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17/ENG04/076

ELECTRICAL ELECTRONICS ENGINEERING

EEE 471: ELECTRONIC INSTRUMENTATION (DIGITAL)

QUESTIONS:

1. Explain briefly the signal processing and interfacing techniques in measuring instruments.

2. Explain briefly the expert system instrumentation.

No.1

SIGNAL PROCESSING IN MEASURING INSTRUMENTS

When a sensor signal is converted into a digital form through an Analogue to digital converter(ADC), the digital output is normally in binary form; it is further processed by a microcomputer. In many cases, the processing may involve some rudimentary checks and display. Checks to see whether signals remain within safe limits or not and logical decisions based on the same are of this category. Others like handling keyboards and displays, binary to binary coded decimal(BCD) and other number conversions, are common to microcomputer routines also. Corrections for extraneous factors like cold junction compensation of thermocouples, normalization, simple algebra (obtaining power from current and voltage, obtaining square root to determine flow rate from head drop), are somewhat more involved. Though quite varied in nature, these are accommodated easily in ordinary microprocessor based design. Activities like calibration, which call for execution of carefully planned sequences and minimal computation are also of this category. These are all specific to instrumentation schemes and allied areas. At the other extreme, we have the front-end software applications and those of a specialized nature as used with data acquisition systems, or image processing applications.

INTERFACING TECHNIQUES IN MEASURING INSTRUMENTS

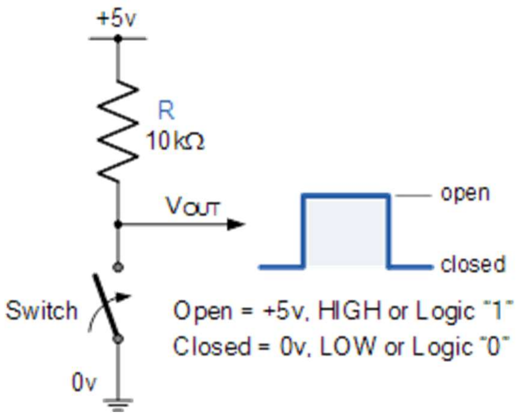
One of the key ways to add efficiency and accuracy to laboratory is by interfacing the instruments. **Interfacing** is the method of connecting or linking together one device, especially a computer or micro-controller with another allowing us to design or adapt the output and input configurations of the two electronic devices so that they can work together. The instruments that are used within laboratories range from simplistic 'dumb' instruments that simply output a number to instruments that include data management software that can communicate with external systems in a bidirectional manner. System integration with interfaced instruments offer high accuracy over result, Interfaced systems allow effective utilization of instruments to improve sample analysis.

Below are different interfacing techniques used in measuring instruments;

1.) Input Interfacing Circuits

The simplest and most common type of input interfacing device is the push button switch. Mechanical ON-OFF toggle switches, push-button switches, rocker switches, key switches and reed switches, etc. are all popular as input devices because of their low cost and easy of input interfacing to any circuit. Also the operator can change the state of an input simply by operating a switch, pressing a button or moving a magnet over a reed switch.

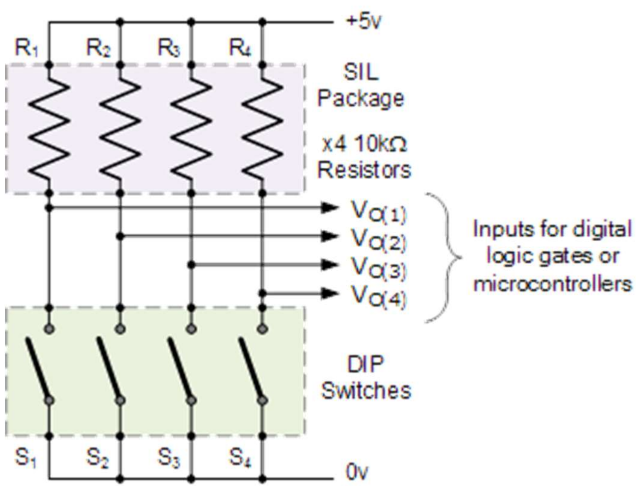
Input Interfacing A Single Switch



Switches and push-buttons are mechanical devices that have two or more sets of electrical contacts. When the switch is open or disconnected, the contacts are open circuited and when the switch is closed or operated these contacts are shorted together.

The most common way of input interfacing a switch (or push button) to an electronic circuit is via a pull-up resistor to the supply voltage as shown. When the switch is open, 5 volts, or a logic "1" is given as the output signal. When the switch is closed the output is grounded and 0v, or a logic "0" is given as the output.

DIP Switch Input Interfacing

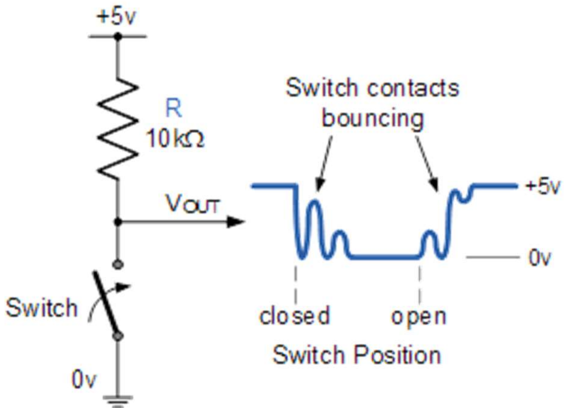


As well as input interfacing individual push-buttons and rocker switches to circuits, we can also interface several switches together in the form of keypads and DIP switches.

DIP or Dual-in-line Package switches are individual switches that are grouped together as four or eight switches within a single package. This allows DIP switches to be inserted into standard IC sockets or wired directly onto a circuit or breadboard.

Each switch within a DIP switch package normally indicates one of two conditions by its ON-OFF status and a four switch DIP package will have four outputs as shown. Both slide and rotary type DIP switches can be connected together or in combinations of two or three switches which makes input interfacing them to a wide range of circuits very easy.

Switch Bounce Waveform



The problem is that any electronic or digital circuit which the mechanical switch is input interfaced too could read these multiple switch operations as a series of ON and OFF signals lasting several milliseconds instead of just the one intended single and positive switching action.

This multiple switch closing (or opening) action is called **Switch Bounce** in switches with the same action being called **Contact Bounce** in relays. Also, as switch and contact bounce occurs during both the opening and closing actions, the resultant bouncing and arcing across the contacts causes wear, increases contact resistance, and lowers the working life of the switch.

However, there are several ways in which we can solve this problem of switch bounce by using some extra circuitry in the form of a debounce circuit to "de-bounce" the input signal. The easiest and most simplest way is to create an RC debounce circuit that allows the switch to charge and discharge a capacitor.

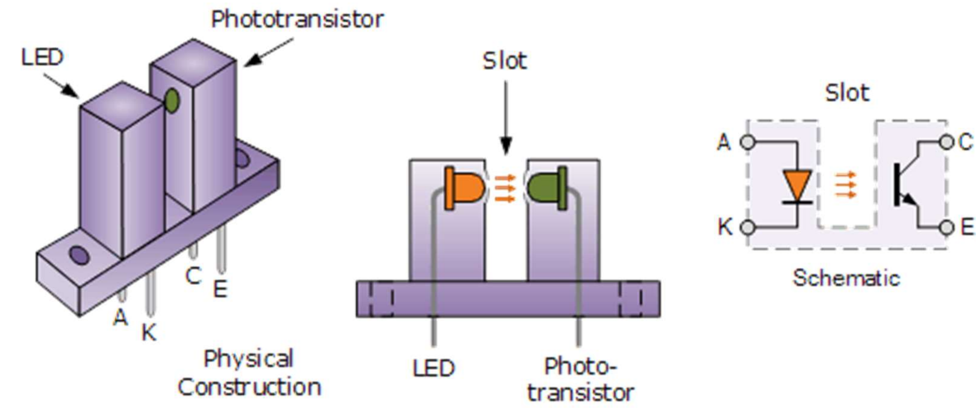
2.) Interfacing with Opto Devices

An **Optocoupler** (or optoisolator) is an electronic component with an LED and photo-sensitive device, such as a photodiode or phototransistor encased in the same package. The Opto-coupler which we look at in a previous tutorial interconnects two separate electrical circuits by means of a light sensitive optical interface. This means that we can effectively interface two circuits of different voltage or power ratings together without one electrically affecting the other.

Optical Switches (or opto-switches) are another type of optical (photo) switching devices which can be used for input interfacing. The advantage here is that the optical switch can be used for input interfacing harmful voltage levels onto the input pins of microcontrollers, PICs and other such digital circuits or for detecting objects using light as the two components are electrically separate but optically coupled providing a high degree of isolation (typically 2-5kV).

Optical switches come in a variety of different types and designs for use in a whole range of interfacing applications. The most common use for opto-switches is in the detection of moving or stationary objects. The phototransistor and photodarlington configurations provide most of the features required for photo-switches and are therefore the most commonly used.

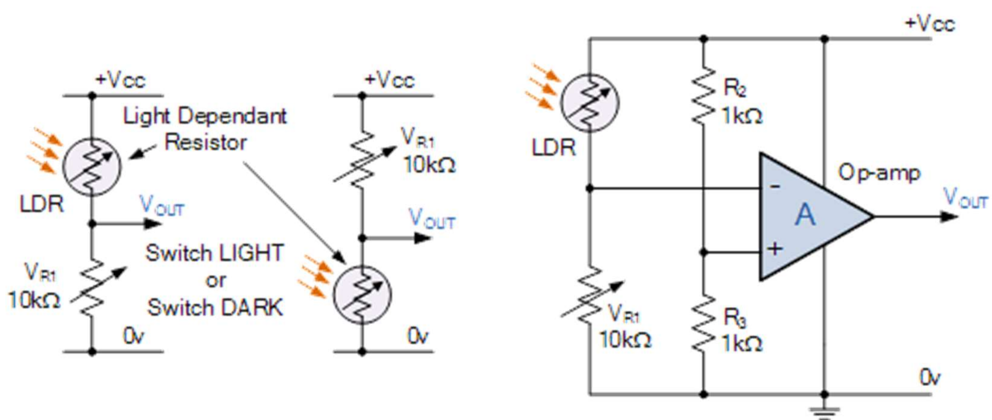
Slotted Optical Switch



A DC voltage is generally used to drive a light emitting diode (LED) which converts the input signal into infrared light energy. This light is reflected and collected by the phototransistor on the other side of the isolation gap and converted back into an output signal.

For normal opto-switches, the forward voltage drop of the LED is about 1.2 to 1.6 volts at a normal input current of 5 to 20 milliamperes. This gives a series resistor value of between 180 and 470Ω's.

3.) Interfacing LDR Photoresistors



Light dependant resistors change their resistive value in proportion to the light intensity. Then LDRs can be used with a series resistor, R to form a voltage divider network across the supply. In the dark the resistance of the LDR is much greater than that of the resistor so by connecting the LDR from supply to resistor or resistor to ground, it can be used as a light detector or as a dark detector as shown.

As LDRs such as the NORP12, produce a variable voltage output relative to their resistive value, they can be used for analogue input interfacing circuits. But LDRs can also be connected as part of a Wheatstone Bridge arrangement as the input of an op-amp voltage comparator or a Schmitt trigger circuit to produce a digital signal for interfacing to digital and microcontroller input circuits.

No.2

In artificial intelligence, an **expert system** is a computer system emulating the decision-making ability of a human expert. Expert systems are designed to solve complex problems by reasoning through bodies of knowledge, represented mainly as if–then rules rather than through conventional procedural code. In addition to providing advice and recommendations, expert systems can be extended to act on their own results by controlling, for example, instrumentation or process plant. Since such real-time operations require decisions within a fixed, and often limited, timescale, restrictions may be imposed on the way such expert systems function. Intelligent control of instruments in industrial plants is growing. The speed and quantity of data produced by modern instrumentation outstrips the rate at which humans can process and respond to it. The value of an expert system depends on the quality (both accuracy and completeness) of the data it contains, as well as the sophistication of the shell or inference engine. As computer power grows and instrumentation becomes more automated, the development of larger and better knowledge bases will continue and the application of expert systems will become more evident.