# Function Generator

- Various waveforms such as sine, triangular, square, etc. are required in many electronics applications in laboratories and industries.
- *A signal generator is an electronic instrument that generates repeating voltage waveforms.*
- The amplitude and frequencies of all these waveforms can be adjusted through a wide range.

# 70 Block Diagram of Function Generator

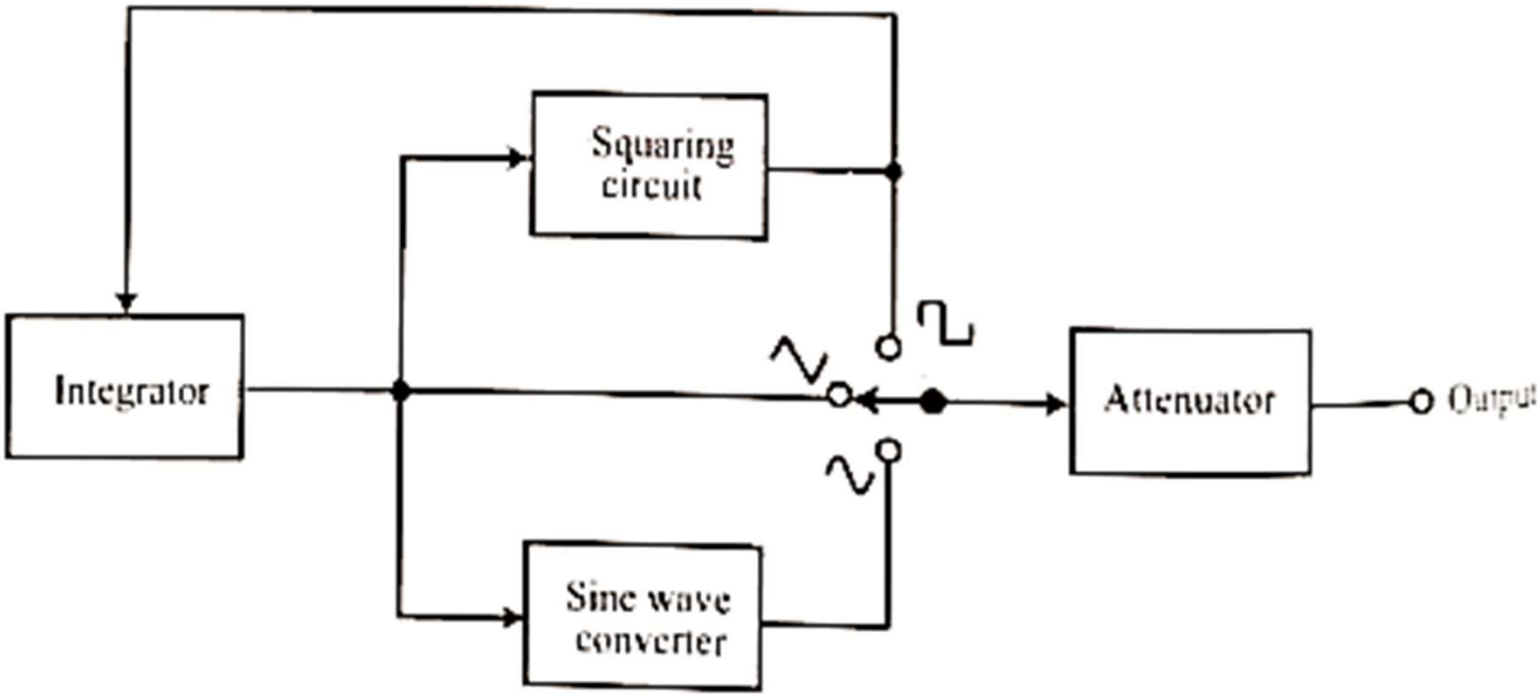



Figure 7.4: Block diagram for function generator

# 71 Block Diagram of Function Generator

- Figure 7.4 shows the block diagram of a function generator.
- A function generator consists of an integrator, squaring circuit, sine wave converter, and attenuator in addition to amplitude and frequency control.
- Integrator
  - The integrator generates a linearly varying ramp waveform from the applied dc supply.
- The integrator output is fed into the squaring circuit and the sinewave converter.
- The integrator converts the square wave from the squaring circuit into a triangular wave.
- The sinewave converter converts the signal from integrator to sinewave.

# 72 Block Diagram of Function Generator

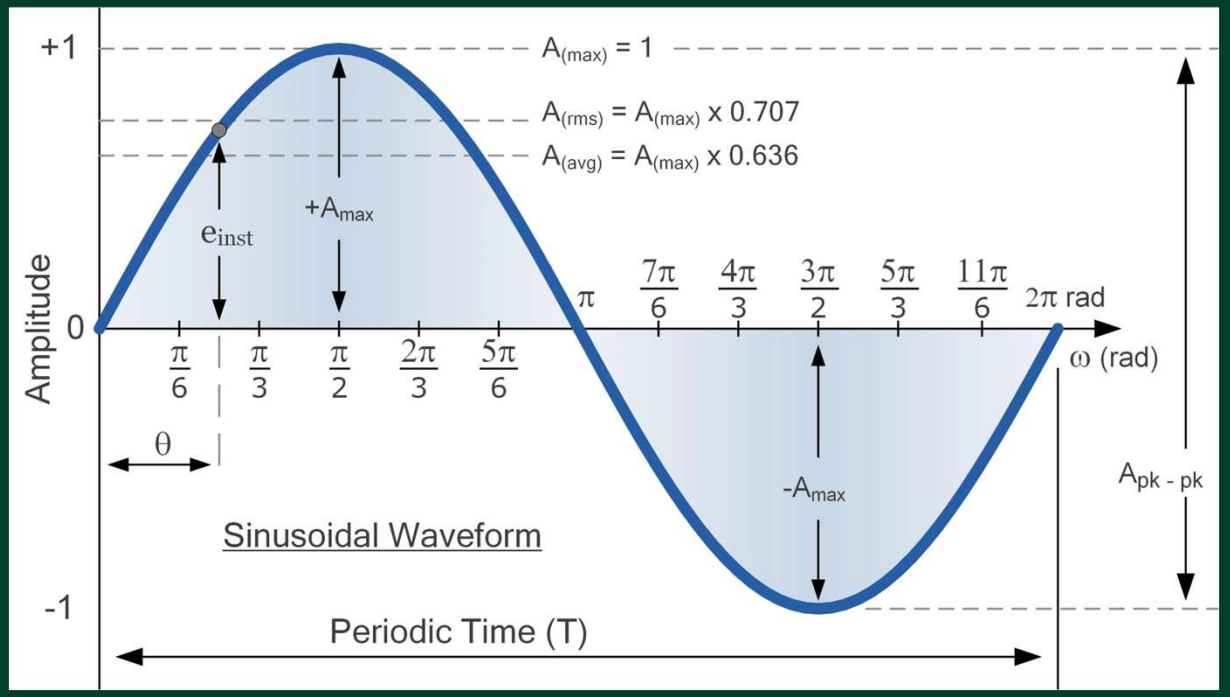
- A switch is used to select sine, triangular, or square waves.
- The attenuator is used for reducing amplitude to a desired value.
  - It provides low output impedance and control of output amplitude.
- Function generators are available with a variety of controls such as amplitude and frequency selection, dc offset, attenuation to desired levels, waveform symmetry, etc.
- Generally they provide a frequency range from a minimum of 0.2Hz to a maximum of 1 MHz and amplitude zero to 20V peak to peak.

# Generated Waveforms

- Function generators are capable of producing a variety of repetitive waveforms, generally the following waveforms.
- Sine wave
- Square wave
- Pulse wave
- Triangular wave
- Sawtooth wave

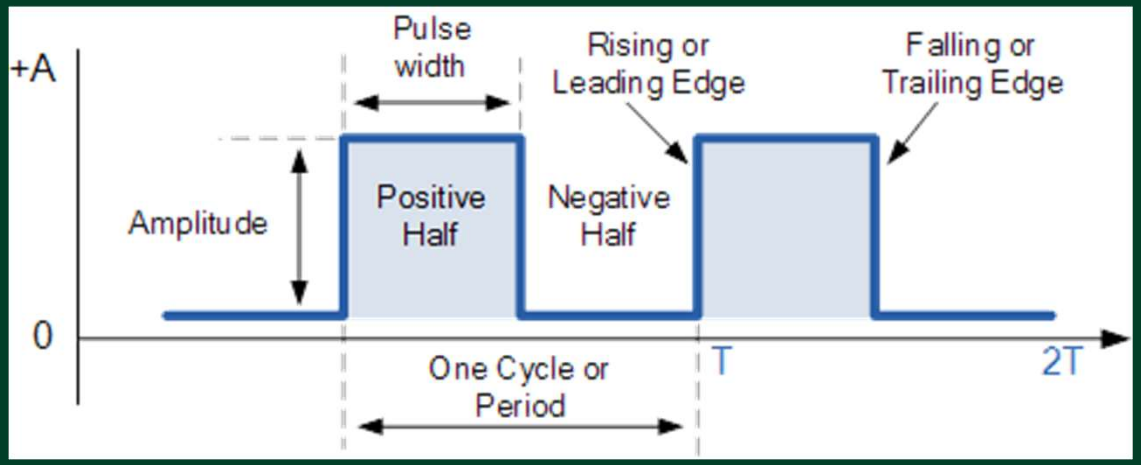
# Sinewave

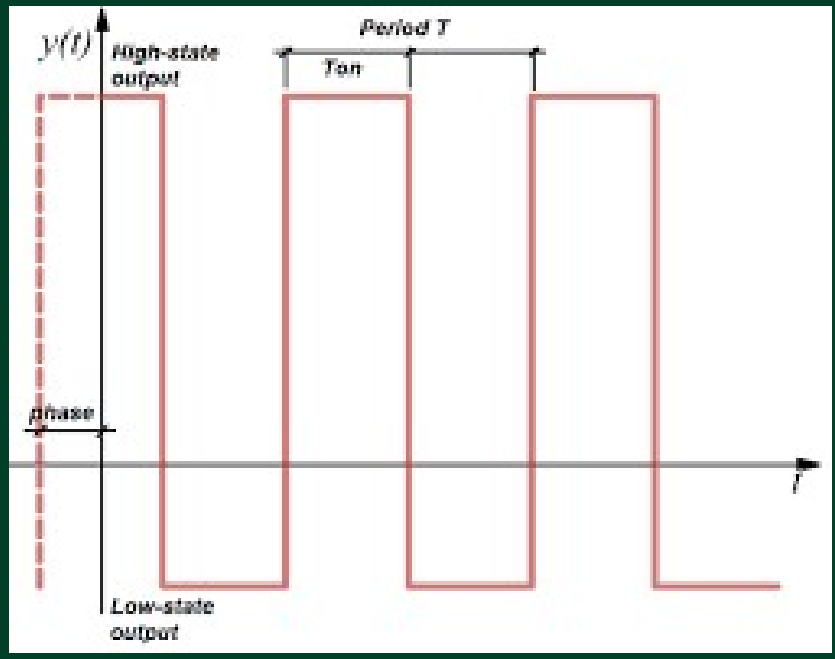
- A function generator will normally have the capability to produce a standard sine wave output.
- Figure. Shows a standard waveform that oscillates between two levels with a standard sinusoidal shape.



# Square wave

- A square wave is a signal which takes one high level and a low level.
- It is characterized by the duty cycle or a duty ratio.
- Duty cycle is the ratio of time the signal possesses a high level to it time period.



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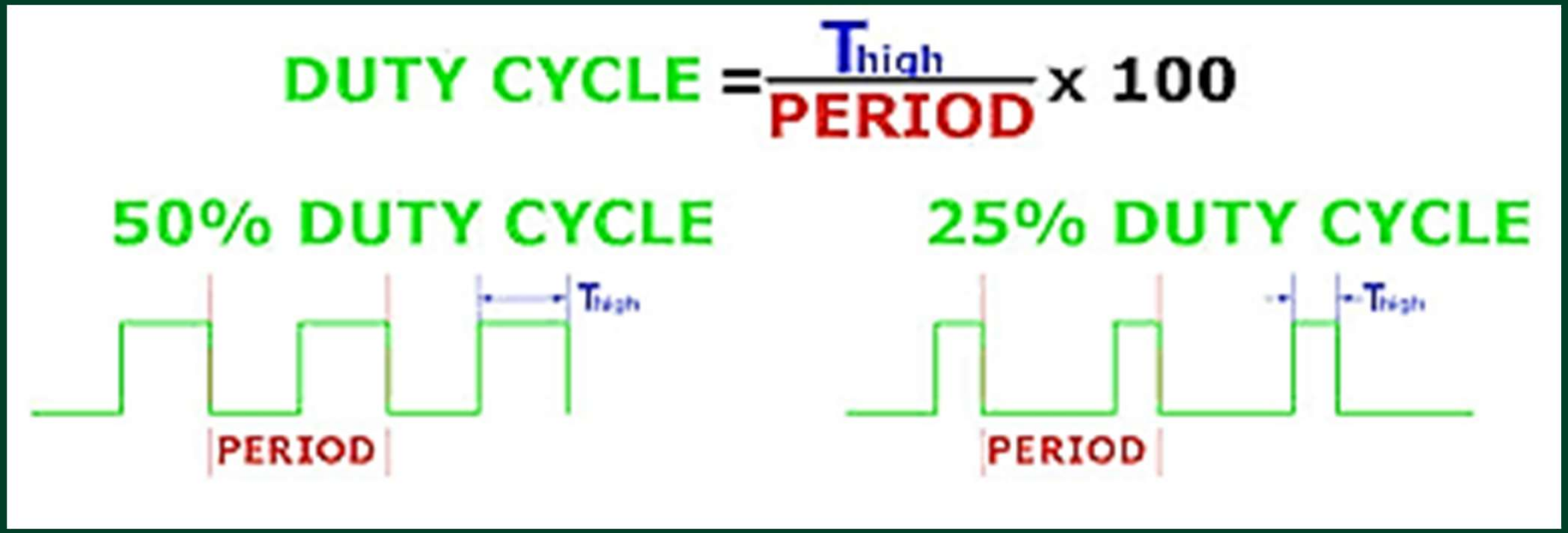


# Pulse Wave

- It is similar to a square wave but with either positive or negative voltage levels.

**Pulse wave** It is similar to a square wave but with either positive or negative voltage levels.

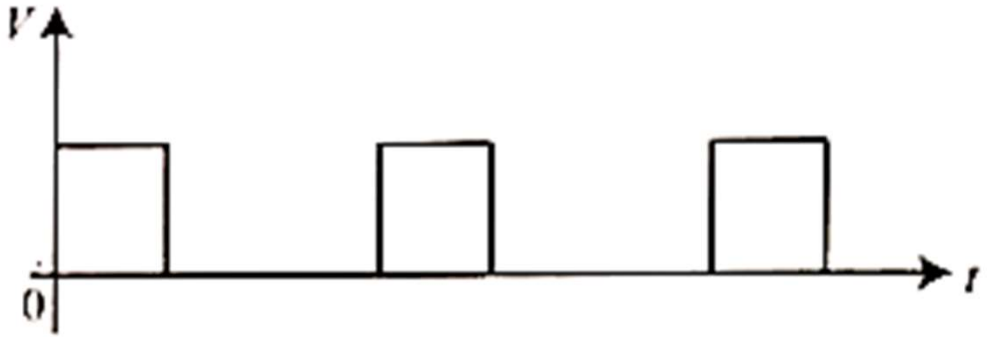
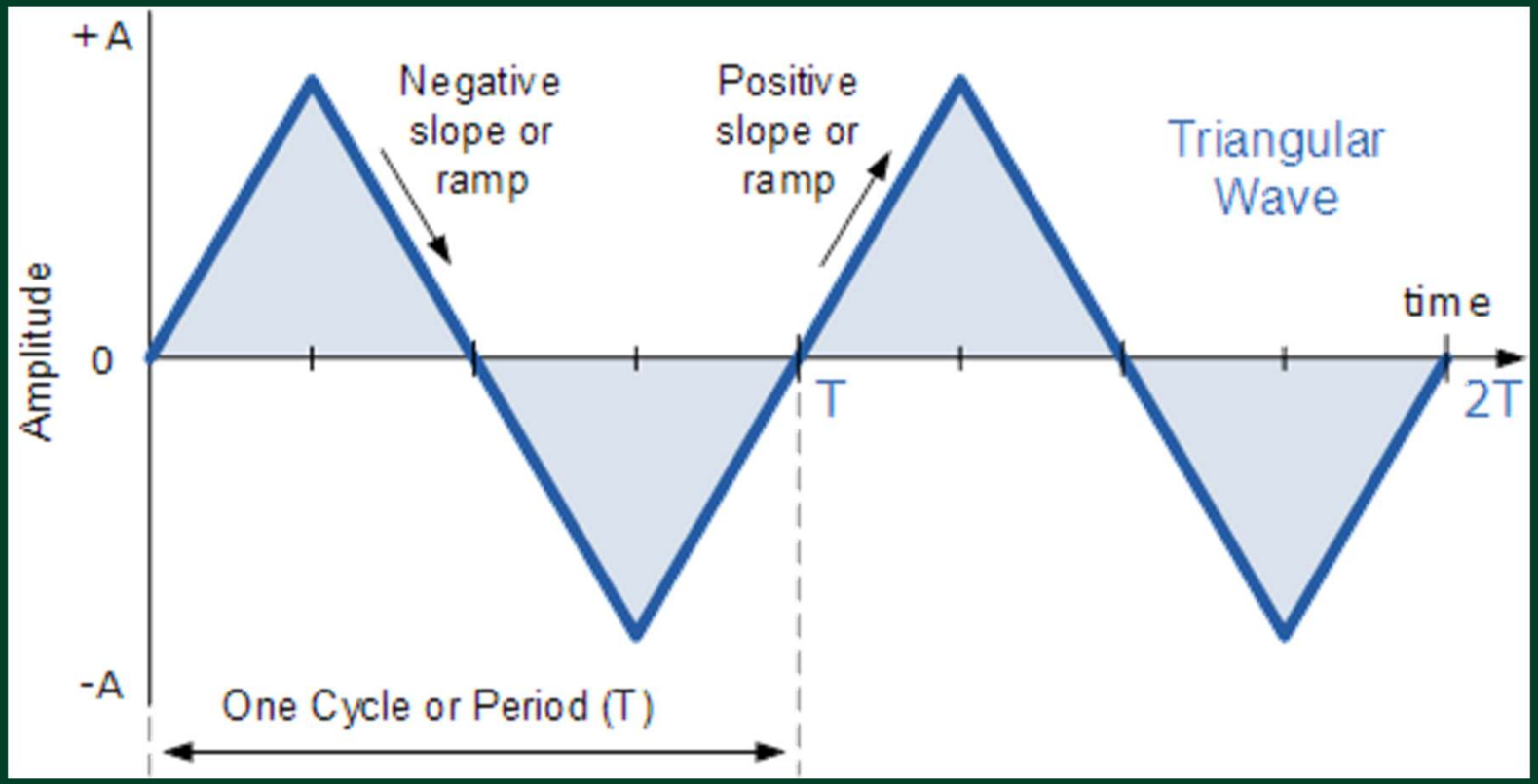



Figure 7.7: Pulse wave from function generator

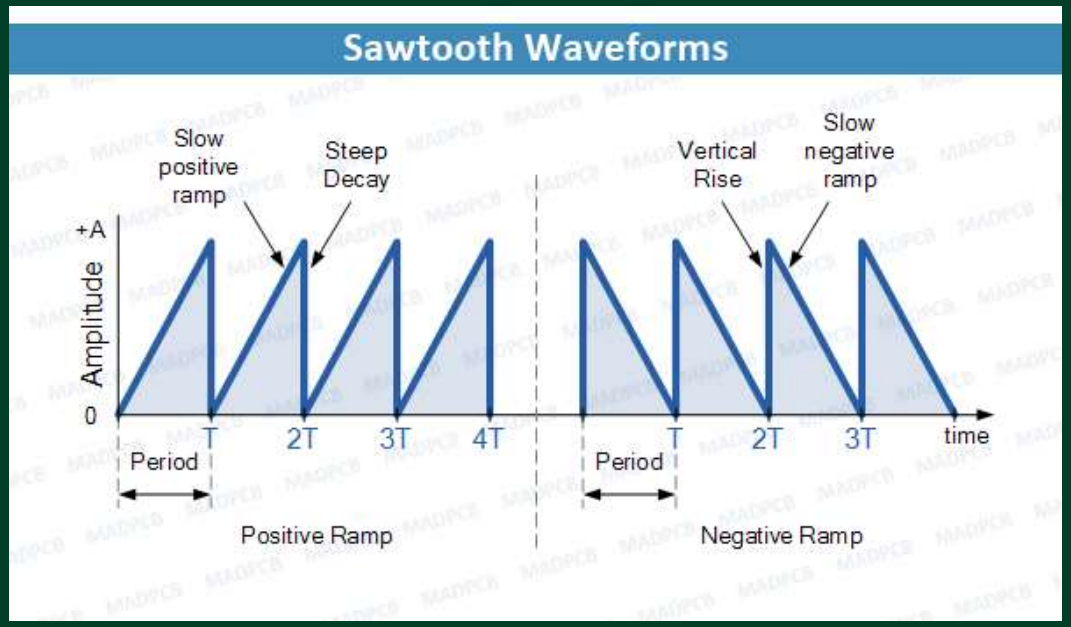
# Triangular Wave

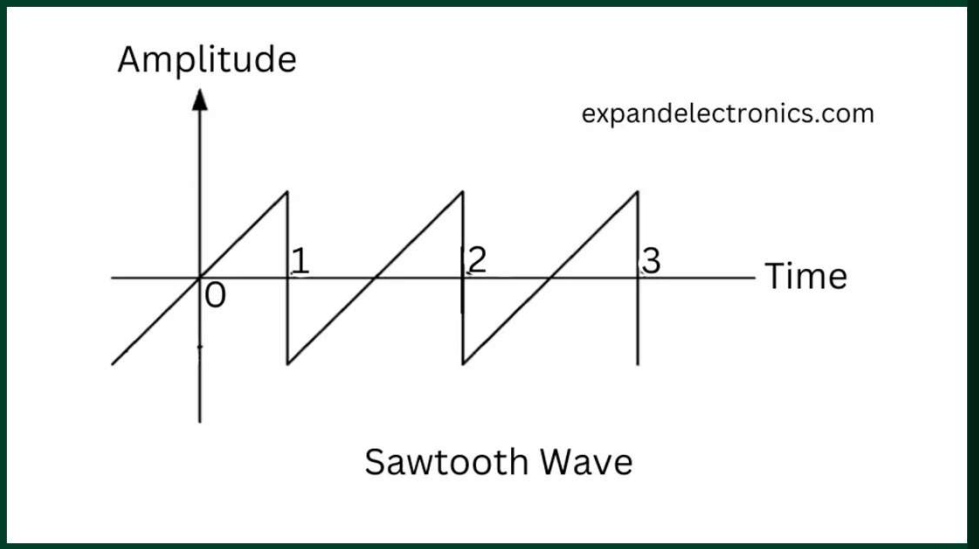
- This form of signal produced by the function generator linearly moves between a high and low point.



# Sawtooth Wave

- This is similar to a triangular waveform, but the fall time is negligibly small.



# 80 Controls of Function Generator

- Control knobs are provided on the front panel of the function generator for selecting the required waveform and various parameters of the selected waveforms.
- The front panel of a function generator is shown in figure. 7.10

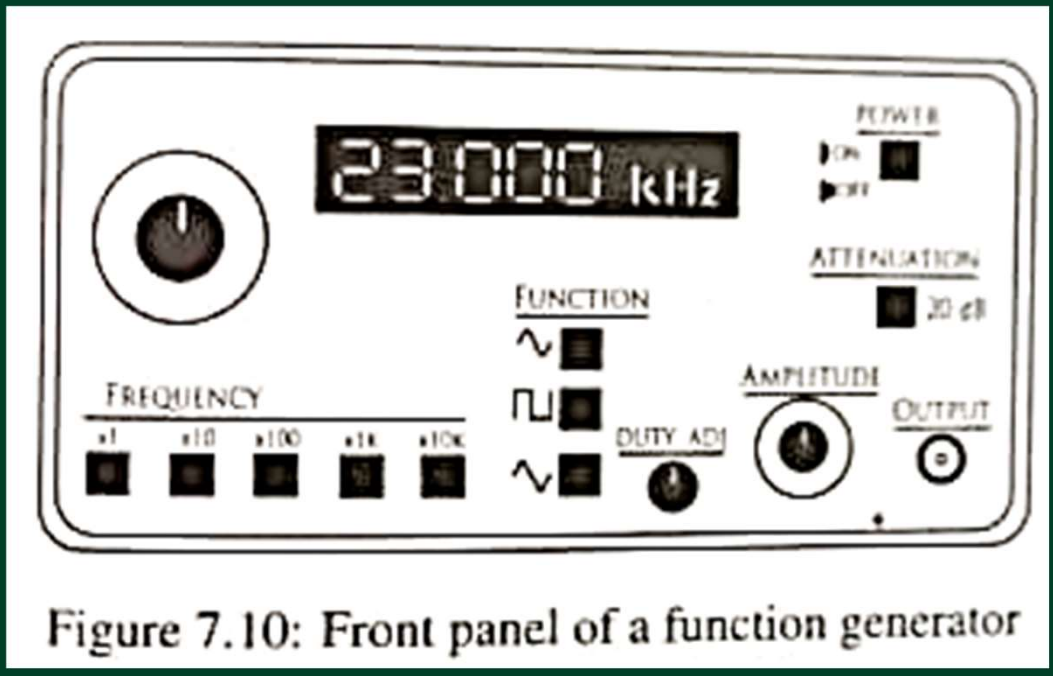



Figure 7.10: Front panel of a function generator

# 81 Controls of Function Generator

- The various knobs are briefly explained below.
- **Power** This is to turn ON and OFF the function generator.
- **Function** This selects different types of waveform
- **Frequency** This knob varies the frequency of the waveform,
- **Amplitude** This knob varies the amplitude of the waveform.
- **Duty Cycle** This controls the duty cycle of square wave and pulse waveform.
- **Attenuation** It is used to reduce the amplitude of the signal in some testing applications of electronic circuits where a low amplitude of the order of mV is required.

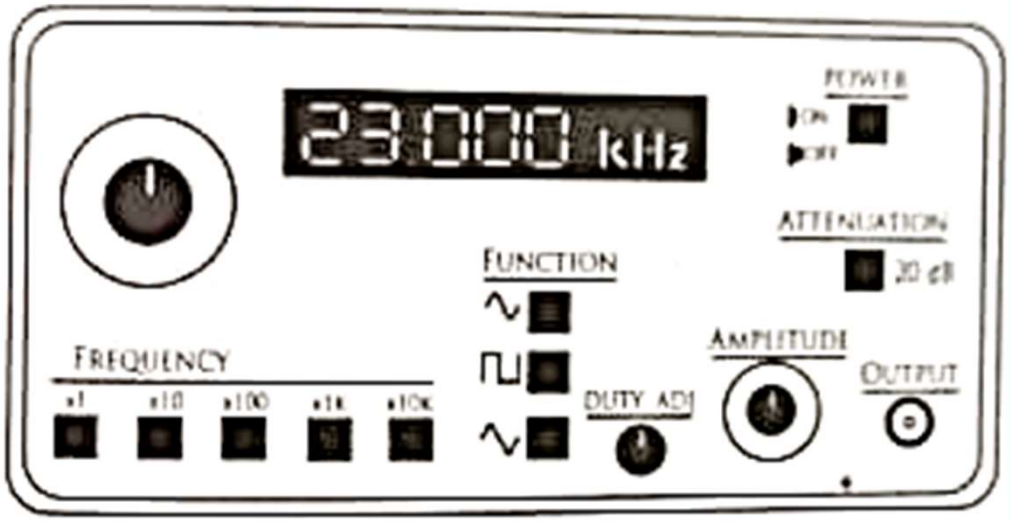



Figure 7.10: Front panel of a function generator

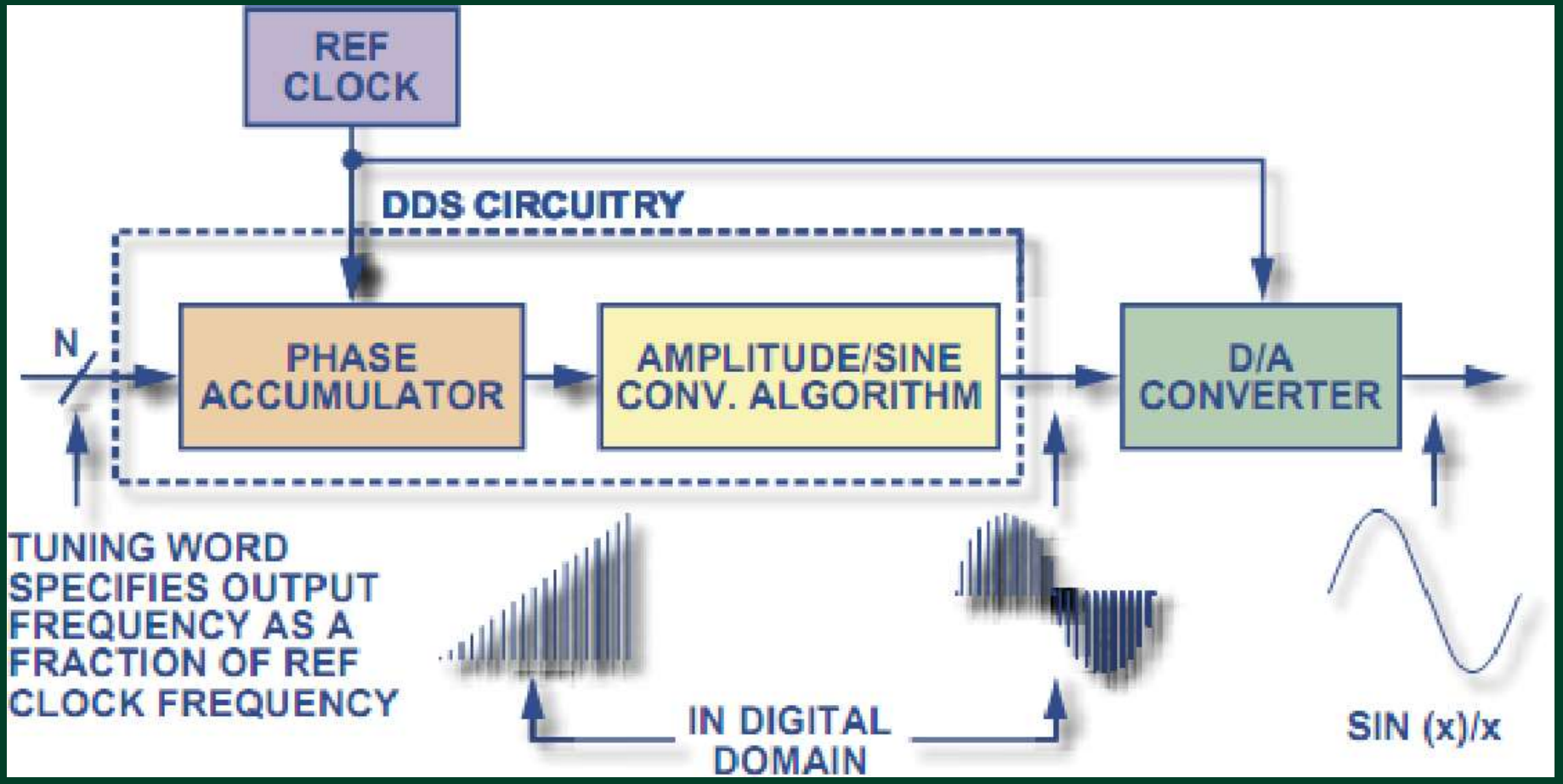
# Controls of Function Generator

- Advantages of Analog Function Generators
  - They are very cost-effective
  - It provides an effective test instrument that can meet most user needs while remaining simple and easy to use
  - They do not have high-frequency limitations on non-sinusoidal waveforms such as triangles and ramps as the digital function generators.

# 83 Digital Function Generators

- As the name indicates, digital function generators utilize digital technology to generate waveforms.
  - They are able to offer high levels of accuracy and stability because the clock for the system is crystal-controlled.
  - Also, digital function generators provide high-frequency stability and low noise.
- The disadvantage of digital function generators is that they are more expensive since they require a high-performance DAC and other complex digital circuitry.
- The most versatile and most widely used technique for digital function generator is Direct Digital Synthesis (DSS).
- DSS essentially consists of a time–base system, a Numerically controlled Oscillator (NCO), and a DAC.
  - Time base system provides a stable clock to NCO.
  - NCO produces a discrete-time waveform (dot waveform).
  - This discrete-time waveform is converted to analog form by DAC.

# Digital Function Generators



# Digital Function Generators

# Sine wave Generator

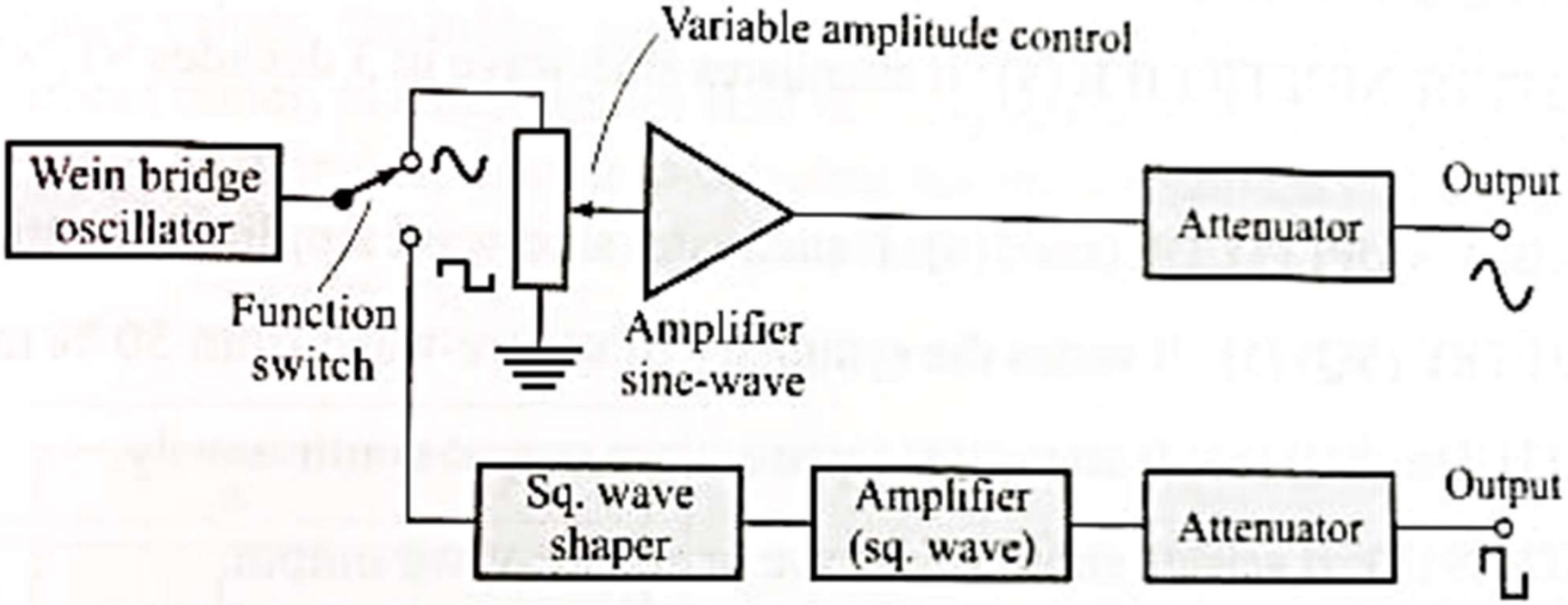



**Fig. 14.29** *Block diagram of an audio sine-square wave oscillator*

# Sine wave Generator

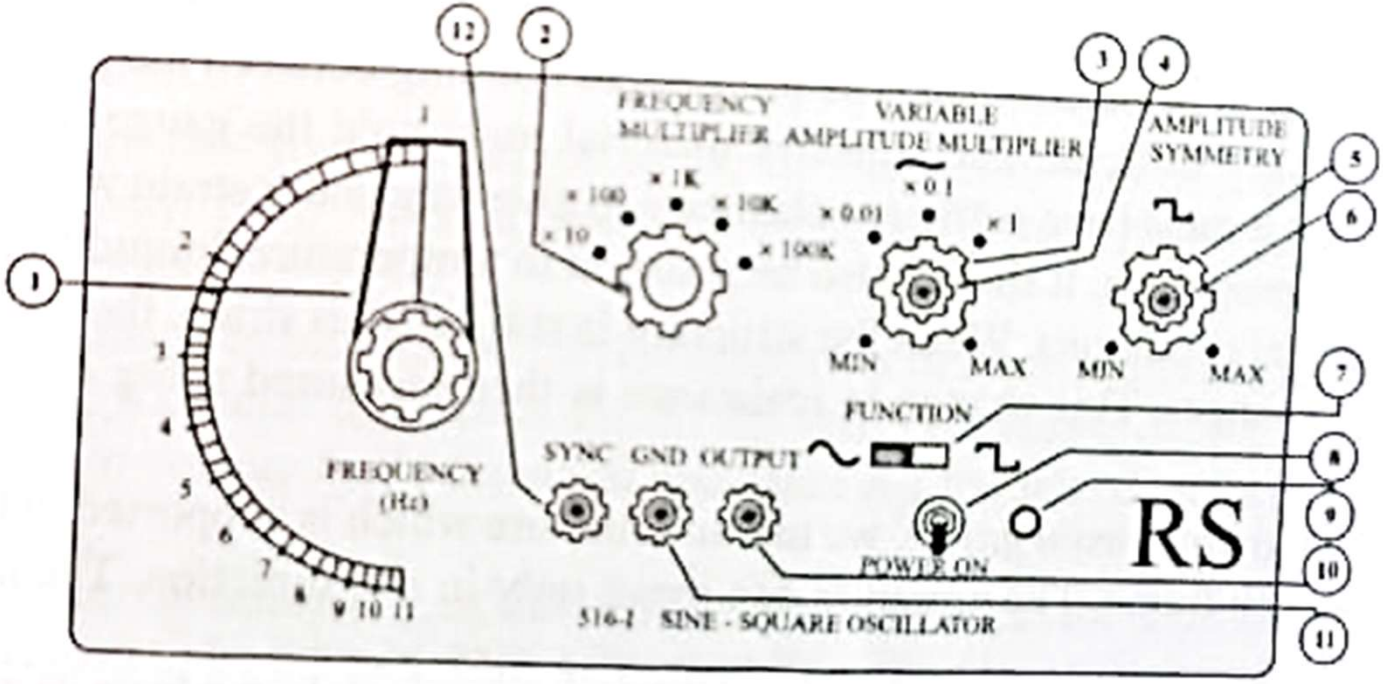



**Fig. 14.30** *Front panel controls of sine-square oscillator. (Model 516-1), manufactured by Ruttonsha Simpson Pvt. Ltd.*

# Multimeter



- The multimeter is an electronic measuring instrument that combines several measurement functions in one unit.
- It is used to measure voltages (ac and dc), currents (ac and dc), and resistance.
- It is also known as a volt/ohmmeter or VOM.
- Mulitmeters may be analog-type or digital-type, depending on the type of circuit being used.
- They are also very useful for detecting faults in devices or providing instruments with a high degree of accuracy.
- They are widely used in various applications for troubleshooting electrical problems in appliances, circuits, power supplies, and wiring systems.

# Multimeter



- The measurements of voltage, current and resistance can be done using an analog or digital multimeter.
- Analog meters work based on current sensing and digital multimeters are generally based on voltage sensing.
  - Current sensing instruments are mostly of the electromagnetic meter movement type,
  - Voltage sensing instruments are mostly digital(electronic) in nature using amplifiers and semiconductor devices.
  - Now analog multimeters are widely replaced by digital multimeters.

# Digital multimeter



- Digital multimeter (DMM) displays the measured quantities in digits.
- It measures dc and ac voltages, currents and resistances and displays their values in digits.
- Digital meters offer
  - high accuracy,
  - smaller reading and interpolation errors,
  - elimination of parallax error,
  - unambiguous readings at greater viewing distances,
  - smaller size, and
  - digital electrical output in addition to visual readout.
- Digital multimeters normally have autoranging, so that the range selection is not required.

# Digital multimeter

- The main part of the digital multimeter is an analog-to-digital converter (ADC) which converts an analog input signal to a digital output.
- The block diagram of a digital multimeter is shown in figure.

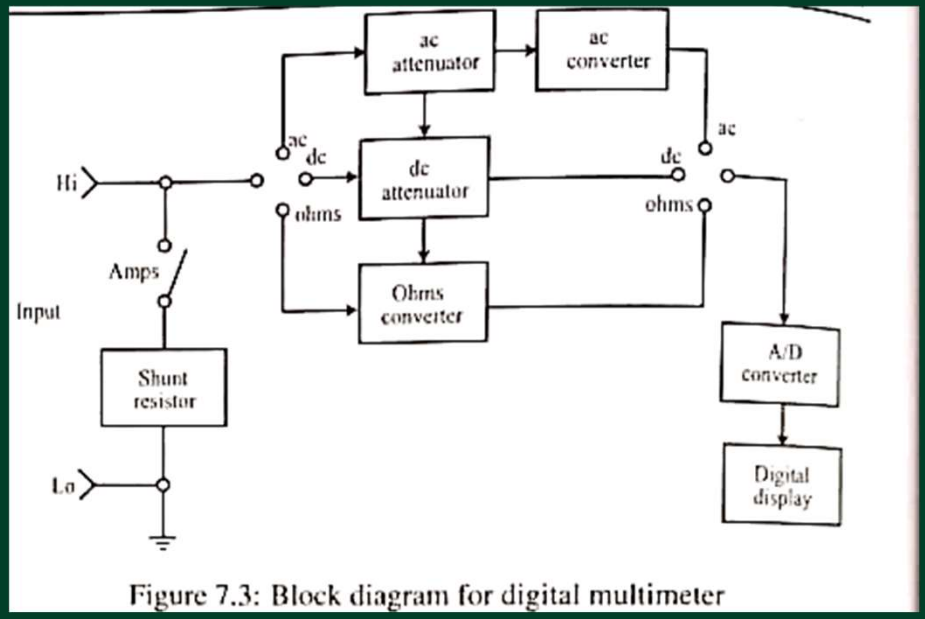



Figure 7.3: Block diagram for digital multimeter

# Digital multimeter

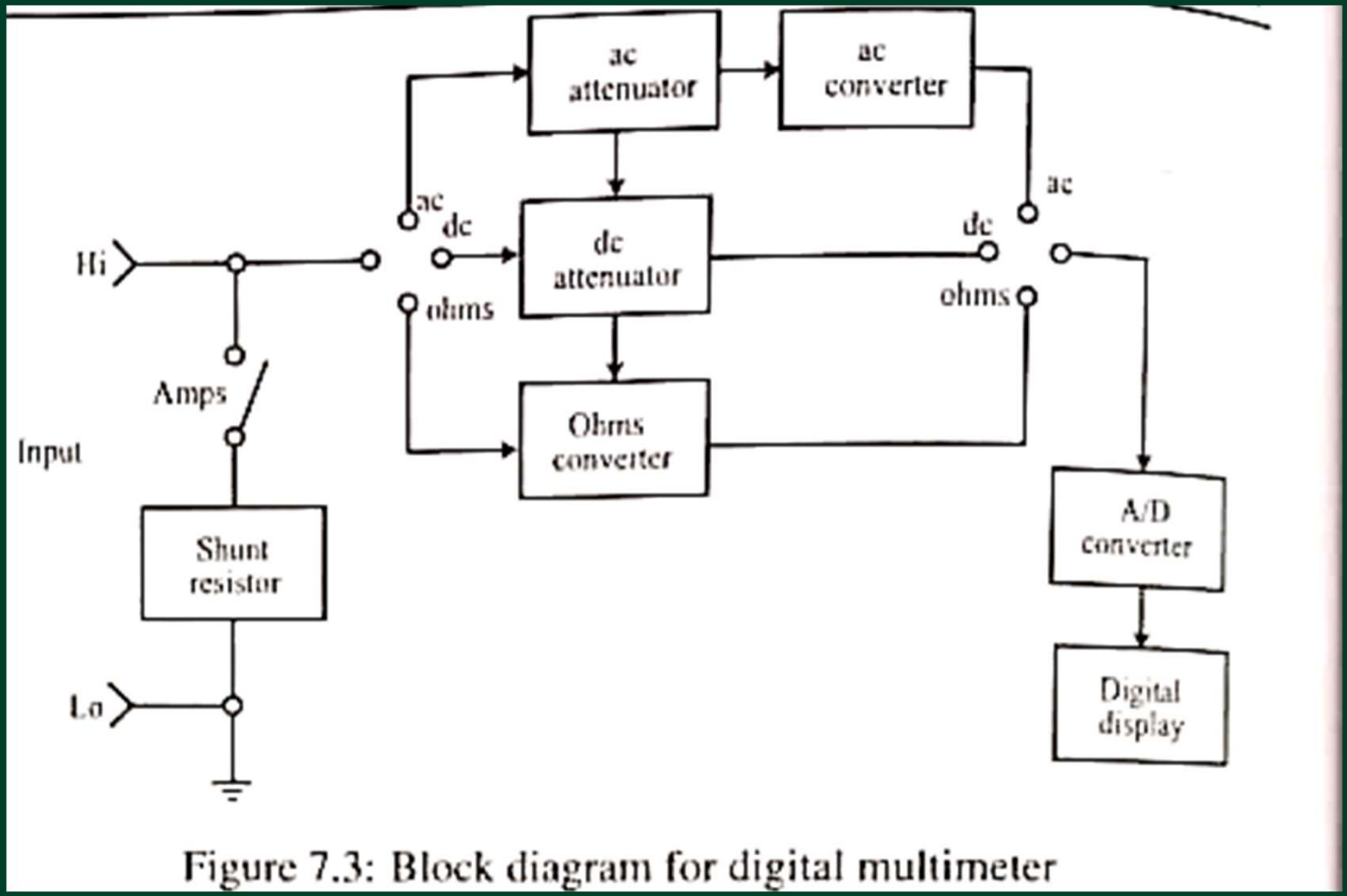



Figure 7.3: Block diagram for digital multimeter

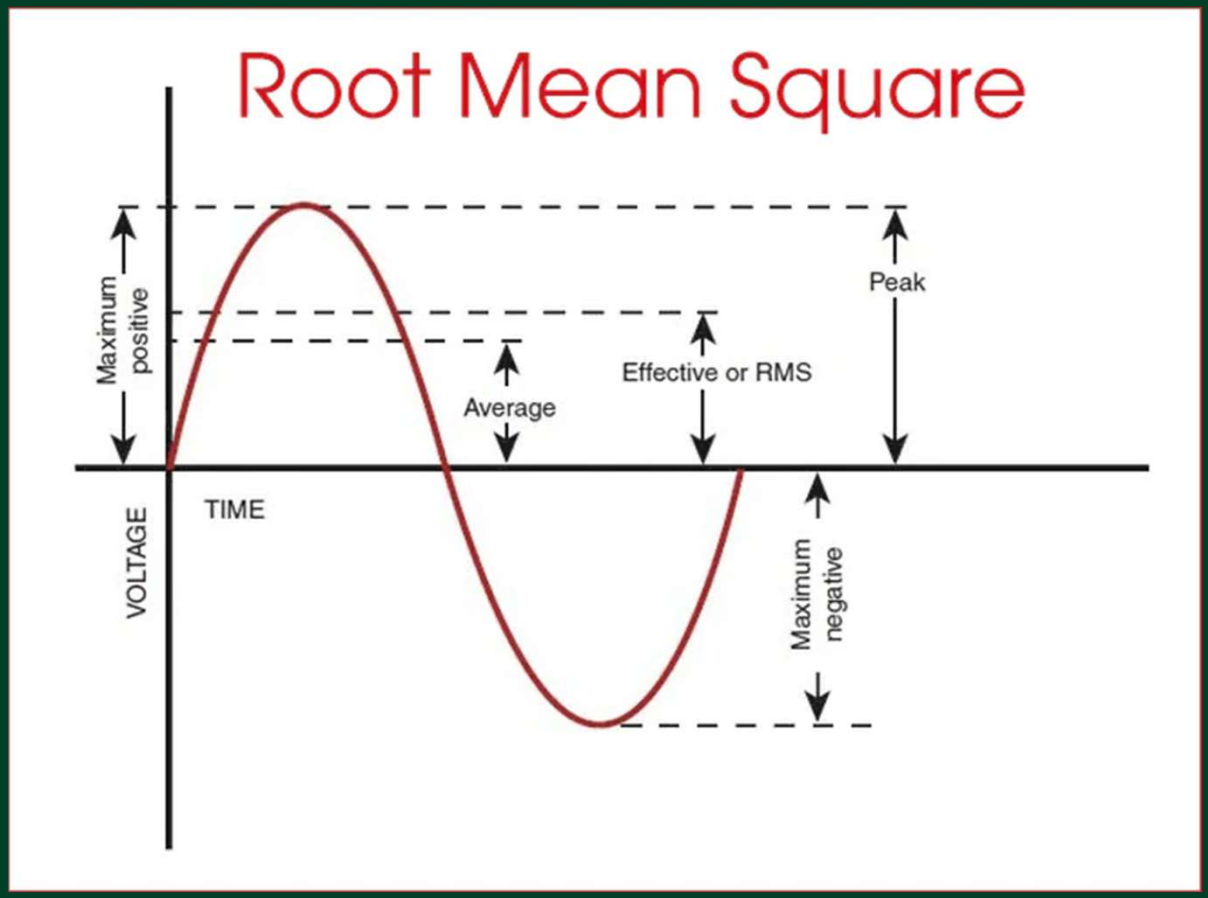
# Digital multimeter

- DMM is a voltage-sensing meter.
- Current Measurement
  - DC
    - For the current measurement, current is converted to volts by passing it through a precision low resistance shunt.
    - An attenuator then scales down the voltage to be measured.
  - AC
    - AC is first converted to DC with the help of an AC converter by employing rectifiers and filters.
    - Most of the AC converters detect the peak value of the signal and are calibrated to give the rms value of a sine wave.
    - However, some measure the mean of the rectified signal.
    - Finally, this DC level is applied to an analog-to-digital converter (ADC) to obtain the digital information.

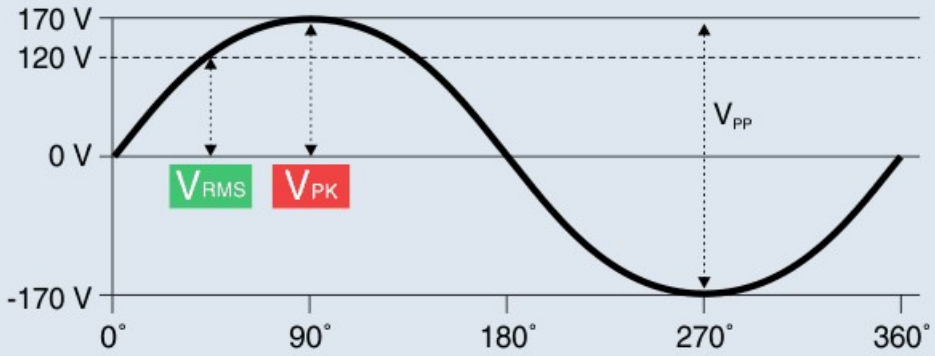
# Digital multimeter

- Resistance
  - The meter includes a precision low current source that is applied across the unknown resistor.
  - Then the DC voltage across the resistor, which is proportional to the value of the unknown resistor is measured.
- AC measurements,
  - the digital multimeter is a True RMS instrument that measures the true rms value of any periodic signal.

# Digital multimeter

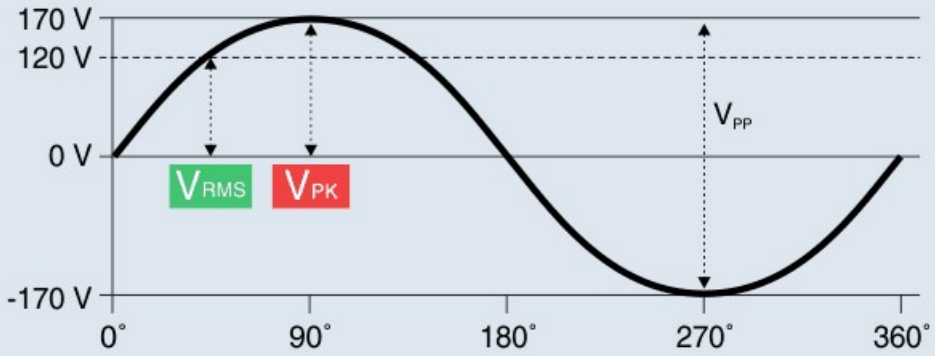


# Digital multimeter



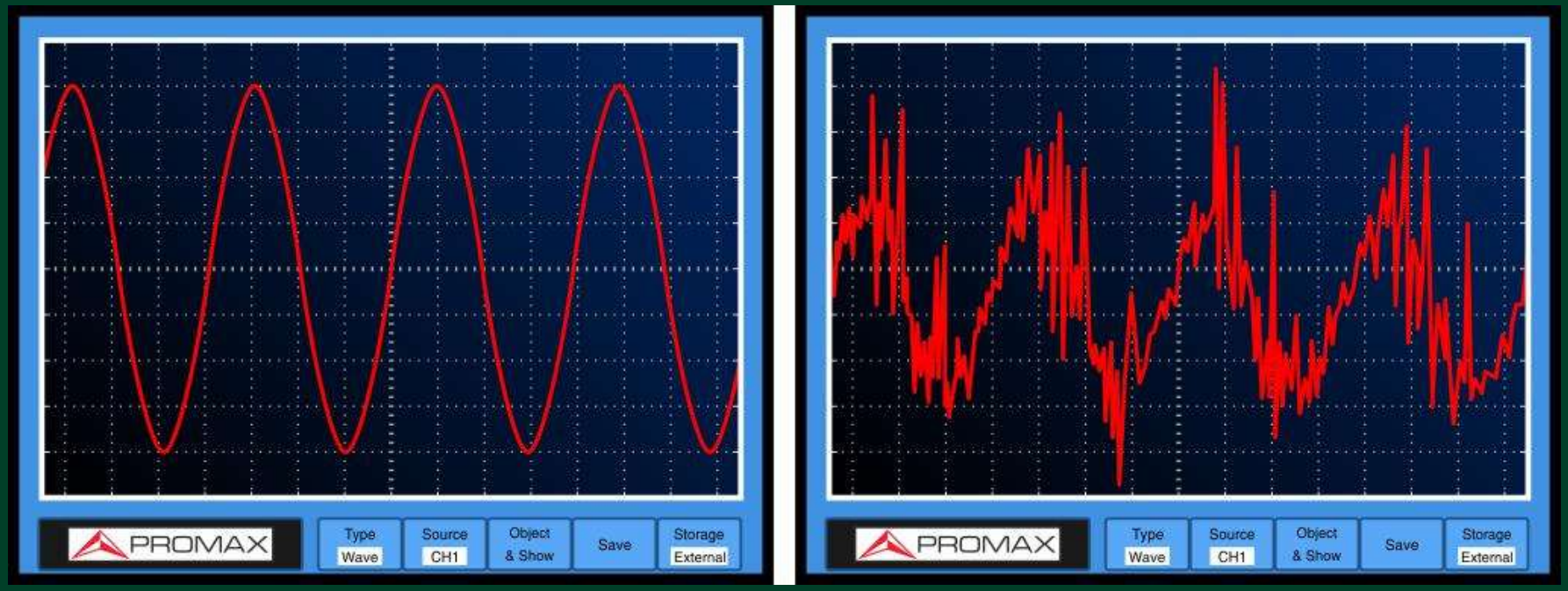

$$V_{RMS} = \frac{V_{PK}}{\sqrt{2}} \approx V_{PK} \times 0{,}707$$

# Digital multimeter




$$V_{TRMS} = \sqrt{\frac{V_1^2 + V_2^2 + \ldots + V_n^2}{n}}$$

# Digital multimeter



# Digital multimeter