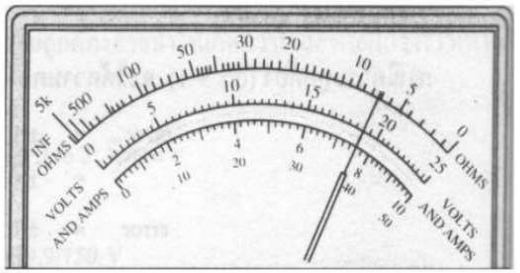
Digital Votmeter

Digital Voltmeter (DVM)

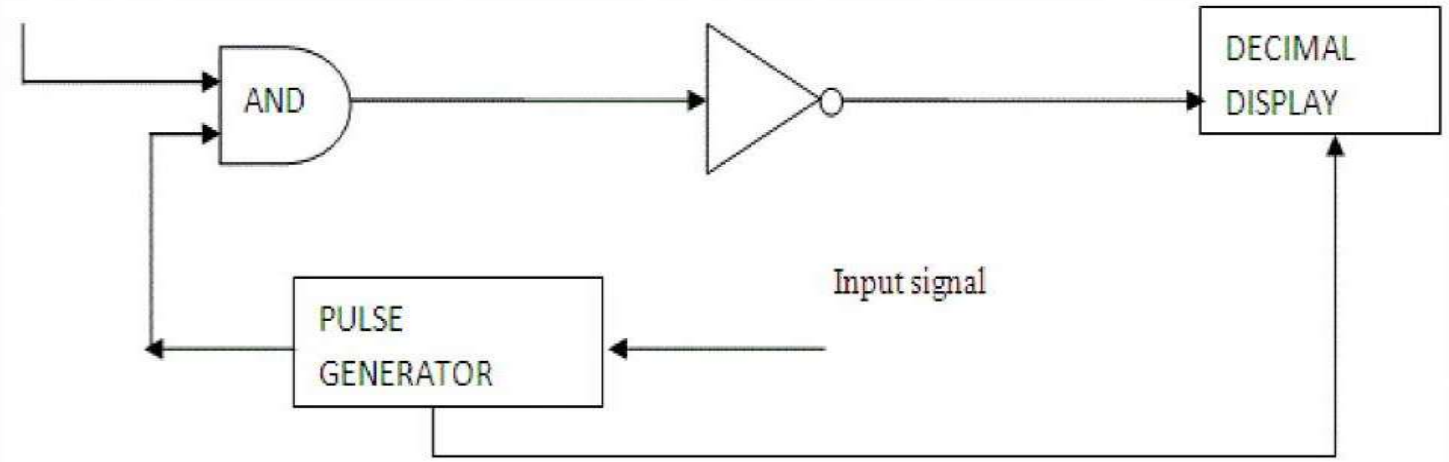
- Voltmeter is an electrical measuring instrument used to measure potential difference between two points. The voltage to be measured may be AC or DC.
- Two types of voltmeters are available for the purpose of voltage measurement i.e. analog and digital. Analog voltmeters generally contain a dial with a needle moving over it according to the measure and hence displaying the value of the same.
- Digital voltmeters display the value of AC or DC voltage being measured directly as discrete numerical instead of a pointer deflection on a continuous scale as in analog instruments.

Comparison of Digital and Analog Meter



Digital meter	Analog meter
Leaves no doubt about the measured quantity.	Wrong scale might be used or might be read incorrectly.
Superior resolution and accuracy. (±0.5% or better)	Inferior resolution and accuracy. (±3% in common)
Indicates a negative quantity when the terminal polarity is reversed	Pointer attempts to deflect to the left when the polarity is reversed
No usually damaged by rough treatment	Can be damaged when dropped from bench level

Block Diagram of DVM



From the above block diagram, the voltage to be measured is given to the input signal present in the circuit diagram. And next to this signal is processed onto the pulse generator which generates a train of rectangular pulses by using both analog and digital techniques.

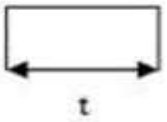
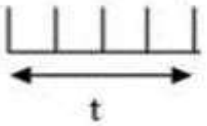
The digital circuitry present inside the pulse generator will control the width and frequency while analog circuitry will control the amplitude, rise time and fall time of the pulse generator. When AND gate is fed with train pulse and rectangular pulse, it will give train pulses with the same duration of that of the rectangular pulse.

Explanation of various blocks:

Input signal: It is basically the signal i.e. voltage to be measured.

Pulse generator: Actually it is a voltage source. It uses digital, analog or both techniques to generate a rectangular pulse. The width and frequency of the rectangular pulse is controlled by the digital circuitry inside the generator while amplitude and rise and fall time is controlled by analog circuitry.

AND gate: It gives high output only when both the inputs are high. When a train pulse is fed to it along with rectangular pulse, it provides us an output having train pulses with duration as same as the rectangular pulse from the pulse generator.

	Train pulse
	Rectangular pulse
	Output of AND gate

NOT gate: It inverts the output of AND gate.

	Output of NOT gate

Decimal Display: It counts the numbers of impulses and hence the duration and display the value of voltage on LED or LCD display after calibrating it.

Working of a digital voltmeter as follows:

- Unknown voltage signal is fed to the pulse generator which generates a pulse whose width is proportional to the input signal.
- Output of pulse generator is fed to one leg of the AND gate.
- The input signal to the other leg of the AND gate is a train of pulses.
- Output of AND gate is positive triggered train of duration same as the width of the pulse generated by the pulse generator.
- This positive triggered train is fed to the inverter which converts it into a negative triggered train.
- Output of the inverter is fed to a counter which counts the number of triggers in the duration which is proportional to the input signal i.e. voltage under measurement.
- Thus, counter can be calibrated to indicate voltage in volts directly.

RAMP TYPE DVM

- The main building block of ramp type dvm is a ramp generator. This is generating a waveform which is representing a ramp. The heart of the circuit is the ramp generator.
- Therefore it is called ramp type digital voltmeter(DVM).
- The input which should be measured is given at input voltage.
- This input fed to ranging and attenuator circuit which will amplify the signal if it is small or attenuates the signal if it is large.

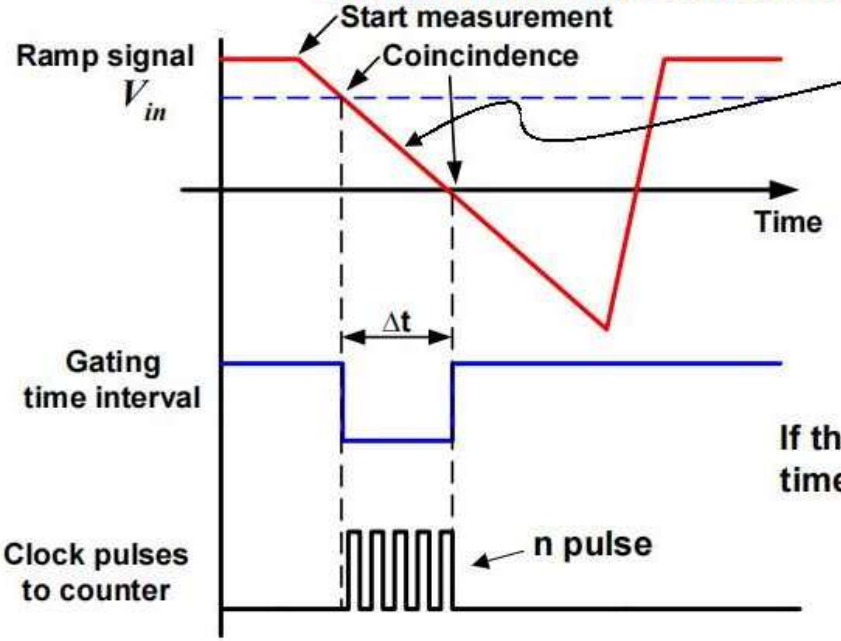
- This is given to an input comparator which will compare two signals and generate the output.
- One input to the input comparator is from the input voltage and another input from the ramp.
- This input voltage and ramp signal are compared and output is given. If the ramp signal is more than input voltage there will be no output but if the input voltage is greater than the ramp signal then a is generated which will open the gate.
- Now when the gate get opened, clock oscillator will send clock pulses which are counted by the counter and displays on the screen.

Operating Principle:

- The operating **principle of ramp type digital voltmeter** is to measure the time that a linear ramp voltage takes to change from the level of the input voltage to zero voltage (or vice versa). 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 of the output readout of the voltmeter.

Timing Diagram:

Operation principle: **The measurement of the time it takes for a linear ramp voltage to rise from O 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.**



Voltage-to-time conversion using gated clock pulses.

$$V_{ramp}(t) = V_o - m\,t$$

Where *m* is the ramp rate

$$V_{ramp}(t_1) = V_{in} = V_o - m\,t_1$$

$$V_{ramp}(t_2) = 0 = V_o - m\,t_2$$

$$\Delta t = t_2 - t_1 = V_{in}/m$$

If the period of the clock is *T*, then during the time interval Δt_1, the number of pulses is

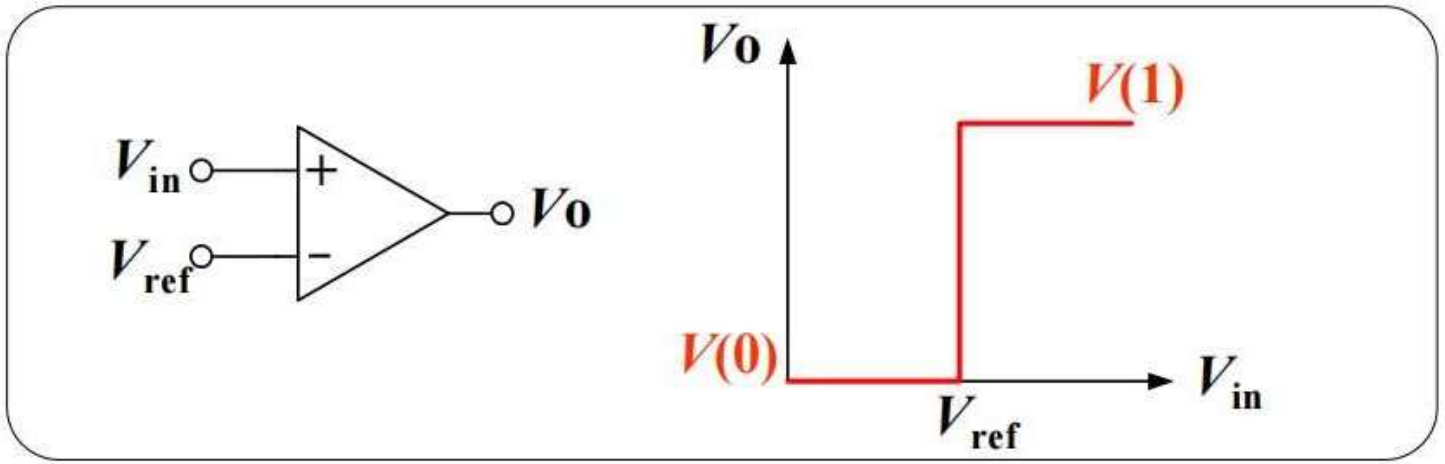
$$\Delta t \approx nT \text{ or } V_{in} \approx nmT$$

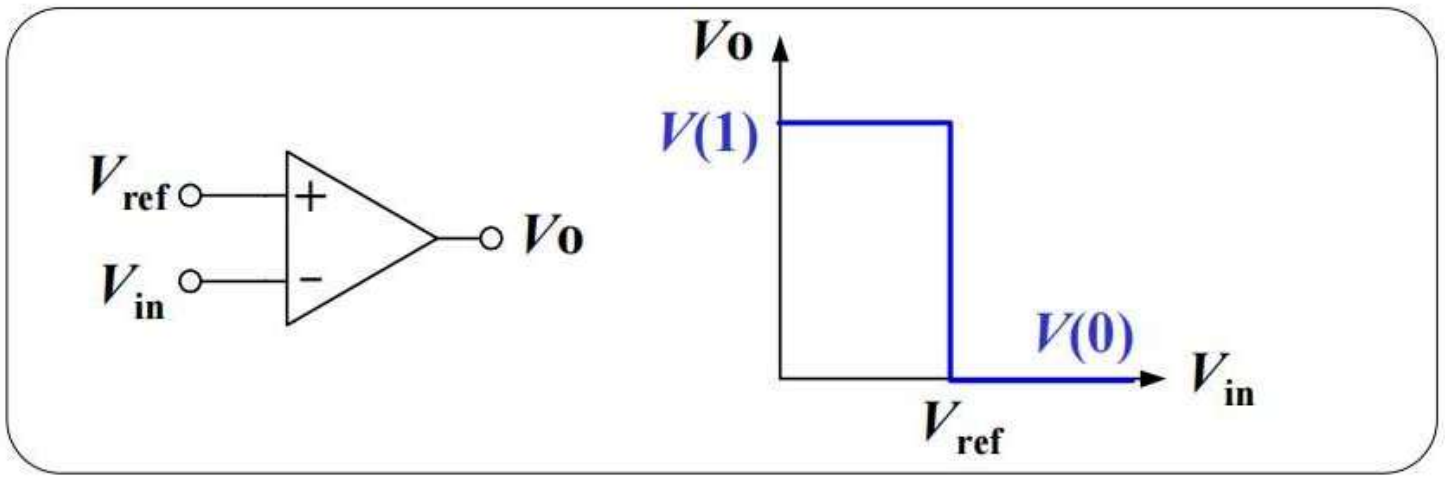
•Accuracy depends on both the ramp rate and clock period.

Comparator

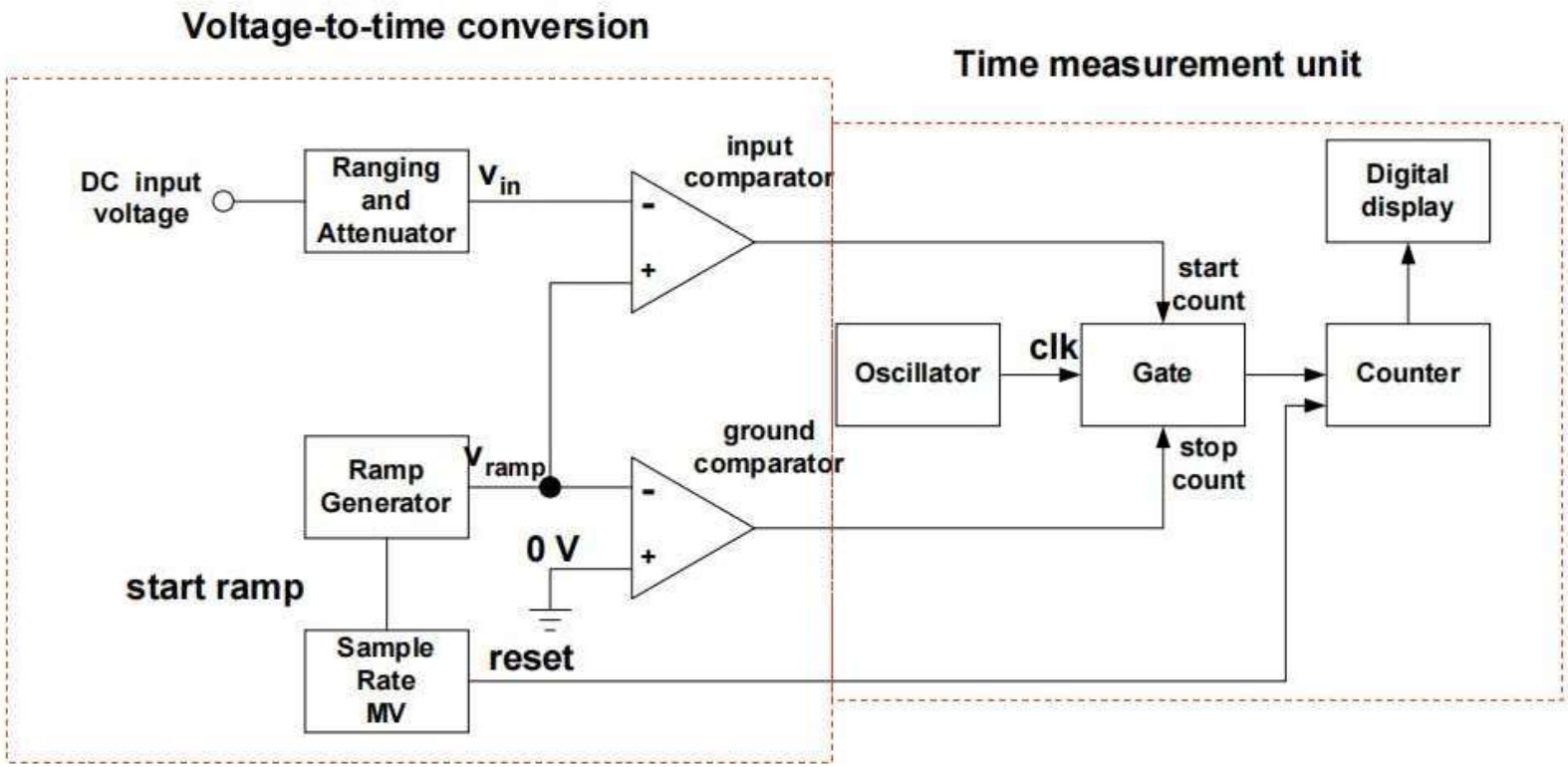
$V+ > V-$; $Vo = V(1)$ Logic high

$V+ < V-$; $Vo = V(0)$ Logic low





Ramp-type Digital Voltmeter



Block diagram of a ramp-type digital voltmeter.