Maintenance Circle
NEWSLETTER FOR MAINTENANCE COMMUNITY

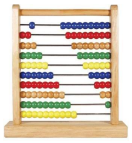
Word for the day: **DIGITAL TECHNOLOGY– A Brief Overview**

Whether you are working on a sophisticated machine, operating a personal computer or fiddling your mobile phone, you cannot miss a word that is supposedly creating revolution: DIGITAL. From a simple FM radio hanging in your pocket to operating a highly sophisticated aircraft, digital technology has revolutionized the way any activity is handled and performed. And, in a manufacturing set-up, no machine exists today that does not have digital technology built into it in one form or other.

So, what is digital?

It is indeed difficult to give a standard & book definition for this word which has occupied an important place in today's technological world. So, to simplify and make understanding little easier, let us visit the human history for getting some clarity on what digital means. One of the greatest gifts for human being is the power of communication. There are thousands of languages, scripts that help us communicate with each other and perform many tasks which otherwise would have been impossible or very difficult. But, this vast variation of language and script posed a major barrier when communication was expected to happen between two different language groups around the world or with people who had visual or hearing disabilities. In the process, many devices and standards were designed and agreed upon by all the people around the world.

Let us take a look at few well known methods, which most of us have seen at one time other.



Abacus: It was one of the oldest known methods of teaching numbering system to children (and probably to some adults as well!). The position of beads in the rod determined the number it represented. It was usually used to teach numbers from zero to one hundred. It is used in many schools even today.

Light House: Ships occupy a prominent position in moving huge quantities of cargo (and people) from one corner of globe to another. Prior to radio communication days, ships needed precise guidance to reach the harbor safely. So Light houses were built near every harbor for two purposes. One, obviously to provide a continuous beam of strong light that helped ships to approach harbor correctly. Second, the light was switched OFF and ON in a specific sequence to convey certain messages to the ship controller for taking suitable decisions.

Morse code Machine: A small device that passed on a series of dots (•) and dashes (**–**) which in various combinations represented words that users could decode and understand. It was very widely used during First World War for conveying urgent and emergency messages across the globe.

One of the common factors that can be observed among on these different devices is that, the information is not given continuously - like talking - but "one" at a time. Light house switches the light ON or OFF, Morse code machine sends a DOT or a DASH one at a time, and but one after the other using which, the user will eventually combine and understand the meaning. This type of *discrete*[1] representation of information can be broadly termed as DIGITAL, which has been known to mankind from ancient times.

With the advent of computer technology and electronics, the representation and understanding of what DIGITAL means underwent a radical change, but essence remains the same as to what the ancient devices represented. We are very familiar with the fact that most of the electronic devices, including computers understand only '0s' and '1s' which are generally called as bits. They are also called as LOW & HIGH states respectively. Normally, all electronic devices operate on very low voltages, up to 5V DC. So, a LOW state or 0 corresponds to 0 volts and a HIGH state or 1

[1] Separated or individual piece of information which can be combined to understand

corresponds to 3.3V or higher. Refer to figure 1. A combination of these '0s' and '1s' in thousands and millions form the basis for all information or program processing in DIGITAL form.

These '0s' and '1s' are combined using various mathematical models, the most common being BINARY ARITHMETIC. We will be discussing about this interesting subject in subsequent newsletters, which will also be very useful in troubleshooting basic electronic component problems on any modern machines.

Giving specific attention to a machine system, not all the signals will be in ON or OFF form. Many devices will give continuous signals like a simple potentiometer or auto-transformer. If a computer or a programmable controller is controlling a machine system, how does it understand these different signal types? Let us go thru few commonly used input and output devices in a typical machine to understand the concept.

1. Normally Open Limit switch (LS) which is expected to close when a door closes – Since it only opens or closes, it gives either ON or OFF output. This can be considered as DIGITAL input to controller. Let us assume it is connected to a 230V AC signal.

2. A 10 Kilo Ohm potentiometer is used to control the machine speed and is expected to give 0 to 10 volt DC input to the controller. It is NOT a DIGITAL input. This type is called ANALOG[2] signal, about which we will discuss in subsequent newsletters.

3. A feedback device which is giving sine wave output. is NOT a DIGITAL input. This signal can also be considered as ANALOG[2] signal.

The computer / controller understand only 0s and 1s as we now know. So these signals must be "converted" into the DIGITAL format. This conversion is done using what is known as ANALOG to DIGITAL converters. The type of converter and its working principle depend on the signal it is converting. Refer figure 1, for the conversion process involved in handling signals mentioned above.

Similarly, the reverse of above situation is also required. For example, if a motor's speed is controlled by a drive, a 0 to 10V DC input will be required for drive to regulate the motor speed. This is an ANALOG signal. Another example could be the input signal for a proportional hydraulic / pneumatic valve. This will be accomplished using DIGITAL to ANALOG to converter. Refer to figure 2 for illustration.

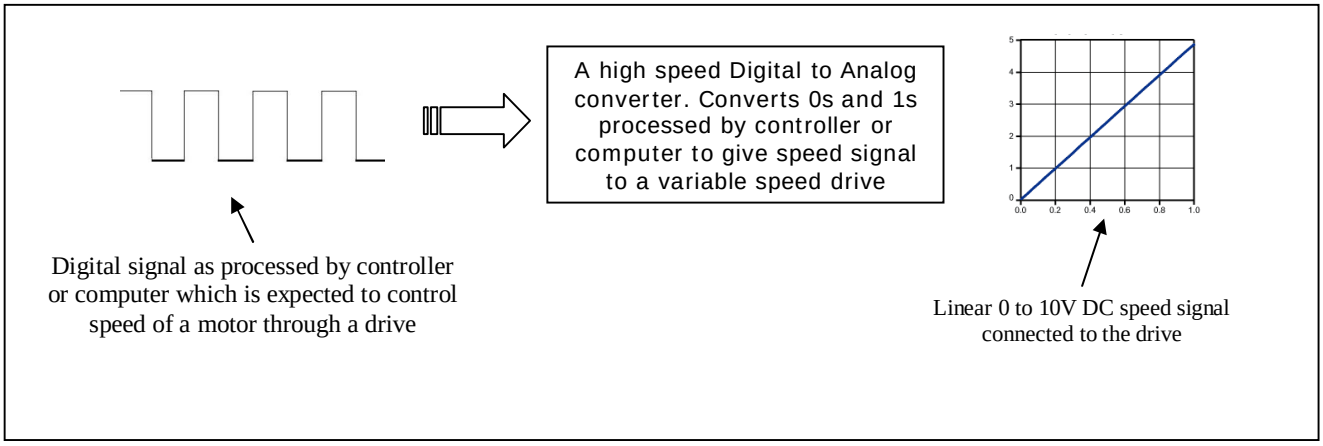


Figure-2

[2] Any signal that is not discrete and continuously varies can be called as analog signal.

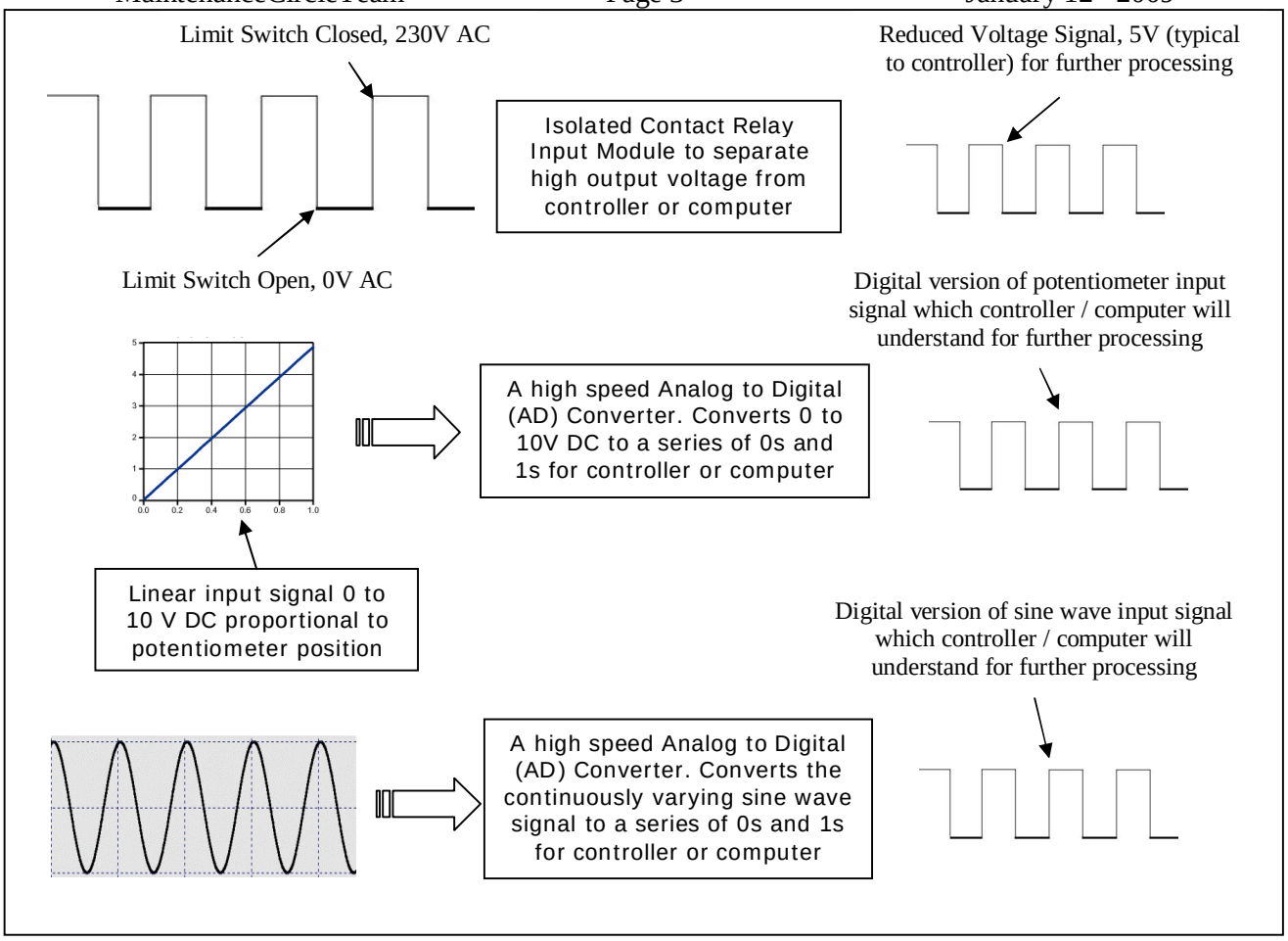


Figure-1

It is interesting to note that DIGITAL concept exists not only in electrical or electronics field, but also in mechanical parts of the machines. Two of the best examples for digital concept are gears and clutch. The gears shift from one ratio to another. There is no in between positions. Similarly, clutch is either ENGAGED or DISENGAGED.

The brake system can be a best example for ANALOG system. Amount of brake applied is proportional to the input force and it can vary continuously between its minimum and maximum limits.

In a typical house, old fan regulators which generally had four voltage selection positions can be classified as DIGITAL type and new electronic regulators giving continuous voltage can be classified as ANALOG type. Light switches are digital type where as the water tap can be classified as analog type!

Table below gives some of the commonly used input and output devices / sensors classified as DIGITAL or ANALOG type. Remember that the controller / computer ALWAYS convert any signal into DIGITAL before performing further processing.

Device Type	DIGITAL	ANALOG
Limit Switch	✓	
Thermocouple		✓
Proximity Sensor	✓	
Speed Signal		✓
Clutch	✓	
Brake		✓
Transmission Gears	✓	
Linear Potentiometer		✓
Compact Disc	✓	
Audio Cassette		✓
Mechanical Watch		✓
Digital Clock	✓	
Dial Indicator / Micrometer		✓
Bourdon Pressure Gauge		✓
Weather Cock		✓

And the list can be endless……

If we have to diagnose or analyze a problem, it is very important to understand the type of signal that we are dealing with. We are very familiar and comfortable with Digital Multi Meter, because it gives reading on a LCD screen. But if we have to measure and understand a varying signal or its stability – insulation resistance for instance – it is better to use a conventional analog meter with dial that displays exact and instantaneous behavior.

Analog to Digital and Digital to Analog converters form vital part of any machine control system for smooth and seamless operation. The accuracy of conversion is identified with two parameters. One, number of bits a converter can produce and the speed, in kilohertz, at which it can convert. The type of converter selected also depends on input signal form that it is expected to handle.

A converter required to change thermocouple signal, which usually gives milli volt signal, is different from the one used for a tachometer. Normally, these are designed at design stage itself and as end users, we may only have to select a suitable type of converter boards, which are generally called as analog boards.