PERIPHERALS

TIMERS:-

- Timer is a very common and useful peripheral.
- It is used to generate events at specific times or measures the duration of specific events which are external to the processor.
- It is a programmable device, i.e. the time period can be adjusted by writing specific bit patterns to some of the registers called timer-control registers.
- A timer measures time by counting pulses that occur on an input clock signal having a known period.

COUNTERS:-

- A counter is nearly identical to a timer except that instead of counting the clock cycle, a counter counts the number of pulses of input signal.
- It can be free running device with a clock input pulse and for comparing the counts with one which is preloaded in the register.
- This device is used for the alarm and the other processors.
- It is useful for the processor interrupt at the preset time.

WATCHDOG TIMERS:-

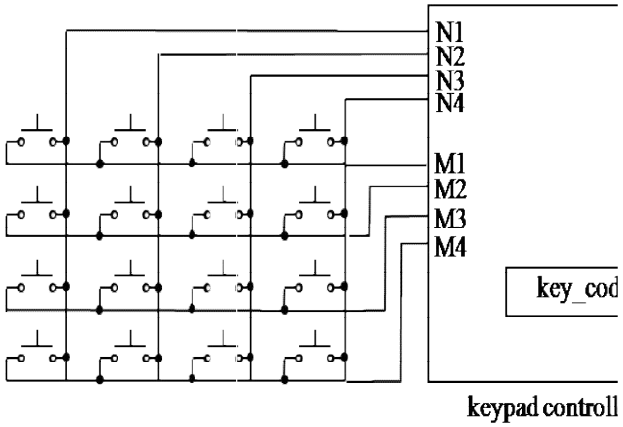
- A watchdog timer (WDT; sometimes called a computer operating properly or COP timer, or simply a watchdog) is an electronic timer that is used to detect and recover from computer malfunctions.
- During normal operation, the computer regularly restarts the watchdog timer to prevent it from elapsing, or "timing out".
- If, due to a hardware fault or program error, the computer fails to restart the watchdog, the timer will elapse and generate a timeout signal.
- The timeout signal is used to initiate corrective action or actions. The corrective actions typically include placing the computer system in a safe state and restoring normal system operation.
- Watchdog timers are commonly found in embedded systems and other computer-controlled equipment where humans cannot easily access the equipment or would be unable to react to faults in a timely manner.
- In such systems, the computer cannot depend on a human to reboot it if it hangs; it must be self-reliant.

LCD CONTROLLERS:-

- A liquid crystal display (LCD) is a low cost, low power device capable of displaying text and images.
- LCDs are extremely common in embedded systems.
- LCDs can be found in numerous common devices like watches, fax and copy machines and calculators.
- Each type of LCD may be able to display multiple characters.
- The LCD may permit a character to be blinking or may permit display of a cursor indicating the "current" character. Such functionality would be difficult for us to implement using software.
- Thus we use an LCD controller to provide us with a simple interface to an LCD with eight data input and one enable input.
- To send a byte to the LCD, we provide a value to the eight inputs and one enable input.
- This byte may be a control word, which instructs the LCD controller to initialize the LCD, clear the display, select the position of the cursor, brighten the display and so on.

KEYPAD CONTROLLERS:-

- A keypad consists of a set of buttons that may be pressed to provide input to an embedded system.
- A simple keypad has buttons arranged in an N- column by M-row grid as shown in the figure below.



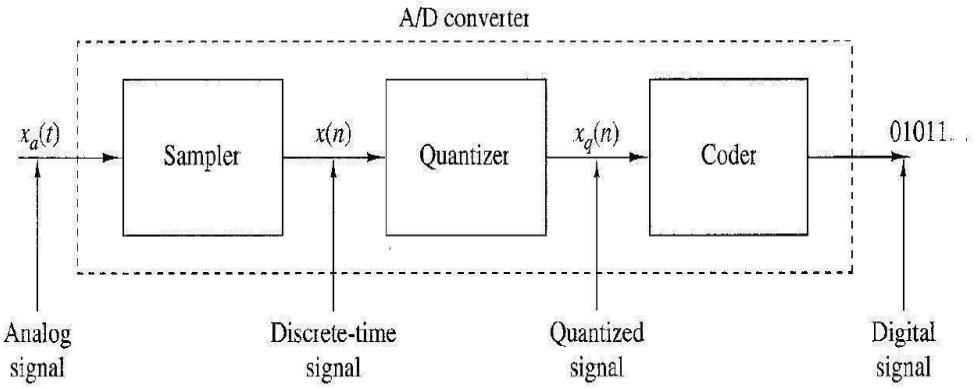
N=4, M=4

- The device has N outputs, each output corresponding to a column, and another M outputs, each output corresponding to a row. When a button is pressed one column output and one row output go high, uniquely identifying the pressed button.
- To read such a keypad from software, scan the column and row outputs. The scanning is performed by keypad controller.
- The controller scans the column and row outputs of the keypad. When the controller detects a press button, it stores a code corresponding to that button into a register, key_code, and sets an output high, k_ pressed, indicating that a button has been pressed.
- The software may poll this output every 100 milliseconds or so, and read the register when the output is high.

ANALOG TO DIGITAL CONVERTERS:-

- An ADC is a device which converts the analog signal to a digital signal and a digital signal to analog signal by the help of digital to analog converter.
- Such conversion are necessary because the embedded system deals with digital signal and is surrounded by system involving analog signal.
- The analog to digital conversion goes under the following 3 process:-
    1. Sampling
    2. Quantization
    3. Coding

Block diagram of ADC:-



Basic parts of an analog-to-digital (A/D) converter.

1. **Sampling:-**
   It is the process in which a continuous time signals or analog signal is converted into discrete time signal. This is done by the device sampler.

2. **Quantization:-**
   It is a process as in which a discrete time signal is converted into quantized signal. It can also defined as the process of conversion from continuous value to discrete value. This process is done by the device called quantizer.
3. **Coding:-**
   - Coding is the process in which the discrete valued signal is converted into corresponding binary form.
   - Analog always refers to continuous valued signal and digital always refers to discrete valued signal.
   - By converting from analog to digital we use a device called digital processor to compute the analog value to digital value.
     For this the formula is
     $e/V_{max} = d / (2^n - 1)$

     where V_{max} = Maximum voltage of analog signal

     n = no. of bits available for digital encoding

     d = the present digital encoding

     e = the present analog voltage

   - The resolution of the digital signal can be found by the formula $V_{max} / (2^n - 1)$.

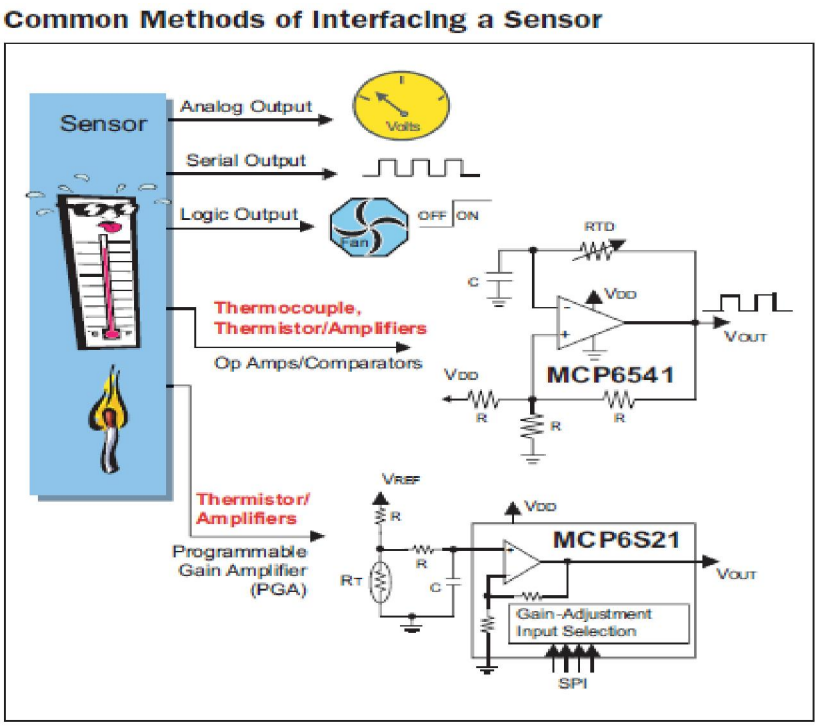
REAL - TIME CLOCKS:-

- A real – time clock (RTC) keeps the time and date in an embedded system.
- Real – time clocks are typically composed of a crystal – controlled oscillator, cascade counters and battery backup.
- The crystal – controlled oscillator generates a very consistent high-frequency digital pulse that feeds the cascaded counters.
- The first counter counts these pulses up to the oscillator frequency, which corresponds to exactly one second.
- At this point it generates a pulse that feeds the next counter. This counter counts up to 59, at which point it generates a pulse feeding the minute counter. The hour, date, month and year counters work in the same manner. Real- time clocks adjust for the leap years.
- The rechargeable back-up battery is used to keep the real-time clock running the system is powered off.

APPLICATION OF EMBEDDED SYSTEMS

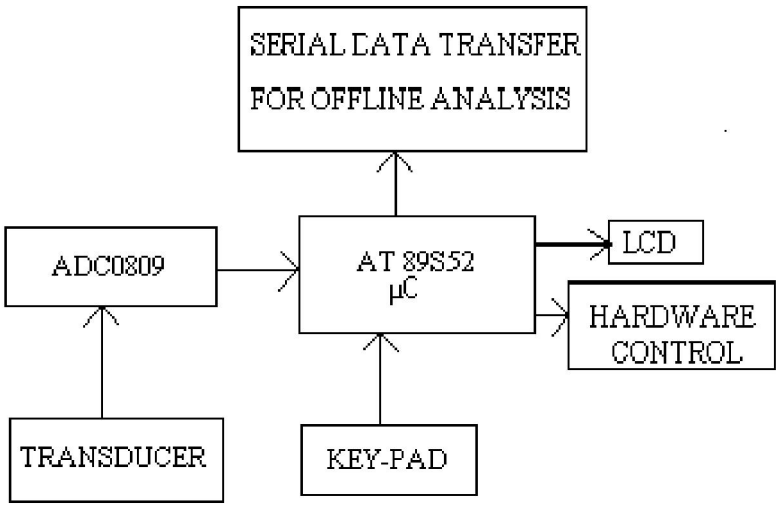
TEMPERATURE MEASURING SYSTEM:-

In many systems, temperature control is fundamental. There are a number of passive and active temperature sensors that can be used to measure system temperature, including: thermocouple, resistive temperature detector, thermistor and silicon temperature sensors. These sensors provide temperature feedback to the system controller to make decisions such as, over-temperature shutdown, turn-on/off cooling fan, temperature compensation or general purpose temperature monitor.



Temperature Measurement Applications

- Computing:
- CPU overtemperature protection
- Fan control
- Cellular/PCS:
- Power amplifier temperature compensation
- Thermal sensing of display for contrast control
- Power Supply Embedded Systems:
- Overtemperature shutdown
- Battery management



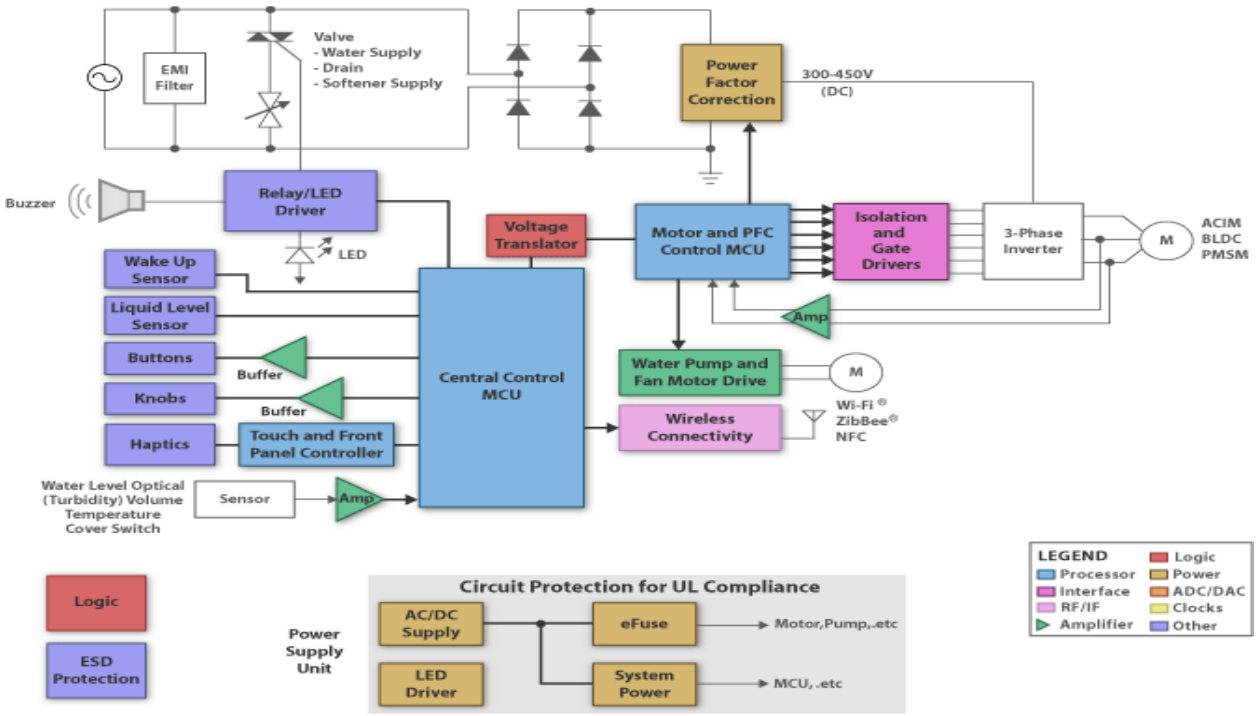
Hardware Description

Whole circuit can be divided into following sections:-

(a) Power supply section: The regulated power supply section made with full wave rectifier (with IN 4007 diodes) using voltage regulator IC 7805 and IC 7812 which provide a constant voltage of 5V to the circuit as well as constant 12V to relays.

(b) Analog to digital conversion section: Since we have to sense analog parameters i.e. temperature and light hence we have to use any analog to digital converter. We have opted for ADC 0809 as it has 8 channels and is microprocessor compatible ADC which is easily available. It will convert the analog signal of the transducer to digital value with respect to the reference voltage which in our case is 2.5V. This reference voltage is obtained using TL431, which is a programmable shunt voltage reference with output voltage range of 2.5V to 36V and works like zener diode. For the conversion ADC requires a reference frequency which is supplied from 555 IC in the form of astable oscillator. The conversion frequency is kept around 150 kHz. Sensor used for temperature measurement is LM 35 and for light intensity is LDR. LM 35 is calibrated in ºC and is linear in +10 mV/ ºC scale factor with 0.5ºC accuracy [5]. The calibration curve given here with will make the scenario clear.

Washing Machine



Description

Today's state-of-the-art high-end appliances are more energy efficient, consume less water, and are smarter than the machines developed in years past. Texas Instruments has developed products to meet the challenges and requirements for these new sophisticated systems.

Energy Efficiency: Home appliance (a.k.a. white goods) motors are often oversized to account for the load torque changes and transients. Scalar techniques for control can result in inefficient systems and noisy operation. This, in turn, leads to a mediocre energy efficiency that hovers in the 40% to 50% range. By implementing the control system with TI's digital signal controllers, designers are able to implement smaller, quieter motors with energy efficiency as high as 85% - 90%. A high efficiency is necessary to receive a stamp of approval from a governing body such as the US Environmental Protection Agency and Department of Energy's STAR rating.

Power Factor Correction (PFC): PFC is a technique of counteracting the undesirable effects of electric loads that create a power factor that is less than 1. In washing machines, PFC is needed because of the continuous transients and surge currents exhibited by the electric motor during the wash cycle, for example. It is also used to boost the rectified mains voltage up to 300 V to 450 V, which is then used to power the 3-phase inverters which ultimately operate the electric motor.

With TI products, PFC can be performed externally with a separate integrated circuit or it can be done in the digital signal controller eliminating the need for a separate external PFC controller.

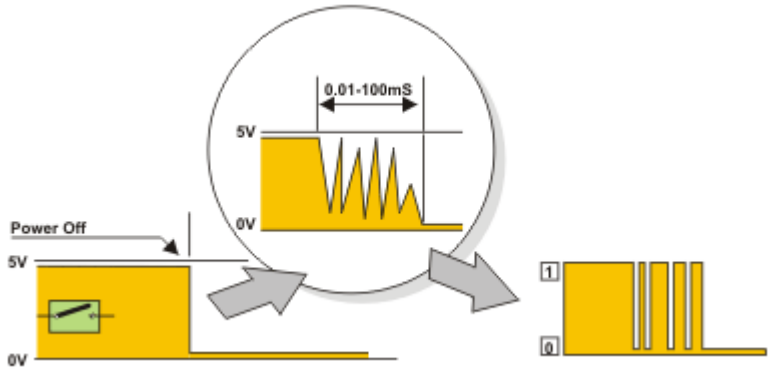
IEC 60730 Compliance: Home appliance manufacturers continually introduce new design enhancements to their automatic electronic controls that ensure safe, reliable and efficient operation of the equipment. Among other things, the IEC 60730 specification discusses mechanical, electrical, electronic, EMC, and abnormal operation of AC appliances. For microcontrollers, the specification details new test and diagnostic methods for the real-time embedded software to ensure the safe operation of embedded control hardware and software. All TI TMSxx24xxxx and TMSxx28xxxx digital signal controllers support IEC 60730 compliance.

High-Voltage Isolation: For larger, higher-performance products where reliability and motor-control accuracy are key concerns, TI offers isolation products that block high voltage, isolate grounds, and prevent noise currents from entering the local ground and interfering with or damaging sensitive circuitry.

Integration: Texas Instruments provides fully-integrated solutions such as the digital signal controllers (for digital motor control, PFC, and other system functions), and relay drivers that provide up to 8 channels, zero-volt detection, and 5 V linear regulation for 5 V logic that may reside on the board.

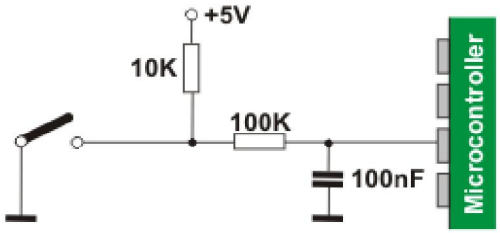
Switches and Push buttons

There are no simpler devices than switches and push-buttons. This is the simplest way of detecting appearance of a voltage on the microcontroller input pin.



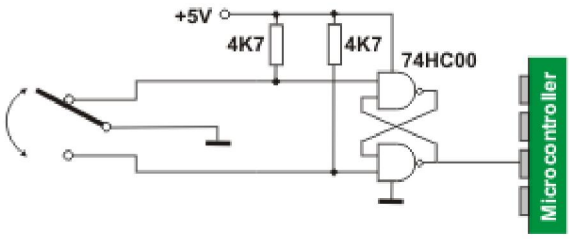
Nevertheless, it is not so simple in practice... It is about contact bounce- a common problem with m e c h a n i c a l switches. When the contacts strike together, their momentum and elasticity act together to cause bounce. The result is a rapidly pulsed electrical current instead of a clean transition from zero to full current. It mostly occurs due to vibrations, slight rough spots and dirt between contacts. This effect is usually unnoticeable when using these components in everyday life because the bounce happens too quickly. In other words, the whole this process does not last

long (a few micro- or miliseconds), but it is long enough to be registered by the microcontroller. When using only a push-button as a pulse counter, errors occur in almost 100% of cases.



The simplest solution to this problem is to connect a simple RC circuit to suppress quick voltage changes. Since the bounce period is not defined, the values of components are not precisely determined. In most cases, it is recomended to use the values shown in figure below.

If complete stability is needed then radical measures should be taken. The output of the circuit, shown in figure (RS flip-flop), will change its logic state only after detecting the first pulse triggered by contact bounce. This solution is expensive (SPDT switch), but effecient, the problem is definitely solved. Since the capacitor is not used, very short pulses can also be registered in this way.



In addition to these hardware solutions, there is also a simple software solution. When a program tests the state of an input pin and detects a change, the check should be done one more time after a certain delay. If the change is confirmed, it means that a switch or push button has changed its position. The advantages of such solution are obvious: it is free of charge, effects of noises are eliminated and it can be applied to the poorer quality contacts as well. Disadvantage is the same as when using RC filter, i.e. pulses shorter than program delay cannot be registered.

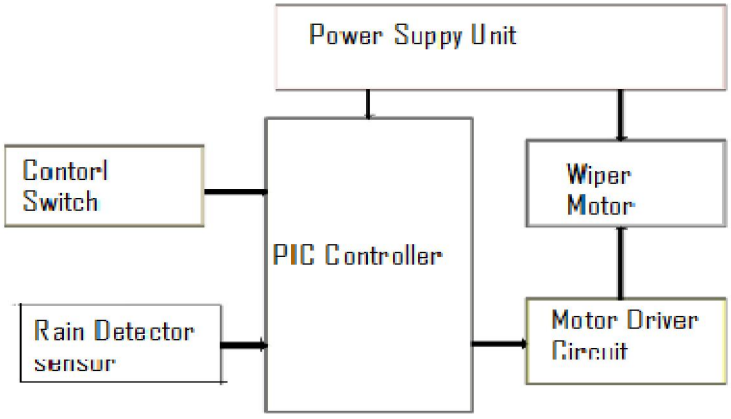
Working of windscreen wiper:-

The working of the wiper is based on the conversion of the wiper motors linear motion into linear back and forth movement of the wiper blades. The wiper combines two mechanical technologies to perform their tasks:

A combination of electric motor and worm gear reduction power to the wipers and a neat linkage

converts the rotational output of the motor into the back and forth motion of the wiper.

Motor takes a lot of force to accelerate the wiper blades back and forth across the windshield so quickly. In order to generate this type of force, a worm gear is used on the output of a small electric motor. The worm gear reduction can multiply the torque of the motor by about 50 times and can slow it down with the same force. The output of the gear reduction operates a linkage that moves the wipers back and forth. Inside the motor/gear assembly is the electronic circuit which senses the wipers are in their down position. The circuit maintains power to the wipers until they are parked at bottom of the windshield, and then cuts the power to the motor. A short cam is attached to the output shaft of the gear reduction. This cam spins around as the wiper motor turns. The cam is connected to a long road; as the cam spins, it moves the rod back and forth. The long rod is connected to a short rod that actuates the wiper blade on the driver's side. Another long rod transmits the force from the driver's side to the passenger's side wiper blade.



The basic control units of the hardware comprises of power supply unit, control switch, wiper motor, rain detector sensor ,motor driver circuit and the most important of all pic controller. Power supply unit maintains the continuous power to the controller and the wiper motor. Control switch is directly connected to the controller. Motor driver circuit is linked with the wiper motor and the controller. The command it gets from the controller is used to either drive the wiper motor or switch it off. Rain detection sensor detects the amount of moisture on the windscreen and accordingly sends the signal to the controller. A wiper motor control using a load sense resistor to monitor conditions confronting the wiper operation.

The control switch can detect if the wiper is frozen to the window, moving too slowly, moving too quickly, etc. The power to the motor is then adjusted to achieve a desired speed, or, otherwise adjusted, based upon the detected conditions. Further, the direction of the motor may be reversed based upon the detected conditions. In a preferred embodiment, the load sense resistor is provided by a defroster filament strip. Alternatively, a temperature sensor may be used to detect the conditions confronting the wiper operation.