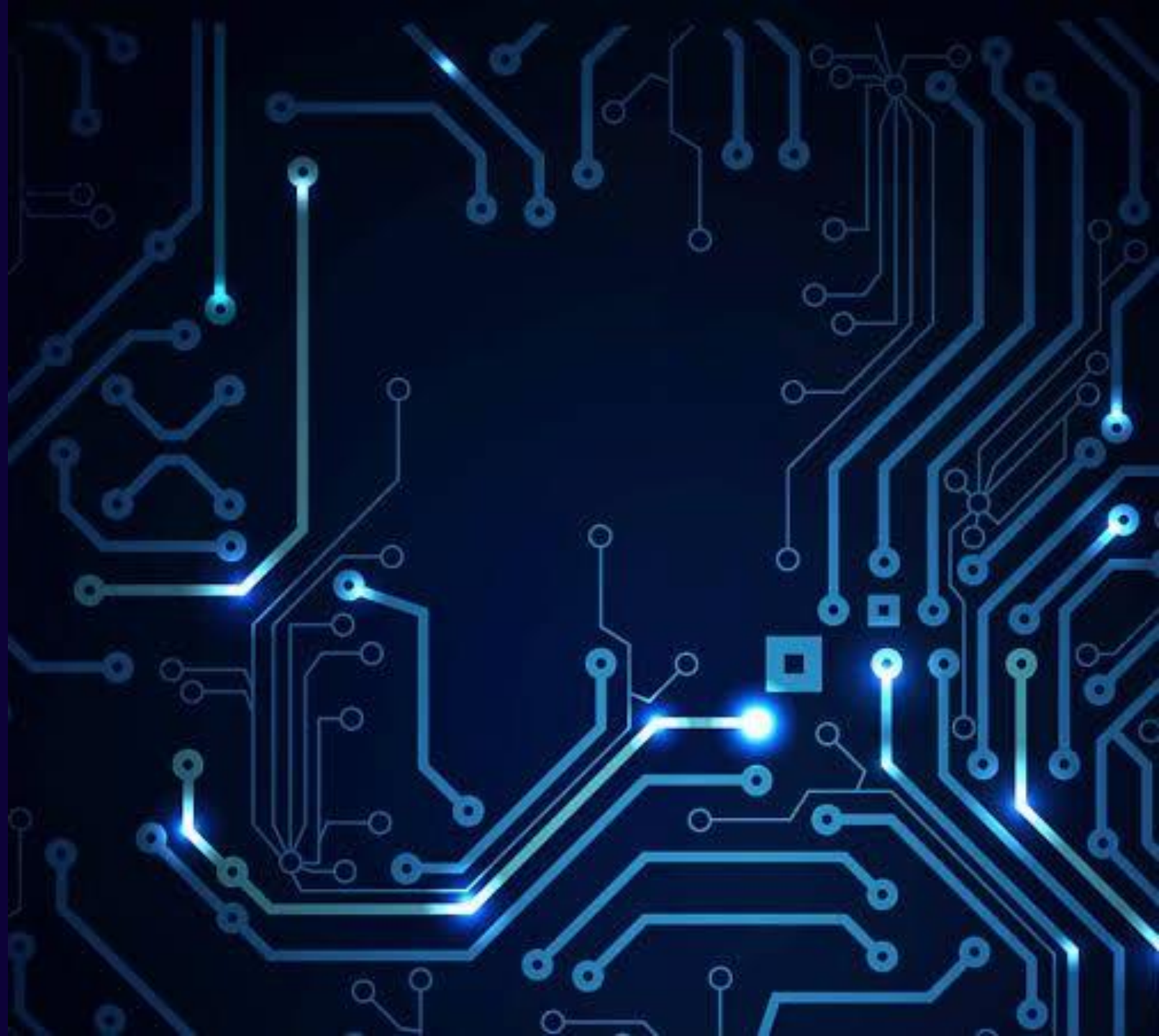
Dr. Ibrahim Zewail

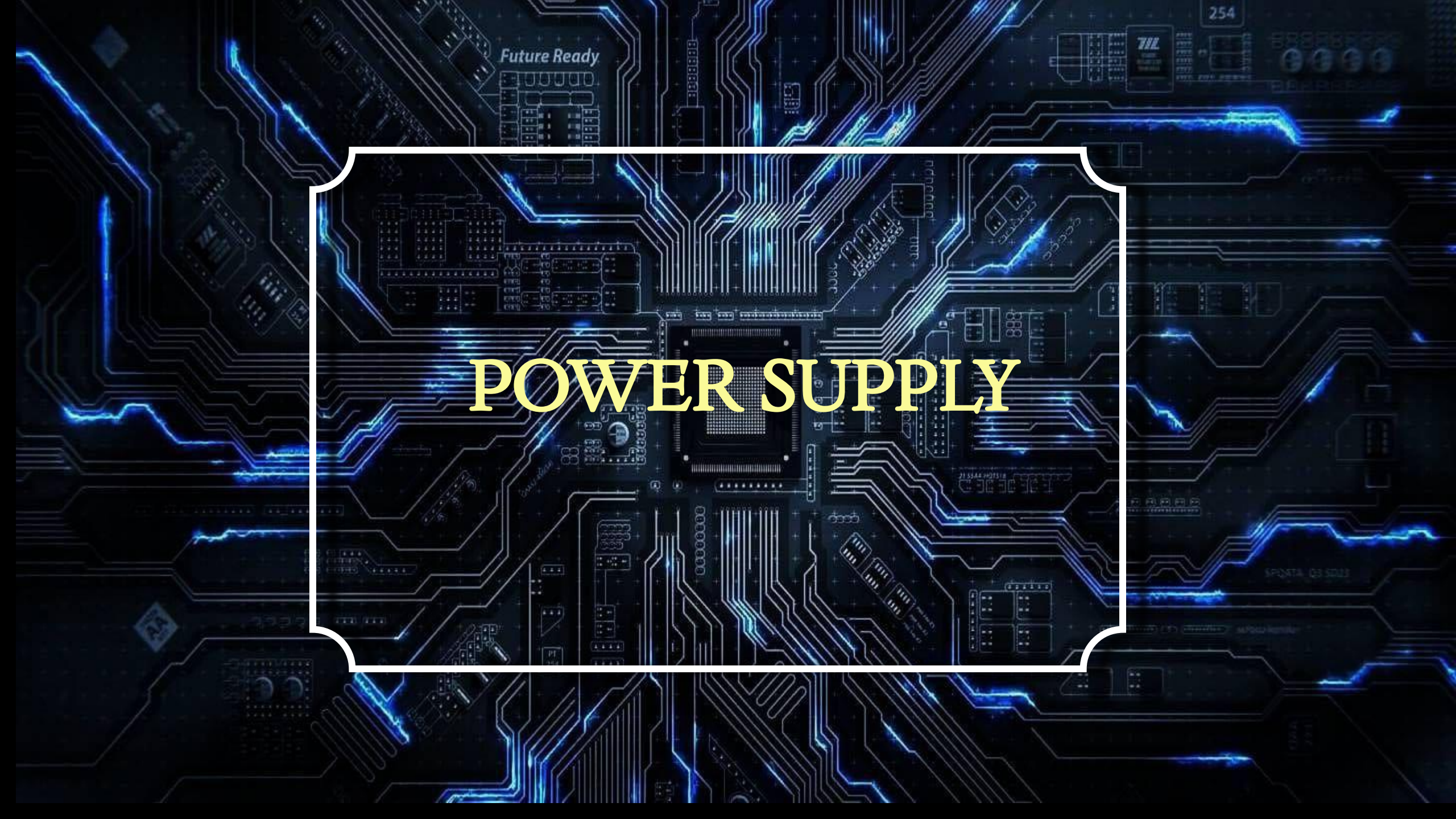
Project: Electronic Kit

PULSE TEAM



CIRCUITS

- [x] Power supply
- [x] Function Generator
- [x] Amplitude shift keying
- [x] Monostable Multivibrator
- [x] Adder
- [x] R-2R DAC
- [x] Phase locked loop
- [x] Active BPF
- [x] Passive BSF
- [x] Active HPF
- [x] Active LPF
- [x] The Differential Amplifier
- [x] Flash ADC
- [x] Op-amp Comparator


Future Ready
POWER SUPPLY

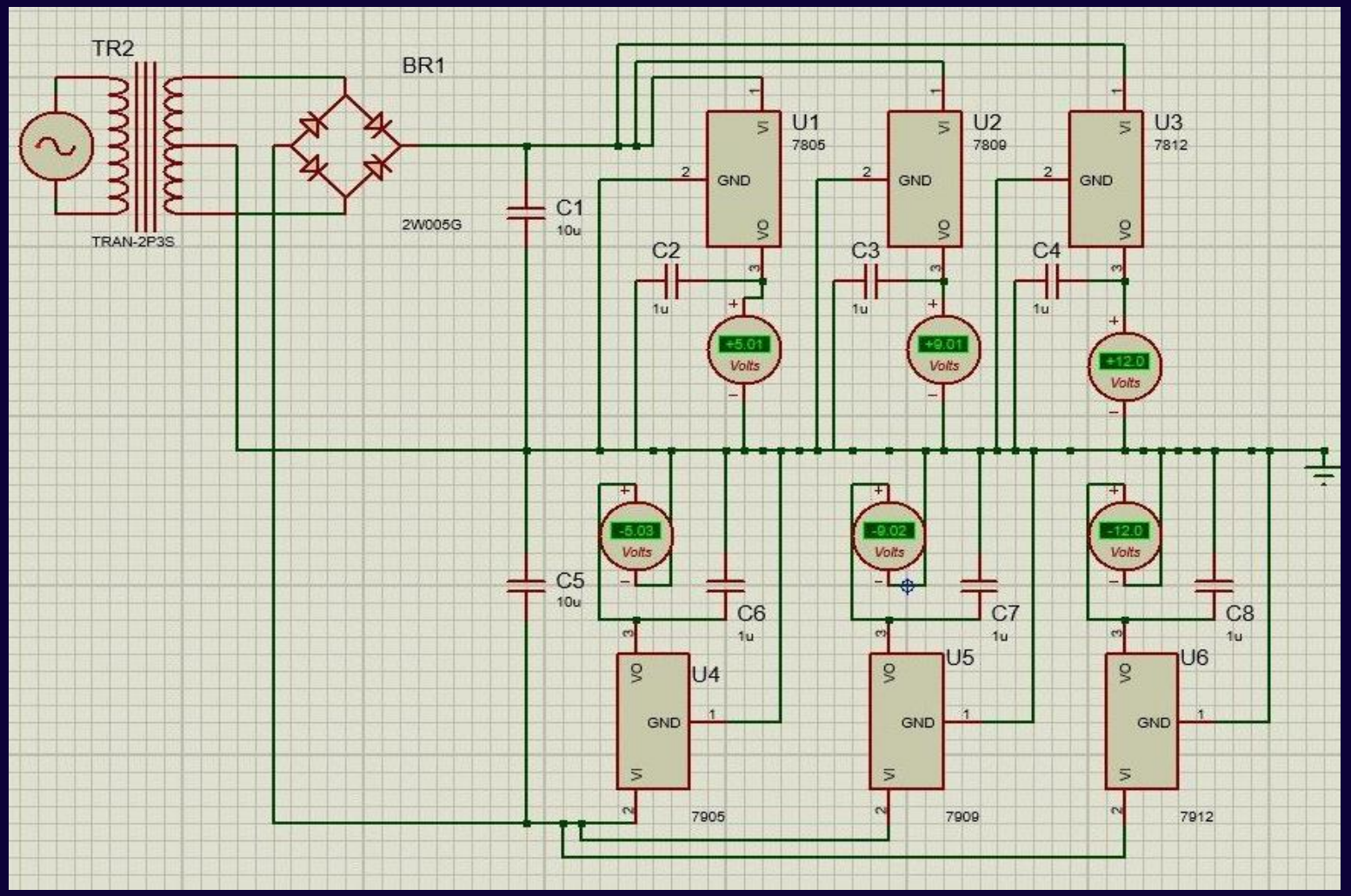
POWER SUPPLY

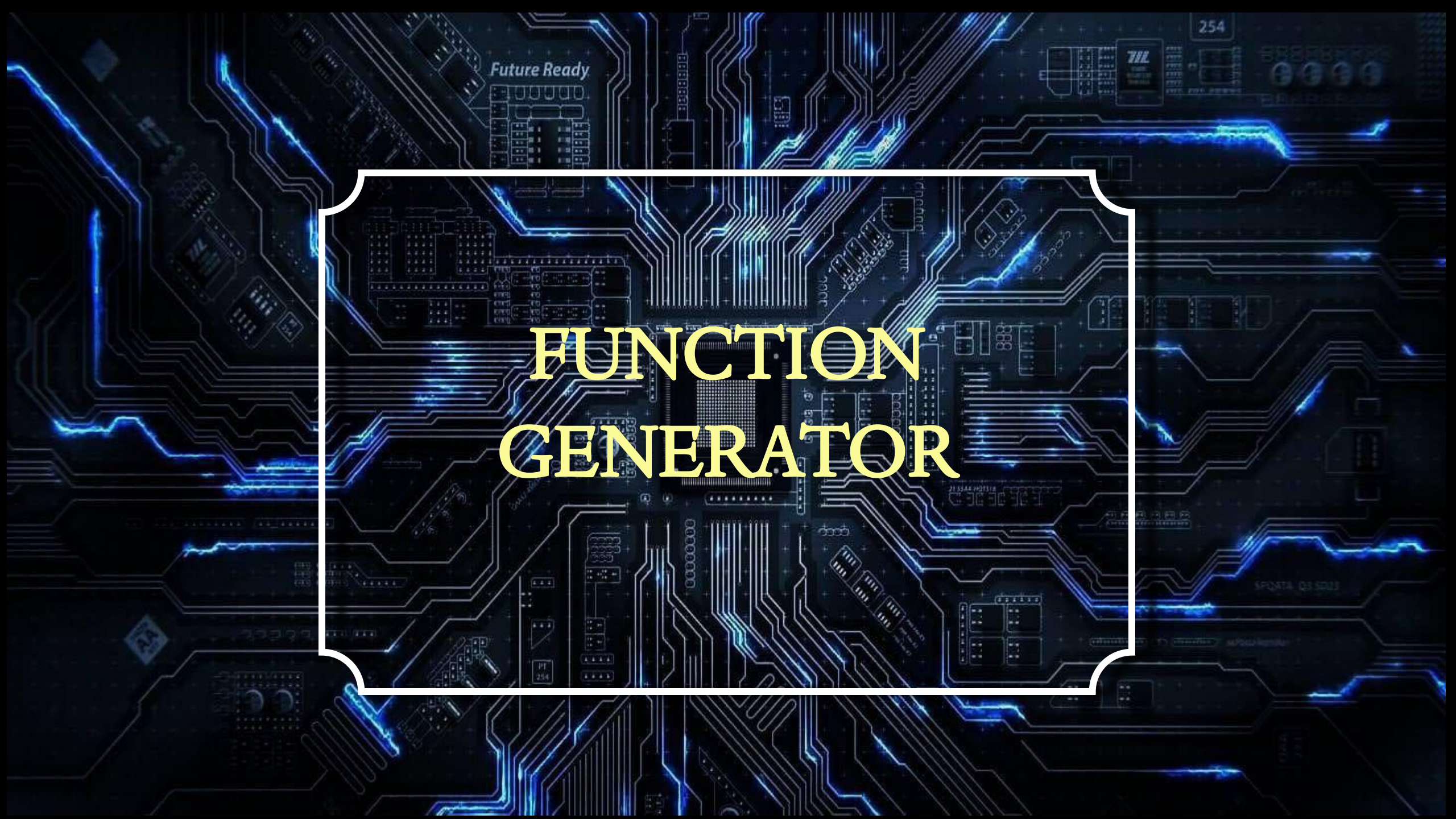
A DC power supply is a device that provides a steady direct current (DC) voltage to power electronic devices or systems.

It is commonly used in labs, industries, and consumer electronics where DC power is required.

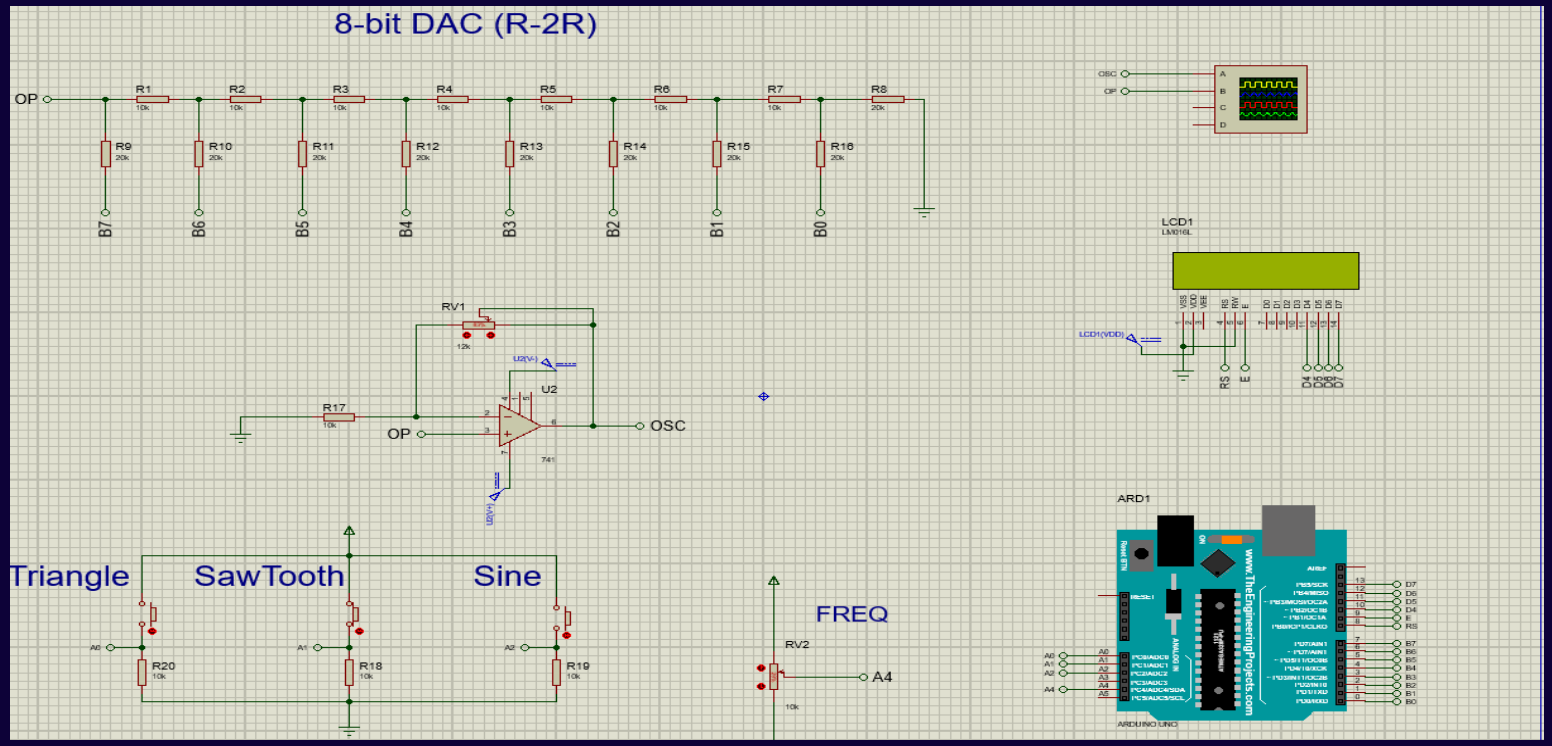
Types of DC Power Supplies:

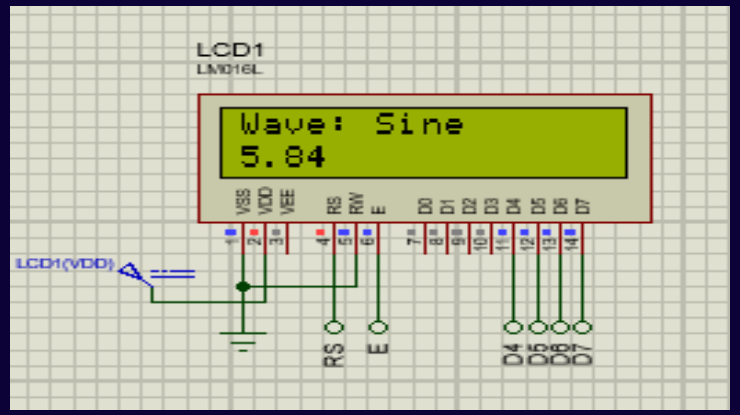
1. Linear DC Power Supply: • Converts AC to DC using a transformer, rectifier, filter, and regulator.
   - Advantages: Stable output, low noise.
   - Disadvantages: Bulky, less efficient.
   - Applications: Audio equipment, lab equipment

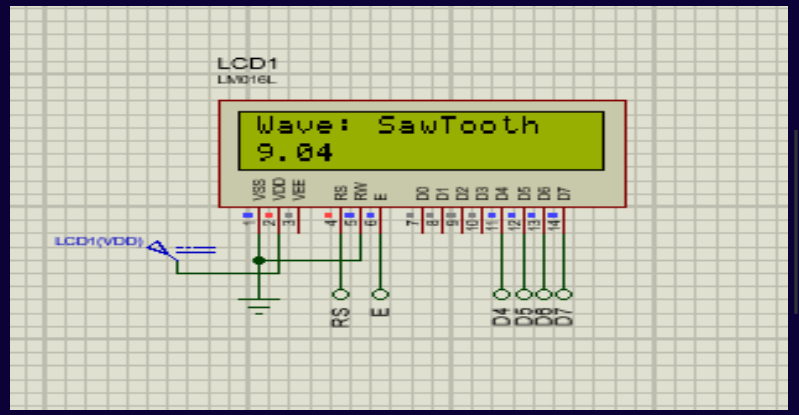


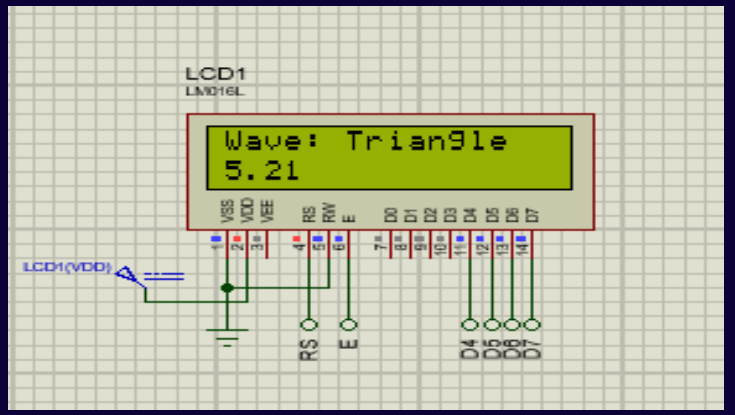

Future Ready
FUNCTION
GENERATOR

FUNCTION GENERATOR DIAGRAM





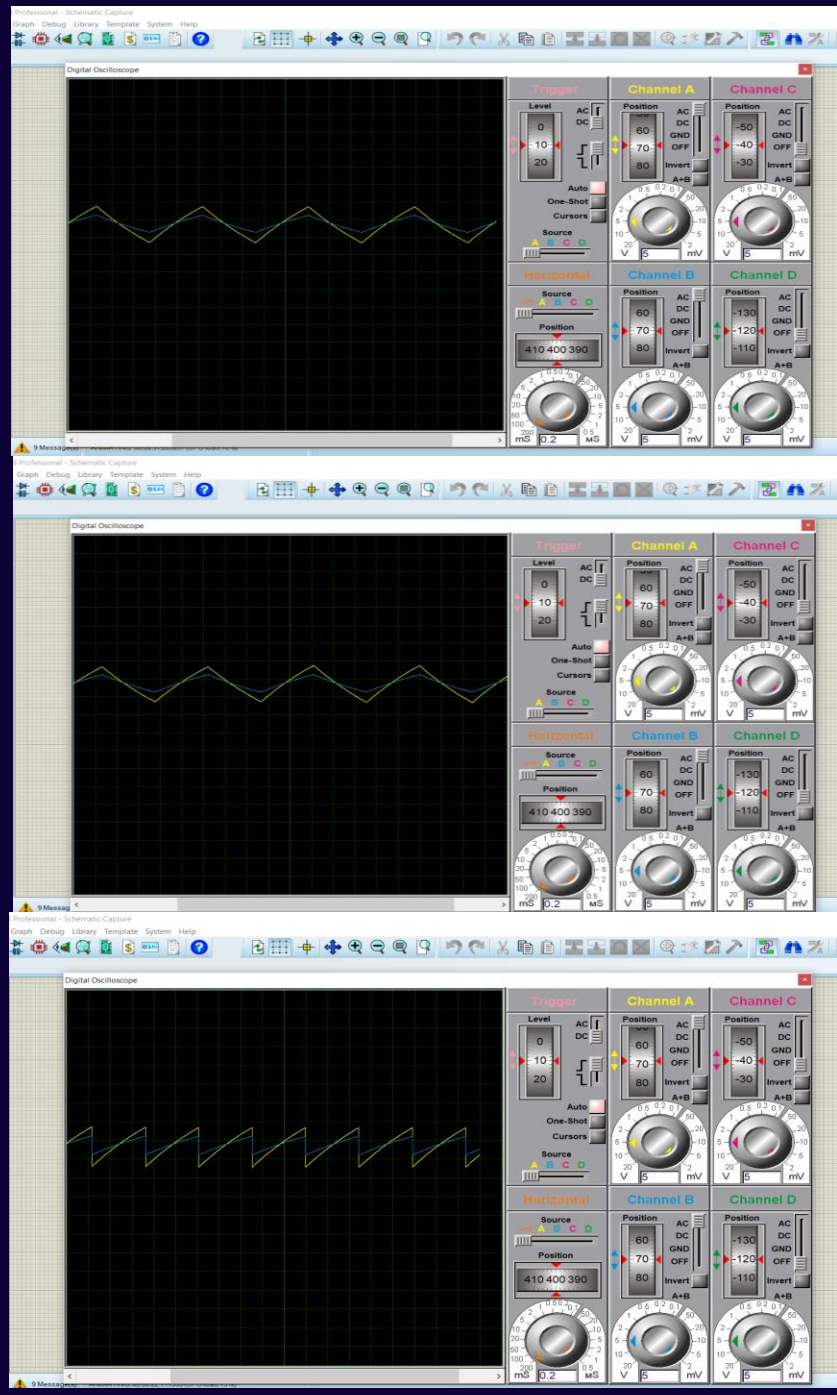




FUNCTION GENERATOR

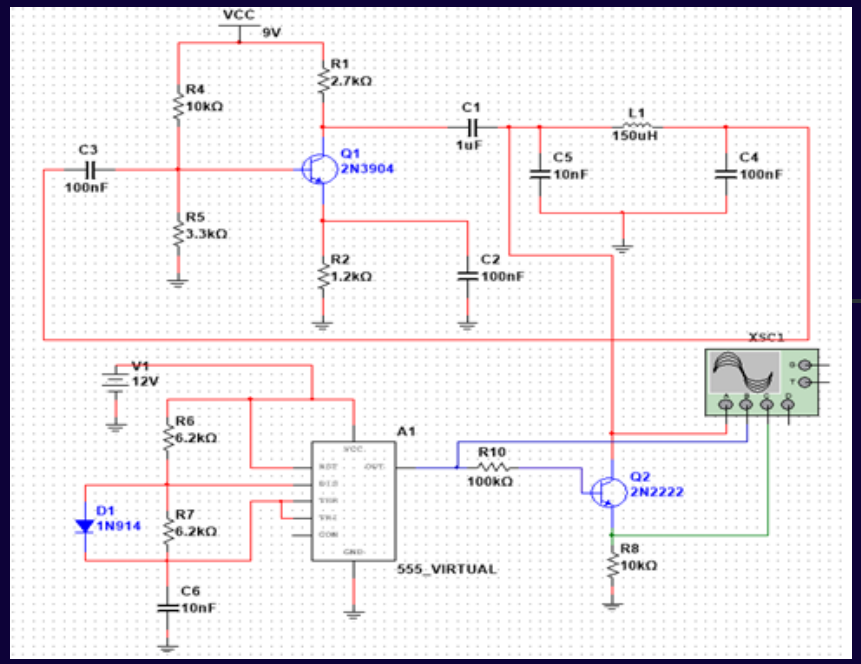
Functional Overview:
This function generator is capable of producing three waveform types: triangle, sawtooth, and sine waves.
The user can:
.Adjust the waveform frequency using the frequency control potentiometer.
.View the selected waveform and frequency on the LCD.
.Observe the output waveform on an external oscilloscope for verification.

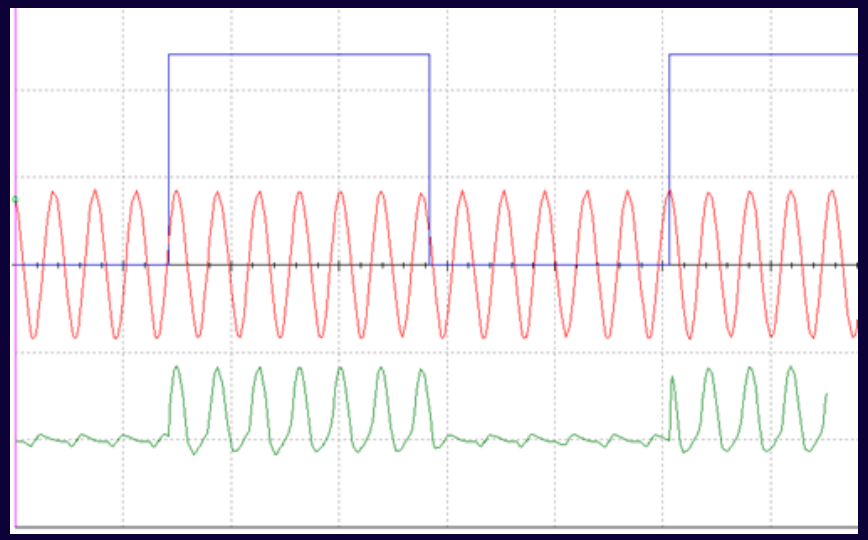
The Arduino handles waveform generation via software, sending corresponding digital values to the DAC. The R-2R network converts these digital values into a continuous analog signal, which is then shaped and output as the final waveform.



AMPLITUDE SHIFT KEYING

Amplitude Shift Keying (ASK)





This circuit is an **Amplitude Shift Keying** (ASK) **modulator** that transmits digital data by switching a high-frequency carrier signal on and off.

The upper section uses a **2N3904 transistor** with an LC tank circuit to generate a sinusoidal carrier wave, while the lower part employs a **555 timer** in astable mode to produce a square wave representing binary data.

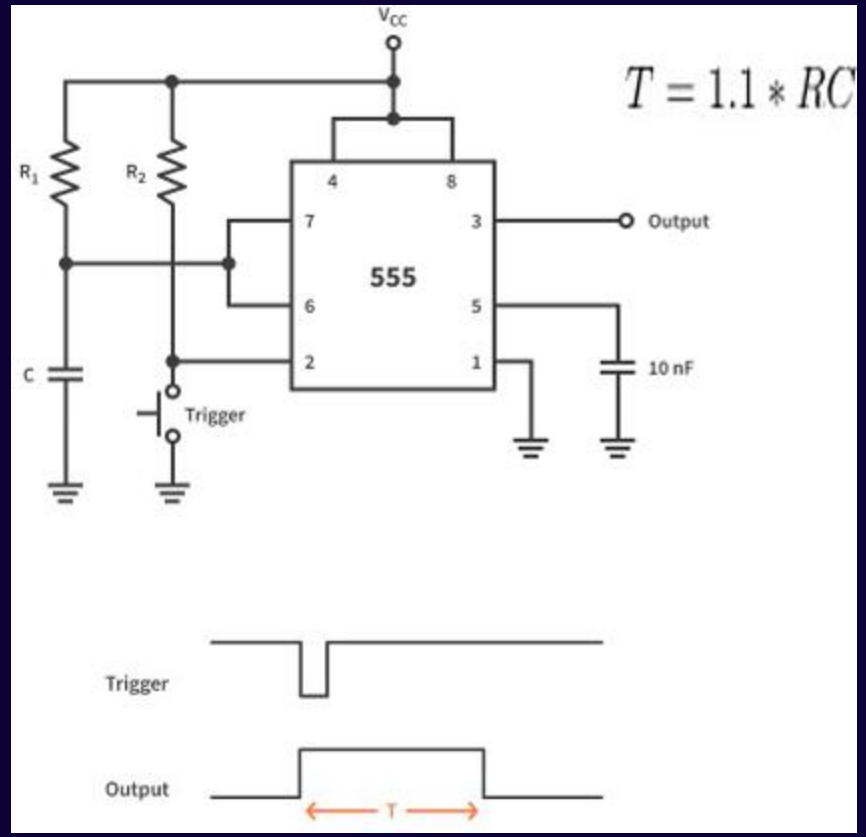
A **2N2222 transistor** acts as a switch, allowing the carrier to pass through only when the data signal is high, thus achieving ASK modulation.

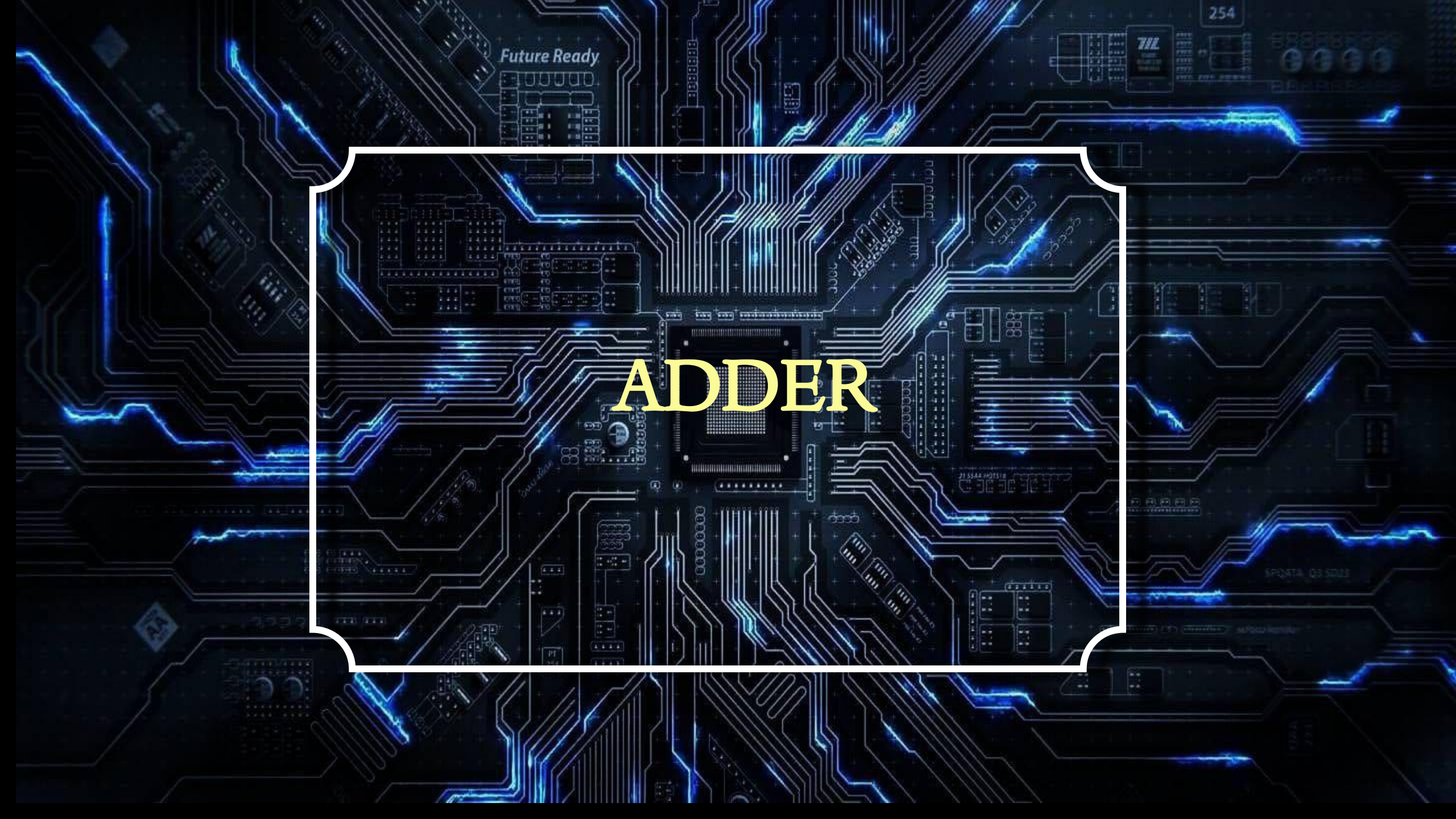
The output shows bursts of the carrier corresponding to the logic level of the data.


Future Ready
Monostable
Multivibrator

Monostable Multivibrator

A monostable multivibrator is basically an electronic device having only one stable state out of the two possible logic states: HIGH or LOW. When a monostable multivibrator is triggered externally, it produces a single output pulse in the "unstable" state for a short duration and then returns back to the stable state.



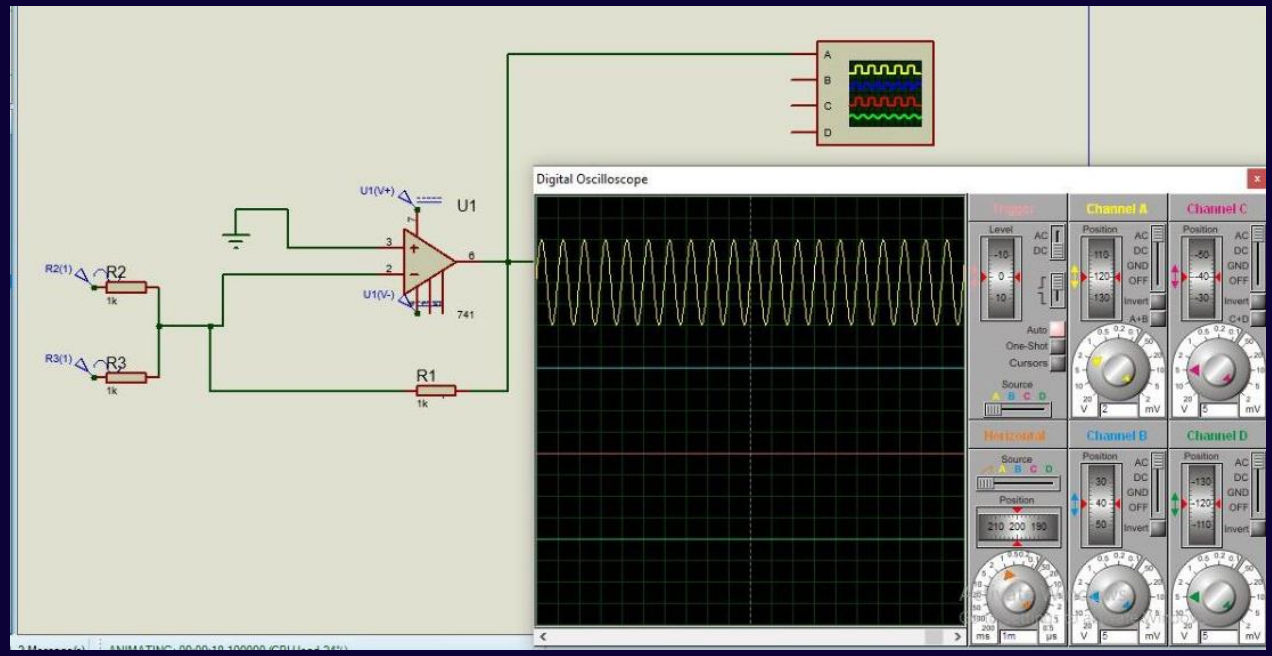

Future Ready
ADDER

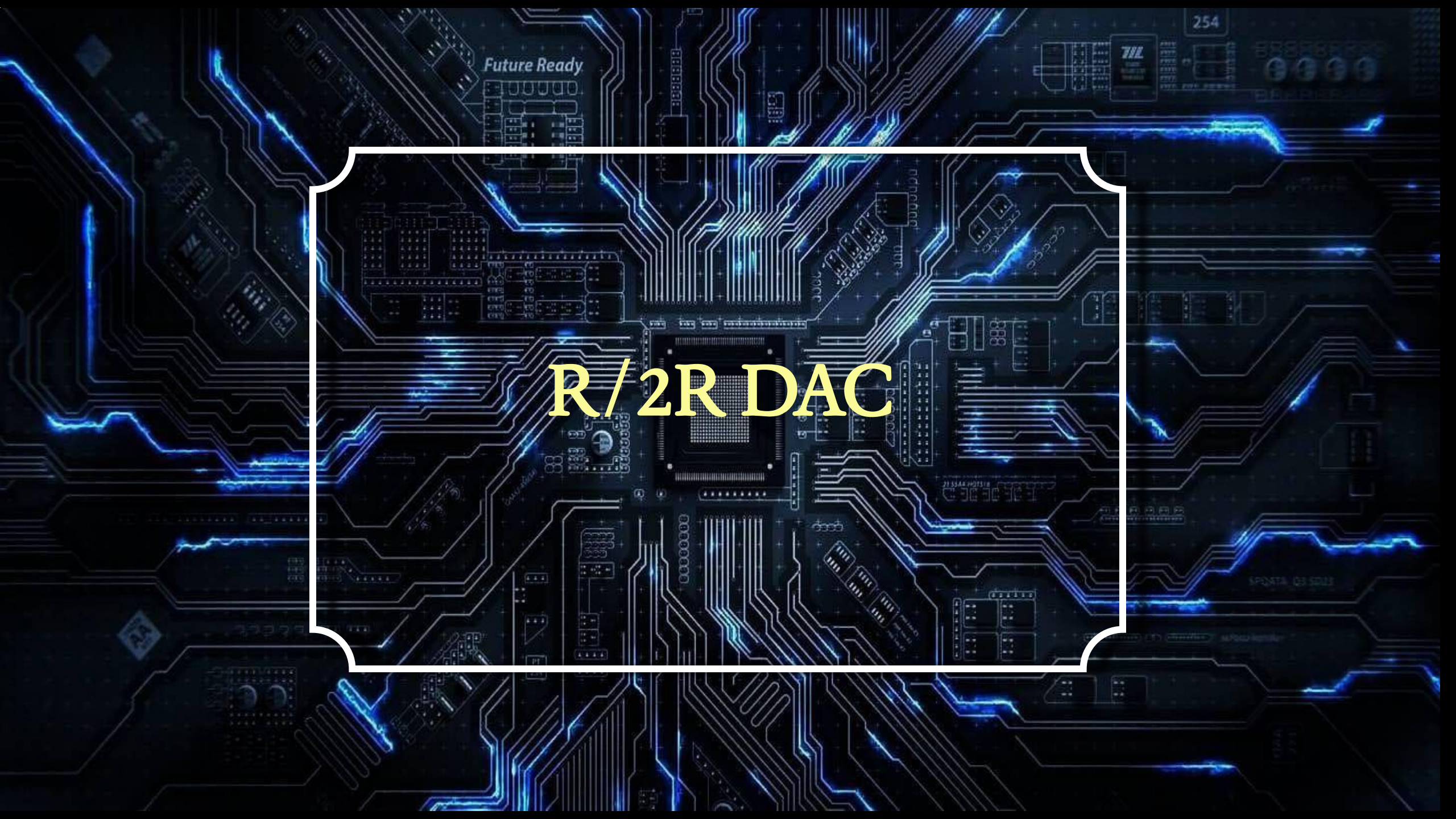
ADDER CIRCUIT

An adder circuit is a fundamental digital circuit used in arithmetic operations to add binary numbers. It is widely used in processors, calculators, and digital systems.

Applications:

- Arithmetic Logic Units (ALUs).
- Digital signal processors.
- Calculators.
- Data processing in computers.




Future Ready
R/2R DAC

R/2R CIRCUIT (DAC)

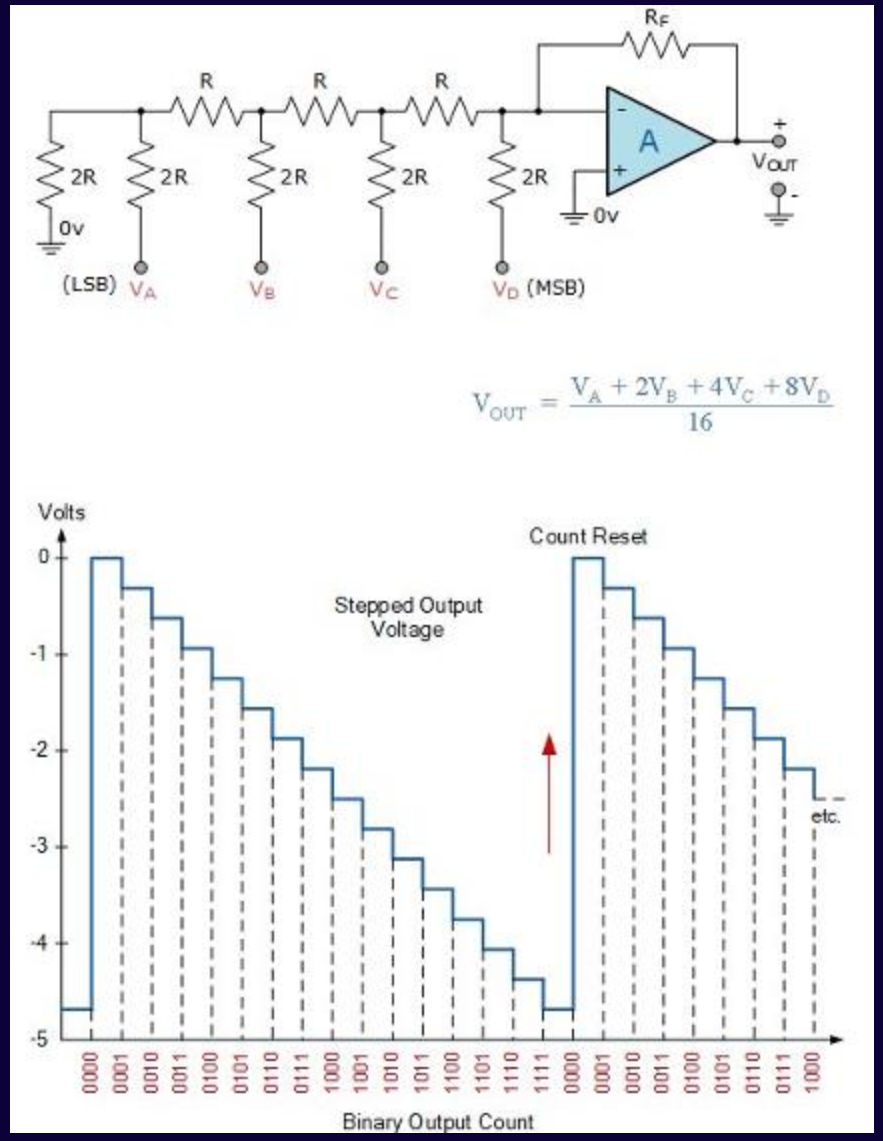
An R/2R ladder circuit is a type of digital-to-analog converter (DAC) that converts digital signals (binary) into analog signals. It is widely used in digital systems to generate precise analog voltages.

Advantages:

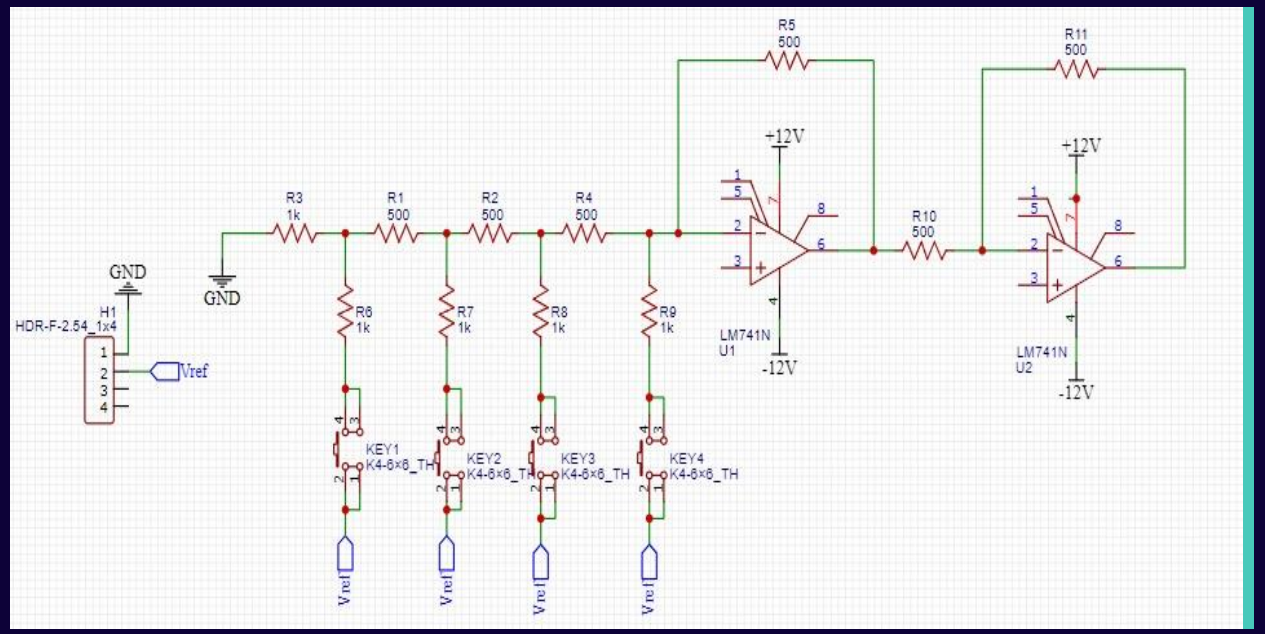
1. Precision: Only requires two resistor values, making it highly accurate.
2. Simplicity: Easy to design and implement.
3. Scalability: Can handle multiple bits by extending the ladder.

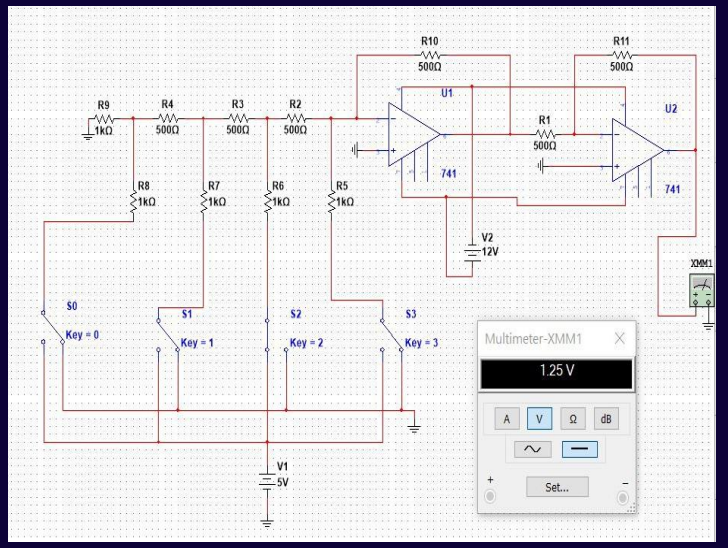
Applications:

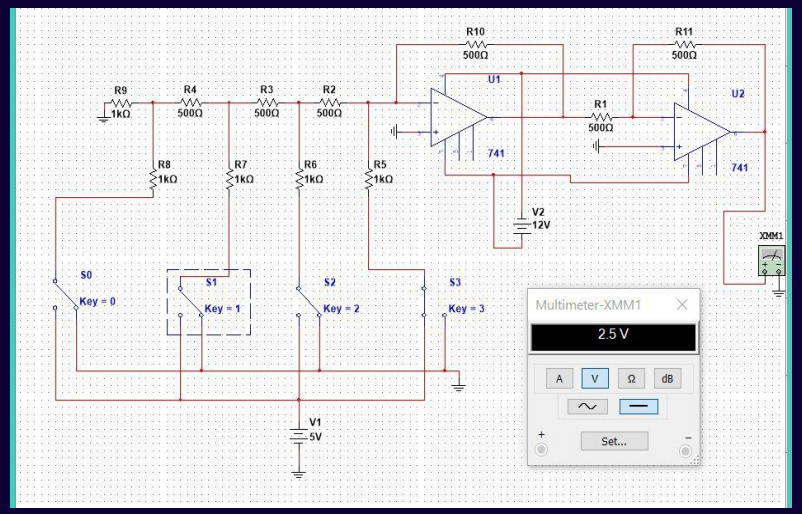
- Digital-to-analog conversion in microcontrollers and signal processing.
- Audio systems.
- Control systems in instrumentation.

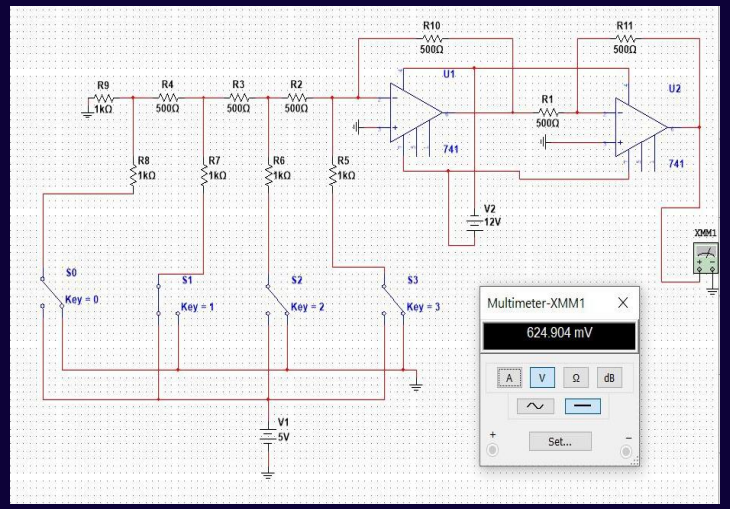


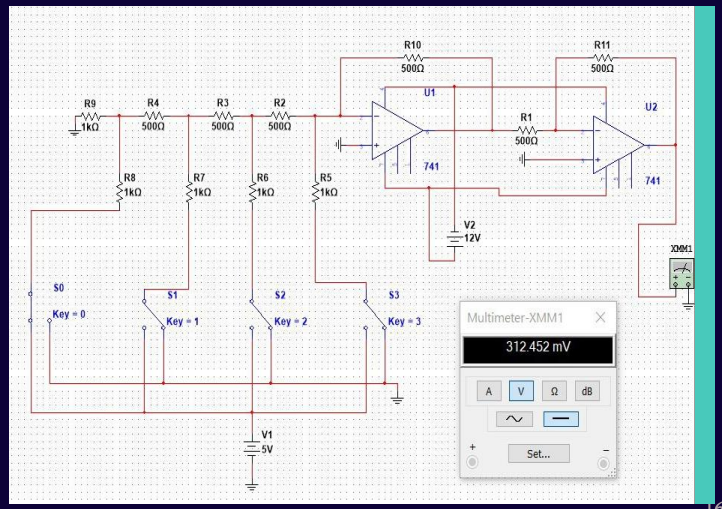
R/2R CIRCUIT (DAC)

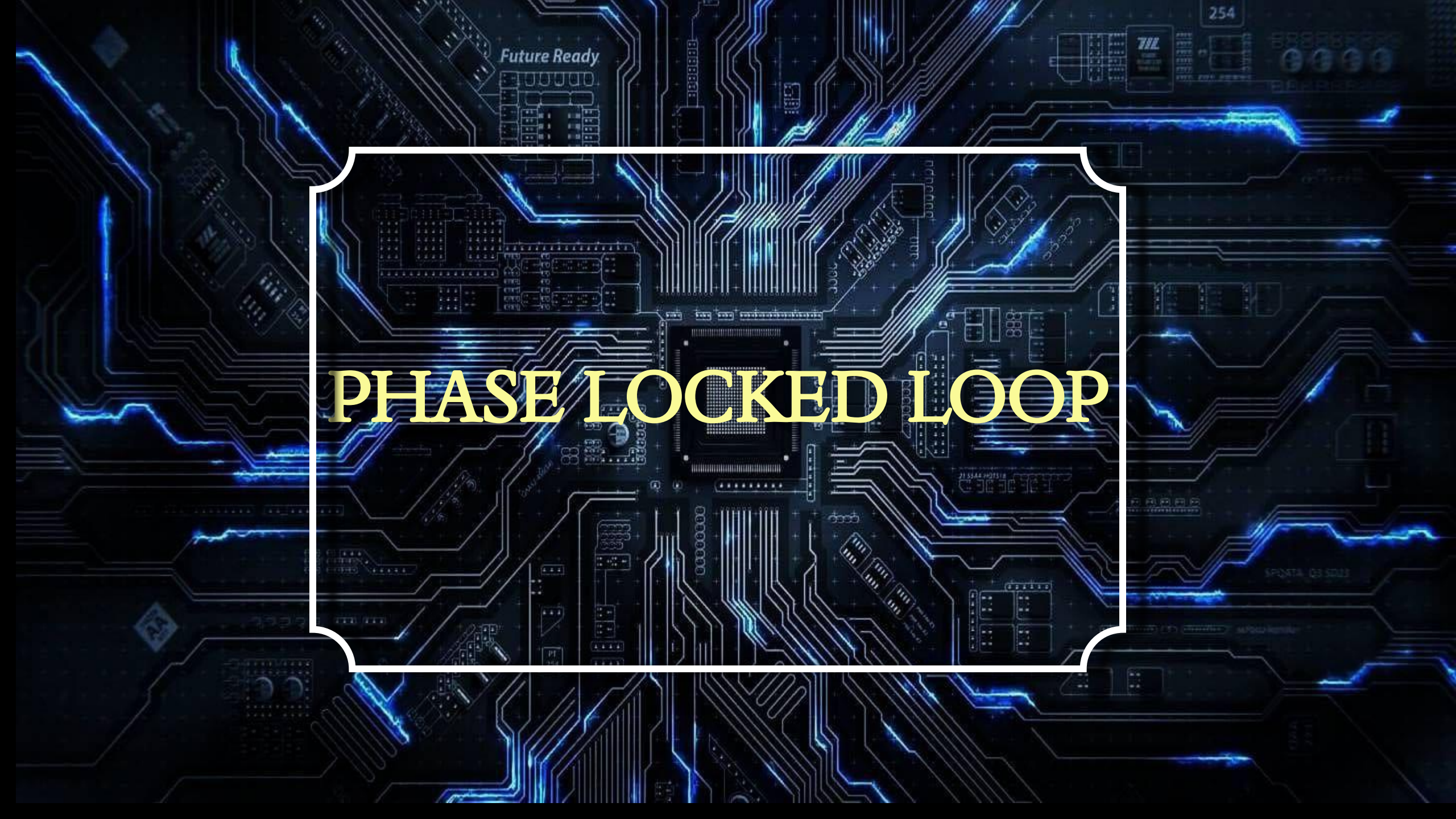










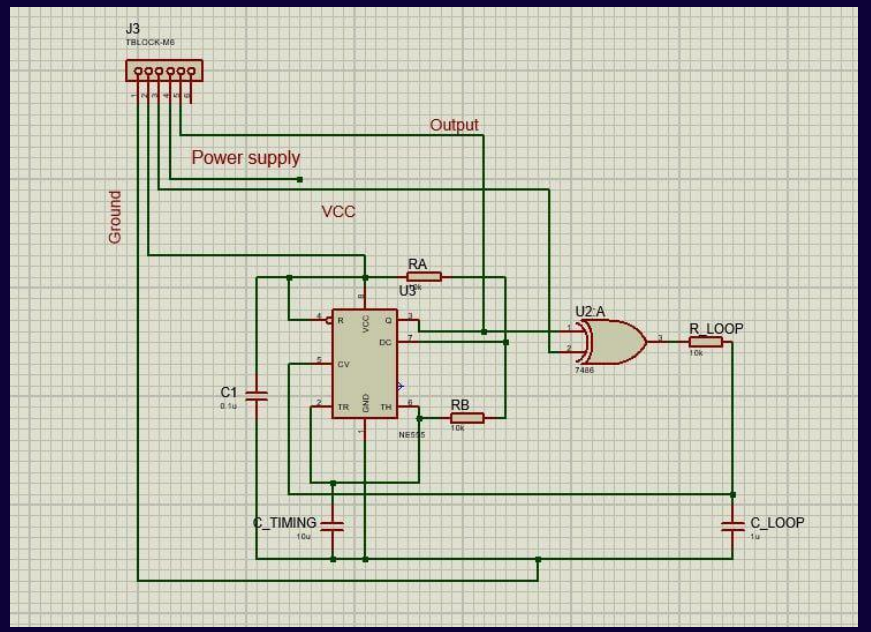

Future Ready
PHASE LOCKED LOOP

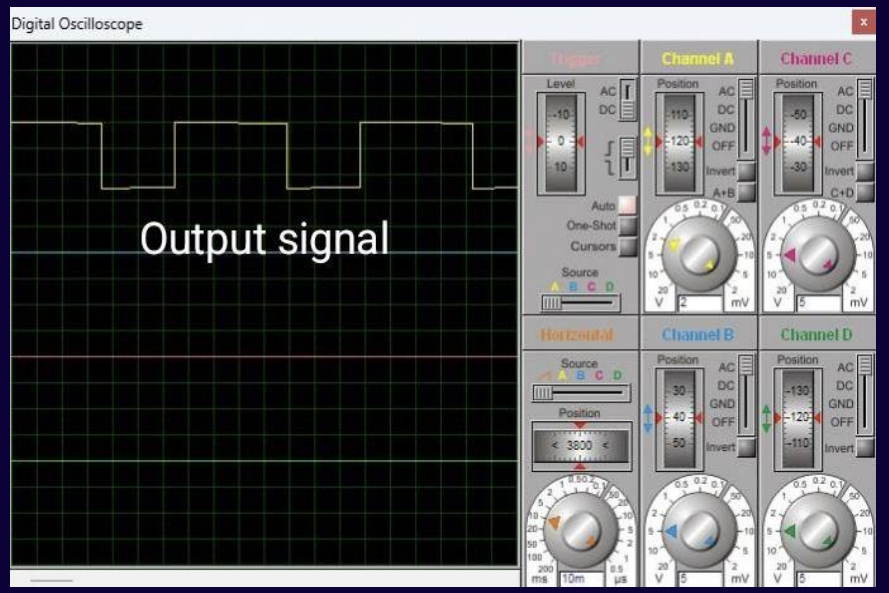
Phase locked loop

Phase-Locked Loop (PLL) :
A device that generates an output signal whose phase is related to the phase of an input signal. It is used in applications such as communication systems, frequency synthesis, and clock generation.
Circuit components and design:
Input Signal.
Phase Detector.
Loop Filter.
Voltage-Controlled Oscillator (VCO).
Output: Frequency.

Jobs and applications:
The input signal is compared with the feedback signal by the phase detector.
The signal is filtered by the loop filter.
The resulting signal controls the VCO to adjust the output frequency.

Applications:
Frequency synthesis in communication systems.
Clock synchronization in digital circuits.
Signal modulation and demodulation.





ACTIVE BAND-PASS FILTER

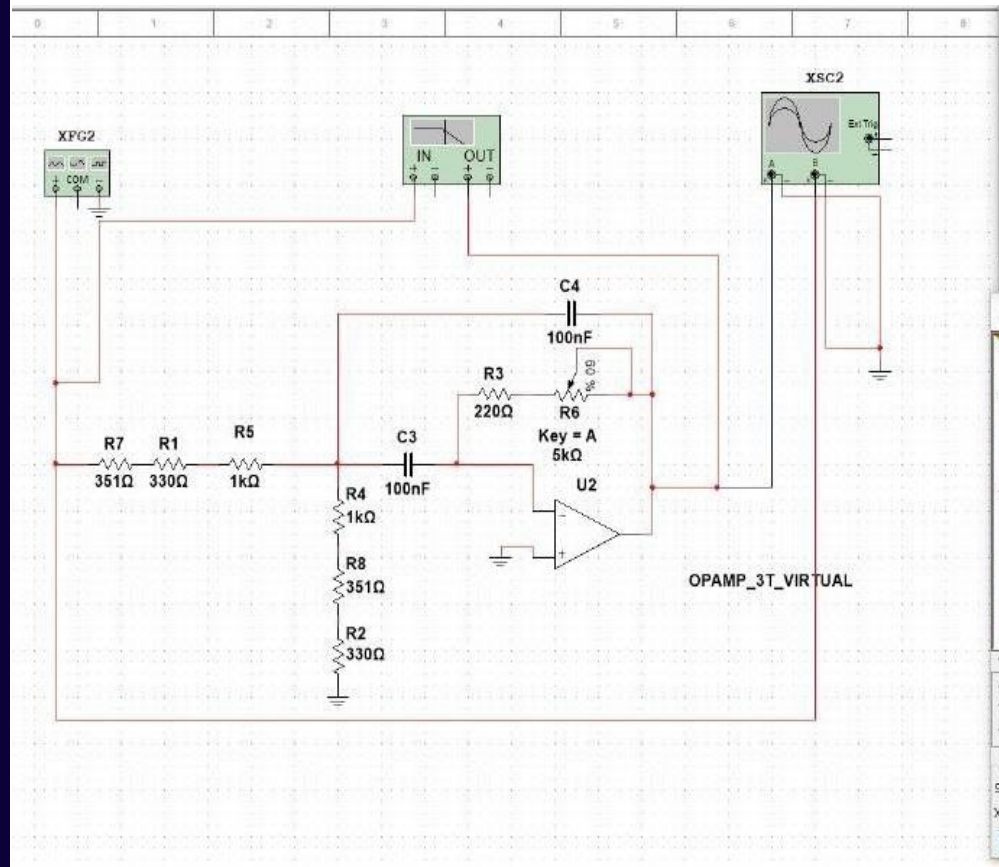
ACTIVE BAND-PASS FILTER

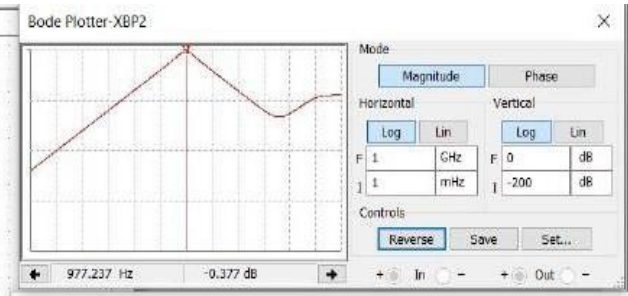
Band-Pass Filter:

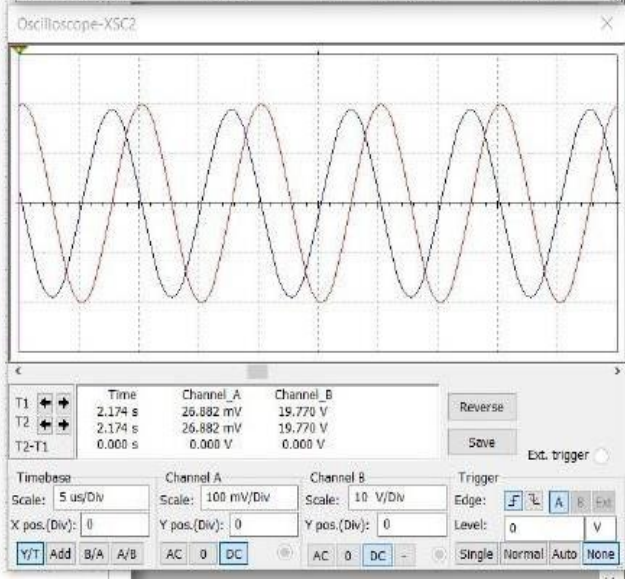
• Function: Allows frequencies within a specific range (band) to pass through and attenuates (blocks) frequencies outside this range.

• Use: Commonly used in communication systems to isolate a specific frequency band, or in audio processing to focus on certain tones.

• Example: Passes signals from 1 kHz to 3 kHz, and blocks frequencies below 1 kHz and above 3 kHz.







PASSIVE BAND-STOP FILTER

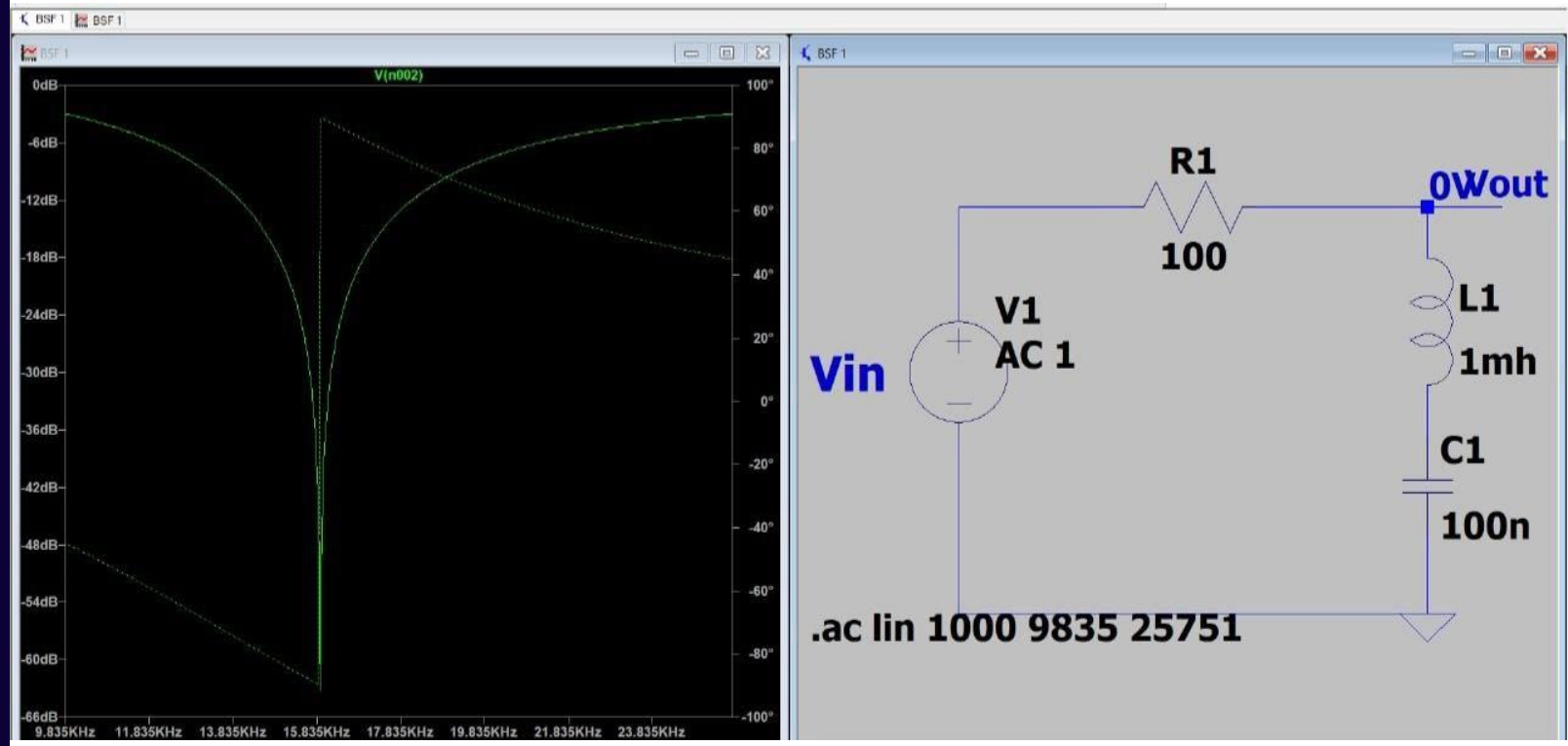
PASSIVE BAND-STOP FILTER

Band-Stop Filter :

• Function: Opposite of a band-pass filter. It blocks or attenuates frequencies within a specific range, and passes frequencies outside this range.

• Use: Often used to eliminate unwanted frequencies such as electrical noise (e.g., 50/60 Hz hum).

• Example: Blocks frequencies between 1 kHz and 3 kHz, but allows frequencies lower than 1 kHz and higher than 3 kHz.



ACTIVE HIGH-PASS FILTER

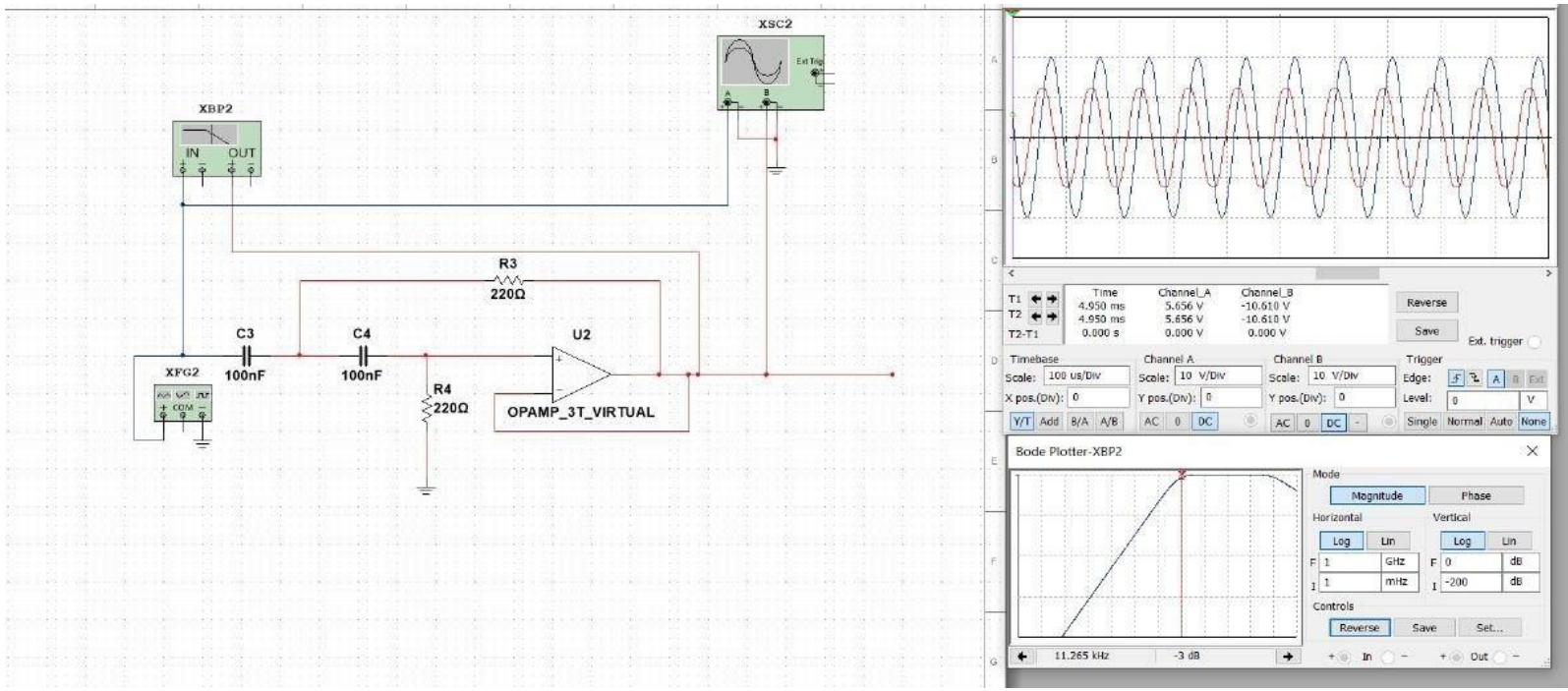
ACTIVE HIGH-PASS FILTER

High-Pass Filter:

• Function: Allows high frequencies to pass through and attenuates low frequencies below a certain cutoff frequency.

• Use: Used to remove low-frequency noise or hum from signals, or in audio to allow treble sounds and block bass.

• Example: Passes all frequencies above 1 kHz and blocks those below it.



ACTIVE LOW-PASS FILTER

ACTIVE LOW PASS FILTER

A low-pass filter: is an electronic filter that allows signals with frequencies lower than a specific cutoff frequency to pass through while attenuating (reducing) signals with higher frequencies. It is commonly used in signal processing, audio systems, and communication systems.

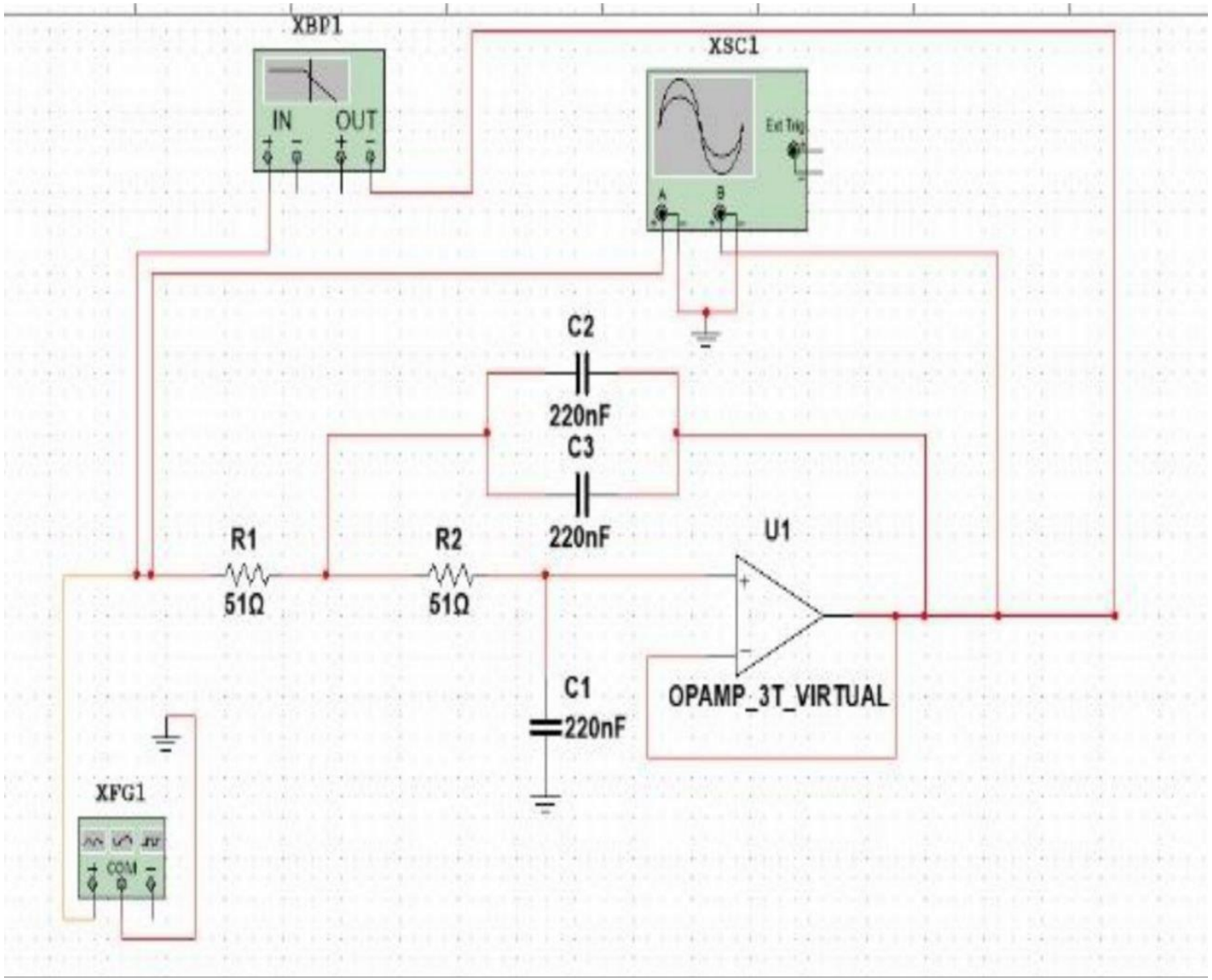
Types of Low-Pass Filters:

1. Passive Low-Pass Filter:
2. Active Low-Pass Filter:

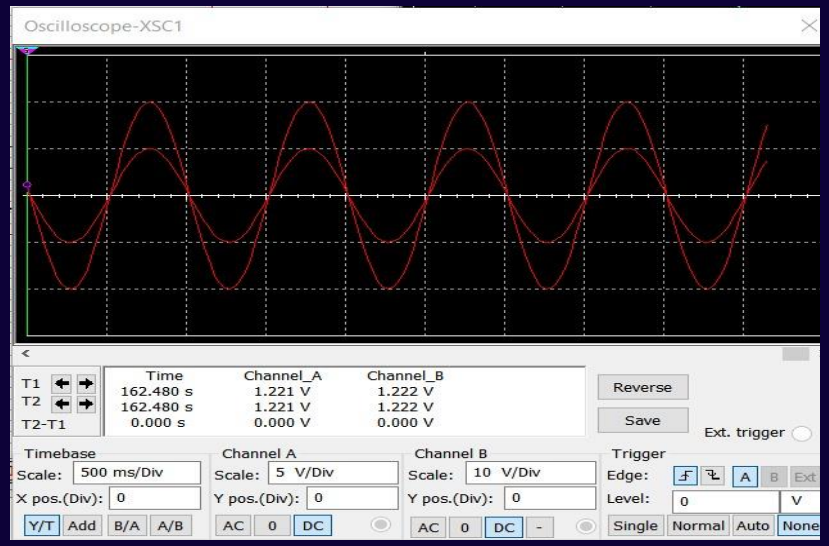
. Uses operational amplifier (op-amps) in addition to resistors and capacitors.

. Can amplify the signal and provide better performance

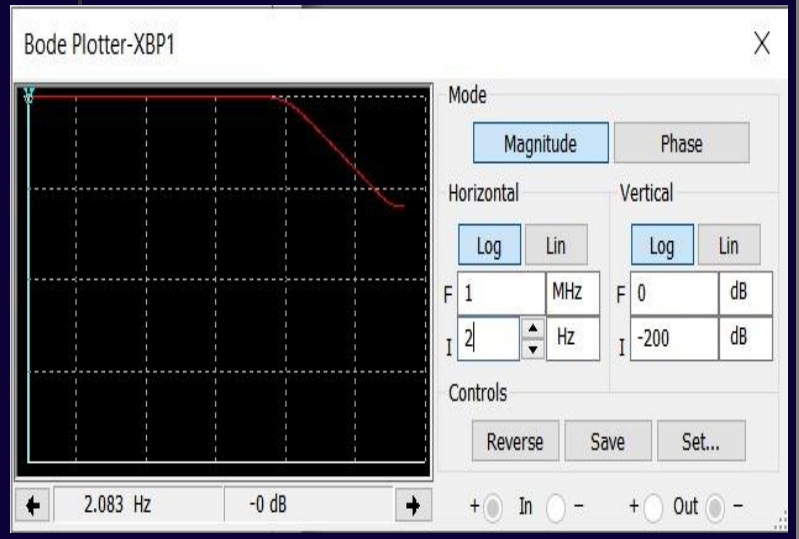
Low-pass filters are fundamental tools in electronics for ensuring signal clarity and reducing unwanted noise.



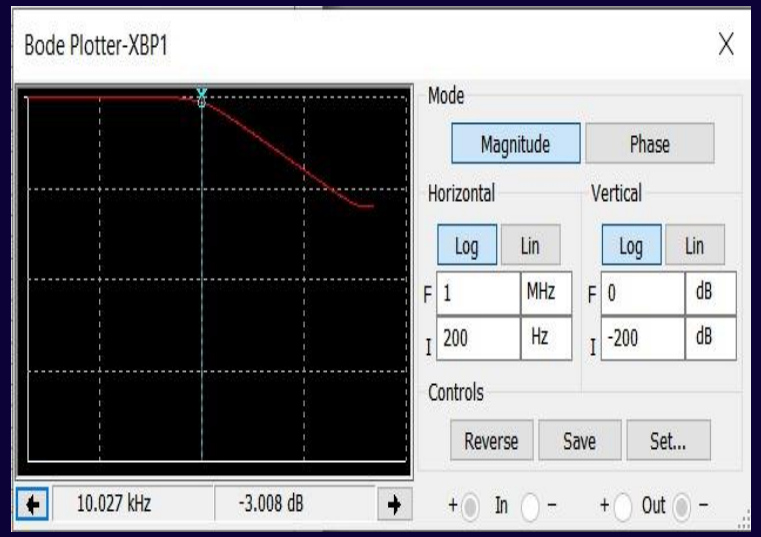
ACTIVE LOW PASS FILTER



Input & output wave



Frequency response

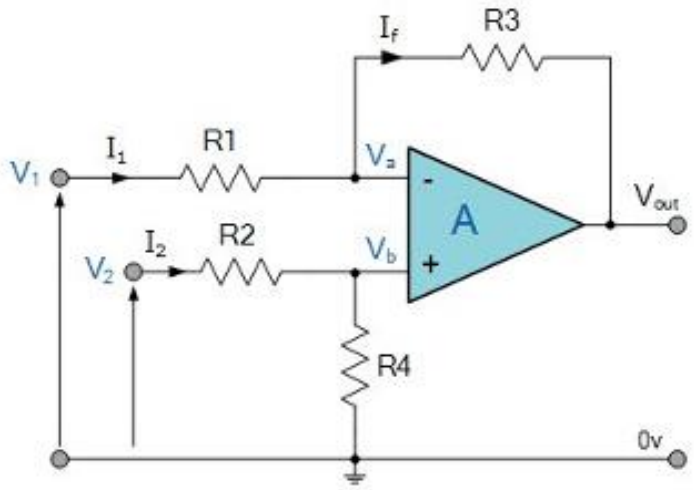


-3db

The Differential Amplifier

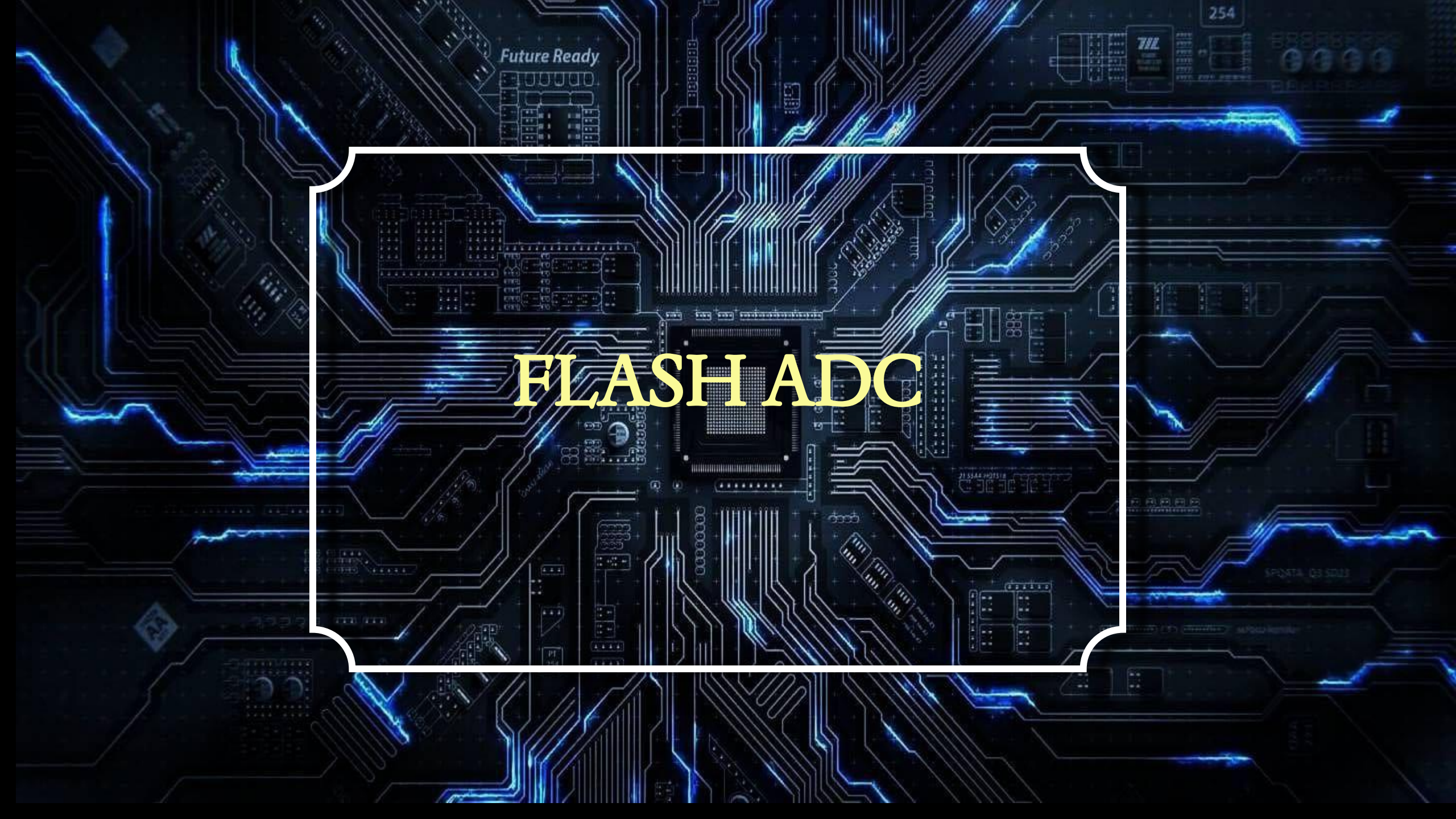
The Differential Amplifier

The differential amplifier is a voltage subtractor circuit which produces an output voltage proportional to the voltage difference of two input signals applied to the inputs of the inverting and non-inverting terminals of an operational amplifier.



Differential Amplifier Equation

$$V_{OUT} = \frac{R_3}{R_1}(V_2 - V_1)$$


Future Ready
FLASH ADC

FLASH ADC CIRCUIT

A Flash ADC (Analog-to-Digital Converter) is a high-speed converter that transforms an analog signal into a digital output almost instantaneously. It is also known as a parallel ADC due to its architecture.

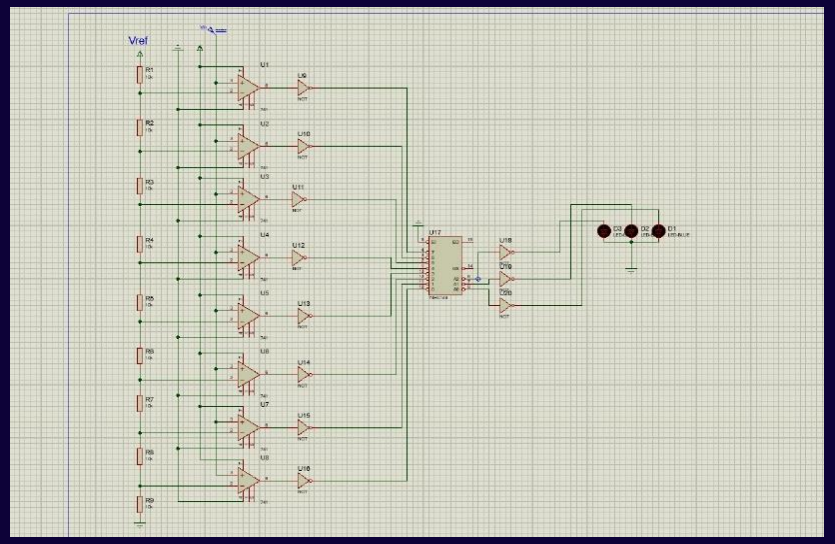
Advantages:

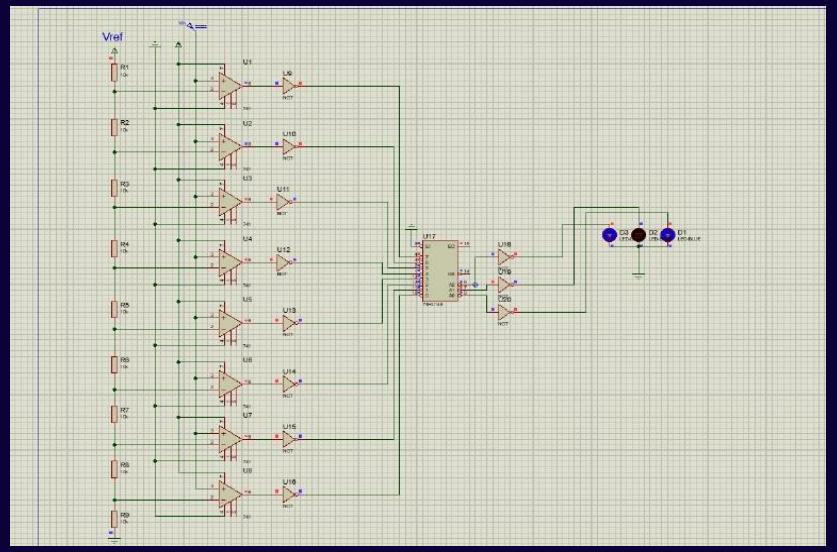
- Fastest type of ADC.
- No need for clock cycles for conversion

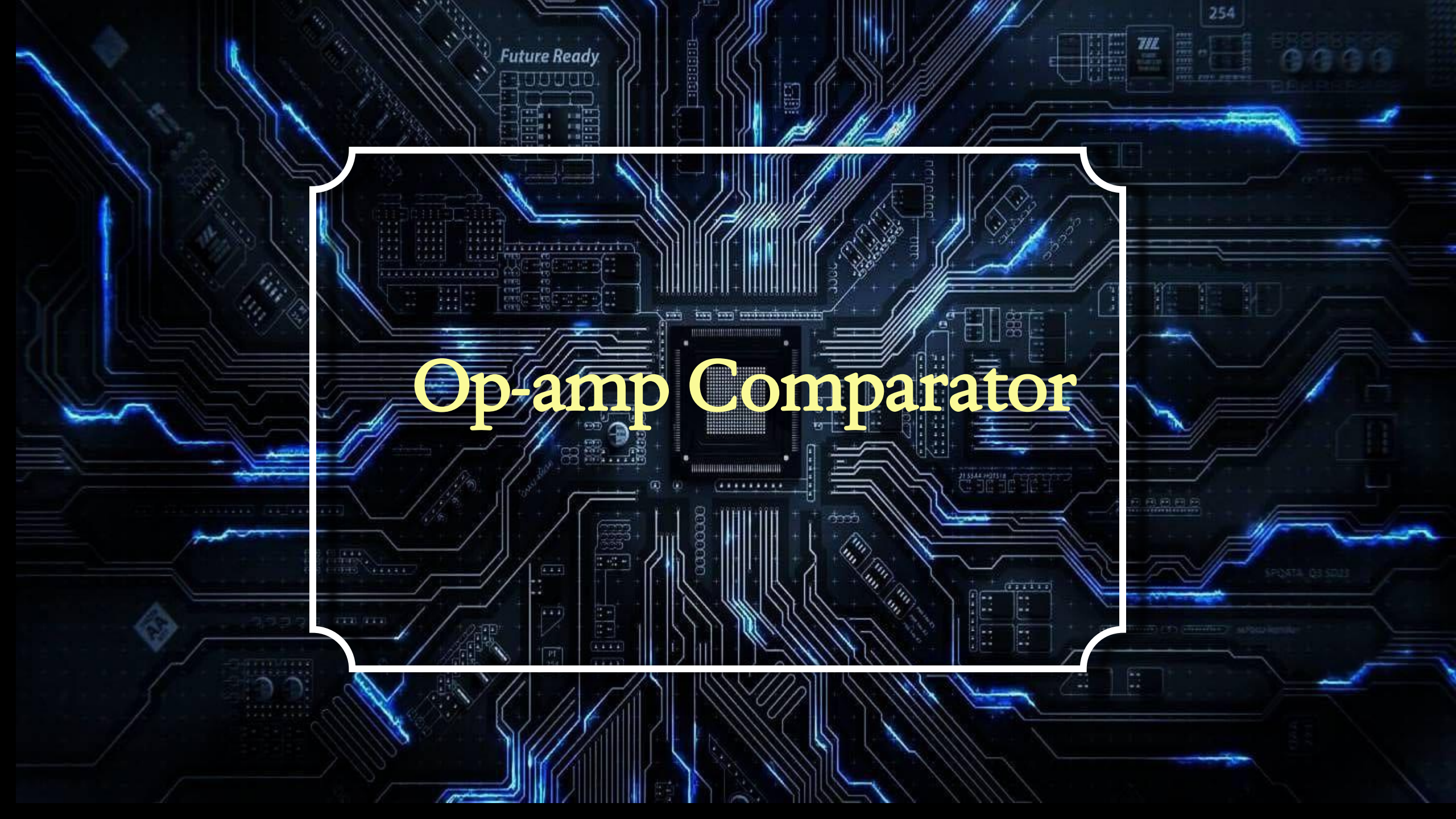
Applications:

- Oscilloscopes.
- High-frequency communication systems.
- Radar and imaging systems.
- Digital video.

Flash ADCs are ideal for applications requiring ultra-fast conversion but are less practical for low-speed, high-resolution tasks due to cost and power consumption.





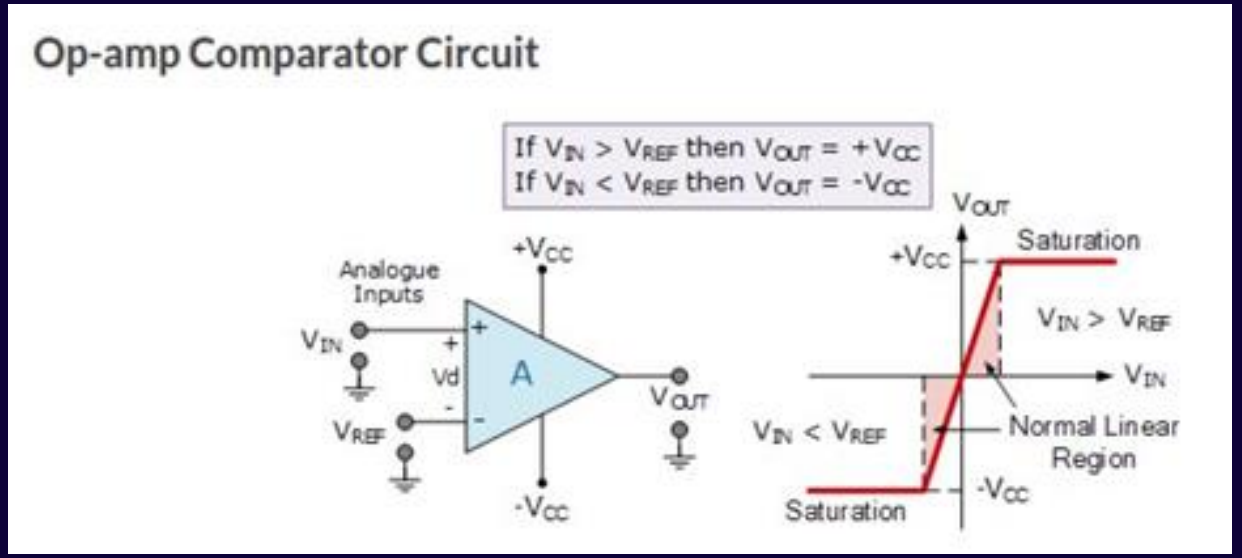


Op-amp Comparator

Op-amp Comparator

The Op-amp comparator compares one analogue voltage level with another analogue voltage level, or some preset reference voltage, VREF and produces an output signal based on this voltage comparison. In other words, the op-amp voltage comparator compares the magnitudes of two voltage inputs and determines which is the largest of the two.

With reference to the op-amp comparator circuit above, lets first assume that VIN is less than the DC voltage level at VREF, (VIN < VREF). As the non-inverting (positive) input of the comparator is less than the inverting (negative) input, the output will be LOW and at the negative supply voltage, Vcc resulting in a negative saturation of the output. If we now increase the input voltage, VIN so that its value is greater than the reference voltage VREF on the inverting input, the output voltage rapidly switches HIGH towards the positive supply voltage, +Vcc resulting in a positive saturation of the output. If we reduce again the input voltage VIN, so that it is slightly less than the reference voltage, the op-amp's output switches back to its negative saturation voltage acting as a threshold detector.

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