port bit1.
RD2/PSP2	bit2	ST/TTL(1)	Input/output port pin or parallel slave port bit2.
RD3/PSP3	bit3	ST/TTL(1)	Input/output port pin or parallel slave port bit3.
RD4/PSP4	bit4	ST/TTL(1)	Input/output port pin or parallel slave port bit4.
RD5/PSP5	bit5	ST/TTL(1)	Input/output port pin or parallel slave port bit5.
RD6/PSP6	bit6	ST/TTL(1)	Input/output port pin or parallel slave port bit6.
RD7/PSP7	bit7	ST/TTL(1)	Input/output port pin or parallel slave port bit7.

Legend: ST = Schmitt Trigger input, TTL = TTL input

Note 1: Input buffers are Schmitt Triggers when in I/O mode and TTL buffers when in Parallel Slave Port mode.

TABLE 3-9: PORTE FUNCTIONS

Name	Bit#	Buffer Type	Function
RE0/$\overline{RD}$/AN5	bit0	ST/TTL(1)	I/O port pin or read control input in Parallel Slave Port mode or analog input: $\overline{RD}$ 1 = Idle 0 = Read operation. Contents of PORTD register are output to PORTD I/O pins (if chip selected)
RE1/$\overline{WR}$/AN6	bit1	ST/TTL(1)	I/O port pin or write control input in Parallel Slave Port mode or analog input: $\overline{WR}$ 1 = Idle 0 = Write operation. Value of PORTD I/O pins is latched into PORTD register (if chip selected)
RE2/$\overline{CS}$/AN7	bit2	ST/TTL(1)	I/O port pin or chip select control input in Parallel Slave Port mode or analog input: $\overline{CS}$ 1 = Device is not selected 0 = Device is selected

Legend: ST = Schmitt Trigger input, TTL = TTL input

Note 1: Input buffers are Schmitt Triggers when in I/O mode and TTL buffers when in Parallel Slave Port mode.

TABLE 3-10: SUMMARY OF REGISTERS ASSOCIATED WITH PORTE

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
09h	PORTE	—	—	—	—	—	RE2	RE1	RE0	---- -xxx	---- -uuu
89h	TRISE	IBF	OBF	IBOV	PSPMODE	—	PORTE Data Direction Bits			0000 -111	0000 -111
9Fh	ADCON1	ADFM	—	—	—	PCFG3	PCFG2	PCFG1	PCFG0	--0- 0000	--0- 0000

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0'. Shaded cells are not used by PORTE.

TABLE 3-8: SUMMARY OF REGISTERS ASSOCIATED WITH PORTD

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
08h	PORTD	RD7	RD6	RD5	RD4	RD3	RD2	RD1	RD0	xxxx xxxx	uuuu uuuu
88h	TRISD	PORTD Data Direction Register								1111 1111	1111 1111
89h	TRISE	IBF	OBF	IBOV	PSPMODE	—	PORTE Data Direction Bits			0000 -111	0000 -111

Legend: x = unknown, u = unchanged, - = unimplemented, read as '0'. Shaded cells are not used by PORTD.

STATUS REGISTER (ADDRESS 03h, 83h, 103h, 183h)

R/W-0	R/W-0	R/W-0	R-1	R-1	R/W-x	R/W-x	R/W-x
IRP	RP1	RP0	$\overline{TO}$	$\overline{PD}$	Z	DC	C
bit 7							bit 0

bit 7 **IRP**: Register Bank Select bit (used for indirect addressing)
1 = Bank 2, 3 (100h - 1FFh)
0 = Bank 0, 1 (00h - FFh)

bit 6-5 **RP1:RP0**: Register Bank Select bits (used for direct addressing)
11 = Bank 3 (180h - 1FFh)
10 = Bank 2 (100h - 17Fh)
01 = Bank 1 (80h - FFh)
00 = Bank 0 (00h - 7Fh)
Each bank is 128 bytes

bit 4 $\overline{\text{TO}}$: Time-out bit
1 = After power-up, CLRWDT instruction, or SLEEP instruction
0 = A WDT time-out occurred

bit 3 $\overline{\text{PD}}$: Power-down bit
1 = After power-up or by the CLRWDT instruction
0 = By execution of the SLEEP instruction

bit 2 Z: Zero bit
1 = The result of an arithmetic or logic operation is zero
0 = The result of an arithmetic or logic operation is not zero

bit 1 DC: Digit carry/$\overline{\text{borrow}}$ bit (ADDWF, ADDLW, SUBLW, SUBWF instructions)
(for borrow, the polarity is reversed)
1 = A carry-out from the 4th low order bit of the result occurred
0 = No carry-out from the 4th low order bit of the result

bit 0 C: Carry/$\overline{\text{borrow}}$ bit (ADDWF, ADDLW, SUBLW, SUBWF instructions)
1 = A carry-out from the Most Significant bit of the result occurred
0 = No carry-out from the Most Significant bit of the result occurred

Note: For borrow, the polarity is reversed. A subtraction is executed by adding the two's complement of the second operand. For rotate (RRF, RLF) instructions, this bit is loaded with either the high, or low order bit of the source register.

INTCON REGISTER (ADDRESS 0Bh, 8Bh, 10Bh, 18Bh)

R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-0	R/W-x
GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	RBIF
bit 7							bit 0

bit 7 **GIE**: Global Interrupt Enable bit
1 = Enables all unmasked interrupts
0 = Disables all interrupts

bit 6 **PEIE**: Peripheral Interrupt Enable bit
1 = Enables all unmasked peripheral interrupts
0 = Disables all peripheral interrupts

bit 5 **T0IE**: TMR0 Overflow Interrupt Enable bit
1 = Enables the TMR0 interrupt
0 = Disables the TMR0 interrupt

bit 4 **INTE**: RB0/INT External Interrupt Enable bit
1 = Enables the RB0/INT external interrupt
0 = Disables the RB0/INT external interrupt

bit 3 **RBIE**: RB Port Change Interrupt Enable bit
1 = Enables the RB port change interrupt
0 = Disables the RB port change interrupt

bit 2 **T0IF**: TMR0 Overflow Interrupt Flag bit
1 = TMR0 register has overflowed (must be cleared in software)
0 = TMR0 register did not overflow

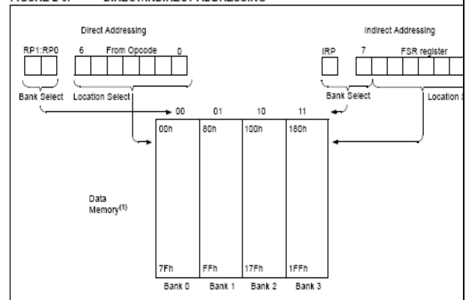
bit 1 **INTF**: RB0/INT External Interrupt Flag bit
1 = The RB0/INT external interrupt occurred (must be cleared in software)
0 = The RB0/INT external interrupt did not occur

bit 0 **RBIF**: RB Port Change Interrupt Flag bit
1 = At least one of the RB7:RB4 pins changed state; a mismatch condition will continue the bit. Reading PORTB will end the mismatch condition and allow the bit to be clea (must be cleared in software).
0 = None of the RB7:RB4 pins have changed state

Indirect Addressing, INDF and FSR Registers

The INDF register is not a physical register. Addressing the INDF register will cause indirect addressing. Indirect addressing is possible by using the INDF register. Any instruction using the INDF register actually accesses the register pointed to by the File Select Register, FSR. Reading the INDF register itself, indirectly (FSR = '0') will read 00h. Writing to the INDF register indirectly results in a no operation (although status bits may be affected). An effective 9-bit address is obtained by concatenating the 8-bit FSR register and the IRP bit (STATUS<7>), as shown in figure 2.6.

FIGURE 2-6: DIRECT/INDIRECT ADDRESSING



Note 1: For register file map detail, see Figure 2-3.

ANALOG TO DIGITAL CONVERSION

The Analog-to-Digital (A/D) Converter module has five inputs for the 28-pin devices and eight for the other devices.
The analog input charges a sample and hold capacitor. The output of the sample and hold capacitor is the input into the converter. The converter then generates a digital result of this analog level via successive approximation. The A/D conversion of the analog input signal results in a corresponding 10-bit digital number. The A/D module has high and low voltage reference input that is software selectable to some combination of V_{DD}, V_{SS}, RA2, or RA3.

The A/D converter has a unique feature of being able to operate while the device is in SLEEP mode. To operate in SLEEP, the A/D clock must be derived from the

A/D's internal RC oscillator.
The A/D module has four registers. These registers
are:
• A/D Result High Register (ADRESH)
• A/D Result Low Register (ADRESL)
• A/D Control Register0 (ADCON0)
• A/D Control Register1 (ADCON1)
The ADCON0 register, shown in Register 11-1, controls
the operation of the A/D module. The ADCON1 register, configures the functions of the port pins. The port pins can be configured as analog inputs (RA3 can also be the voltage reference), or as digital I/O. Additional information on using the A/D module can be found in the PICmicro™ Mid-Range MCU Family reference Manual (DS33023).

These steps should be followed for doing an A/D Conversion:

1. Configure the A/D module:
   - Configure analog pins/voltage reference and digital I/O (ADCON1)
   - Select A/D input channel (ADCON0)
   - Select A/D conversion clock (ADCON0)
   - Turn on A/D module (ADCON0)
2. Configure A/D interrupt (if desired):
   - Clear ADIF bit
   - Set ADIE bit
   - Set PEIE bit
   - Set GIE bit
3. Wait the required acquisition time.
4. Start conversion:
   - Set GO/$\overline{\text{DONE}}$ bit (ADCON0)
5. Wait for A/D conversion to complete, by either:
   - Polling for the GO/$\overline{\text{DONE}}$ bit to be cleared (with interrupts enabled); OR
   - Waiting for the A/D interrupt
6. Read A/D result register pair (ADRESH:ADRESL), clear bit ADIF if required.
7. For the next conversion, go to step 1 or step 2, as required. The A/D conversion time per bit is defined as T_{AD}. A minimum wait of $2T_{AD}$ is required before the next acquisition starts.

11.1 A/D Acquisition Requirements

For the A/D converter to meet its specified accuracy, the charge holding capacitor (C_{HOLD}) must be allowed to fully charge to the input channel voltage level. The analog input model is shown in Figure 11-2. The source impedance (R_S) and the internal sampling switch (R_{SS}) impedance directly affect the time required to charge the capacitor C_{HOLD}. The sampling switch (R_{SS}) impedance varies over the device voltage (V_{DD}), see Figure 11-2. **The maximum recommended impedance for analog sources is 10 kΩ.** As the impedance is decreased, the acquisition time may be decreased.

After the analog input channel is selected (changed), this acquisition must be done before the conversion can be started.

To calculate the minimum acquisition time, Equation 11-1 may be used. This equation assumes that 1/2 LSb error is used (1024 steps for the A/D). The 1/2 LSb error is the maximum error allowed for the A/D to meet its specified resolution.

To calculate the minimum acquisition time, T_{ACQ}, see the PICmicro™ Mid-Range Reference Manual (DS33023).

11.4.1 A/D RESULT REGISTERS
The ADRESH:ADRESL register pair is the location where the 10-bit A/D result is loaded at the completion of the A/D conversion. This register pair is 16-bits wide. The A/D module gives the flexibility to left or right justify

the 10-bit result in the 16-bit result register. The A/D Format Select bit (ADFM) controls this justification. Figure 11-4 shows the operation of the A/D result justification. The extra bits are loaded with ’0’s’. When an A/D result will not overwrite these locations (A/D disable), these registers may be used as two general purpose 8-bit registers .

10.1 USART Baud Rate Generator (BRG)

The BRG supports both the Asynchronous and Synchronous modes of the USART. It is a dedicated 8-bit baud rate generator. The SPBRG register controls the period of a free running 8-bit timer. In Asynchronous mode, bit BRGH (TXSTA<2>) also controls the baud rate. In Synchronous mode, bit BRGH is ignored. Table 10-1 shows the formula for computation of the baud rate for different USART modes which only apply in Master mode (internal clock).

Given the desired baud rate and FOSC, the nearest integer value for the SPBRG register can be calculated using the formula in Table 10-1. From this, the error in baud rate can be determined.

It may be advantageous to use the high baud rate (BRGH = 1), even for slower baud clocks. This is because the FOSC/(16(X + 1)) equation can reduce the baud rate error in some cases.

Writing a new value to the SPBRG register causes the BRG timer to be reset (or cleared). This ensures the BRG does not wait for a timer overflow before outputting the new baud rate.

10.1.1 SAMPLING

The data on the RC7/RX/DT pin is sampled three times by a majority detect circuit to determine if a high or a low level is present at the RX pin.

TABLE 10-1: BAUD RATE FORMULA

SYNC	BRGH = 0 (Low Speed)	BRGH = 1 (High Speed)
0	(Asynchronous) Baud Rate = FOSC/(64(X+1))	Baud Rate = FOSC/(16(X+1))
1	(Synchronous) Baud Rate = FOSC/(4(X+1))	N/A

X = value in SPBRG (0 to 255)

When setting up an Asynchronous Transmission, follow these steps:

1. Initialize the SPBRG register for the appropriate baud rate. If a high speed baud rate is desired, set bit BRGH (Section 10.1).	5. Enable the transmission by setting bit TXEN, which will also set bit TXIF.
2. Enable the asynchronous serial port by clearing bit SYNC and setting bit SPEN.	6. If 9-bit transmission is selected, the ninth bit should be loaded in bit TX9D.
3. If interrupts are desired, then set enable bit TXIE.	7. Load data to the TXREG register (starts transmission).
4. If 9-bit transmission is desired, then set transmit bit TX9.	8. If using interrupts, ensure that GIE and PEIE (bits 7 and 6) of the INTCON register are set.

When setting up an Asynchronous Reception, follow these steps:

1. Initialize the SPBRG register for the appropriate baud rate. If a high speed baud rate is desired, set bit BRGH (Section 10.1).	6. Flag bit RCIF will be set when reception is complete and an interrupt will be generated if enable bit RCIE is set.
2. Enable the asynchronous serial port by clearing bit SYNC and setting bit SPEN.	7. Read the RCSTA register to get the ninth bit (if enabled) and determine if any error occurred during reception.
3. If interrupts are desired, then set enable bit RCIE.	8. Read the 8-bit received data by reading the RCREG register.
4. If 9-bit reception is desired, then set bit RX9.	9. If any error occurred, clear the error by clearing enable bit CREN.
5. Enable the reception by setting bit CREN.	10. If using interrupts, ensure that GIE and PEIE (bits 7 and 6) of the INTCON register are set

TABLE 10-6: REGISTERS ASSOCIATED WITH ASYNCHRONOUS RECEPTION

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
0Bh, 8Bh, 10Bh,18Bh	INTCON	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	R0IF	0000 000x	0000 000u
0Ch	PIR1	PSPIF[(1)]	ADIF	RCIF	TXIF	SSPIF	CCP1IF	TMR2IF	TMR1IF	0000 0000	0000 0000
18h	RCSTA	SPEN	RX9	SREN	CREN	—	FERR	OERR	RX9D	0000 -00x	0000 -00x
1Ah	RCREG	USART Receive Register								0000 0000	0000 0000
8Ch	PIE1	PSPIE[(1)]	ADIE	RCIE	TXIE	SSPIE	CCP1IE	TMR2IE	TMR1IE	0000 0000	0000 0000
98h	TXSTA	CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D	0000 -010	0000 -010
99h	SPBRG	Baud Rate Generator Register								0000 0000	0000 0000

Legend: x = unknown, - = unimplemented locations read as '0'. Shaded cells are not used for asynchronous reception.
Note 1: Bits PSPIE and PSPIF are reserved on PIC16F873/876 devices; always maintain these bits clear.

TABLE 10-5: REGISTERS ASSOCIATED WITH ASYNCHRONOUS TRANSMISSION

Address	Name	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0	Value on: POR, BOR	Value on all other RESETS
0Bh, 8Bh, 10Bh,18Bh	INTCON	GIE	PEIE	T0IE	INTE	RBIE	T0IF	INTF	R0IF	0000 000x	0000 000u
0Ch	PIR1	PSPIF[(1)]	ADIF	RCIF	TXIF	SSPIF	CCP1IF	TMR2IF	TMR1IF	0000 0000	0000 0000
18h	RCSTA	SPEN	RX9	SREN	CREN	—	FERR	OERR	RX9D	0000 -00x	0000 -00x
19h	TXREG	USART Transmit Register								0000 0000	0000 0000
8Ch	PIE1	PSPIE[(1)]	ADIE	RCIE	TXIE	SSPIE	CCP1IE	TMR2IE	TMR1IE	0000 0000	0000 0000
98h	TXSTA	CSRC	TX9	TXEN	SYNC	—	BRGH	TRMT	TX9D	0000 -010	0000 -010
99h	SPBRG	Baud Rate Generator Register								0000 0000	0000 0000

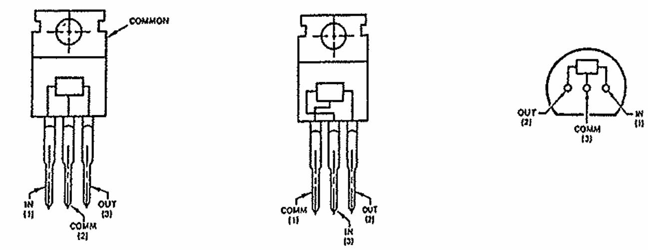
Legend: x = unknown, - = unimplemented locations read as '0'. Shaded cells are not used for asynchronous transmission.
Note 1: Bits PSPIE and PSPIF are reserved on the PIC16F873/876; always maintain these bits clear.

CODI Semiconductor, Inc.

LINEAR

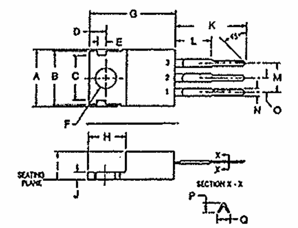
LOGIC SYMBOLS AND CONNECTION DIAGRAMS

L-CD1 L-CD2 L-CD3



PACKAGE OUTLINES

JEDEC TO-220 Outline
Plastic Power Package

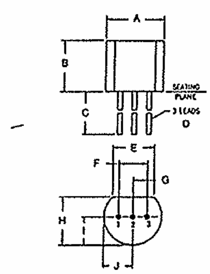


	INCHES			MILLIMETERS		
DIM.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	.385		.410	10.03		10.41
B	.365		.385	9.27		9.77
C	.300		.320	7.62		8.13
D	.100		.120	2.54		3.05
E	.040		.080	1.02		1.52
F	.141		.145	3.58		3.68
G	.575		.600	14.6		15.24
H	.235		.265	5.97		6.73
I	.160		.190	4.06		4.83
J	.020		.055	.508		1.40
K	.500			12.70		
L			.250			6.35
M	.190		.210	4.83		5.33
N	.045		.055	1.05		1.40
O	.095		.105	2.41		2.66
P	.015		.030	.381		.762
Q	.020		.045	.508		1.43

NOTES: See table for dimensions in inches and millimeters
Center lead is electrical contact with the mounting tab

Package weight is 2.1 grams

JEDEC TO-92 Outline
Plastic Package



	INCHES			MILLIMETERS		
DIM.	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	.175		.205	4.45		5.20
B	.170		.210	4.32		5.33
C	.500			12.70		
D	.016		.019	0.406		0.483
E	.135			.343		
F		.100			2.54	
G		.050			1.27	
H	.125		.165	3.18		4.19
I	.080		.105	2.03		2.67
J	.080		.105	2.03		2.67

NOTES: See table for dimensions in inches and millimeters
Package material is transfer molded thermosetting plastic
Package weight is 0.25 grams

LINEAR INTEGRATED CIRCUITS
3 - TERMINAL VOLTAGE REGULATORS

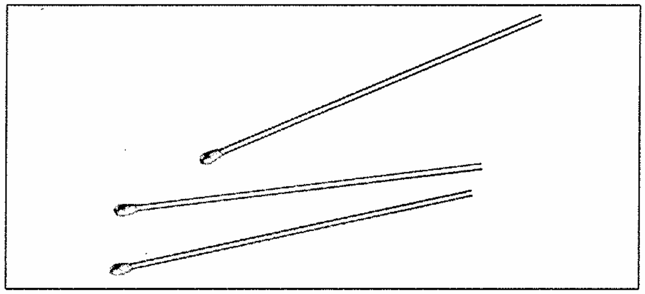
	1 AMP Pos. 7805-7824	1 AMP Neg. 7905-7924	.5A Pos. 78M05-78M24	.1A Pos. 78L05-78L24
Thermal resistance Rj-c Rj-a	5°c/w 70°c/w			7°c/w 100°c/w
Power Dissipation	20W		10W	500MW
Temperature range Operating Ambient Operating Junction Storage	-20 to + 80°C -20 to + 125°C -55 to + 125°C			-20 to + 75°C -20 to + 125°C -40 to + 125°C
Line Regulation (MV) Vo/Vi (%)	2.0		1.0	2.0
Load Regulation (MV) Vo/Io (%)	2.0		1.0	
Logic/Connection diagram	L-CD 1	L-CD 2	L-CD 1	L-CD 3
Package	TO-220			TO-92

TYPE No.	Nominal OUTPUT Voltage Range (V)	OUTPUT Voltage Range (V)	INPUT Voltage Range (V)	Quiescent Current (MA)	Ripple Rejection (dB) MIN	OUTPUT Noise Voltage (uV)	OUTPUT Voltage Drift (TYP) MV/°C
1 AMP POSITIVE							
7805	5.0	4.8-5.2	7.0-35.0	5.3	62	40	0.6
7806	6.0	5.75-6.25	8.0-35.0	4.7	59	45	0.6
7808	8.0	7.7-8.3	10.5-35.0	4.7	56	50	0.6
7812	12.0	11.5-12.5	14.5-35.0	4.7	55	70	0.8
7815	15.0	14.4-15.6	17.5-35.0	4.7	54	85	1.0
7818	18.0	17.3-18.7	21.0-35.0	5.0	53	95	1.2
7824	24.0	23.0-25.0	27.0-40.0	5.0	50	120	1.6
1 AMP NEGATIVE							
7905	-5.0	-4.8-5.2	-7.0-35.0	1.0	54	100	-0.4
7906	-6.0	-5.75-6.25	-8.0-35.0	1.0	54	150	-0.5
7908	-8.0	-7.7-8.3	-10.5-35.0	1.0	54	200	-0.6
7912	-12.0	-11.5-12.5	-14.5-35.0	1.5	54	300	-0.8
7915	-15.0	-14.4-15.6	-17.5-35.0	1.5	54	375	-1.0
7918	-18.0	-17.3-18.7	-21.0-35.0	1.5	54	450	-1.0
7924	-24.0	-23.0-25.0	-27.0-40.0	1.5	51	600	-1.0
.5A (500ma) POSITIVE							
78M05	5.0	4.8-5.2	7.0-35.0	4.5	62	40	-1.0
78M06	6.0	5.75-6.25	8.0-35.0	4.6	59	45	-1.0
78M08	8.0	7.7-8.3	10.5-35.0	4.6	56	52	-1.0
78M12	12.0	11.5-12.5	14.5-35.0	4.8	55	35	-1.0
78M15	15.0	14.4-15.6	17.5-35.0	4.8	54	90	-1.0
78M18	18.0	17.3-18.7	21.0-35.0	4.8	53	100	-1.0
78M24	24.0	23.0-25.0	27.0-40.0	5.0	50	170	-1.0
.1A (100ma) POSITIVE							
78L05	5.0	4.75-5.25	7.0-30.0	6.0*	40	40	-1.0
78L06	6.0	5.95-6.45	8.0-30.0	6.0*	39	50	-1.0
78L08	8.0	7.6-8.4	10.5-30.0	6.0*	39	60	-1.0
78L12	12.0	11.4-12.6	14.5-35.0	6.5*	37	80	-1.5
78L15	15.0	14.3-15.7	17.5-35.0	6.5*	34	90	-1.5
78L18	18.0	17.1-18.9	21.0-40.0	6.5*	33	120	-2.0
78L24	24.0	22.8-25.2	27.0-40.0	7.0*	32	200	-2.0

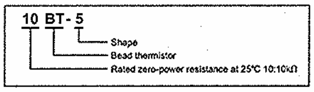
*max

BT THERMISTOR

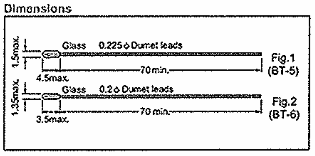
The BT thermistor is a small thermal sensing device providing high reliability, stable characteristics and a wide operating range of −50°C to 300°C.
It is used in various applications including medical apparatus, industrial equipment and home electric appliances.



Part number



Dimensions



Specifications

Port No.	R_{25}*1	B value*2	Dissipation factor (mW/°C)	Thermal Time constant(s)*3	Rated power at 25°C(mW)	Operating temp. range(°C)
1BT-5	1.000kΩ±10%	3,250K±3%	0.5	4~12	2.5	−50~150
2BT-5	2.000kΩ±10%	3,420K±3%	0.5	4~12	2.5	−50~300
5BT-5(6)	5.000kΩ±10%	3,450K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
9BT-5(6)	9.000kΩ±10%	3,470K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~150
10BT-5(6)	10.00kΩ±10%	3,250K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
20BT-5(6)	20.00kΩ±10%	3,330K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
30BT-5(6)	30.00kΩ±10%	3,450K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
40BT-5(6)	40.00kΩ±10%	3,550K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
100BT-5(6)	100.0kΩ±10%	3,750K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
400BT-5(6)	400.0kΩ±10%	4,050K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
500BT-5(6)	500.0kΩ±10%	3,760K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300
1.3MBT-5(6)	1300kΩ±10%	4,380K±3%	0.5(0.4)	4~12(3~8)	2.5(2)	−50~300

*1 R_{25}: Rated zero-power resistance value at 25°C, ±5% are also available.
*2 B value: determined by rated zero-power resistance at 25°C and 85°C.
*3 Time when thermistor temperature reaches 63.2% of the temperature difference. The value is measured in the air

Resistance-Temperature

Temperature (°C)	Type											
	1BT	2BT	5BT	9BT	10BT	20BT	30BT	40BT	100BT	400BT	500BT	1.3MBT
−50	29.87	70.71		344.8	284.8	686.7			4860			
−40	17.33	40.02		190.3	163.4	383.1			2599	11043		
−30	10.35	23.28		109.1	97.62	222.6			1439	6198		
−20	6.374	13.96	35.44	64.81	60.41	134.2		306.8	827.4	3573		
−10	4.038	8.640	21.84	39.70	38.63	83.61		184.7	491.1	2109		8066
0	2.629	5.513	13.87	25.15	25.45	53.75	83.80	115.0	301.4	1274	1486	4598
10	1.755	3.610	9.057	16.36	17.22	35.53	54.46	73.88	190.1	788.4	945.3	2718
20	1.200	2.421	6.060	10.92	11.92	24.09	36.37	48.77	123.1	498.7	614.7	1652
25	1.000	2.000	5.000	9.000	10.00	20.00	30.00	40.00	100.0	400.0	500.0	1300
30	0.8380	1.661	4.148	7.456	8.434	16.70	24.88	33.00	81.71	322.4	408.9	1029
40	0.5973	1.163	2.898	5.200	6.084	11.81	17.39	22.82	55.39	212.8	277.7	656.0
50	0.4338	0.8311	2.065	3.698	4.456	8.511	12.40	16.10	38.31	143.3	192.1	427.8
60	0.3205	0.6043	1.497	2.677	3.303	6.248	8.990	11.57	27.00	98.24	135.3	284.5
70	0.2407	0.4468	1.104	1.970	2.460	4.658	6.629	8.457	19.38	68.52	96.90	193.0
80	0.1834	0.3357	0.8267	1.473	1.850	3.522	4.962	6.279	14.14	48.50	70.47	133.0
90	0.1417	0.2559	0.6280	1.117	1.405	2.698	3.767	4.730	10.48	34.91	52.00	92.76
100	0.1110	0.1978	0.4836	0.8581	1.078	2.093	2.897	3.611	7.866	25.47	38.90	65.53
110	0.08789	0.1547	0.3771	0.6685	0.8355	1.640	2.255	2.792	5.968	18.83	29.49	46.91
120		0.1224	0.2975	0.5264	0.6540	1.296	1.774	2.182	4.580	14.10	22.63	34.03
130		0.09789	0.2373	0.4191	0.5171	1.027	1.410	1.727	3.551	10.68	17.55	25.02
140		0.07908	0.1913	0.3369	0.4126	0.8190	1.130	1.378	2.782	8.180	13.76	18.59
150		0.06450	0.1556	0.2735	0.3321	0.6581	0.9113	1.107	2.201	6.332	10.90	13.99
160			0.1278		0.2696	0.5327	0.7374	0.8943	1.757	4.957	8.717	10.63
170			0.1058		0.2207	0.4345	0.5997	0.7252	1.416	3.915	7.034	8.163
180			0.08836		0.1818	0.3567	0.4909	0.5915	1.150	3.120	5.722	6.336
190			0.07432		0.1508	0.2947	0.4048	0.4859	0.9418	2.508	4.692	4.965
200			0.06295		0.1258	0.2451	0.3360	0.4018	0.7770	2.032	3.876	3.926
210					0.1056	0.2052	0.2808	0.3344	0.6458	1.658	3.225	3.131
220							0.2360	0.2802	0.5403	1.363	2.702	2.517
230							0.1995	0.2361	0.4551	1.127	2.277	2.039
240							0.1695	0.2000	0.3855	0.9390	1.930	1.663
250							0.1447	0.1704	0.3286	0.7864	1.644	1.366
260							0.1243	0.1458	0.2816	0.6626	1.407	1.129
270							0.1072	0.1255	0.2426	0.5613	1.209	0.9398
280							0.09283	0.1084	0.2100	0.4780	1.041	0.7871
290							0.08078	0.09408	0.1826	0.4091	0.8995	0.6628
300							0.07060	0.08200	0.1595	0.3518	0.7810	0.5612

Unit(kΩ)

16

National Semiconductor

February 1995

LM78XX Series Voltage Regulators

General Description

The LM78XX series of three terminal regulators is available with several fixed output voltages making them useful in a wide range of applications. One of these is local on card regulation, eliminating the distribution problems associated with single point regulation. The voltages available allow these regulators to be used in logic systems, instrumentation, HiFi, and other solid state electronic equipment. Although designed primarily as fixed voltage regulators these devices can be used with external components to obtain adjustable voltages and currents.

The LM78XX series is available in an aluminum TO-3 package which will allow over 1.0A load current if adequate heat sinking is provided. Current limiting is included to limit the peak output current to a safe value. Safe area protection for the output transistor is provided to limit internal power dissipation. If internal power dissipation becomes too high for the heat sinking provided, the thermal shutdown circuit takes over preventing the IC from overheating.

Considerable effort was expanded to make the LM78XX series of regulators easy to use and minimize the number of external components. It is not necessary to bypass the output, although this does improve transient response. Input bypassing is needed only if the regulator is located far from the filter capacitor of the power supply.

For output voltage other than 5V, 12V and 15V the LM117 series provides an output voltage range from 1.2V to 57V.

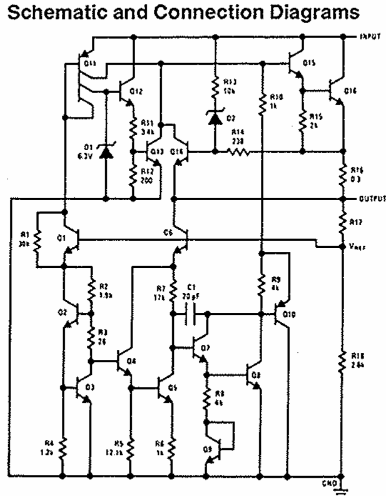
Features

- Output current in excess of 1A
- Internal thermal overload protection
- No external components required
- Output transistor safe area protection
- Internal short circuit current limit
- Available in the aluminum TO-3 package

Voltage Range

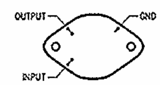
LM7805C	5V
LM7812C	12V
LM7815C	15V

Schematic and Connection Diagrams



TL/H/7746–1

Metal Can Package
TO-3 (K)
Aluminum

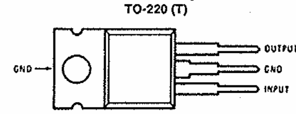


TL/H/7746–2

Bottom View

Order Number LM7805CK, LM7812CK or LM7815CK
See NS Package Number KC02A

Plastic Package
TO-220 (T)



TL/H/7746–3

Top View

Order Number LM7805CT, LM7812CT or LM7815CT
See NS Package Number T03B

RRD-B30M115/Printed in U. S. A.

Absolute Maximum Ratings

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Input Voltage (V_O = 5V, 12V and 15V)	35V
Internal Power Dissipation (Note 1)	Internally Limited
Operating Temperature Range (T_A)	0°C to +70°C
Maximum Junction Temperature	
(K Package)	150°C
(T Package)	150°C
Storage Temperature Range	−65°C to +150°C
Lead Temperature (Soldering, 10 sec.)	
TO-3 Package K	300°C
TO-220 Package T	230°C

Electrical Characteristics LM78XXC (Note 2) 0°C ≤ Tj ≤ 125°C unless otherwise noted.

Output Voltage				5V			12V			15V			Units
Input Voltage (unless otherwise noted)				10V			19V			23V			
Symbol	Parameter	Conditions		Min	Typ	Max	Min	Typ	Max	Min	Typ	Max	
V_O	Output Voltage	Tj = 25°C, 5 mA ≤ I_O ≤ 1A		4.8	5	5.2	11.5	12	12.5	14.4	15	15.6	V
		P_D ≤ 15W, 5 mA ≤ I_O ≤ 1A		4.75		5.25	11.4		12.6	14.25		15.75	V
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.5 ≤ V_{IN} ≤ 27)			(17.5 ≤ V_{IN} ≤ 30)			V
ΔV_O	Line Regulation	I_O = 500 mA	Tj = 25°C		3	50		4	120		4	150	mV
			ΔV_{IN}	(7 ≤ V_{IN} ≤ 25)			14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
			0°C ≤ Tj ≤ +125°C			50			120			150	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 20)			(15 ≤ V_{IN} ≤ 27)			(18.5 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 1A	Tj = 25°C			50		.	120			150	mV
			ΔV_{IN}	(7.5 ≤ V_{IN} ≤ 20)			(14.6 ≤ V_{IN} ≤ 27)			(17.7 ≤ V_{IN} ≤ 30)			V
			0°C ≤ Tj ≤ +125°C			25			60			75	mV
			ΔV_{IN}	(8 ≤ V_{IN} ≤ 12)			(16 ≤ V_{IN} ≤ 22)			(20 ≤ V_{IN} ≤ 26)			V
ΔV_O	Load Regulation	Tj = 25°C	5 mA ≤ I_O ≤ 1.5A		10	50		12	120		12	150	mV
			250 mA ≤ I_O ≤ 750 mA			25			60			75	mV
		5 mA ≤ I_O ≤ 1A, 0°C ≤ Tj ≤ +125°C				50			120			150	mV
I_Q	Quiescent Current	I_O ≤ 1A	Tj = 25°C			8			8			8	mA
			0°C ≤ Tj ≤ +125°C			8.5			8.5			8.5	mA
ΔI_Q	Quiescent Current Change	5 mA ≤ I_O ≤ 1A				0.5			0.5			0.5	mA
		Tj = 25°C, I_O ≤ 1A				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7.5 ≤ V_{IN} ≤ 20)			(14.8 ≤ V_{IN} ≤ 27)			(17.9 ≤ V_{IN} ≤ 30)			V
		I_O ≤ 500 mA, 0°C ≤ Tj ≤ +125°C				1.0			1.0			1.0	mA
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(7 ≤ V_{IN} ≤ 25)			(14.5 ≤ V_{IN} ≤ 30)			(17.5 ≤ V_{IN} ≤ 30)			V
V_N	Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			40			75			90		μV
$\frac{\Delta V_{IN}}{\Delta V_{OUT}}$	Ripple Rejection	f = 120 Hz	I_O ≤ 1A, Tj = 25°C or	62	80		55	72		54	70		dB
			I_O ≤ 500 mA, 0°C ≤ Tj ≤ +125°C	62			55			54			dB
		V_{MIN} ≤ V_{IN} ≤ V_{MAX}		(8 ≤ V_{IN} ≤ 18)			(15 ≤ V_{IN} ≤ 25)			(18.5 ≤ V_{IN} ≤ 28.5)			V
R_O	Dropout Voltage	Tj = 25°C, I_{OUT} = 1A			2.0			2.0			2.0		V
	Output Resistance	f = 1 kHz			8			18			19		mΩ
	Short-Circuit Current	Tj = 25°C			2.1			1.5			1.2		A
	Peak Output Current	Tj = 25°C			2.4			2.4			2.4		A
	Average TC of V_{OUT}	0°C ≤ Tj ≤ +125°C, I_O = 5 mA			0.6			1.5			1.8		mV/°C
V_{IN}	Input Voltage Required to Maintain Line Regulation	Tj = 25°C, I_O ≤ 1A			7.5		14.6			17.7			V

Note 1: Thermal resistance of the TO-3 package (K, KC) is typically 4°C/W junction to case and 35°C/W case to ambient. Thermal resistance of the TO-220 package (T) is typically 4°C/W junction to case and 50°C/W case to ambient.

Note 2: All characteristics are measured with capacitor across the input of 0.22 μF, and a capacitor across the output of 0.1μF. All characteristics except noise voltage and ripple rejection ratio are measured using pulse techniques (t_w ≤ 10 ms, duty cycle ≤ 5%). Output voltage changes due to changes in internal temperature must be taken into account separately.

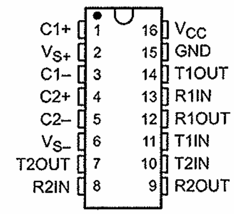
2

MAX232, MAX232I
DUAL EIA-232 DRIVER/RECEIVER

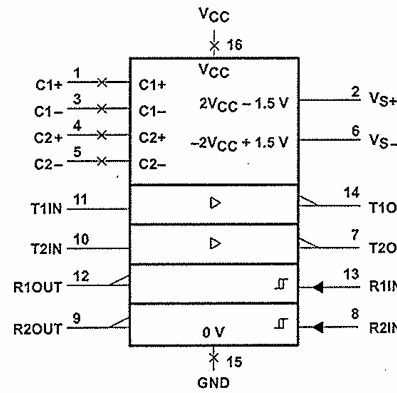
SLLS047G – FEBRUARY 1989 – REVISED AUGUST 1998

- Operates With Single 5-V Power Supply
- LinBiCMOS™ Process Technology
- Two Drivers and Two Receivers
- ±30-V Input Levels
- Low Supply Current . . . 8 mA Typical
- Meets or Exceeds TIA/EIA-232-F and ITU Recommendation V.28
- Designed to be Interchangeable With Maxim MAX232
- Applications
  - TIA/EIA-232-F
  - Battery-Powered Systems
  - Terminals
  - Modems
  - Computers
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015
- Package Options Include Plastic Small-Outline (D, DW) Packages and Standard Plastic (N) DIPs

D, DW, OR N PACKAGE
(TOP VIEW)



logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

description

The MAX232 device is a dual driver/receiver that includes a capacitive voltage generator to supply EIA-232 voltage levels from a single 5-V supply. Each receiver converts EIA-232 inputs to 5-V TTL/CMOS levels. These receivers have a typical threshold of 1.3 V and a typical hysteresis of 0.5 V, and can accept ±30-V inputs. Each driver converts TTL/CMOS input levels into EIA-232 levels. The driver, receiver, and voltage-generator functions are available as cells in the Texas Instruments LinASIC™ library.

The MAX232 is characterized for operation from 0°C to 70°C. The MAX232I is characterized for operation from –40°C to 85°C.

AVAILABLE OPTIONS

T_A	PACKAGED DEVICES		
	SMALL OUTLINE (D)	SMALL OUTLINE (DW)	PLASTIC DIP (N)
0°C to 70°C	MAX232D‡	MAX232DW‡	MAX232N
–40°C to 85°C	MAX232ID‡	MAX232IDW‡	MAX232IN

‡ This device is available taped and reeled by adding an R to the part number (i.e., MAX232DR).

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TEXAS INSTRUMENTS
POST OFFICE BOX 655303 • DALLAS, TEXAS 75265

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Input supply voltage range, V_{CC} (see Note 1) .... –0.3 V to 6 V
Positive output supply voltage range, V_{S+} .... V_{CC} – 0.3 V to 15 V
Negative output supply voltage range, V_{S-} .... –0.3 V to –15 V
Input voltage range, V_I: Driver .... –0.3 V to V_{CC} + 0.3 V
Receiver .... ±30 V
Output voltage range, V_O: T1OUT, T2OUT .... V_{S-} –0.3 V to V_{S+} + 0.3 V
R1OUT, R2OUT .... –0.3 V to V_{CC} + 0.3 V
Short-circuit duration: T1OUT, T2OUT .... Unlimited
Package thermal impedance, θ_{JA} (see Note 2): D package .... 113°C/W
DW package .... 105°C/W
N package .... 78°C/W
Storage temperature range, T_{stg} .... –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds .... 260°C

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under "recommended operating conditions" is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to network ground terminal.
2. The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

recommended operating conditions

		MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	V
High-level input voltage, V_{IH} (T1IN,T2IN)		2			V
Low-level input voltage, V_{IL} (T1IN, T2IN)				0.8	V
Receiver input voltage, R1IN, R2IN				±30	V
Operating free-air temperature, T_A	MAX232	0		70	°C
	MAX232I	–40		85	°C

SOFTWARE DETAILS

ASSEMBLY LANGUAGE PROGRAM - PIC16F877

```
      list      p=16f877            ; list directive to define processor
      #include <p16f877.inc>        ; processor specific variable definitions

Rrdy_Flag     EQU    0x20
Sync_Flag     EQU    0X21

Count         EQU     0X22
Temp          EQU    0X23

H_Byte        EQU    0X24
L_Byte        EQU    0X25
R0            EQU    0X26         ; RAM Assignments
R1            EQU     0X27
R2            EQU    0X28

H_Temp        EQU    0X29         ; temporary register
L_Temp        EQU    0X2A         ; temporary register

Byte0         EQU    0X2b
Byte1         EQU    0X2c
Byte2         EQU    0X2d
Byte3         EQU    0X2e

Rbuf0         EQU    0X31         ;0X21 TO 0X28
Rbuf1         EQU    0X31
Rbuf2         EQU    0X32
Rbuf3         EQU    0X33
Rbuf4         EQU    0X34
Rbuf5         EQU    0X35
Rbuf6         EQU    0X36
Rbuf7         EQU    0X37
Rbuf8         EQU    0X38
Rbuf9         EQU    0X39



;**************************************************************
; Reset and Interrupt Vectors

      org    00000h ; Reset Vector
      goto   Start

      org    00004h ; Interrupt vector
;**************************************************************
; Interrupt Service Routine

IntVector
      ; save context (WREG and STATUS registers) if needed.
      banksel      PIR1
      btfss  PIR1,RCIF     ; Did USART cause interrupt?
      goto   ISREnd

      bcf    PIR1,RCIF
       moviw 06h            ; mask unwanted bits
```

```
       andwf RCSTA,w      ; check for error
       btfss STATUS,z      ; was error status but set?
        Goto RcvError      ; found error flag it

Receive_Int

       btfss  Sync_Flag,0
       goto   Syn_Rx
       movlw  ']'
       Subwf  RCREG,W
       btfss  STATUS,Z
       goto   Rxchar
       bsf    Rrdy_Flag,0
       bcf    Sync_Flag,0
       goto   ISREnd

Rxchar
       btfss  RCREG,6
       goto   Numerals
       movlw  0X0F
       andwf  RCREG,W
       addlw  0X09

Rxpro
       movwf  INDF
       incf   FSR,F
       goto   ISREnd

Numerals
       movlw  0X0F
       andwf  RCREG,W
       goto   Rxpro
Syn_Rx
       movlw  '['
       subwf  RCREG,W
       btfss  STATUS,Z
       goto   ISREnd
       bsf    Sync_Flag,0
       goto   ISREnd       ; go to end of ISR, restore context, return

RcvError

       bcf    RCSTA,CREN   ; Clear receiver status
       bsf    RCSTA,CREN

ISREnd
       ; Restore context if needed.
       retfie

;***********************************************************
; Program begins here

       org    00200h ; Beginning of program EPROM
Start
       banksel       TRISA

       movlw  0xff
       movwf  TRISA

       movlw  0xff
       movwf  TRISB
```

```
        movlw  0xbf
        movwf  TRISC

        movlw  0xff
        clrf   TRISD

        movlw  0x40   ; 9600 baud @10MHz
        banksel       SPBRG
        movwf  SPBRG

        banksel       PIR1
        bcf    PIR1,RCIF    ; Clear RCIF Interrupt Flag

        banksel       PIE1
        bsf    PIE1,RCIE    ; Set RCIE Interrupt Enable

        banksel       ADCON0
        movlw  0x81
        movwf  ADCON0

        banksel       ADCON1
        movlw  0x80
        movwf  ADCON1

        banksel       INTCON
        bsf    INTCON,PEIE  ; Enable peripheral interrupts
        bsf    INTCON,GIE   ; Enable global interrupts

        bcf   STATUS,RP0
        bcf    STATUS,RP1

        movlw  0x20
        movwf  FSR
        clrf   INDF

ClearNext
        incf   FSR,F
        clrf   INDF
        movf   FSR,W
        xorlw  0x39
        btfss  STATUS,Z
        goto   ClearNext


;*************************************************************
; Main loop


Wait
        btfss  Rrdy_Flag,0 ;s
        goto   Wait

        clrf   Rrdy_Flag

        movf   Rbuf0,W
        xorlw  0X01         ;
        btfss  STATUS,Z     ; s
        goto   ChkNext1


        swapf  Rbuf1,F             ;
        movf   Rbuf2,W
        iorwf  Rbuf1,W
```

```
        andiw   0x10
        ioriw   oxef
       bsf     STATUS,RP0    ;
       movwf   TRISA         ;SET DATA DIRECTION FOR PORT A
       bcf     STATUS,RP0    ;

       swapf   Rbuf3,F              ;
       movf    Rbuf4,W       ;
       iorwf   Rbuf3,W       ;WREG = RXBUF3 || RXBUF4
       bsf     STATUS,RP0    ;
       movwf   TRISB         ;SET DATA DIRECTION FOR PORT B
       bcf     STATUS,RP0    ;

       swapf   Rbuf5,F              ;
        mov     Rbuf6,w
       iorwf   Rbuf5,W       ;WREG = RXBUF5 || RXBUF6
        andiw    0Xbf
        ioriw    0x80
       bsf     STATUS,RP0    ;
       movwf   TRISC         ;SET DATA DIRECTION FOR PORT C
       bcf     STATUS,RP0    ;

       swapf   Rbuf7,F              ;
       movf    Rbuf8,W       ;
       iorwf   Rbuf7,W       ;WREG = RXBUF7 || RXBUF8
       bsf     STATUS,RP0    ;
       movwf   TRISD         ;SET DATA DIRECTION FOR PORT A
       bcf     STATUS,RP0    ;SELECT BANK 0

       goto    Wait          ;

ChkNext1

       movf    Rbuf0,W
       xorlw   0X02          ;
       btfss   STATUS,Z      ; s
       goto    ChkNext2

Wt0
       btfss   PIR1,TXIF ;s
       goto    Wt0
       movlw   '{'
       movwf   TXREG

       call    Delay
       call    Delay


Wt1
       btfss   PIR1,TXIF ;s
       goto    Wt1

       swapf   PORTA,W
       andlw   0x0f
       bsf     PCLATH,1
       bsf     PCLATH,2
       call    HexTable
       bcf     PCLATH,1
       bcf     PCLATH,2
       movwf   TXREG

       call    Delay
       call    Delay
```

```
Wt2
       btfss  PIR1,TXIF;s
       goto   Wt2

        movf   PortA,w

       andlw  0x0f
       bsf    PCLATH,1
       bsf    PCLATH,2
       call   HexTable
       bcf    PCLATH,1
       bcf    PCLATH,2
       movwf  TXREG

       call   Delay
       call   Delay


Wt3
       btfss  PIR1,TXIF ;s
       goto   Wt3

       swapf  PORTB,W
       andlw  0x0f
       bsf    PCLATH,1
       bsf    PCLATH,2
       call   HexTable
       bcf    PCLATH,1
       bcf    PCLATH,2
       movwf  TXREG

       call   Delay
       call   Delay

Wt4
       btfss  PIR1,TXIF;s
       goto   Wt4

       movf   PORTB,W
       andlw  0x0f
       bsf    PCLATH,1
       bsf    PCLATH,2
       call   HexTable
       bcf    PCLATH,1
       bcf    PCLATH,2
       movwf  TXREG

       call   Delay
       call   Delay


Wt5
       btfss  PIR1,TXIF ;s
       goto   Wt5

       swapf  PORTC,W
        andiw  0X0F
       bsf    PCLATH,1
       bsf    PCLATH,2
       call   HexTable
       bcf    PCLATH,1
       bcf    PCLATH,2
```

```
        movwf  TXREG

        call   Delay
        call   Delay

Wt6
        btfss  PIR1,TXIF;s
        goto   Wt6

        movf   PORTC,W
        andlw  0x0f
        bsf    PCLATH,1
        bsf    PCLATH,2
        call   HexTable
        bcf    PCLATH,1
        bcf    PCLATH,2
        movwf  TXREG

        call   Delay
        call   Delay

Wt7
        btfss  PIR1,TXIF ;s

        goto   Wt7

        swapf  PORTD,W
        andlw  0x0f
        bsf    PCLATH,1
        bsf    PCLATH,2
        call   HexTable
        bcf    PCLATH,1
        bcf    PCLATH,2
        movwf  TXREG

        call   Delay
        call   Delay

Wt8
        btfss  PIR1,TXIF;s
        goto   Wt8

        movf   PORTD,W
        andlw  0x0f
        bsf    PCLATH,1
        bsf    PCLATH,2
        call   HexTable
        bcf    PCLATH,1
        bcf    PCLATH,2
        movwf  TXREG

        call   Delay
        call   Delay



Wt9
        btfss  PIR1,TXIF
         goto   wt9
        movlw  '}'
        movwf  TXREG
```

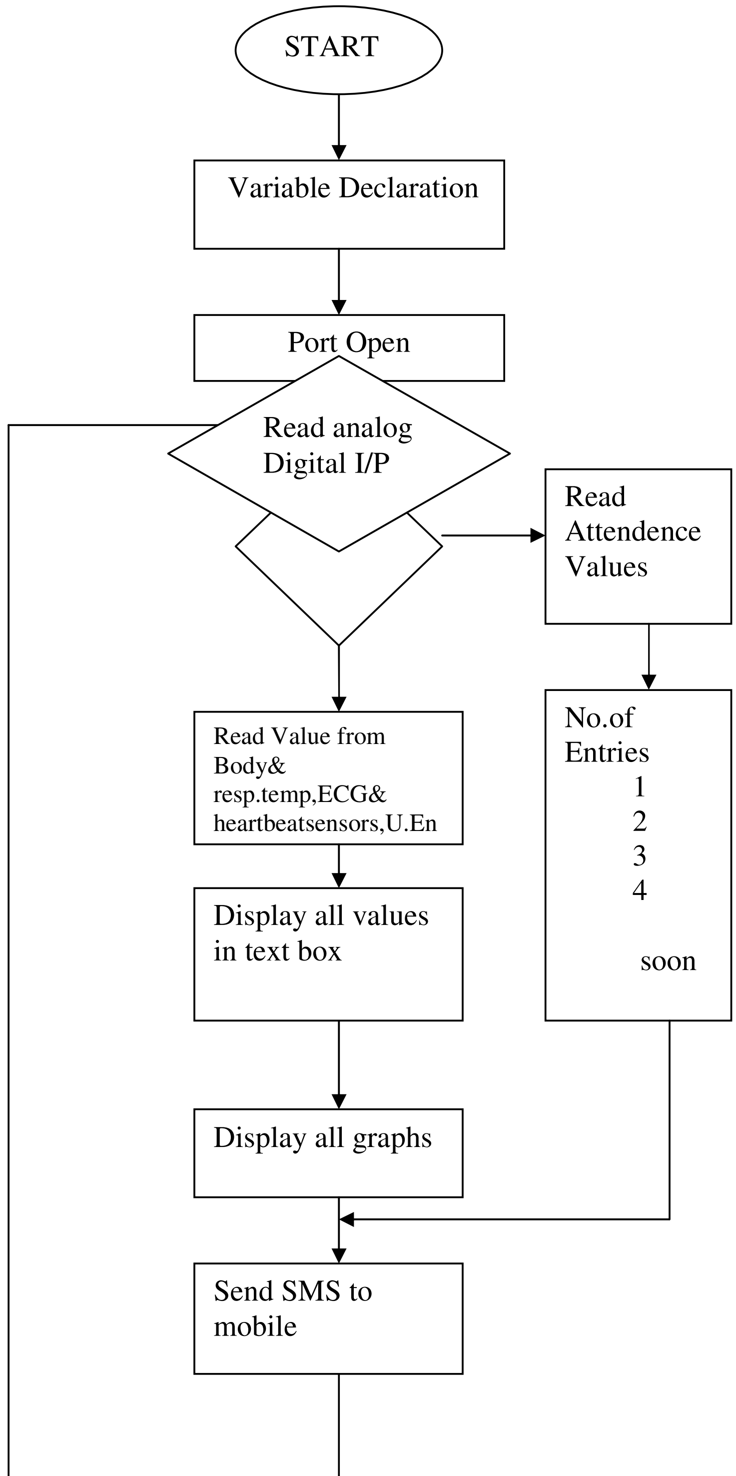
```
        call   Delay
        call   Delay

        goto   Wait

ChkNext2

        movf   Rbuf0,W
        xorlw  0X03          ;
        btfss  STATUS,Z      ; s
        goto   ChkNext3

        swapf  Rbuf1,F              ;
        movf   Rbuf2,W
        iorwf  Rbuf1,W
        movwf  PORTA

        swapf  Rbuf3,F              ;
        movf   Rbuf4,W       ;
        iorwf  Rbuf3,W       ;WREG = RXBUF3 || RXBUF4
        movwf  PORTB

        swapf  Rbuf5,F              ;
        movf   Rbuf6,W       ;
        iorwf  Rbuf5,W       ;WREG = RXBUF5 || RXBUF6
        movwf  PORTC

        swapf  Rbuf7,F              ;
        movf   Rbuf8,W       ;
        iorwf  Rbuf7,W       ;WREG = RXBUF7 || RXBUF8
        movwf  PORTD

        goto   Wait          ;

ChkNext3

        movf   Rbuf0,W
        xorlw  0X04          ;
        btfss  STATUS,Z      ; s
        goto   Wait

        rlf    Rbuf1,F
        rlf    Rbuf1,F
        rlf    Rbuf1,F

        movf   Rbuf1,W
        andlw  B'00111000'
        iorlw  0x81

        movwf  ADCON0

        call   Delay    ; Acq Time Delay

        bsf    ADCON0,GO     ;START CONVERSION
WfEoc
        btfsc  ADCON0,GO     ;DONE
        goto   WfEoc

        movf   ADRESH,W      ;
        movwf  H_Byte        ;

        bsf    STATUS,RP0
        movf   ADRESL,W      ;
```

```
      bcf    STATUS,RP0
      movwf  L_Byte        ; H_BYTE:L_BYTE = ADRESH:ADRESL

AWt0
      btfss  PIR1,TXIF ;s
      goto   AWt0
      movlw  '{'
      movwf  TXREG

      call   Delay
      call   Delay


AWt1
      btfss  PIR1,TXIF ;s
      goto   AWt1

      swapf  H_Byte,W
      andlw  0x0f
      bsf    PCLATH,1
      bsf    PCLATH,2
      call   HexTable
      bcf    PCLATH,1
      bcf    PCLATH,2
      movwf  TXREG

      call   Delay
      call   Delay

AWt2
      btfss  PIR1,TXIF;s
      goto   AWt2

      movf   H_Byte,W
      andlw  0x0f
      bsf    PCLATH,1
      bsf    PCLATH,2
      call   HexTable
      bcf    PCLATH,1
      bcf    PCLATH,2
      movwf  TXREG

      call   Delay
      call   Delay

AWt3
      btfss  PIR1,TXIF ;s
      goto   AWt3

      swapf  L_Byte,W
      andlw  0x0f
      bsf    PCLATH,1
      bsf    PCLATH,2
      call   HexTable
      bcf    PCLATH,1
      bcf    PCLATH,2
      movwf  TXREG

      call   Delay
      call   Delay

AWt4
      btfss  PIR1,TXIF;s
```

```
        goto   AWt4

        movf   L_Byte,W
        andlw  0x0f
        bsf    PCLATH,1
        bsf    PCLATH,2
        call   HexTable
        bcf    PCLATH,1
        bcf    PCLATH,2
        movwf  TXREG

        call   Delay
        call   Delay


AWt5
        btfss  PIR1,TXIF
        goto   AWt5
        movlw  '}'
        movwf  TXREG

        call   Delay
        call   Delay


        goto   Wait


Delay
        movlw  0xff

movwf  Count

Dwait
        decfsz Count,F
        goto   Dwait

        return


        org    0x600

HexTable
        addwf  PCL,f
        retlw  0x30
        retlw  0x31
        retlw  0x32
        retlw  0x33
        retlw  0x34
        retlw  0x35
        retlw  0x36
        retlw  0x37
        retlw  0x38
        retlw  0x39
        retlw  0x41

        retlw  0x42
        retlw  0x43
        retlw  0x44
        retlw  0x45
        retlw  0x46

        end
```

USER END SOFTWARE IN VISUAL BASIC

Flow Chart:



PROGRAM:

Form4.frm

```
Private Sub BTemptimer_Timer()
MSComm1.Output = "[45]"
Sleep (20)
Rtext = MSComm1.Input
Rtext = Mid$(Rtext, 2, 4)
Pt2 = T2
T2 = Val("&h" & Rtext)
T2 = T2 / 5
T2 = -T2+195
T2=Round(T2,1)

If T2 < 77 Then T2 = Pt2
End If

Text7.text =T2
Label4.Caption = "BodyTemp Vs Time"
DrawWidth = 2
Line (536, 184)-(536, 384), vbYellow
Line (536, 384)-(744, 384), vbYellow
Line (528, 192)-(536, 184), vbYellow
Line (544, 192)-(536, 184), vbYellow
Line (736, 376)-(744, 384), vbYellow
Line (736, 392)-(744, 384), vbYellow
DrawWidth = 2
Line (oldx, oldy)-(536 + k, 384 - (T2 / (200 / 200#))), vbGreen
DrawWidth = 1
oldx = 536 + k
oldy = 384 - (T2 / (200 / 200#))
k = k + 3

If k > 208 Then
Line (528, 182)-(744, 384), Form4.BackColor, BF
oldx = 536#
oldy = 384#
k = 0
End If

End Sub

'Private Sub btimer_Timer()
'btimer.Enabled = False
'out = out And &HCF
```

```
'End Sub

Private Sub Command1_Click()
MSComm1.Output = "[3ffffbfff]"
Sleep (50)
End
End Sub

Private Sub Command3_Click()
Form4.Hide
Form3.Show
End Sub

Private Sub Ecg1Timer_Timer()
MSComm1.Output = "[40]"
Sleep (50)
Rtext = MSComm1.Input
Rtext = Mid$(Rtext, 2, 4)
Ecg1 = Val("&h" & Rtext)
Ecg1 = Round(Ecg1, 1)
Text9.Text = Ecg1
End Sub

Private Sub Form_Load()
For i = 1 To 100
Egra1(i) = 50
Next
ptr = 19
MSComm1.PortOpen = True
MSComm1.Output = "[1ffffbfff]"
Sleep (30)
MSComm1.Output = "[3ffffbfff]"
Sarr(1) = 0
Sarr(2) = 0
Sarr(3) = 0
Sarr(4) = 0
Sarr(5) = 0
Sarr(6) = 0
Fnames(1) = "D:\PanimalarCBSS\hitemp.wav"
Fnames(2) = "D:\PanimalarCBSS\Patient1.wav" 'p1 call
Fnames(3) = "D:\PanimalarCBSS\Patient2.wav" 'p2 call
Fnames(4) = "D:\PanimalarCBSS\Patient3.wav " 'p3 call
Fnames(5) = "D:\PanimalarCBSS\Patient4.wav" 'p4 call
Fnames(6) = "D:\PanimalarCBSS\Saline1.wav" 'p4 call
Fcnt = 0
Label5.Caption = Format(Date, "dd/mm/yyyy")
```

```
Set db = OpenDatabase("D:\PanimalarCBSS\hos12.mdb")
Set rs = db.OpenRecordset("patient")
Set Srs = db.OpenRecordset("Digital")
Set Drs = db.OpenRecordset("Doc")
Pa = &H0
Sal = &H0
oldx = 536#
oldy = 384#
k = 0
x=0
a(0) = 5  a(1) = 5  a(2) = 5  a(3) = 6  a(4) = 5  a(5) = 5  a(6) = 5  a(7) = 5  a(8) = 3
a(9) = 10  a(10) = 1  a(11) = 5  a(12) = 5  a(13) = 5  a(14) = 7  a(15) = 5  a(16) = 6
a(17) = 5  a(18) = 5  a(19) = 5

Lg = Shell("C:\Program Files\Microsoft Office\Office\outlook.exe", vbNormalFocus)
End Sub

Private Sub Heartbeattimer_Timer()
MSComm1.Output = "[2]"
Sleep (20)
Rtext = MSComm1.Input
Rtext = Mid$(Rtext, 8, 1)
Beat = Val("&h" & Rtext)
If Beat = 0 And Bflg = 0 Then
Bcnt = Bcnt + 1
Bflg = 1
ElseIf Beat > 0 And Bflg = 1 Then
Bflg = 0
End If
Text1.Text = Round(Bcnt, 0)
End Sub

Private Sub Hrtcmd_Click()
hcnt = 0
Bcnt = 0
End Sub

Private Sub MMControl1_Done(NotifyCode As Integer)
MMControl1.Command = "Close"
Timer2.Enabled = True
End Sub

Private Sub Option1_Click()
Rtemptimer.Enabled = False
BTemptimer.Enabled = False
Ecg1Timer.Enabled = False
Heartbeattimer.Enabled = False
```

```
Rtemptimer.Enabled = True
Picture1.Cls
Text1.Text = Clear
Text5.Text = Clear
Text7.Text = Clear
Text9.Text = Clear
grval = 0
End Sub

Private Sub Option2_Click()
Rtemptimer.Enabled = False
BTemptimer.Enabled = False
Ecg1Timer.Enabled = False
Heartbeattimer.Enabled = False
BTemptimer.Enabled = True
Picture1.Cls
Text1.Text = Clear
Text5.Text = Clear
Text7.Text = Clear
Text9.Text = Clear
grval = 1
End Sub

Private Sub Option3_Click()
Rtemptimer.Enabled = False
BTemptimer.Enabled = False
Ecg1Timer.Enabled = False
Heartbeattimer.Enabled = False
Ecg1Timer.Enabled = True
Picture1.Cls
Text1.Text = Clear
Text5.Text = Clear
Text7.Text = Clear
Text9.Text = Clear
End Sub

Private Sub Option7_Click()
Rtemptimer.Enabled = False
BTemptimer.Enabled = False
Ecg1Timer.Enabled = False
Heartbeattimer.Enabled = False
Heartbeattimer.Enabled = True
Picture1.Cls
Text1.Text = Clear
Text5.Text = Clear
Text7.Text = Clear
Text9.Text = Clear
```

```
grval = 2
End Sub
Private Sub Rtemptimer_Timer()
MSComm1.Output = "[46]"
Sleep (20)
Rtext = MSComm1.Input
Rtext = Mid$(Rtext, 2, 4)
Pt1 = T1
T1 = Val("&h" & Rtext)
T1 = T1 / 5
T1 = -T1+195
T1 = Round(T1, 1)

If T1 < 77 Then T1 = Pt1
EndIf

Text5.Text = T1
Label4.Caption = "RespTemp Vs Time"
DrawWidth = 2
Line (536, 184)-(536, 384), vbYellow
Line (536, 384)-(744, 384), vbYellow
Line (528, 192)-(536, 184), vbYellow
Line (544, 192)-(536, 184), vbYellow
Line (736, 376)-(745, 385), vbYellow
Line (736, 392)-(744, 384), vbYellow
DrawWidth = 2
Line (oldx, oldy)-(536 + k, 384 - (T1 / (200 / 200#))), vbGreen
DrawWidth = 1
oldx = 536 + k
oldy = 384 - (T1 / (200 / 200#))
k = k + 3
If k > 208 Then
Line (528, 182)-(744, 384), Form4.BackColor, BF
oldx = 536#
oldy = 384#
k = 0
End If

End Sub

Private Sub Timer1_Timer()
Label6.Caption = Format(Time, "hh:mm:ss")

If Heartbeattimer.Enabled = True Then
Text2.Visible = True
Hrtcmd.Visible = True
Else
```

```
Text2.Visible = False
Hrtcmd.Visible = False
End If

If (Ecg1 > 100) And Strt = 0 Then
Strt = 1
End If

MSComm1.Output = "[2]"
Sleep (20)
Rtext = MSComm1.Input
Pa = Val("&h" & Mid$(Rtext, 8, 2))
If ((Pa And &H1) = &H0) Then
 Label23.Visible = True
  p1 = "Yes"
 Sarr(2) = 1

 If pflg1 = 0 Then
 pflg1 = 1
  Set objOutlookMsg = objOutlook.CreateItem(olMailItem)
           With objOutlookMsg
              .To = "9884169070@sms.sancharnet.in"    ' The To Address Field
              .Subject = "P1 Call"    ' txtSubject  - The Subject Field
              .Body = "Patient 1 is calling"
              .Importance = olImportanceHigh   ' Priority. Mostly Not Required
   .Send     ' Send the Composed Message…
                                  End With
Set objOutlookMsg = Nothing
 Else
  Label23.Visible = False
  p1 = "No"
  Sarr(2) = 0
End If

If ((Pa And &H2) = &H0) Then
Label24.Visible = True
  p2 = "Yes"
  Sarr(3) = 1
Else
Label24.Visible = False
   p2 = "No"
End If

If ((Pa And &H4) = &H0) Then
Label25.Visible = True
  p3 = "Yes"
  Sarr(4) = 1
```

```
Else
Label25.Visible = False
 p3 = "No"
End If

If ((Pa And &H8) = &H0) Then
Label26.Visible = True
  p4 = "Yes"
  Sarr(5) = 1
Else
Label26.Visible = False
p4 = "No"
End If

MSComm1.Output = "[2]"
Sleep (20)
Rtext = MSComm1.Input
pb = Val("&h" & Mid$(Rtext, 6, 2))

If ((pb And &H10) = &H10) Then
Label8.Visible = False
Saline.Visible = True
Sal = ‘‘Empty ’’
Sarr(6) = 1

  Set objOutlookMsg = objOutlook.CreateItem(olMailItem)
          With objOutlookMsg
              .To = "9884169070@sms.sancharnet.in"   ' The To Address Field
              .Subject = "saline Emp"    ' txtSubject  - The Subject Field
              .Body = "Saline bottle Empty"
              .Importance = olImportanceHigh   ' Priority. Mostly Not Required
              .Send   ' Send the Composed Message…
                                   End With
Set objOutlookMsg = Nothing
End If

Else
Saline.Visible = False
Label8.Visible = True
Sal =”Not Empty”
End If

If (T1 > 100) Or (T2 > 100) Then
Label22.Visible = True
Else
Label22.Visible = False
End If
```

```
MSComm1.Output = "[2]"
Sleep (50)
Rtext = MSComm1.Input
pc = Val("&h" & Mid$(Rtext, 6, 2))
pc = pc And &HF

Select Case (pc And &HF)
Case &HE
   Atttxt(0) = "Rahul"
   Atttxt(1) = "Doctor"
   Atttxt(2) = Date
   Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr1.gif")
   If vvv2 = 0 Then
   Atttxt(3) = Time
   Drs.AddNew
   Drs.Fields(0) = Atttxt(0)
   Drs.Fields(1) = Atttxt(1)
   Drs.Fields(2) = Atttxt(2)
   Drs.Fields(3) = Atttxt(3)
   Drs.Update
   vvv2 = 1
   End If
Case &HD
   Atttxt(0) = "Anita"
   Atttxt(1) = "Nurse"
   Atttxt(2) = Date
   Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr2.gif")
   If vvv2 = 0 Then
   Atttxt(3) = Time
   Drs.AddNew
   Drs.Fields(0) = Atttxt(0)
   Drs.Fields(1) = Atttxt(1)
   Drs.Fields(2) = Atttxt(2)
   Drs.Fields(3) = Atttxt(3)
   Drs.Update
   vvv2 = 1
   End If
   Case &HC
   Atttxt(0) = "Naresh"
   Atttxt(1) = "Compounder"
   Atttxt(2) = Date
   Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr3.gif")
   If vvv2 = 0 Then
   Atttxt(3) = Time
   Drs.AddNew
   Drs.Fields(0) = Atttxt(0)
```

```
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
      vvv2 = 1
  End If
Case &HB
    Atttxt(0) = "Bhuvan"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr4.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
    Case &HA
    Atttxt(0) = "Raghu"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr1.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
Case &H9
    Atttxt(0) = "Kamala"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr2.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
```

```
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
Case &H8
    Atttxt(0) = "Soman"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr3.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
 vvv2 = 1
    End If
    Case &H7
    Atttxt(0) = "Binu"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr4.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
Case &H6
    Atttxt(0) = "Algates"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr1.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
```

```
     vvv2 = 1
    End If
Case &H5
  Atttxt(0) = "Jagadeesh"
    Atttxt(1) = "Doctor"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr2.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
Case &H4
    Atttxt(0) = "Mohan"
    Atttxt(1) = "Wardboy"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr3.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
Case &H3
    Atttxt(0) = "Naga"
    Atttxt(1) = "Anaesthesian"
    Atttxt(2) = Date
    Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr4.gif")
    If vvv2 = 0 Then
    Atttxt(3) = Time
    Drs.AddNew
    Drs.Fields(0) = Atttxt(0)
    Drs.Fields(1) = Atttxt(1)
    Drs.Fields(2) = Atttxt(2)
    Drs.Fields(3) = Atttxt(3)
    Drs.Update
     vvv2 = 1
    End If
```

```
Case &H2
Atttxt(0) = "Desai"
   Atttxt(1) = "Nurse"
   Atttxt(2) = Date
   Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr1.gif")
   If vvv2 = 0 Then
   Atttxt(3) = Time
   Drs.AddNew
   Drs.Fields(0) = Atttxt(0)
   Drs.Fields(1) = Atttxt(1)
   Drs.Fields(2) = Atttxt(2)
   Drs.Fields(3) = Atttxt(3)
   Drs.Update
    vvv2 = 1
   End If
Case &H1
   Atttxt(0) = "Mukharjee"
   Atttxt(1) = "Doctor"
   Atttxt(2) = Date
   Image1.Picture = LoadPicture("D:\PanimalarCBSS\dr2.gif")
   If vvv2 = 0 Then
   Atttxt(3) = Time
   vvv2 = 1
   End If
Case &HF
   Atttxt(0) = ""
   Atttxt(1) = ""
   Atttxt(2) = ""
   vvv2 = 0
   Atttxt(3) = ""
   Image1.Picture = LoadPicture("")
            End Select

X = X + 1

If X >= 30 Then
rs.AddNew
rs(0) = Format(Date, "dd/mm/yyyy")
rs(1) = Format(Time, "hh:mm:ss")
rs(2) = T1  rs(3) = T2  rs(4) = Ecg1
rs.Update
Srs.AddNew
Srs(0) = Format(Date, "dd/mm/yyyy")
Srs(1) = Time   Srs(2) = p1   Srs(3) = p2   Srs(4) = p3   Srs(5) = p4S   rs(6) =Sal
Srs.Update
X = 0
End If
```

```
End Sub

Private Sub Timer2_Timer()
 Fcnt = Fcnt + 1

If Fcnt > 6 Then
        Fcnt = 1
End If

If (Sarr(Fcnt) = 1) Then
        MMControl1.FileName = Fnames(Fcnt)
        MMControl1.Command = "Open"
        MMControl1.Command = "Play"
        Sarr(Fcnt) = 0
        Timer2.Enabled = False
End If

End Sub

Private Sub Timer3_Timer()

If Ecg1Timer.Enabled = True Then

     If Strt = 1 And ptr > 0 Then
      Egra1(1) = 50 - ((a(ptr) * 10) / (200# / 50#))
      ptr = ptr - 1
      Else
      Egra1(1) = 50 - (Ecg1 / (200# / 50#))
      ptr = 19
      Strt = 0
      End If

For i = 100 To 2 Step -1
Egra1(i) = Egra1(i - 1)
Next
Picture1.Cls
vvv = 1
For i = 1 To 99
Picture1.Line (vvv, Egra1(i))-(vvv + 2, Egra1(i + 1)), vbYellow
vvv = vvv + 2
Next
EndIf

End Sub

Private Sub Timer4_Timer()
```

```
If Heartbeattimer.Enabled = True Then
hcnt = hcnt + 1
Text2.Text = hcnt

If hcnt >= 60 Then
Text3.Text = Bcnt

If (Bcnt < 72 Or Bcnt > 84) Then
Label9.Caption = "Heart Beat Abnormal"
btimer.Enabled = True
Else
Label9.Caption = "Heart Beat Normal"
End If

hcnt = 0
Bcnt = 0
End If

If hcnt < 3 Then
Label9.Visible = True
Else
Label9.Visible = False
End If

End If

End Sub
```

Form3.frm

```
Private Sub Command1_Click()

Form3.Hide
Form5.Show

Form5.Data1.RecordSource=”Doc”

Form5.Data1.Refresh

Form5.DBGrid1.ClearFields

Form5.DBGrid1.ReBind

End Sub


Private Sub Command2_Click()

Form3.Hide

Form5.Show

Form5.Data1.RecordSource=”patient”

Form5.Data1.Refresh

Form5.DBGrid1.ClearFields

Form5.DBGrid1.ReBind

End Sub


Private Sub Command3_Click()

Form3.Hide

Form5.Show

Form5.Data1.RecordSource=”Digital”
```

```
Form5.Data1.Refresh

Form5.DBGrid1.ClearFields

Form5.DBGrid1.ReBind

End Sub


Private Sub Command5_Click()

Form3.Hide

Form5.Show

End Sub


Private Sub Command6_Click()

End

End Sub


Private Sub Form_DblCliclk()

‘Me.PrintForm

End Sub
```

Form5.frm

```
Private Sub Command1_Click()
Data1.Recordset.MoveFirst
While Not (Data1.Recordset.EOF)
Data1.Recordset.Delete
Data1.Recordset.MoveNext
Wend
DBGrid1.ClearFields
End Sub



Private Sub Command2_Click()
Form5.Hide
Form4.Show
Line(528,182)-(744,384),Form4.BackColor,BF
oldx=536
oldy=384
k=0
End Sub



Private Sub Command3_Click ()
Form4.MSComm1.Output =”[3ffff80ff]”
Sleep(50)
End
End Sub
```

Module1

```
Option Explicit

Public db as Database
Public textval , dtext, SString, Sendstr, Rtext As String
Public  trs, rps, prs, Srs, Drs As Recordset
Public X,  Eout1, bout1, out, Timeout1, As Integer
Public pch, pa, pb, attin, pc, As Integer
Public oldx, oldy, Maxv As Single
Public k, grval As Integer
Public t1, tt0, tt1, t2, t3, t4, tt2, Ecg1  As Double
Public p1, p2, p3, p4, Sal As String
Public  Strt As Integer
Public Fnames(1 to 7) As String
Public Egra1(1 to 100) As Single
Public Fcnt As Integer
Public a(0 to 19) As Single
Public pt1, pt2 As Single
Public ptr, vvv, vvv2  Sarr(1 to 7) As Integer
Public  Beat, Bcnt, Bflg, Tcount As Single
Public hcnt, hout As Integer
Public Declare Function Sleep Lib "kernel32" (ByVal dwMilliseconds As Long) As Long
Public objOutlook As New Outlook.Application
Public objOutlookMsg As Outlook.MailItem
Public pflg, sale, t1flg, t2flg, hflg1, finflg, myflg As Integer
Public Lg  As Long
```

CONCLUSION

CONCLUSION

This Project which demonstrates an automated patient monitoring system has its own merits and demerits which are discussed below:

Merits:

2. The wireless alert system using WAP notifies physicians of critical results on their cellular phones.
3. With online recoding of medical parameters, the workload of the case providers and the nursing staff is reduced.
4. The clinical information database contains all data regarding the patients in electronic form.
5. The patient call switches help emergency situations to be handled quickly.

Future enhancements can be easily implemented with the PLC controller.

De-Merits:

1. The heart beat sensor is highly temperature dependent and the dynamic characteristics change with different levels of ambient light and temperature level.
2. The ECG amplifier needs a high CMRR and additional narrowband filters are necessary to attenuate effects of mains and noise interference.
3. Thermistors used for respiratory temperature measurement may need to be heated initially in order to provide better sensitivity. However, this excessive heating may cause discomfort to the patient.

FUTURE ENHANCEMENTS

FUTURE ENHANCEMENTS

The human body scanning system could be made more sophisticated by incorporating blood pressure and EEG sensors. The analog channel inputs AN4 and AN7 can be used and the Port B can be programmed as an input port along with an additional ADC chip in the external circuit.

Hospitable –wide wireless capability would allows doctor to occur the patients' database using their word held computers.

The entire medical data acquisition could be made wireless and wearable. Such a package would contain the circuiting for inputs from ECG sensors, EEG sensors, pressure measurement and pulse rate transducers. This wearable module can transmit the data continuously over a fiber optic link or through an internet digital radio. The received data can be stored in separate memory and be processed by a microcontroller. This enhancement will enable monitoring of patients to be more flexible and strain-free.

COST ESTIMATE

COST ESTIMATE

COMPONENTS	PRICE (Rs.)
Power supply board	105.00
Resistors and wires	35.00
Transistors	25.00
Trimpots	40.00
Switches	40.00
IC OP07	110.00
9 pin female connector	15.00
MAX232	70.00
PIC16F877	700.00
Heartbeat sensor	1300.00
ECG sensor	950.00
Saline bottle	17.00
PCB and GPB	50.00
Microcontroller board	800.00
Cabinet	450.00
Miscellaneous	600.00
TOTAL	**5307.00**

BIBLIOGRAPHY

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1. **Handbook of Bio-Medical Instrumentation - R.S.Khandpur**

2. **Bio-Medical Instrumentation and measurements - Leslie Cromwell - Fred. J. Wejnbell - Erich . A. Pleiffer**

3. **Linear Integrated Circuits - Roy Chowdary**

4. **IBM PC Handbook - IBM Corporation**

5. **www.microchip.com**

6. **VISUAL BASIC---- Ground Up - Gary Cornell**