Unit Name:- Digital Instruments

What is a DMM, Digital Multimeter?

A digital multimeter, DMM is a test instrument used to measure electrical values including voltage, current and resistance, although modern DMMs often make many more measurements.

A digital multimeter compares better than the analog type, but it is also important to remember that it comes with some drawbacks that you should look into. Weigh down its advantages and disadvantages to know if it is the best solution for your needs.

2. It is more expensive than the analog type.

As an older technology, the prices of analog multimeters are typically lower than the digital versions. Fortunately, as time goes by, the difference in prices between analog and digital is no longer that big.

3. It can be difficult to find one for your specific needs.

Within the current digital market, there is already a wide range of digital multimeters with various prices and capabilities. Typically, you should pick a meter that perfectly suits your needs, and this can be difficult with the plethora of options out there. If you are going to use it once or twice for a job,

1. Ramp type DVM

In a ramp type DVM, the operation basically depends on the measurement of time. The time which a ramp voltage takes to change from the level of the input voltage to that of 0 voltage or vice versa. An electronic time interval counter is used to measure the time interval and the count is displayed in digits as voltmeter output.

Let us have look at the block diagram and operating principle of a ramp-type DVM.

In **analog technology**, a wave is recorded or used in its original form. So, for example, in an analog tape recorder, a signal is taken straight from the microphone and laid onto tape. The wave from the microphone is an analog wave, and therefore the wave on the tape is analog as well. That wave on the tape can be read, amplified and sent to a speaker to produce the sound.

In **digital technology**, the analog wave is **sampled** at some interval, and then turned into **numbers** that are stored in the digital device. On a CD, the sampling rate is 44,000 samples per second. So on a CD, there are 44,000 numbers stored per second of music. To hear the music, the numbers are turned into a **voltage wave** that approximates the original wave.

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As we have already discussed what is working of digital voltmeter and its types, now we will discuss the second type DVM i.e, **integrating type digital voltmeter**. This digital voltmeter measures the true average value of the input voltage over a fixed measuring period. In contrast, the ramp type DVM samples the voltage at the end of the measuring period.

This voltmeter employs an integration technique whirls uses a voltage to frequency conversion. The voltage to frequency (V/F) converter functions as a feedback control system which governs the rate of pulse generation in proportion to the magnitude of input voltage.

Actually, when we employ the voltage to frequency conversion techniques, a train of pulses, whose frequency depends upon the voltage being measured, is generated. Then the number of pulses appearing in a definite interval of time is counted. Since the frequency of these pulses is a function of unknown voltage, th number of pulses counted in that period of time

Dual Slope Digital Voltmeter –

The dual slope integrating type DVM integrates the input voltage V_i. The slope of the integrated signal is proportional to the input voltage under measurement. After certain period of time, say t_1, the supply of input voltage V_i is stopped, and a negative voltage -V_r of the integrator is applied.

Then the output signal of integrator experiences a negative slope, which is constant and proportional to the magnitude of the input voltage.

The major blocks of a dual slope integrating type DVM are

1. An op-amp employed as an integrator
2. A level comparator
3. Oscillator for generating time pulses
4. Decimal counter
5. Block of logic circuitry

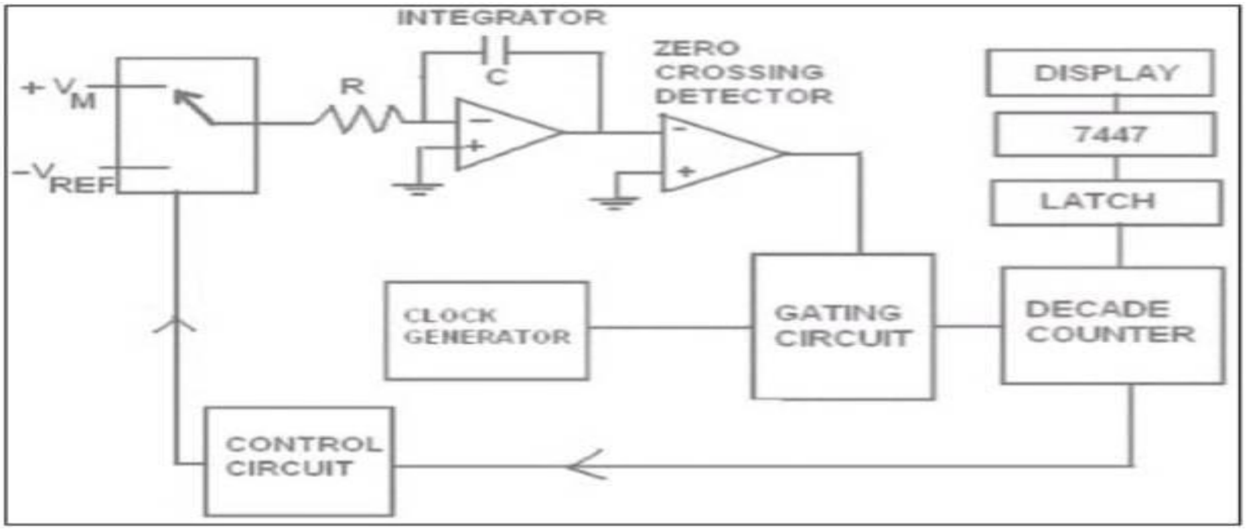


Figure - Block Diagram of Dual Slope DVM

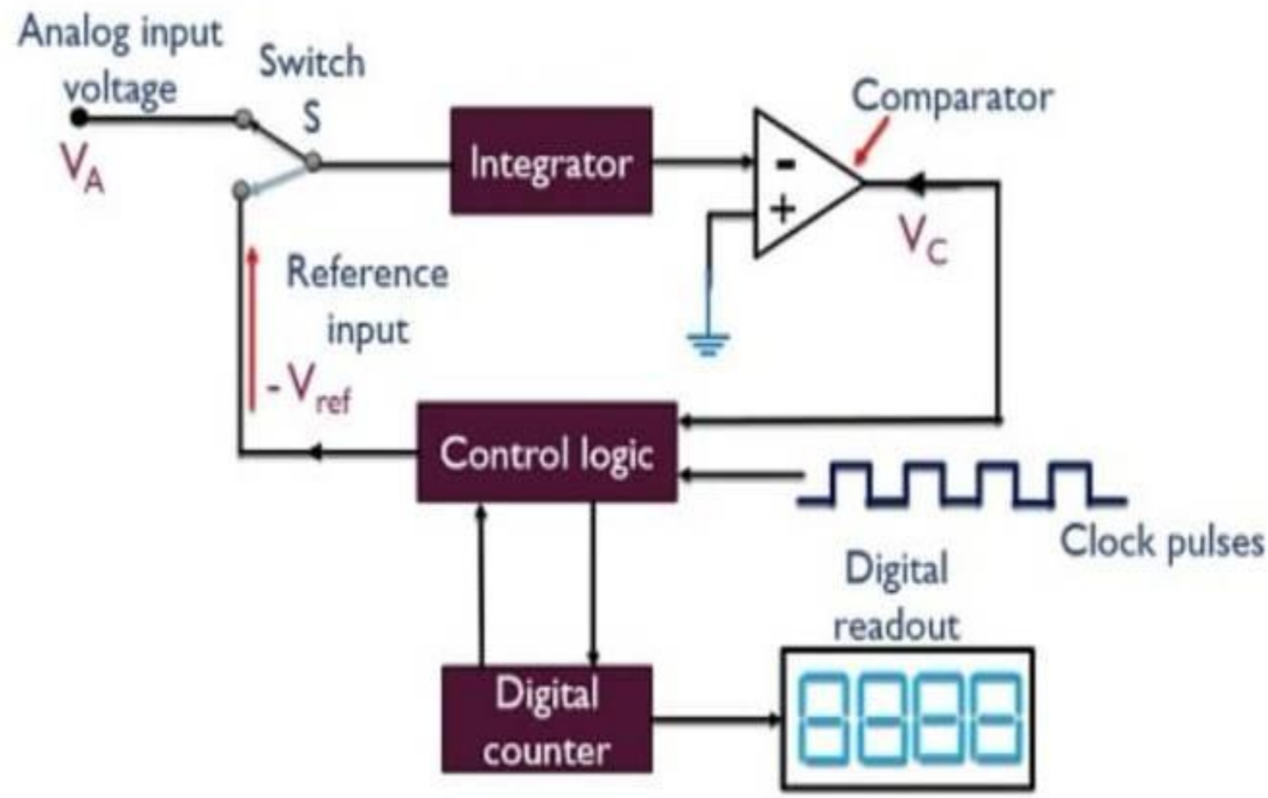
Initially a pulse is applied to reset the counter and the output of flip-flop will be at logic '0.' The switch S_r is in open condition and the switch S_i is in closed condition.

Now, the capacitor 'C' starts to charge. Once the output of the integrator becomes greater than zero, the output state of the comparator changes, which in turn opens the AND gate.

When the gate opens, the output of the oscillator (clock pulses) are allowed to pass through it and are applied to the counter. Now the counter counts the number of pulses fed to it. As soon as it reaches its maximum count i.e. that is the counter is preset to run for a time period r; in this condition the maximum count will be'9999', and for the next

2. Dual slope integrating type DVM

The figure below shows the block diagram of dual slope integrating type DVM.

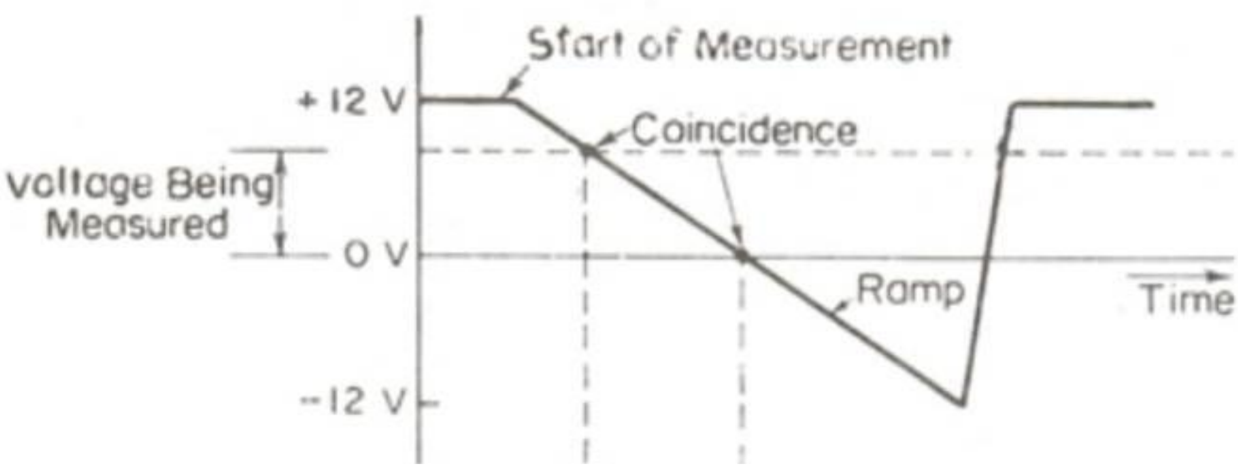


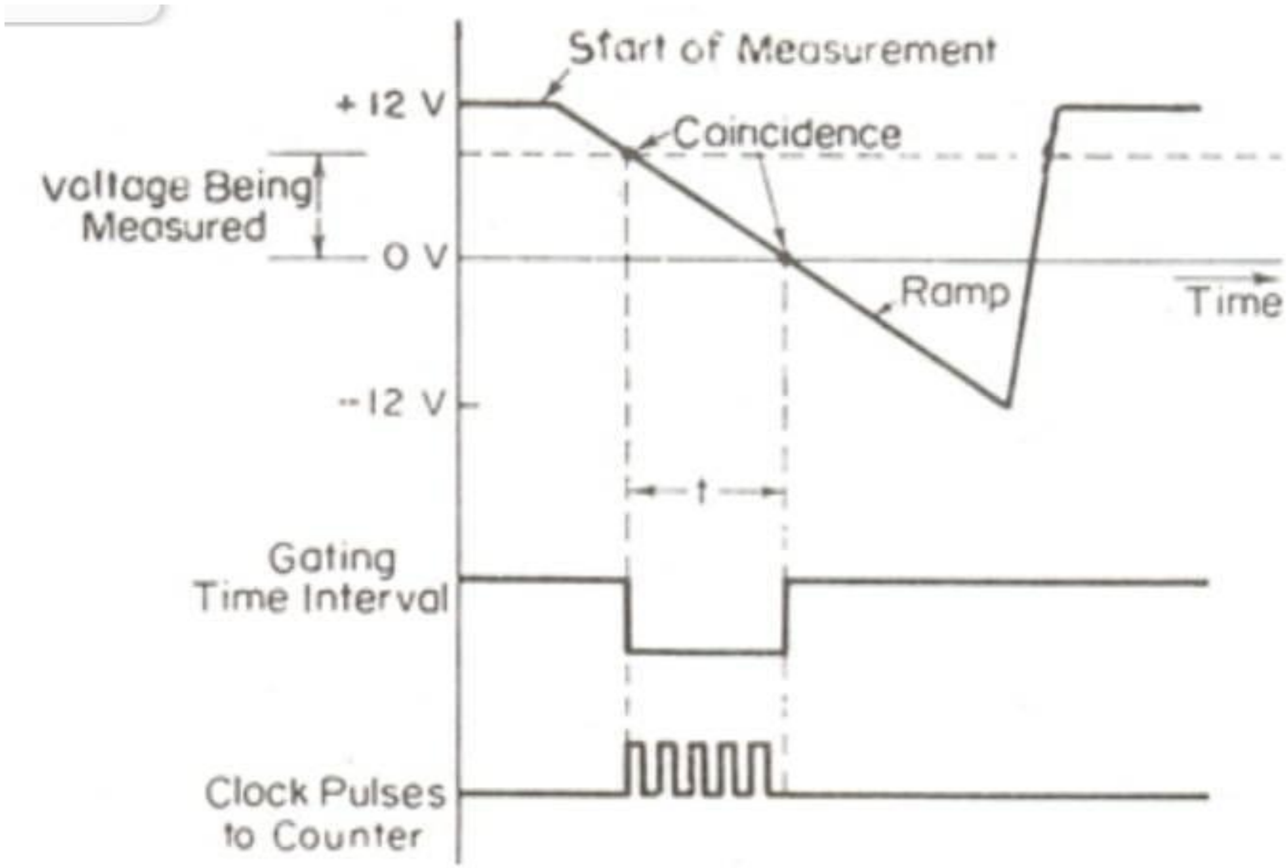
Block diagram of dual slope integrating type DVM

Ramp-Type DVM

The operating principle of the ramp-type DVM is based on the measurement of the time it takes for a linear ramp voltage to rise from 0 V to the level of the input voltage, or to decrease from the level of the input voltage to zero. This time interval is measured with an electronic time-interval counter, and the count is displayed as a number of digits on electronic indicating tubes.

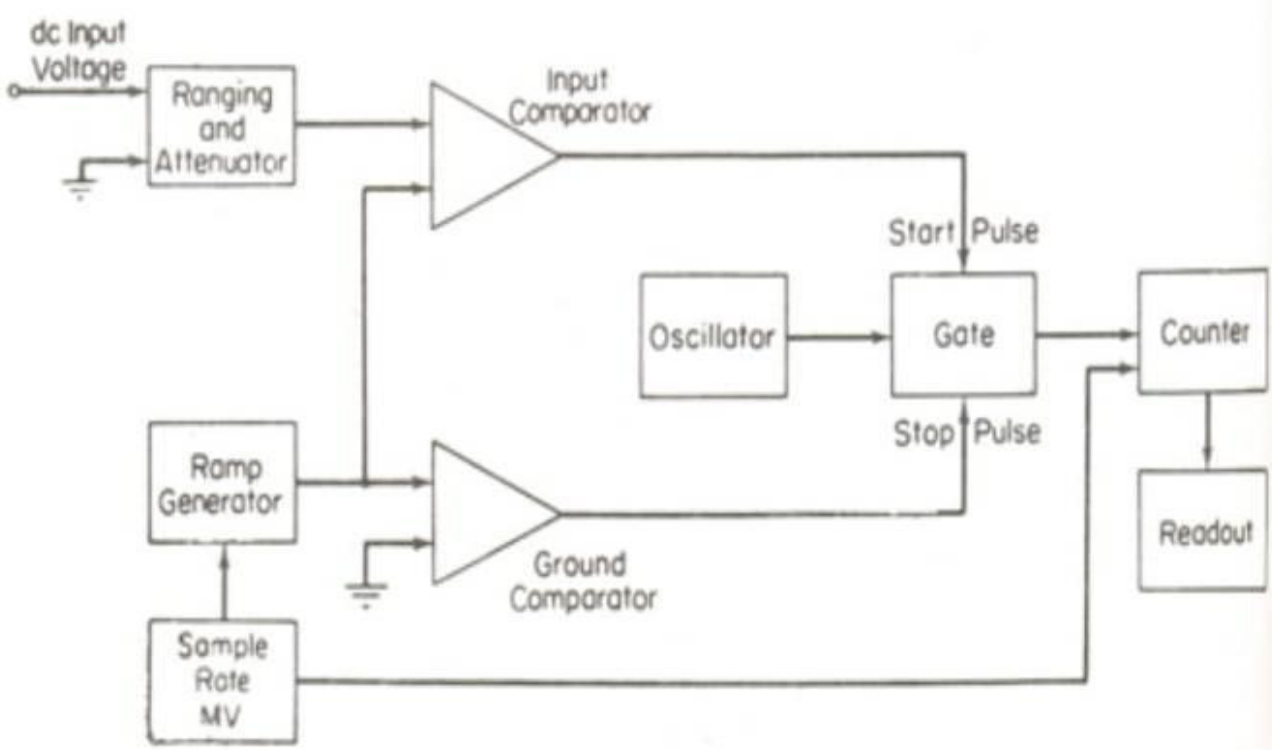
Conversion from a voltage to a time interval is illustrated by the waveform diagram of Figure below.





At the start of the measurement cycle, a ramp voltage is initiated; this voltage can be positive-going or negative-going. The negative-going ramp, shown in Fig. , is continuously compared with the unknown input voltage. At the instant that the ramp voltage equals the unknown voltage, a coincidence circuit, or comparator, generates a pulse which opens a gate.

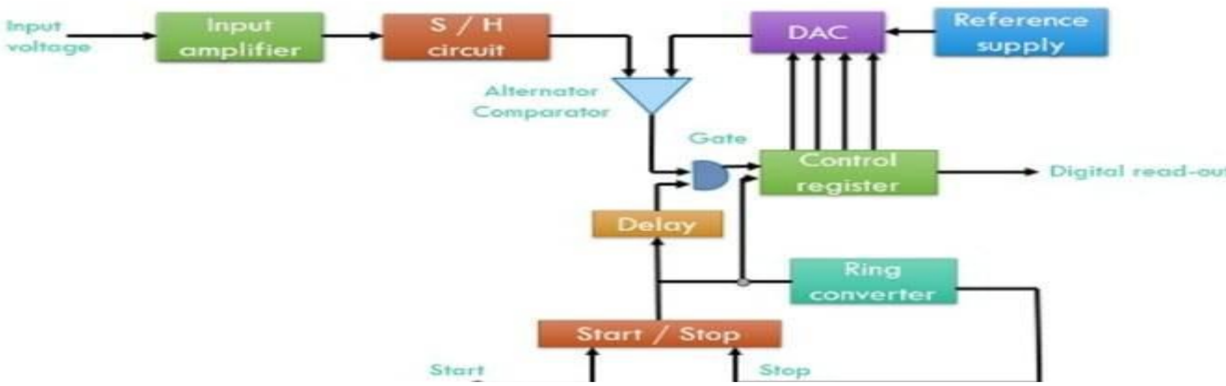
, arator, generates a pulse which opens a gate. This gate is shown in the block diagram of below figure. The ramp voltage continues to decrease with time until it finally reaches 0 V (or ground potential) and a second comparator generates an output pulse which closes the gate.



An oscillator generates clock pulses which are allowed to pass through the gate to a number of decade

4. Successive Approximation DVM

In this category of DVM, the ADC employed makes use of **successive approximation converter**. Thus it is named as so. These are capable of 1000 readings per second.



Advantages of Digital Voltmeter

1. DVM provides numerical readouts that **eliminate observational errors**. Thus providing better **readability**.
2. DVM offers better **accuracy** and **versatility** as compared to analogue voltmeters.

DVM offers better **accuracy** and **versatility** as compared to analogue voltmeters.

3. DVM has a **greater speed** of taking voltage readings as compared to analogue instruments.

4. The output of DVM can be fed to memory devices for further computations.

5. The decreased size of DVM **increases** the **portability** if the instrument.

DVM offers an accuracy of **0.5% + 1** digit and the operating temperature range is **-5 ^{0}C to 55 ^{0}C**.

Accuracy - It is the probability of the reading being accurate. High accuracy is always preferred. Uncertainty - It is a characteristic considered with conjunction to accuracy; i.e. if there is a 1% uncertainty with a DMM, it will give out readings that are 99% accurate. Manufacturers use this term to indicate how the device may go wrong in practice.

Repeatability - It is often more important than absolute accuracy when making a series of measurements. It is the degree of measurement that will give out the same reading each time a measurement is repeated.

Calibration - It indicates how well the DMM has been tested against various quantity measurements and how closer they were to the intended value.

True RMS - RMS measurements are a measure of the equivalent heating effect produced by a voltage and, to be accurate, must include any DC component present along with the AC component that most users associate with RMS readings.

Crest Factor - It is defined as the ratio of the peak or "crest" voltage compared to the RMS voltage.

Form Factor - It is defined as the ratio of the RMS value to the average value and is the factor that when multiplied by the average value of a waveform

2. It ensures accuracy.

Typically, a digital multimeter can show more accurate values than the analog and can provide output of up to 4 decimal places that the analog could never show. With regards to fluctuations, any value within the range of the fluctuations is mostly considered as valid.

3. It has auto polarity functions.

Multimeters can read negative values, especially in terms of voltage. When you place the probes into the opposite polarity, you will get a negative output. This is also where a digital type is more advantageous than the analog, as placing probes into the opposite polarity can cause the analog type to break.

instruments. Following are some important performance specifications that need to be considered. Display Digits - The display must be capable of showing the reading depending upon the application. For a process where the whole 7-digit display is required, a three-and-a-half-digit display would prove useless.

Resolution - Resolution is a measure of the smallest increment that may be discerned. Higher the resolution, better the DMM. Although this is not true in all cases, as other parameters like applications, measuring rate, etc. are also considered.

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List of Advantages of Digital Multimeter

1. It offers automatic output display.

With this device, it will be easy for you to gauge readings, since its output is displayed automatically in numbers through a seven-segment display, unlike the analog multimeter that requires you to take a closer look into the scales to read values. The analog type also takes time and risks human errors to occur, especially for those with poor eyesight.

List of Disadvantages of Digital Multimeter

1. It does not do well with measurement fluctuations.

Unlike analog meters, digital multimeters cannot read measurement fluctuations. When a fluctuation occurs, these meters are unable to represent it and rather record an error or calculate a single reading.