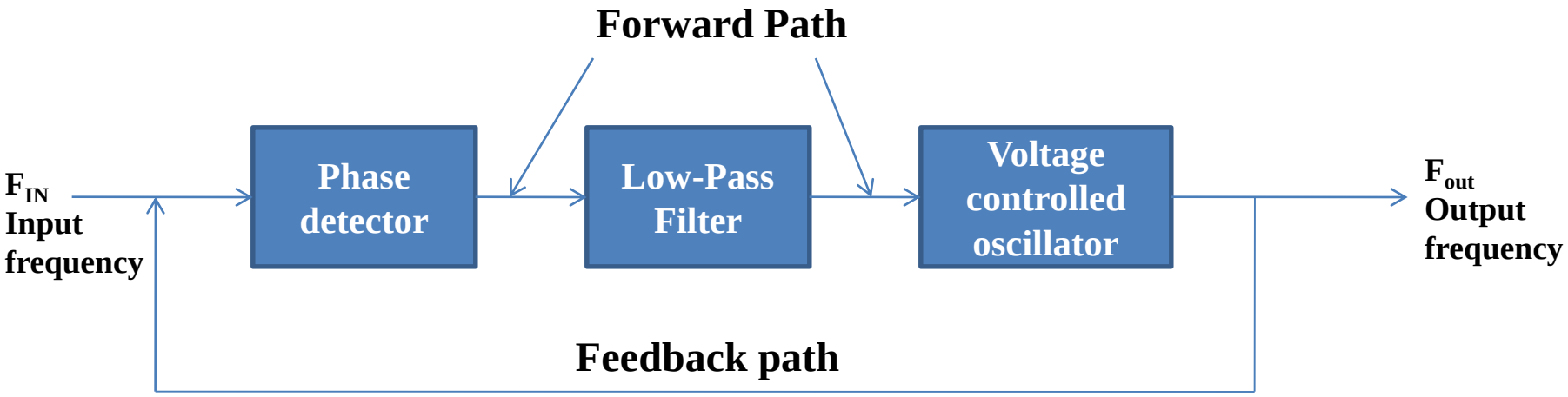
UNIT-III
PHASE-LOOKED LOOPS & REGULATED POWER SUPPLY

CLASS: M.SC PHYSICS(SEM-II)
PREPARED BY:-RONAK PATEL
INDUS UNIVERSITY, AHMEDABAD

PLL Block Diagram

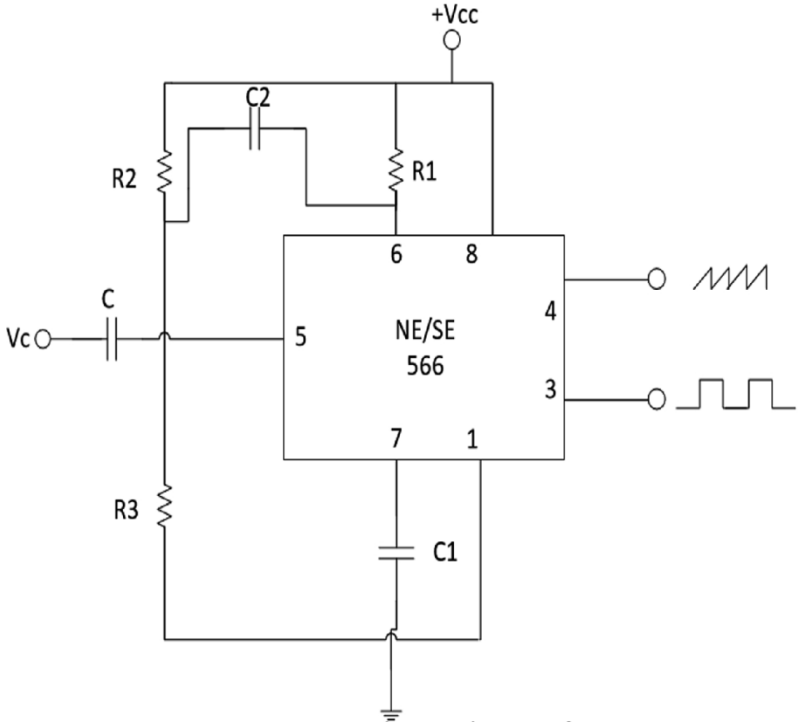


- The system consists of three parts:
  - Phase Detector
  - LPF
  - VCO

- **Phase detector:**
  - Analog Multiplier
  - PD produces error signal that is proportional to the phase error i.e., to the difference between the phases of input and output signals of PLL
- **Low Pass Filter:**
  - Low Pass Filter suppresses the noise and unwanted PD outputs and produces a dc level.
  - It also helps in establishing the dynamic characteristics of the PLL circuits.
- **Voltage Controlled Oscillator:**
  - VCO sinusoidal signal
  - The instantaneous VCO frequency is controlled by its input voltage.

NE/SE566 VCO Block Diagram

- Pin Description:
  - Pin 1: Ground (GND)
  - Pin 2: No connection (NC)
  - Pin 3: Square wave output
  - Pin 4: Triangular wave output
  - Pin 5: Modulation input
  - Pin 6: Timing resistor
  - Pin 7: Timing capacitor
  - Pin 8: Vcc

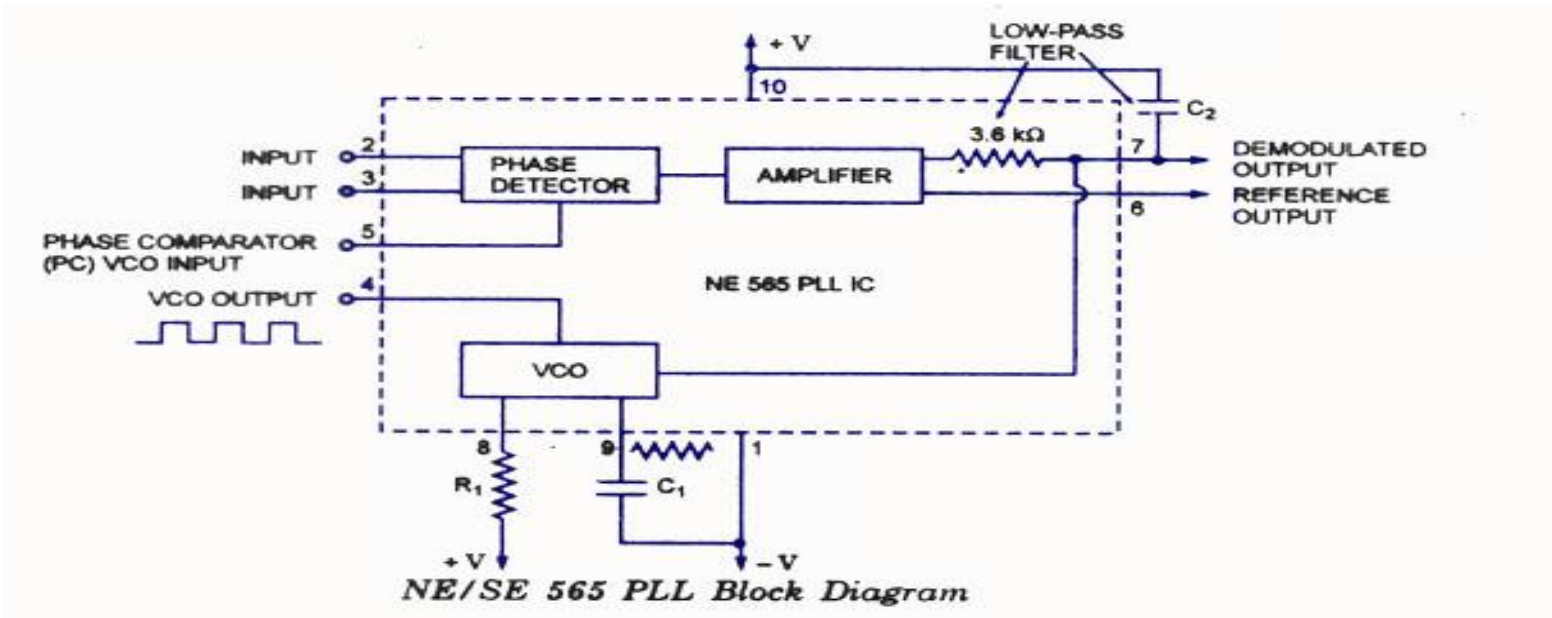


- **Features:**
  - The maximum operating voltage is 10V to 24V
  - High temperature stability
  - Operating temperature is 0˚C to 70˚C
  - The frequency can be controlled by means of current, voltage, resistor or capacitor
  - Power dissipation is 300mV
- **Working:**
  - Resistor R1 and capacitor C1 form the timing components. Capacitor C2 is used to prevent the parasitic oscillations during VCO switching.
  - Resistor R3 is used to provide the control voltage V_c. Triangle and square wave outputs are obtained from pins 4 and 3 respectively.
  - The output frequency of the VCO can be obtained using the following equation:

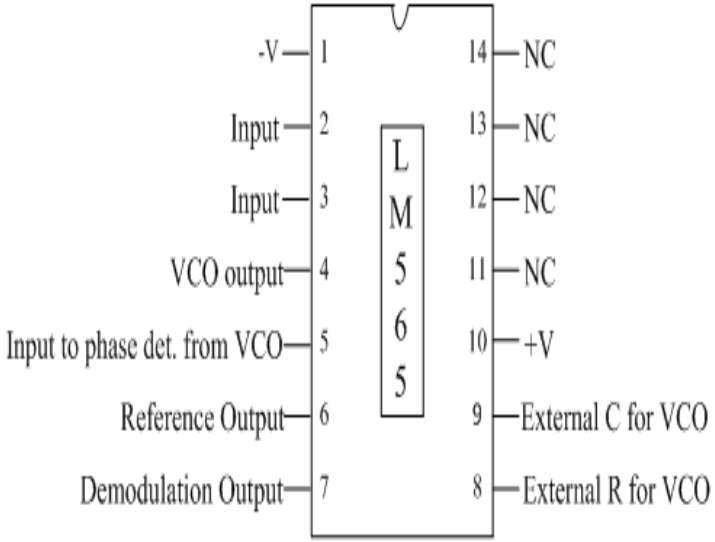
$$f_{out} = \frac{2.4(V^+ - V_1)}{R_1 C_1 V^+}$$

  - Where F_{out} is the output frequency, R1 and C1 are the timing components and V^+ is the supply voltage.

NE/SE565 VCO Block Diagram



NE/SE 565 PLL Block Diagram



Connection Diagram description

- In 565 PLL Diagram , pin 2 and 3 are the input terminal and input signal can be direct-coupled , provided that there is no dc voltage difference between the pins.

- A short between pins 4 and 5 connects the VCO output to the phase comparator and enables comparator to compare f_{out} with the input signal $f_{IN.}$

- A dc reference voltage at pin 6 is approximately equal to dc potential of the demodulated output at pin 7.

- The important electrical characteristics of the 566 PLL are:
  - Operating frequency range: 0.001Hz to 500 Khz.
  - Operating voltage range: ±6 to ±12 V
  - Input level required for tracking: 10m V rms min to 3 Vpp max
  - Input impedance: 10 K ohms typically.
  - Output sink current: 1mA
  - Output source current: 10 mA
- The center frequency of the PLL determined by the free-running frequency of the VCO and it is given by,

$$f_{out} = \frac{1.2}{4R_1C_1} Hz$$

- where R1&C1 are an external resistor & a capacitor connected to pins 8 & 9.
- The VCO free-running frequency f_{OUT} is adjusted externally with R1 & C1 to be at the center of the input frequency range.

- C1 can be any value, R1 must have a value between 2 k ohms and 20 K ohms.
- Capacitor C2 connected between 7 & +V.
- The filter capacitor C2 should be large enough to eliminate variations in the demodulated output voltage in order to stabilize the VCO frequency.
- The lock range f_L & capture range fc of PLL is given by,

$$f_L = \pm \frac{8 f_{OUT}}{V} \; Hz$$

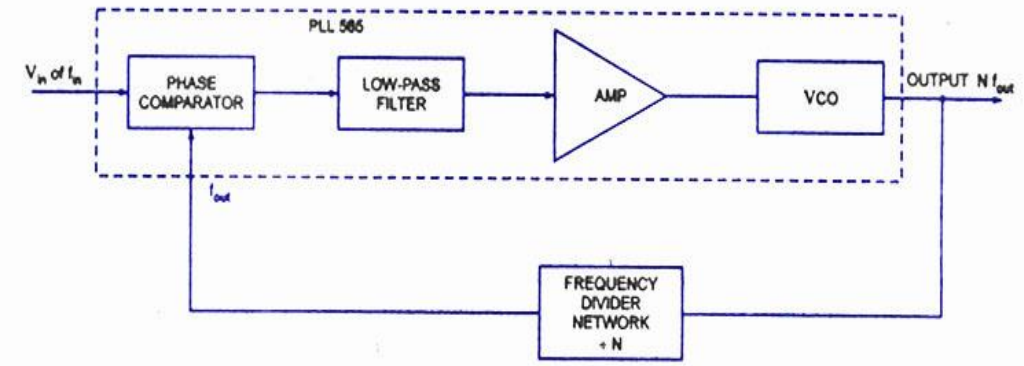
- Where , f_{out}=free-running of VCO(Hz) and V=(V+)-(-V) volts and

$$f_c = \pm \left[\frac{f_L}{(2\pi)(3.6)(10^3)(C_2)} \right]^{1/2}$$

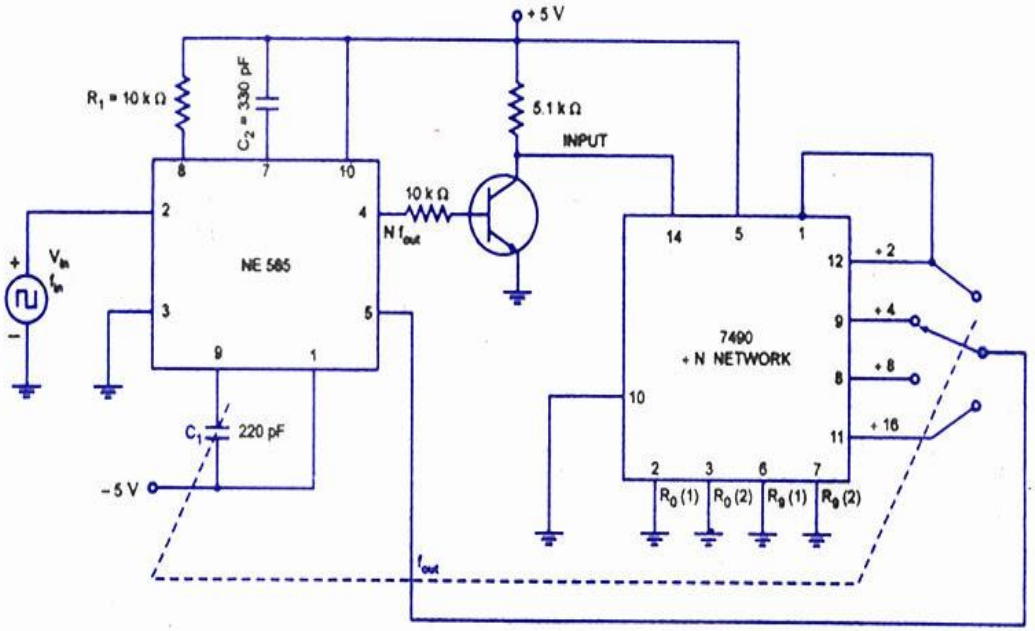
Where, C_2 is in farads.

Frequency Multiplier/divisor

- Frequency divider is inserted between the VCO & phase comparator. Since the output of the divider is locked to the f_{IN}, VCO is actually running at a multiple of the input frequency.
- The desired amount of multiplication can be obtained by selecting a proper divide-by-N network, where N is an integer.

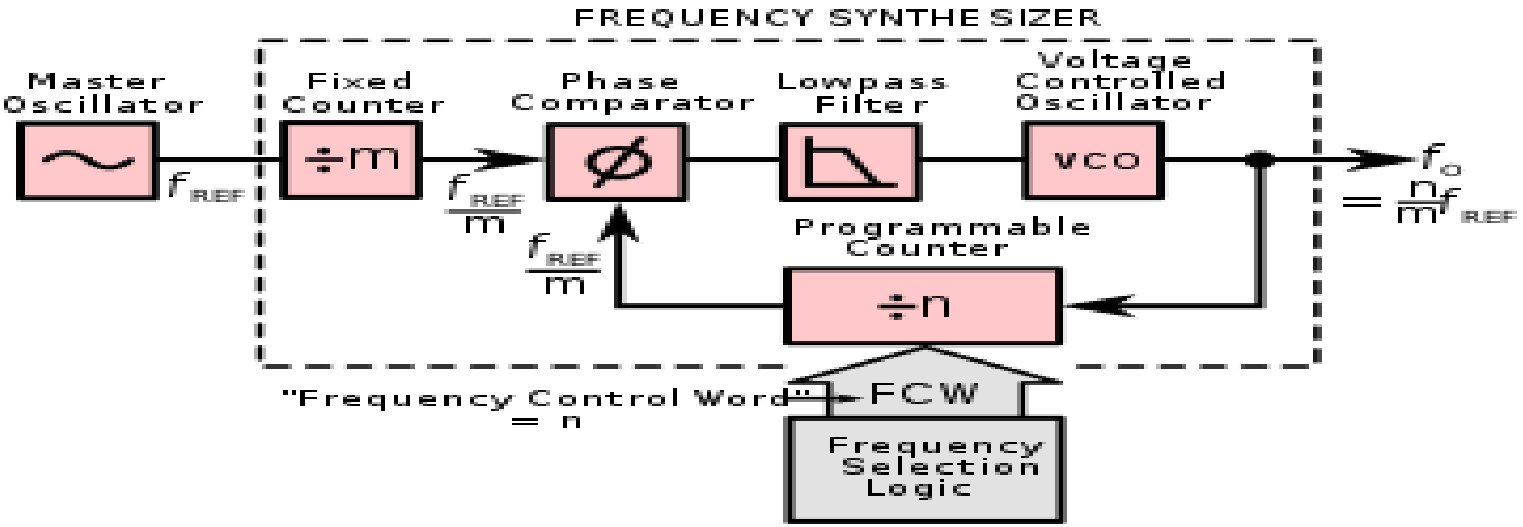


(a) Block Diagram



(b) Connection Diagram For Multiple 4 Frequency Multiplier

Frequency Synthesizer



- Phase locked loop does for frequency what the Automatic Gain Control does for voltage.
- It compares the frequencies of two signals and produces an error signal which is proportional to the difference between the input frequencies.
- The error signal is then low pass filtered and used to drive a voltage-controlled oscillator(VCO) which creates an output frequency

Continue…

- The output frequency is fed through a frequency divider back to the input of the system, producing a negative feedback loop.
- If the output frequency drifts, the error signal will increase, driving the frequency in the opposite direction so as to reduce the error.
- Thus the output is locked to the frequency at the other input.
- This input is called the reference and is derived from a crystal oscillator, which is very stable in frequency.

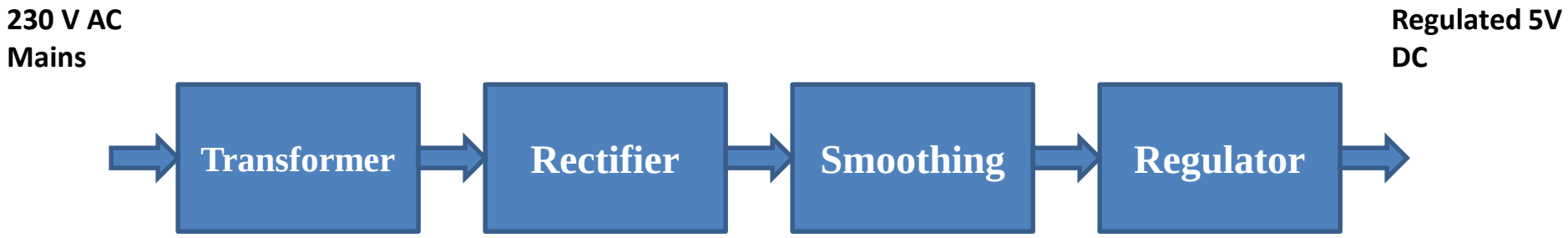
Regulated Power Supply

WHAT IS POWER SUPPLY?

- The power supply can be defined as it is an electrical device used to give electrical supply to electrical loads.

- The main function of this device is to change the electrical current from a source to the accurate voltage, frequency and current to supply the load.

BLOCK DIAGRAM OF POWER SUPPLY



- A step-down transformer converts the 230V AC into12V.
- The bridge rectifier is used to change AC to DC
- A capacitor is used to filter the AC ripples and gives to the voltage regulator.
- Finally voltage regulator regulates the voltage to 5V and finally, a blocking diode is used for taking the pulsating waveform.

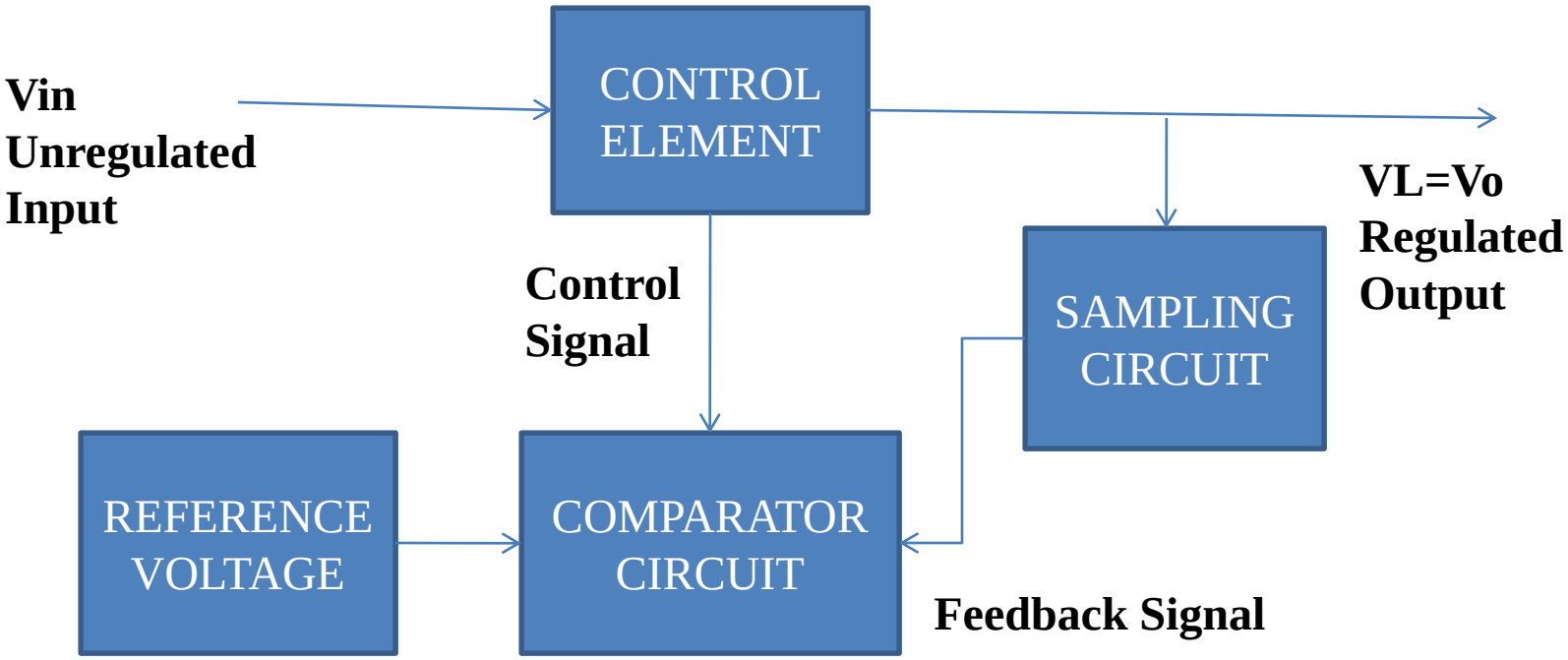
VOLTAGE REGULATOR

- A voltage regulator is used to regulate voltage levels. When a steady, reliable voltage is needed, then the voltage regulator is the preferred device.
- It generates a fixed output voltage that remains constant for any changes in an input voltage or load conditions. It acts as a buffer for protecting components from damages.
- A voltage regulator is a device with a simple feed-forward design and it uses negative feedback control loops.

TYPES OF VOLTAGE REGULATOR

- There are mainly two types of voltage regulator:
  - Linear Voltage Regulator
    - linear regulator acts as a voltage divider.
    - In the Ohmic region, it uses FET.
    - Types: Series and Shunt
  - Switching Voltage Regulator
    - A switching regulator rapidly switches a series device on and off.
    - Types: Step-up , Step-down and Inverter voltage regulators

SERIES VOLTAGE REGULATOR



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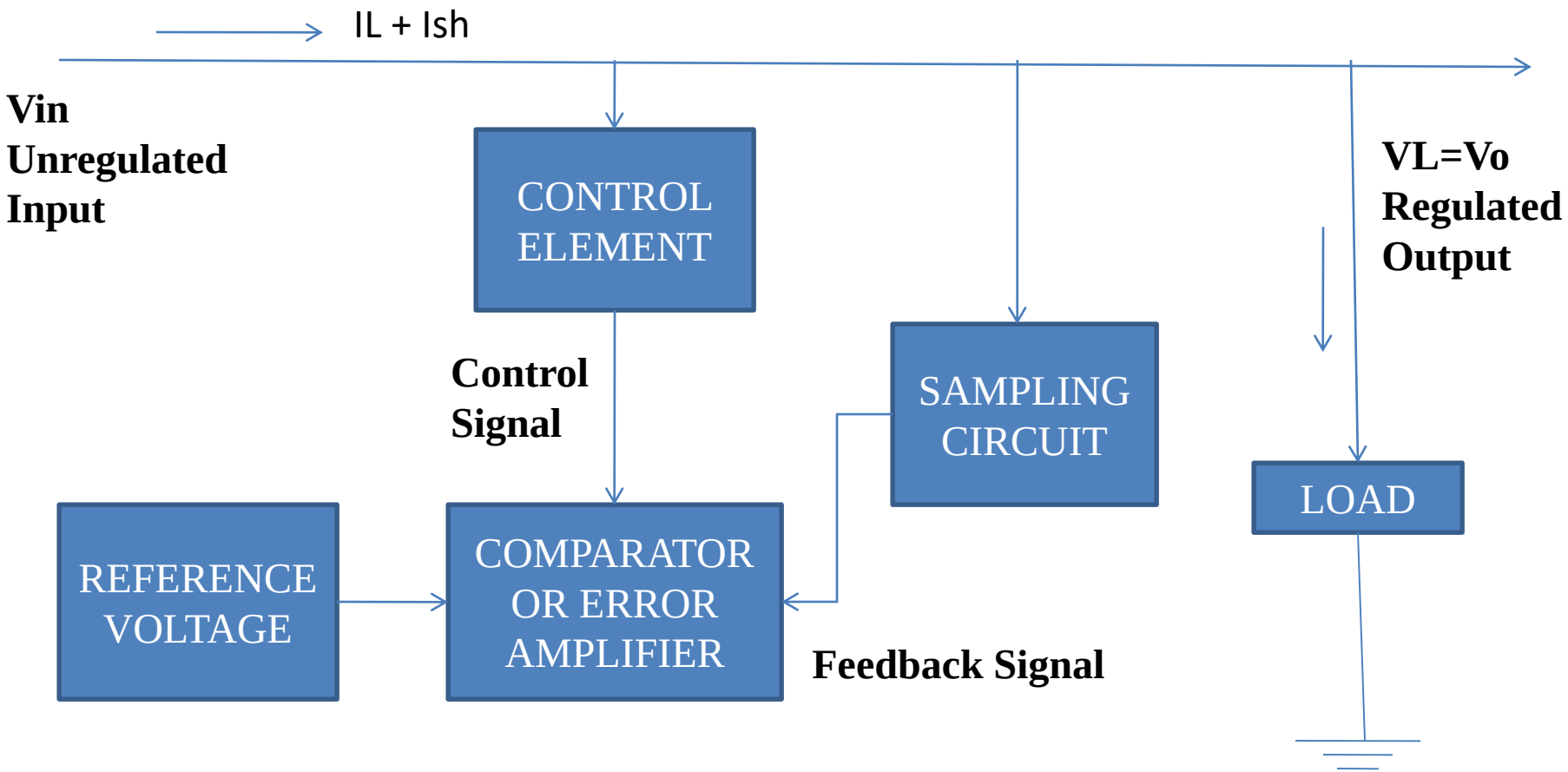
- A series voltage regulator uses a variable element placed in series with the load.
- By changing the resistance of that series element, the voltage dropped across it can be changed. And, the voltage across the load remains constant.
- The amount of current drawn is effectively used by the load; this is the main advantage of the series voltage regulator. Even when the load does not require any current, the series regulator does not draw full current.
- Therefore, a series regulator is considerably more efficient than shunt voltage regulator.

SHUNT VOLTAGE REGULATOR



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- A shunt voltage regulator works by providing a path from the supply voltage to ground through a variable resistance.
- The current through the shunt regulator has diverted away from the load and flows uselessly to the ground, making this form usually less efficient than the series regulator.
- **Application:**
  - Low Output Voltage Switching Power Supplies
  - Current Source and Sink Circuits
  - Error Amplifiers
  - Adjustable Voltage or Current Linear and Switching Power Supplies
  - Voltage Monitoring
  - Analog and Digital Circuits that require precision references
  - Precision current limiters

Constant Voltage Power Supply

- A regulated power supply that acts to maintain its output voltage constant in spite of changes in load, line , temperature, etc.
- Thus, for a change in load resistance, the output voltage of this type of supply remains constant while the output current changes by whatever amount necessary to accomplish this.

Thank You!!