Lab Equipment

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Overview

Function Generator

Panel

Figure: A function generator generates various periodic signals.

- Power
- Output
- Wave
- Frequency
- Amplitude
- Offset
- Duty
- Attenuation

Block Diagram

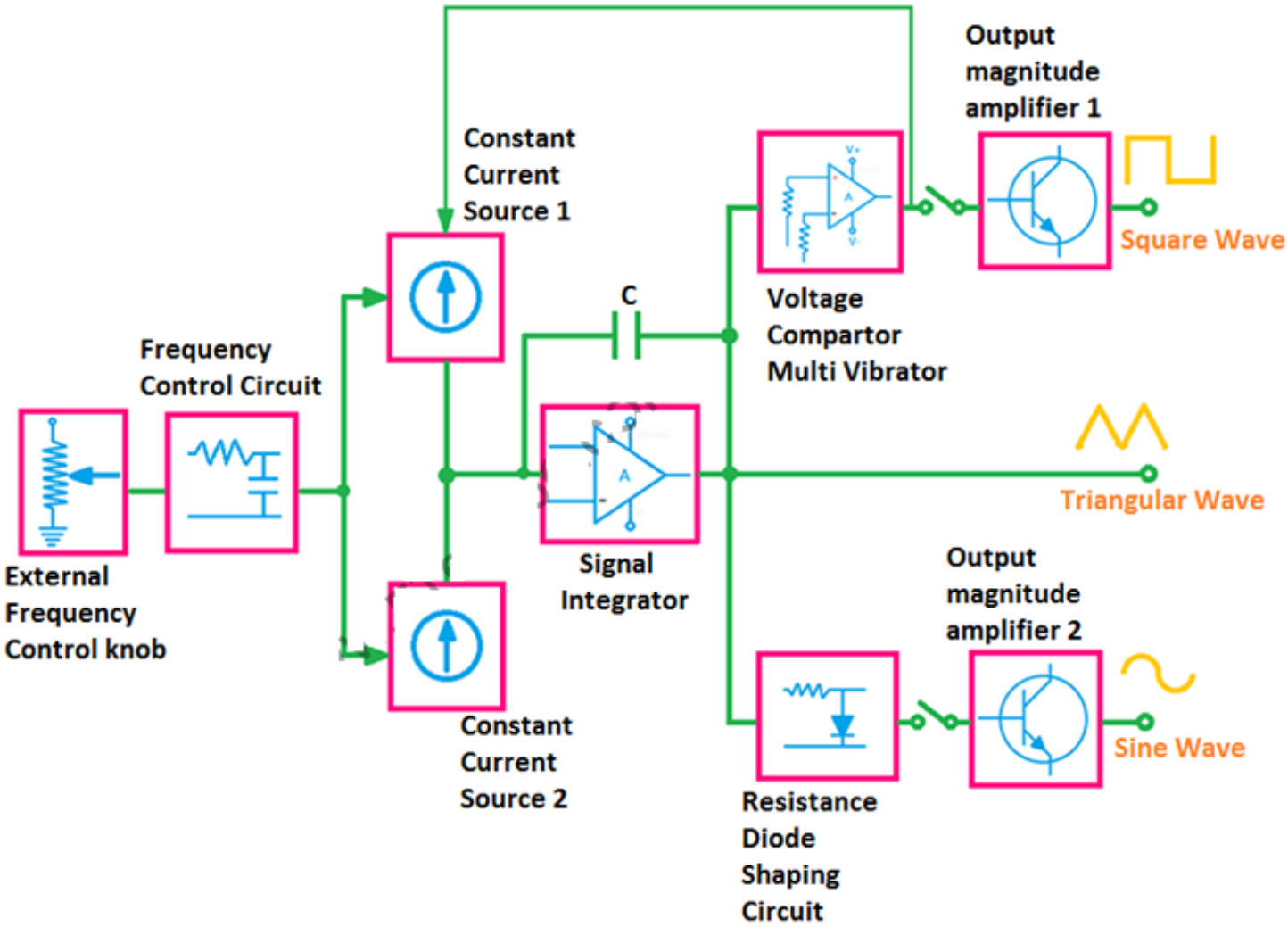

Figure: Block diagram of an analog function generator.

Implementation

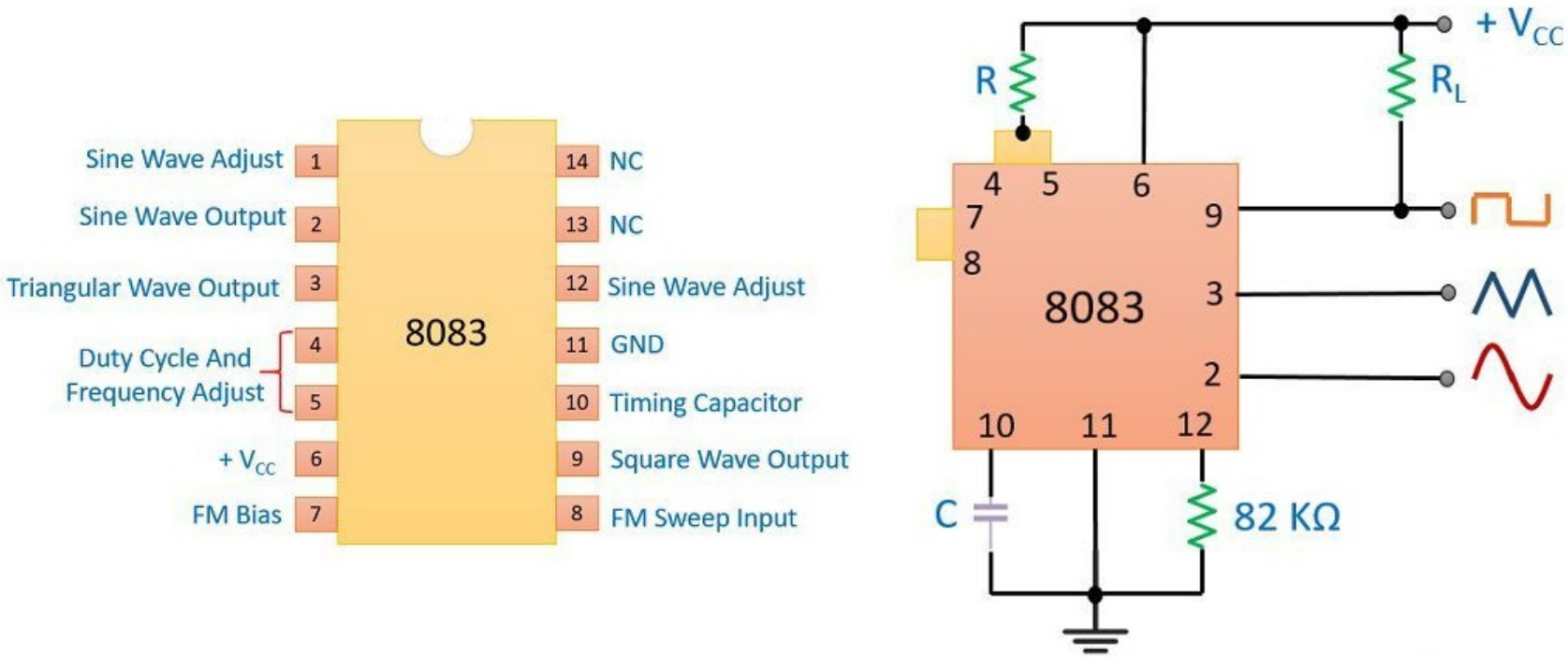

Figure: ICL 8083 function generator.

DC Power Supply

Panel

Figure: A DC power supply generates DC voltage signals.

- Power
- Master/slave/fixed/ground output
- Voltage/current volume
- Independent/series/parallel mode
- c.c/c.v LEDs

Block Diagram

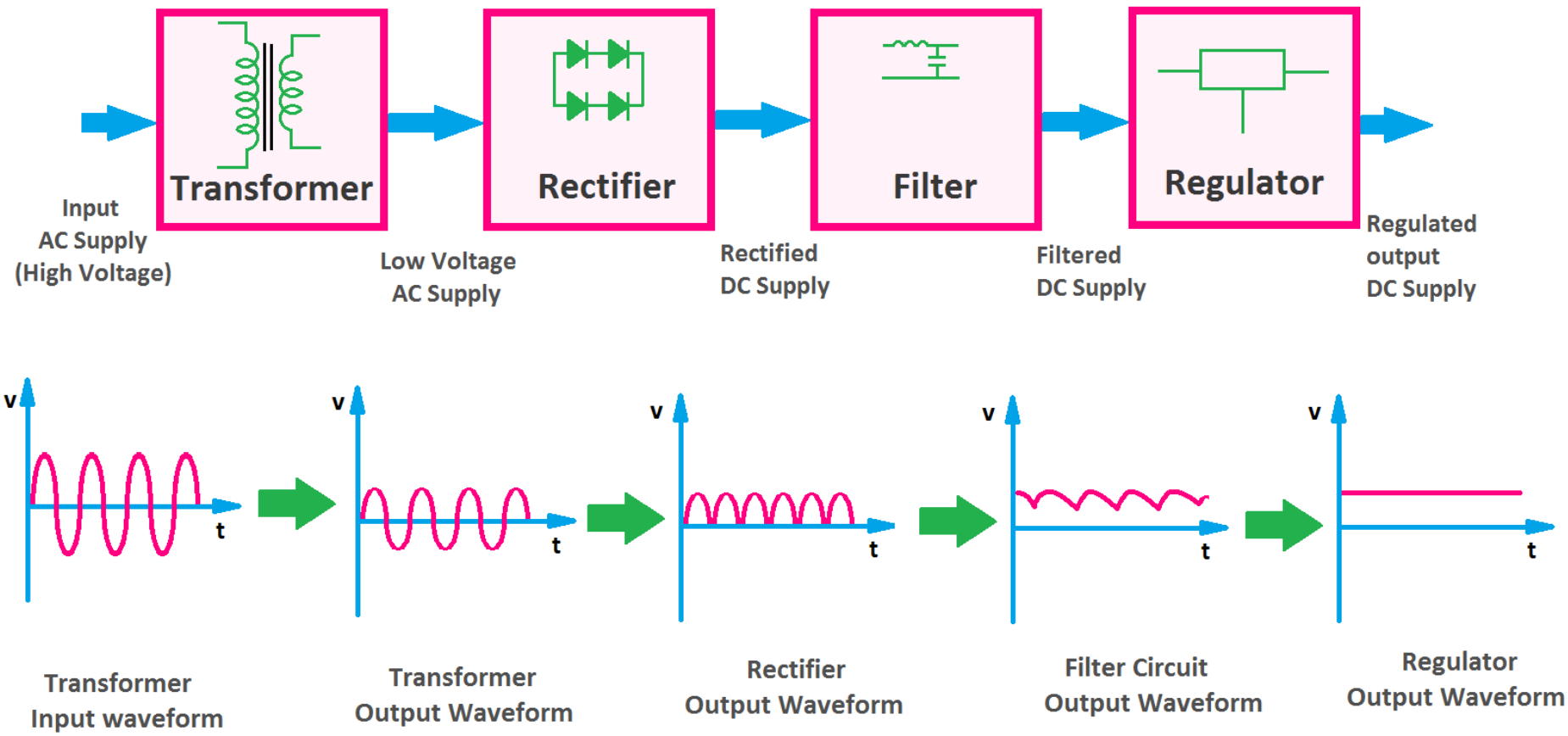

Figure: Block diagram of a DC power supply.

Digital Multimeter

Panel

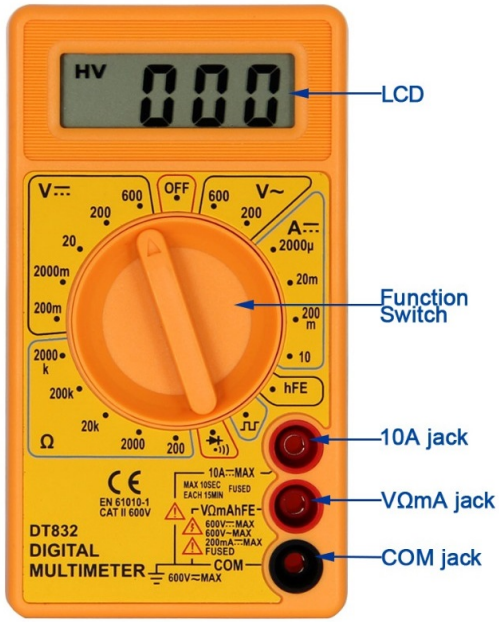

Figure: A digital multimeter measures voltage, current, and resistance.

- Power
- Com/VΩ/mA/10A socket
- Voltage/current/resistance measurement
- Frequency/temperature measurement
- Transistor/diode/continuity test

Block Diagram

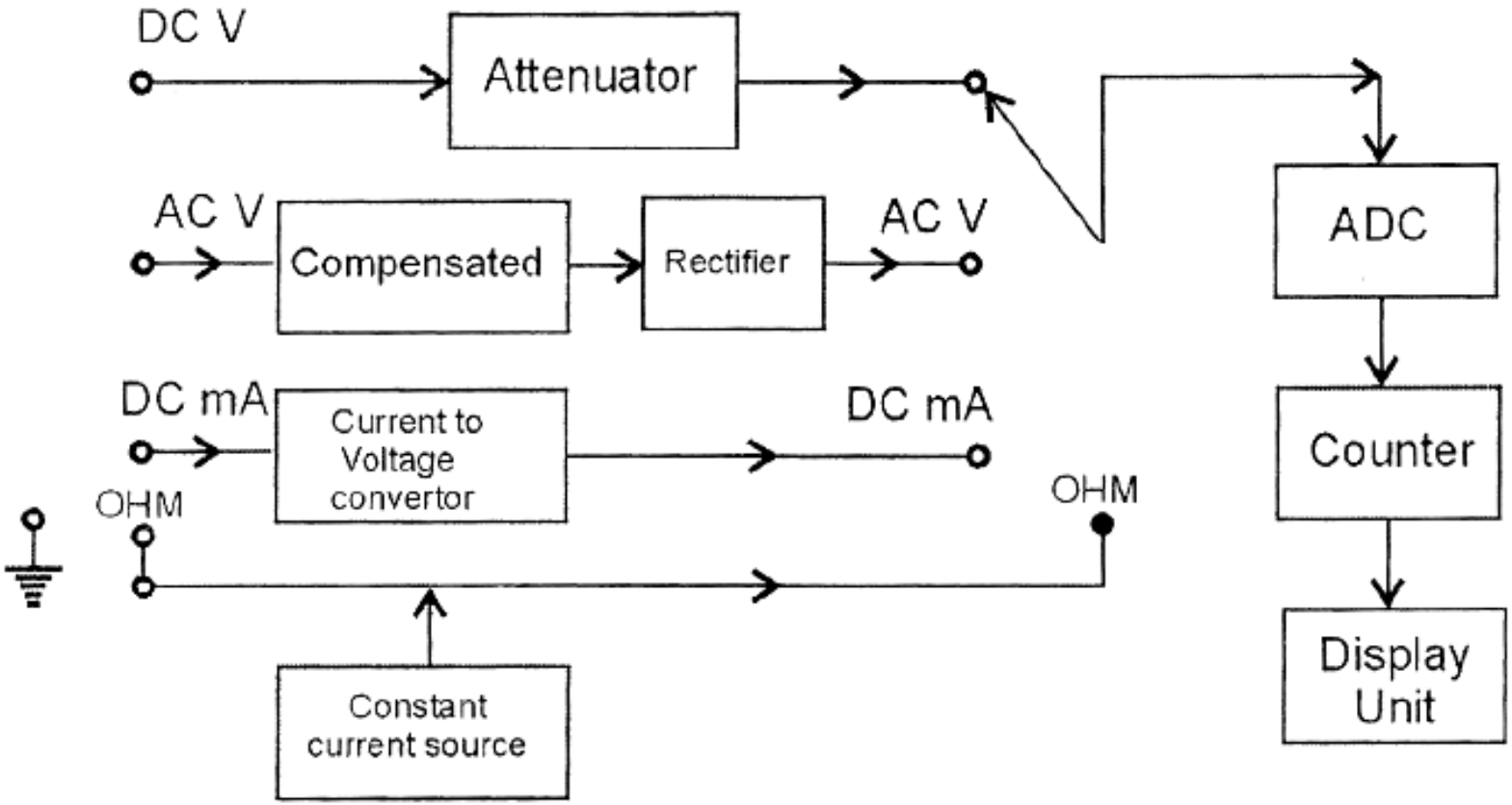

Figure: Block diagram of a digital multimeter.

Digit

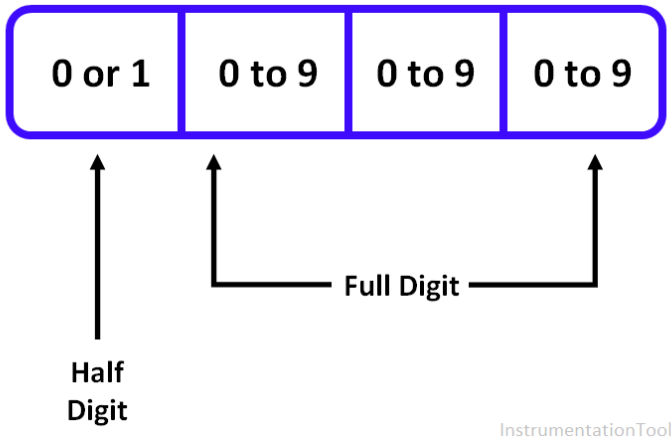

Figure: Display of a $3\frac{1}{2}$ digital multimeter.

- Multimeter digit: $x\frac{y}{z}$
- Half digit $\frac{y}{z} = \frac{1}{2}$: the most significant digit is can be at most 1
- Half digit $\frac{y}{z} = \frac{3}{4}$: the most significant digit is can be greater 1
- Complete digit x: the number of digits that can take $0 - 9$

Count

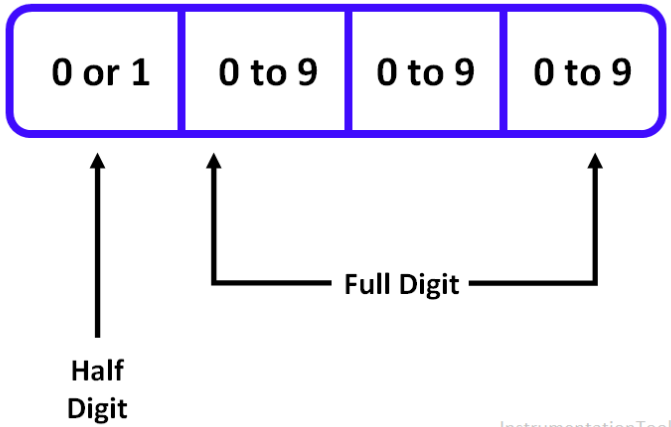

Figure: A $3\frac{1}{2}$ digital multimeter is equivalent to a 2000 count multimeter.

- Multimeter count n: display can show the numbers $0, 1, \cdots, n-1$

Range

Example (Range)

A 40000 count digital multimeter is a $4\frac{3}{4}$ digital multimeter, displays at most 39999, and usually has 5 ranges.

- First range: 0.0000 – 3.9999
- Second range: 00.000 – 39.999
- Third range: 000.00 – 399.99
- Fourth range: 0000.0 – 3999.9
- Fifth range: 00000 – 39999

Resolution

Example (Resolution)

A 40000 count digital multimeter is a $4\frac{3}{4}$ digital multimeter, displays at most 39999, and usually has 5 ranges. Each range has a different resolution.

- First range: 0.0000 – 3.9999 with resolution 0.0001
- Second range: 00.000 – 39.999 with resolution 0.001
- Third range: 000.00 – 399.99 with resolution 0.01
- Fourth range: 0000.0 – 3999.9 with resolution 0.1
- Fifth range: 00000 – 39999 with resolution 1

Accuracy

Statement (Measurement accuracy)

The measurement accuracy is usually reported as x% of reading + n counts meaning x% of the indicated value + n×range resolution.

Example (Voltage measurement)

A multimeter catalog specifies that the DC voltage accuracy on the 4 V range as 0.0017% of reading + 7 counts. On this range, the last digit on the display represents microvolts. i.e. the range resolution is 0.000001. Therefore, with an input to the meter of precisely 3 V, the error would be $3.000000\text{V} * 0.0017/100 + 7\mu\text{V} = 58\mu\text{V}$. Thus, in this example, the actual reading reported by the multimeter for a 3 V source is specified to be within $3\ \text{V} \pm 58\mu\text{V}$ and the reading error is $\pm 58\mu\text{V}/3\text{V} = \pm 0.0019\%$.

Accuracy

Statement (Measurement accuracy)

The measurement accuracy is usually reported as x% of reading + n counts meaning x% of the indicated value + n×range resolution.

Example (Voltage measurement)

A multimeter catalog specifies the DC voltage accuracy on the 4000 V range as 0.0017% of reading + 7 counts. On this range, the last digit on the display represents milivolts. i.e. the range resolution is 0.001. Therefore, with an input to the meter of precisely 3 V, the error would be $0003.000\text{V} * 0.0017/100 + 7 * 1\ \text{mV} = 7.1\text{mV}$. Thus, in this example, the actual reading reported by the multimeter for a 3 V source is specified to be within $3\ \text{V} \pm 7.1\text{mV}$ and the reading error is $\pm 7.1\text{mV}/3\text{V} = \pm 0.24\%$.

Digital Oscilloscope

Panel

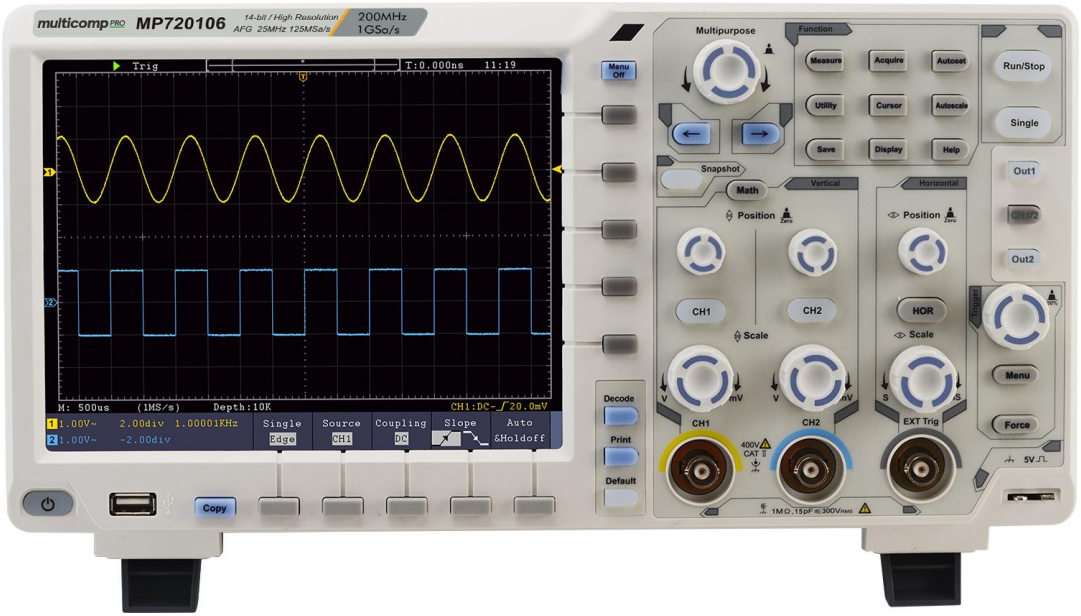

Figure: A digital oscilloscope shows (periodic) voltage signals versus time.

- Display (Time scale, volt scale, trigger settings, frequency, statistics, ...)
- Input channels (GND/AC/DC coupling, probe ratio, probe input impedance, ...)
- Horizontal controls (sec/div, horizontal position)
- Vertical controls (Ch1, Ch2, volt/div, vertical position)
- Trigger controls (Source, level, slope, auto)
- Multifunction buttons (FFT, +/-, ...)

Block Diagram

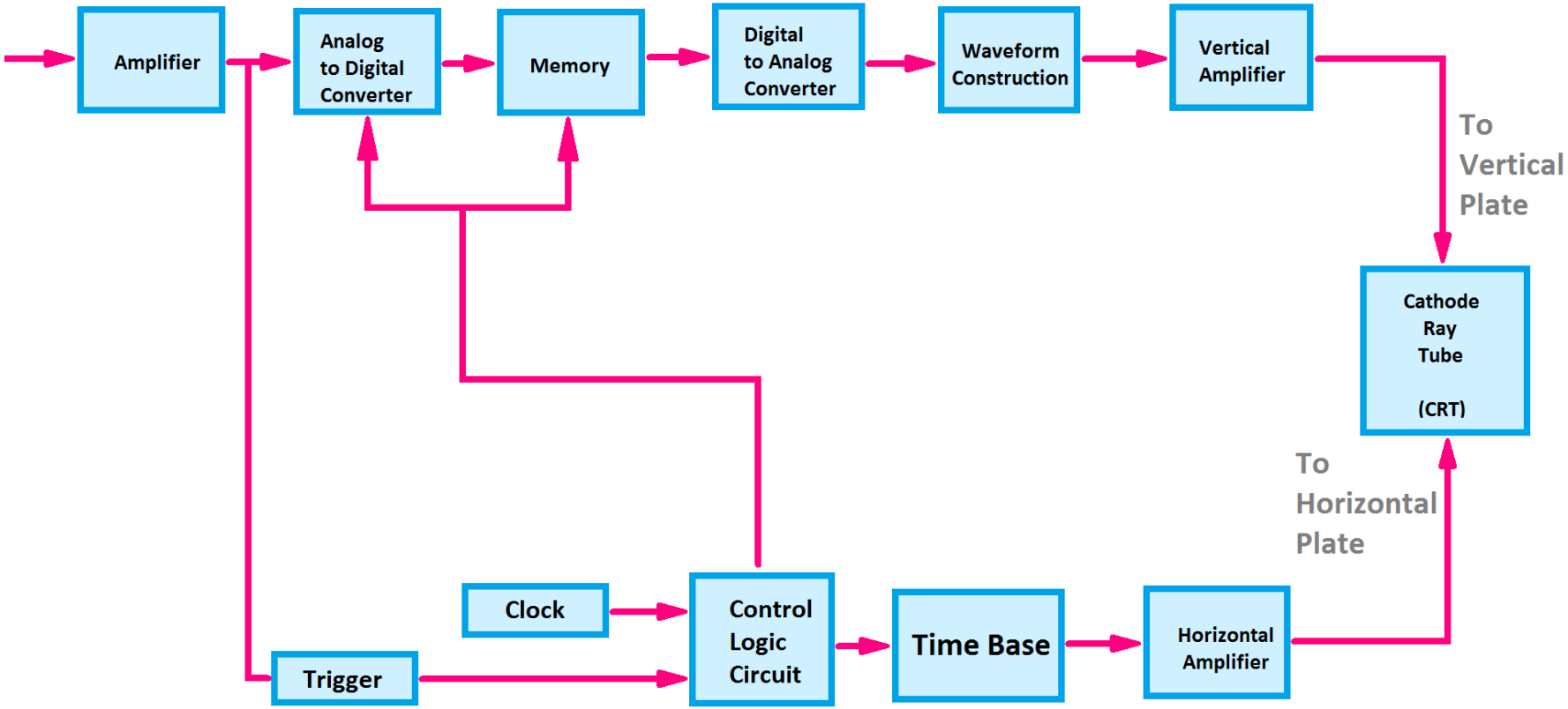

Figure: Block diagram of a digital oscilloscope.

Lissajous Curve

Figure: Some Lissajous curves displayed on an oscilloscope screen.

LCR Meter

Panel

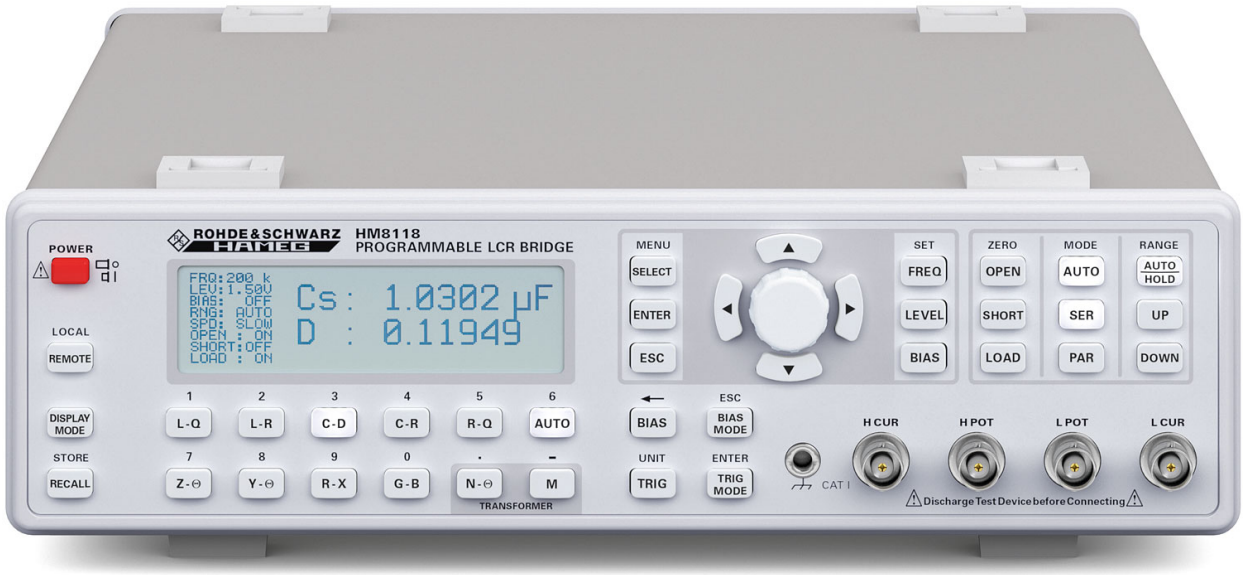

Figure: An LCR meter measures resistance, capacitance, and inductance.

- Power
- L/C/R measurements
- Reactance/admittance measurement
- Q/D factor measurements
- ESR/EPR measurement

Block Diagram

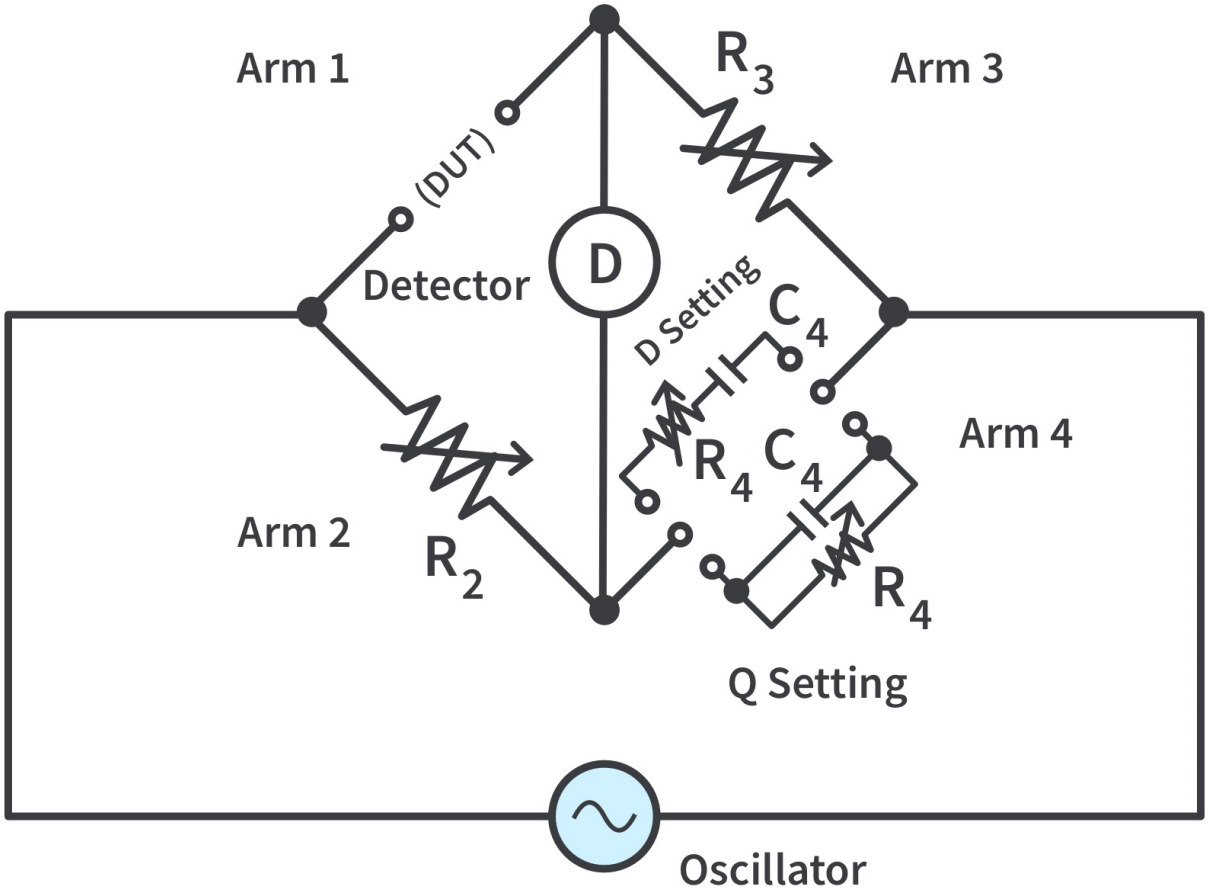

Figure: Block diagram of an LCR meter.

The End