SUMMER INTERNSHIP PROGRAM IN ELECTRICAL ENGINEERING

(SIPEE-2018)

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Motilal Nehru National Institute of Technology

Allahabad-211004

A

Report

ON

MATLAB/ SIMULINK BASED PROJECTS

SUBMITTED BY -

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06/07/2018

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2018

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UNDERTAKING

I declare that the work presented in this report entitled **"SIPEE-2018 PROJECT"** submitted to the Department of Electrical Engineering, Motilal Nehru National Institute of Technology Allahabad, (India) for the award of the ***Summer internship***.I have not plagiarized or submitted the same work for the award of any other course. In case, this undertaking is found incorrect, I accept that my certificate may unconditionally withdrawn. The results contained in this report have not been submitted either in part or in full to any other authority.

Date: 06/07/2018 **SHIVRAJ VISHWAKARMA**

Place: MNNIT, Allahabad **Roll. No. 1673720051**

DEPARTMENT OF ELECTRICAL ENGINEERING

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ALLAHABAD

CERTIFICATE

This is to certify that the work contained in this thesis report entitled ***"SIPEE-2018 PROJECT"***, submitted by ***SHIVRAJ VISHWAKARMA*** (Roll.No. *1673720051*) in the fulfillment of the requirements for the award of certificate in ***Summer Internship*** in the Department of Electrical Engineering of Motilal Nehru National Institute of Technology Allahabad has been carried out under my supervision during a period from ***11 June 2018 to 6 July 2018*** and the matter presented in this report has not been submitted elsewhere for the award of any other certificate.

Date: 06/07/2018

Place: MNNIT Allahabad

Dr. Navneet Kumar Singh
(Assistant Professor)
EED, MNNIT, Allahabad, India

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2018

06/07/2018

PROJECT-1

DATE:25/06/2018

OBJECTIVE: To design buck converter and analyze its characteristics.

SOFTWARE USED: MATLAB R2017a

ABSTRACT

This paper presents a comprehensive modeling and simulation of buck converter. Both the mathematical and circuitry modelare presented. Each modeling approach is demonstrated with various computational implementation methods functional block and text based programming in MATLAB and Simulink environment. The modeling and simulation results for both approaches are presented and the pros and cons of each modeling and implementation methods are discussed. It contributes to power electronic curriculum delivery that help students to gain complete view of modeling, simulation and computational implementation of buck converter at the perspective of circuit theory, differential equation, numerical method, control theory, s-domain, signal and system. The presented models also contribute to the development of buck converter design, simulation, analysis and education tool.

INTRODUCTION

Power electronic is an essential curriculum in undergraduate electrical & electronic engineering programme. It is a curriculum that covers the topic of DC-DC converters that are widely applies in many modern equipment's including LED drive, charger controller, motor drive, MPPT and etc. It is the study of how DC-DC converters manage and control the flow of energy to achieve the best operating condition and efficiency. In curriculum delivery, modeling and simulation approach proven as an important role to aid the learning and understanding of any given DC-DC converter [1-4]. In this paper, modeling and simulation of a buck converter is chosen, because it is the most fundamental of all switch mode based DC-DC converter. There are various approaches to model a buck converter. From the perspective of operating principle, circuit theory and converter efficiency, mathematical and circuitry modeling are commonly used.

There are many power electronic modeling and simulation software available in the market. These include PSpice, PSCAD, PSim, Multisim, Simulink, Proteus and etc. Each software have its own merit [10]. In this paper, MATLAB/Simulink is chosen as a modeling, simulation and implementation platform, simply because it is a universal platform that allows all four modeling approaches to be modeled and implemented under one environment.

THEORY:

A **buck converter** (**step-down converter**) is a DC-to-DC power converter which steps down voltage (while stepping up current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter).[1]

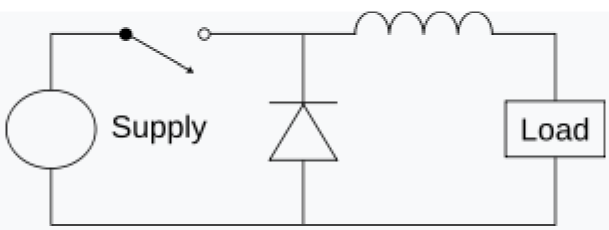
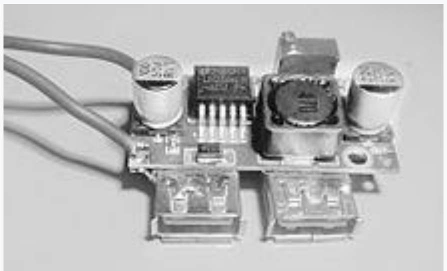


Fig. 1: Buck converter circuit diagram.



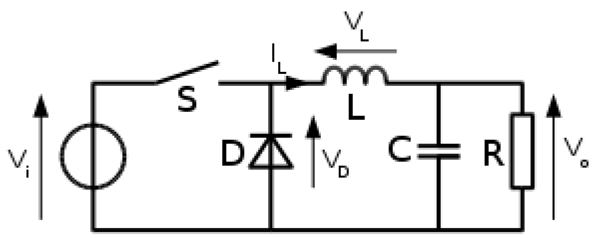
3 A buck converter

Switching converters (such as buck converters) provide much greater power efficiency as DC-to-DC converters than linear regulators, which are simpler circuits that lower voltages by dissipating power as heat, but do not step up output current.[2]

Buck converters can be highly efficient (often higher than 90%), making them useful for tasks such as converting a computer's main (bulk) supply voltage (often 12 V) down to lower voltages needed by USB, DRAM and the CPU (1.8 V or less).

THEORY OF OPERATION:

The basic operation of the buck converter has the current in an inductor controlled by two switches (usually a transistor and a diode). In the idealised converter, all the components are considered to be perfect. Specifically, the switch and the diode have zero voltage drop when on and zero current flow when off, and the inductor has zero series resistance. Further, it is assumed that the input and output voltages do not change over the course of a cycle (this would imply the output capacitance as being infinite).



in the above circuitrdiagram using Amp-sec. balance eqution

WHEN SWITCH IS OFF

$$(-Vo)(1-D)Ts + (Vi-Vo)D*Ts=0$$

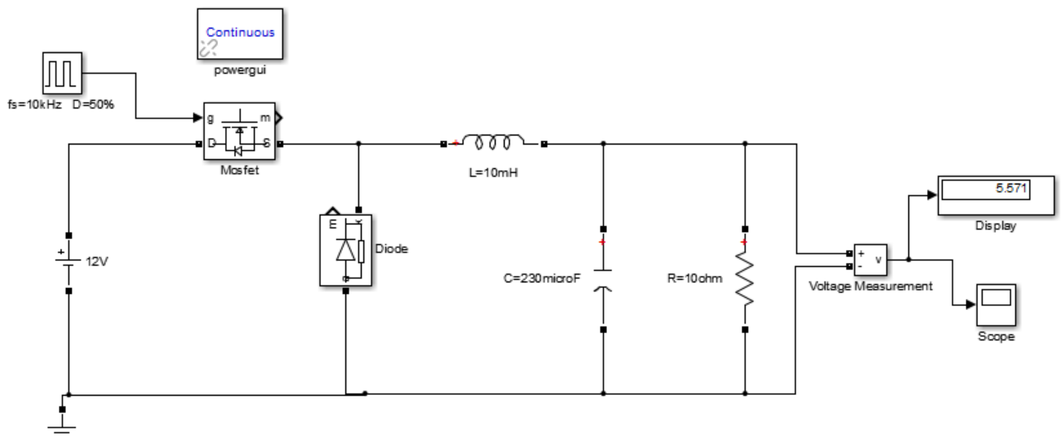
=> Vo=D*Vi

Where D = duty cycle =Ton/(Ton + Toff)

CIRCUITRY MODELING

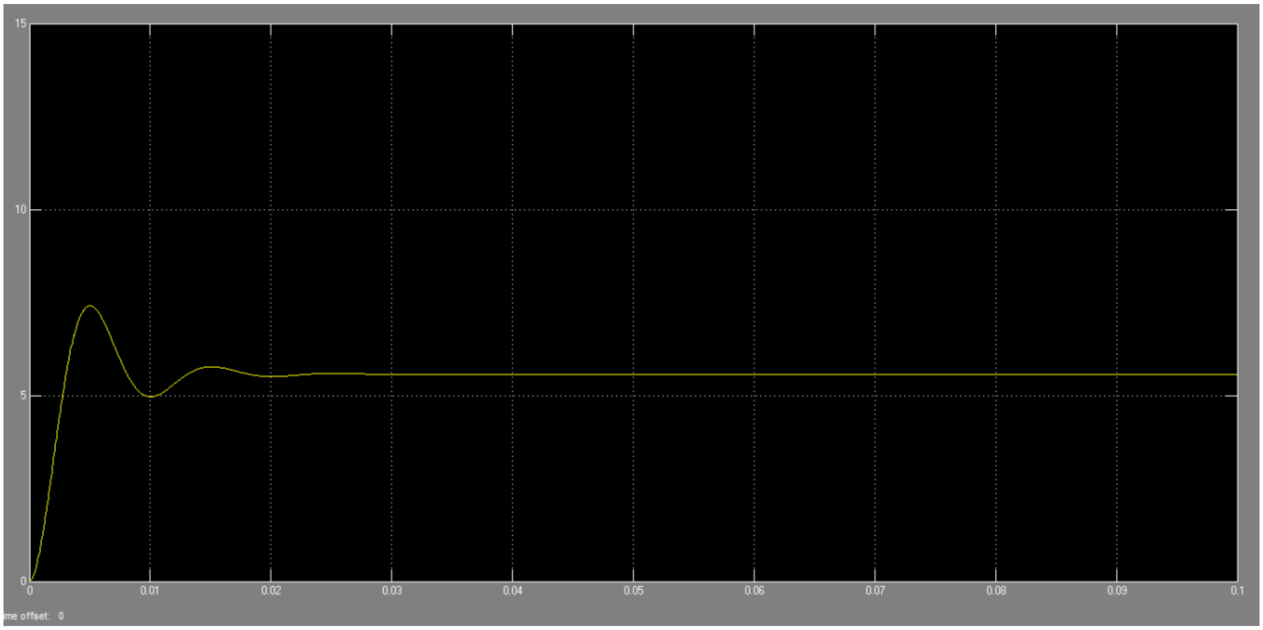
Circuitry modeling is the fundamental approches for modeling electronic systems. It is a graphic representation of the system in term of schematic circuit diagram which comprise of components that interconnected with each other to form the system. circuit diagram is consider an indispensable piece of information for any electronic system design. It allows the electronic system to be implemented and easily duplicate in term of tangible physical hardware.

Simulink allows circuitary modeling to carry out either the simpowersystem or simElectronicblockset under simscapephysical modeling environment.SimPowersystemis the first electrical power related blockset introduced to model an simulate power system,electrical machine and power electronics system in ,simulink environment. Figure shows that circuitary model of Buck converter developed using simpower system.



RESULTS AND DISCUSSION:

As for the above circuit diagram the simulation result obtained at the scope with the input voltage of 12V and 50% of duty cycle for switch S and output voltage nearly equals half of the input voltage according to the relation Vout=(duty cycle)*Vin is :



PROS:

*Easy to implement and simulate

* Easy to model non ideal model With circuit representation

Cons:

*Modeling parameters are limited

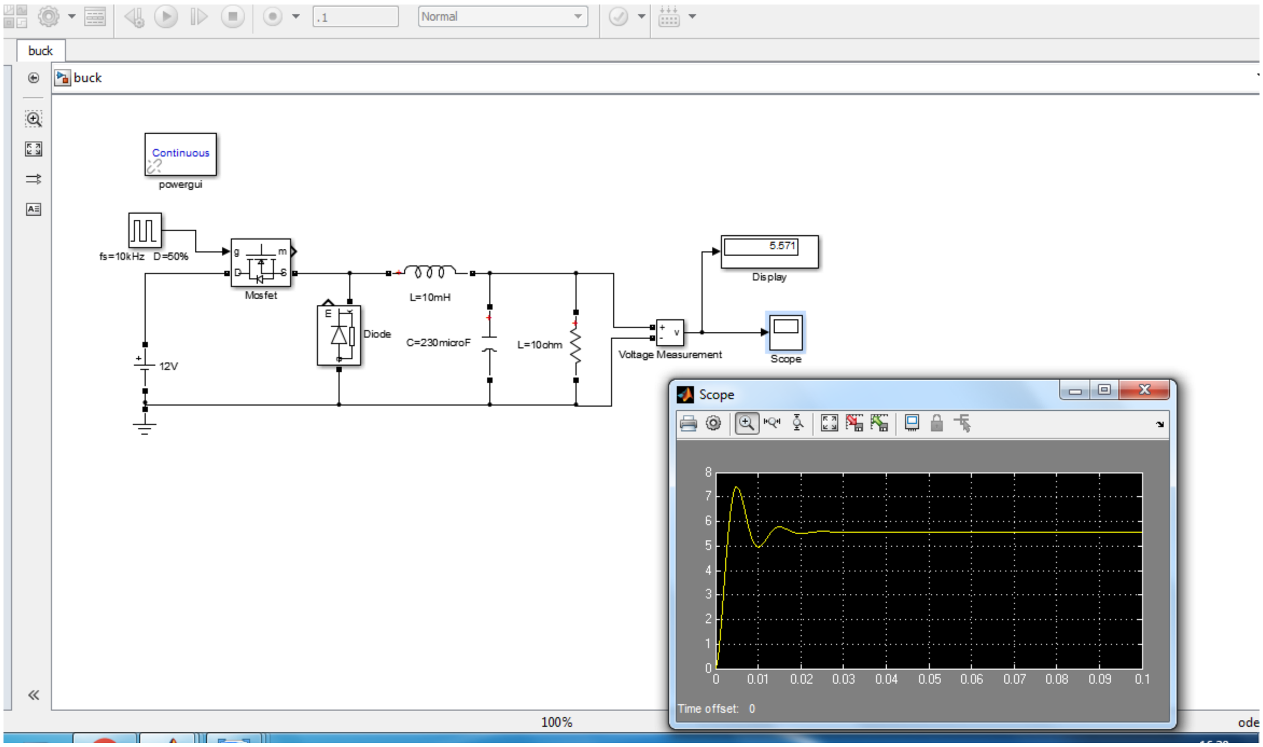
*Cannot simulate ideal model

*Detail MOSFET and diode data are required

CONCLUSION:

In summary, modeling approach of Buck converter has been presented in this paper. The simulation result for above modeling approach is also presented. The pros and cons for modeling and simulation are also discussed which help students to gain complete overview of buck converter modeling and simulation at the perspective of circuit theory, system for DC-DC converter. The presented models also contribute to the development of buck converter design, simulation, analysis and education tool.

The complete simulation model can be finally given as:



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[2.] R.A. Kordkheili, M. Yazdani-Asrami, A.M. Sayidi, "Making DC-DC Converters Easy to Understand for Undergraduate Students", IEEE Conference on Open Systmes (ICOS), 2010, pp. 28-33.

[3.] Monamed. A. Shrud, Ahmad Kharaz, Ahmed. S. Ashur, Mustafa Shater, Ismail Benyoussef, "A Study of Modeling and Simulation for Interleaved Buck Converter", Power Electronic & Drive Systems & Technologies Conference (PEDSTC), 2010, pp. 28-35.

PROJECT -02

DATE: 28/06/2018

OBJECTIVE: To design PID controller Using SIMULINK /MATLAB For Plants

$$P_1(s) = \frac{k_1}{(K_2 s + k3)} \text{ and } P_2(s) = \frac{P1}{(p_2 s^2 + p_3 s + p_4)}$$

SOFTWARE USED: MATLAB R2017a

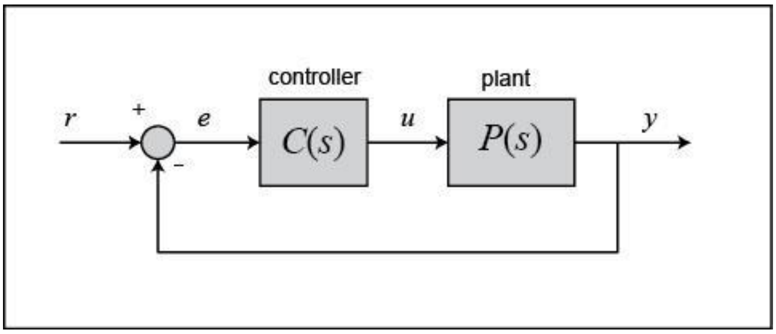
ABSTRACT:

In the paper recent design and simulation of PID controllers are summarized briefly. Several decades have seen the widely application of PID controllers and the design and tuning methods have been of considerable development. The PID controllers are the most popular controllers used in industry because of their simplicity, robustness, a wide range of applicability and near-optimal performance. A survey has shown that 90% of control loops are of PI or PID structure. Good awareness of design and simulation is increasing important to both users and designers.

INTRODUCTION

In this project we will introduce a simple, yet versatile, feedback compensator structure: the Proportional-Integral-Derivative (PID) controller. The PID controller is widely employed because it is very understandable and because it is quite effective. One attraction of the PID controller is that all engineers understand conceptually differentiation and integration, so they can implement the control system even without a deep understanding of control theory. Further, even though the compensator is simple, it is quite sophisticated in that it captures the history of the system (through integration) and anticipates the future behavior of the system (through differentiation). We will discuss the effect of each of the PID parameters on the dynamics of a closed-loop system and will demonstrate how to use a PID controller to improve a system's performance.

THEORY OF OPERATION:



In this tutorial, we will consider the following unity-feedback system:

The output of a PID controller, which is equal to the control input to the plant, is calculated in the time domain from the feedback error as follows:

$$u(t) = K_p e(t) + K_i \int e(t)dt + K_p \frac{de}{dt}$$

First, let's take a look at how the PID controller works in a closed-loop system using the schematic shown above. The variable (e) represents the tracking error, the difference between the desired output (r) and the actual output y. This error signal (e) is fed to the PID controller, and the controller computes both the derivative and the integral of this error signal with respect to time. The control signal (u) to the plant is equal to the proportional gain (Kp) times the magnitude of the error plus the integral gain (Ki) times the integral of the error plus the derivative gain (Kd) times the derivative of the error.

This control signal (u) is fed to the plant and the new output (y) is obtained. The new output (y) is then fed back and compared to the reference to find the new error signal (e) . The controller takes this new error signal and computes an update of the control input. This process continues while the controller is in effect.

The transfer function of a PID controller is found by taking the Laplace transform of Equation

$$K_p + \frac{K_i}{s} + K_d s = \frac{K_d s^2 + K_p s + K_i}{s}$$

were,

Kp= proportional gain, Ki= integral gain, and Kd= derivative gain.

The Characteristics of the P, I, and D Terms

1. Increasing the proportional gain (Kp) has the effect of proportionally increasing the control signal for the same level of error. The fact that the controller will "push" harder for a given level of error tends to cause the closed-loop system to react more quickly, but also to overshoot other effect of increasing (Kp) is that it tends to reduce, but not eliminate, the **steady-state error**.

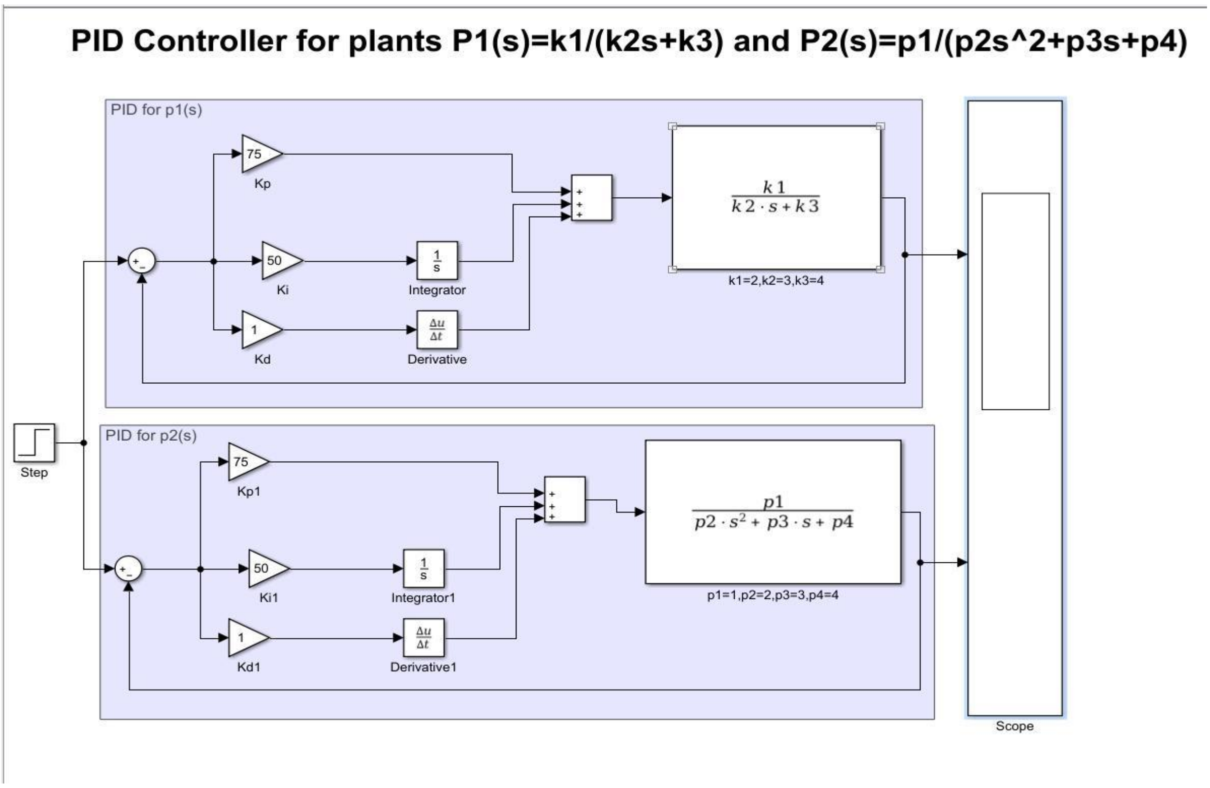
2. The addition of a derivative term to the controller (Kd) adds the ability of the controller to "anticipate" error. With simple proportional control, if is fixed, the only way that the control will increase is if the error increases. With derivative control, the control signal can become large if the error begins sloping upward, even while the magnitude of the error is still relatively small. This anticipation tends to add damping to the system, thereby decreasing overshoot. The addition of a derivative term, however, has no effect on the steady-state error.

3. The addition of an integral term to the controller (Ki) tends to help reduce steady-state error. If there is a persistent, steady error, the integrator builds and builds, thereby increasing the control signal and driving the error down. A drawback of the integral term, however, is that it can make the system more sluggish (and oscillatory) since when the error signal changes sign, it may take a while for the integrator to "unwind."

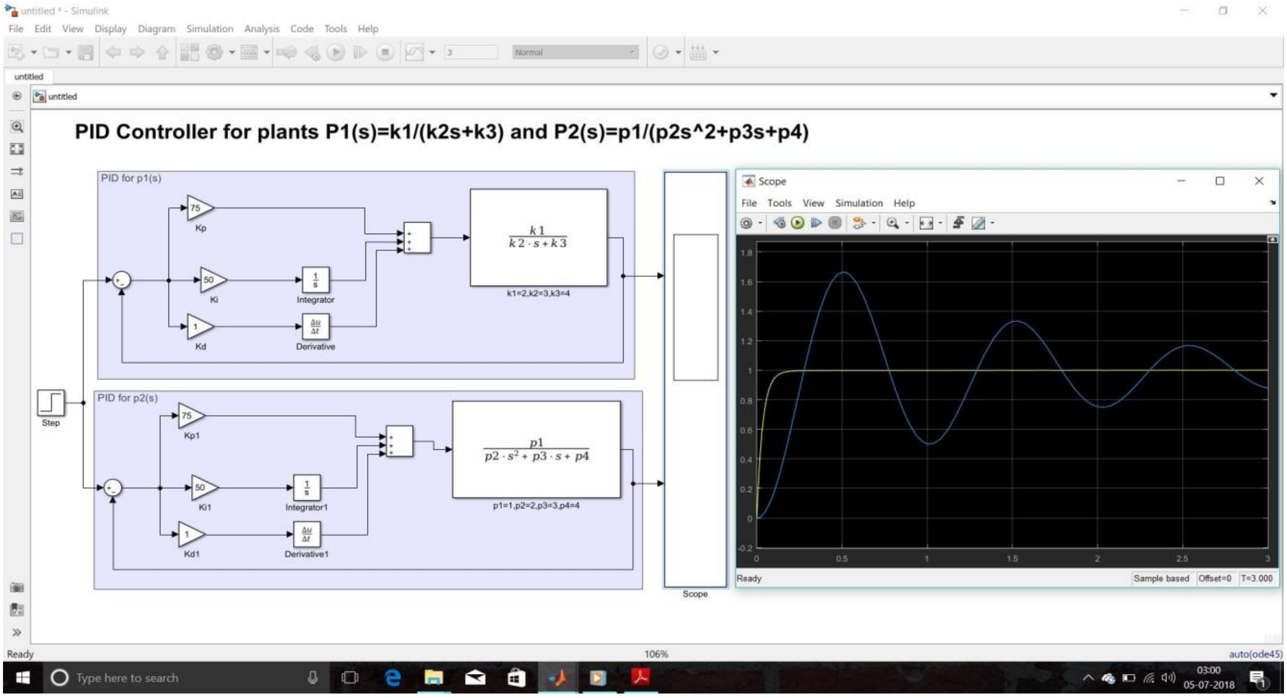
4. The general effects of each controller parameter (Kp, Ki, Kd) on a closed-loop system are summarized in the table below. Note, these guidelines hold in many cases, but not all. If you truly want to know the effect of tuning the individual gains, you will have to do more analysis, or will have to perform testing on the actual system.

CL RESPONSE	***RISE TIME***	***OVERSHOOT***	***SETTLING TIME***	***S-S ERROR***
Kp	Decrease	Increase	Small Change	Decrease
Ki	Decrease	Increase	Increase	Decrease
Kd	Small Change	Decrease	Decrease	No Change

CIRCUIT MODEL ON SIMULINK:



RESULTS: the result obtained at scope is:



CONCLUSION

From the scope result we can conclude that:

1. proportional term improves the rise time.

2. the addition of the derivative term reduced both the overshoot and the settling time, and had a negligible effect on the rise time and the steady-state error.

3. Integral term reduces the steady state error.

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PROJECT- 03

DATE: 30/06/2018
OBJECTIVE: Simulation of Thyristor (SCR)-based converter.
SOFTWARE USED: MATLAB R2017a

ABSTRACT

This paper presents a comprehensive modeling and simulation of single phase half wave controlled rectifier. The Simulink based circuitry model is presented. The modeling approach is demonstrated with functional block in Simulink environment. The modeling and simulation results for above approach are presented and the pros and cons of the modeling and implementation methods are discussed. It contributes to power electronic curriculum delivery that help students to gain complete view of modeling, simulation and computational implementation single phase half wave-controlled rectifier at the perspective of circuit theory, control theory. The presented models also contribute to the development of single-phase half wave-controlled rectifier design, simulation, analysis and education tool.

INTRODUCTION

Power electronic is an essential curriculum in undergraduate electrical & electronic engineering programme. It is a curriculum that covers the topic of AC-DC converters that are widely applies in many modern equipment's including DC motor speed control, battery charging, and high voltage DC transmission. It is the study of how AC-DC converters manage and control the flow of energy to achieve the best operating condition and efficiency. In curriculum delivery, modeling and simulation approach proven as an important role to aid the learning and understanding of any given AC-DC converter. In this paper, modeling and simulation of a single-phase half wave-controlled rectifier using thyristor (SCR) is presented in easy and stepwise method which helps the student to understand the operational characteristics and its implementation of SCR based AC to DC converter.

LITERATURE SURVEY/THEORY:

- **FOR Resistive load**

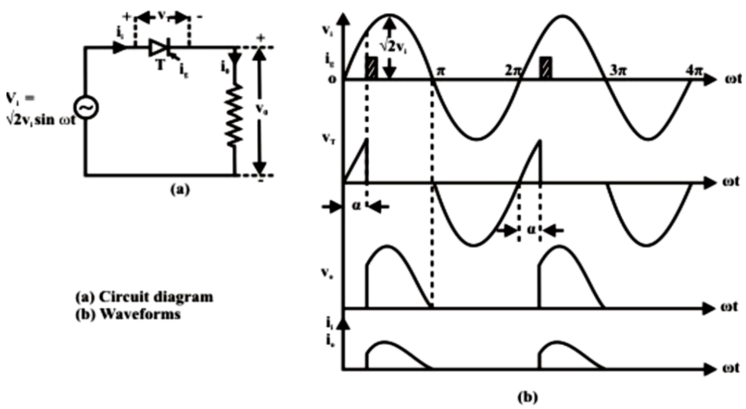


Fig. 10.1: Single phase fully controlled half wave rectifier supplying a resistive load

Fig.10. 1(a) shows the circuit diagram of a single phase fully controlled halfwave rectifier supplying a purely resistive load. At $\omega t = 0$ when the input supply voltage becomes positive the thyristor T becomes forward biased. However, unlike a diode, it does not turn ON till a gate pulse is applied at $\omega t = \alpha$. During the period $0 < \omega t \leq \alpha$, the thyristor blocks the supply voltage and the load voltage remains zero as shown in fig 10.1(b). Consequently, no load current flows during this interval. As soon as a gate pulse is applied to the thyristor at $\omega t = \alpha$ it turns ON. The voltage across the thyristor collapses to almost zero and the full supply voltage appears across the load. From this point onwards the load voltage follows the supply voltage. The load being purely resistive the load current io is proportional to the load voltage. At $\omega t = \pi$ as the supply voltage passes through the negative going zero crossing the load voltage and hence the load current becomes zero and tries to reverse direction. In the process the thyristor undergoes reverse recovery and starts blocking the negative supply voltage. Therefore, the load voltage and the load current remain clamped at zero till the thyristor is fired again at $\omega t = 2\pi + \alpha$. The same process repeats thereafter.

From the discussion above and Fig 10.1 (b) one can write

For $\alpha < \omega t \leq \pi$

$$v_0 = v_i = \sqrt{2}\, V_i \sin\omega t \tag{10.1}$$

$$i_0 = \frac{v_0}{R} = \sqrt{2}\frac{V_i}{R}\sin\omega t \tag{10.2}$$

$v_0 = i_0 = 0$ otherwise.

Therefore

$$V_{OAV} = \frac{1}{2\pi}\int_0^{2\pi} v_0 \, d\omega t = \frac{1}{2\pi}\int_\alpha^{\pi} \sqrt{2}\, V_i \sin\omega t \, d\omega t \tag{10.3}$$

Or

$$V_{OAV} = \frac{V_i}{\sqrt{2}\pi}(1+\cos\alpha) \tag{10.4}$$

$$V_{ORMS} = \sqrt{\frac{1}{2\pi}\int_0^{2\pi} v_0^2 \, d\omega t} \tag{10.5}$$

$$= \sqrt{\frac{1}{2\pi}\int_\alpha^{\pi} 2v_i^2 \sin^2\omega t \, d\omega t}$$

$$= \sqrt{\frac{V_i^2}{2\pi}\int_\alpha^{\pi} (1-\cos 2\omega t)\, d\omega t}$$

$$= \sqrt{\frac{V_i^2}{2\pi}\left[\pi - \alpha + \frac{\sin 2\alpha}{2}\right]}$$

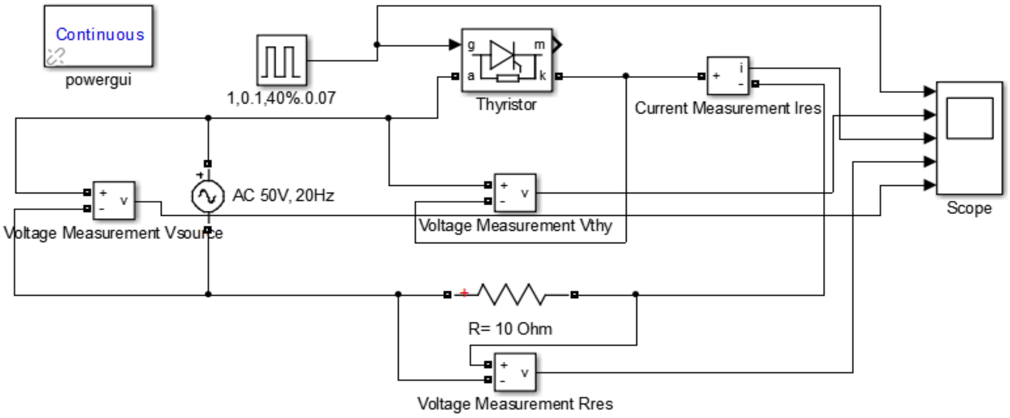
$$= \frac{V_i}{\sqrt{2}}\left(1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2\pi}\right)^{\frac{1}{2}}$$

$$\therefore \quad FF_{VO} = \frac{V_{ORMS}}{V_{OAV}} = \frac{\pi\left(1 - \frac{\alpha}{\pi} + \frac{\sin 2\alpha}{2\pi}\right)^{\frac{1}{2}}}{(1+\cos\alpha)} \tag{10.6}$$

Similar calculation can be done for i_0. In particulars for pure resistive loads $FF_{io} = FF_{vo}$.

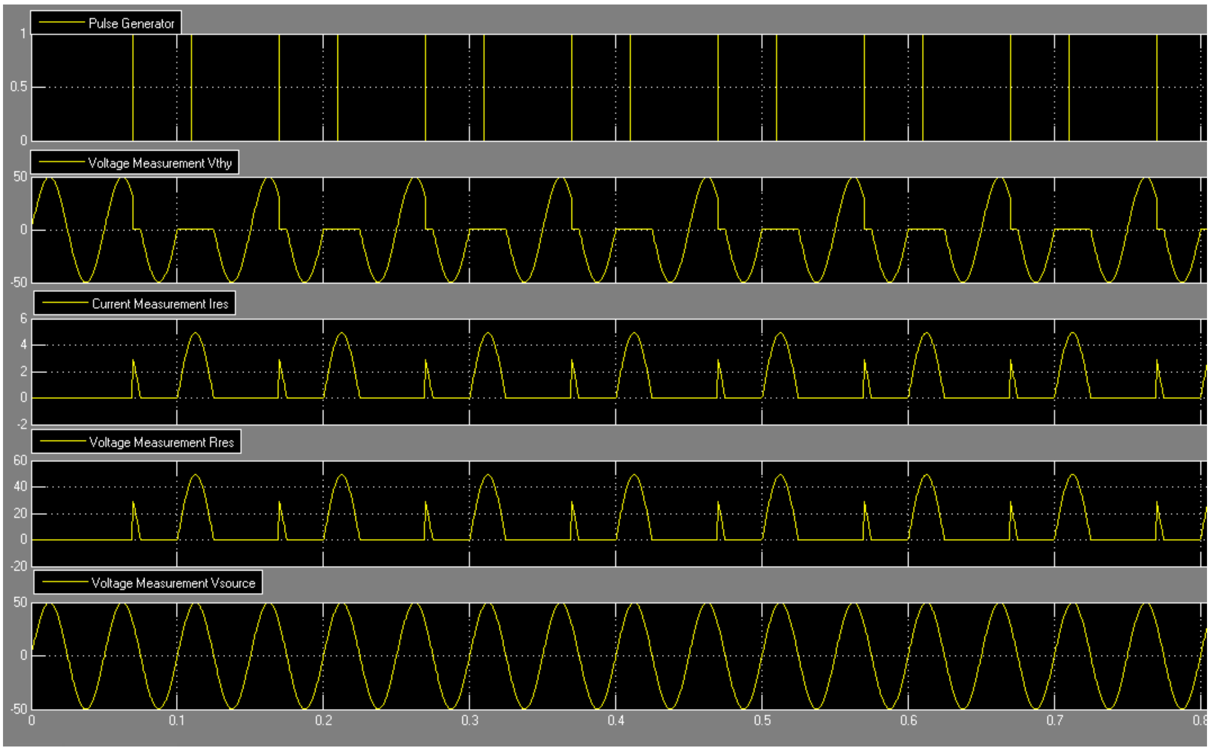
CIRCUITRY MODELING:

Circuitry modeling is the fundamental approaches for modeling electronic systems. It is a graphic representation of the system in term of schematic circuit diagram which comprise of components that interconnected with each other to form the system. circuit diagram is considering an indispensable piece of information for any electronic system design. It allows the electronic system to be implemented and easily duplicate in term of tangible physical hardware



RESULTS AND DISCUSSION:

As for the above circuit diagram the simulation result obtained at the scope with the input voltage of 50V and 20 Hz ac supply and output voltage waveforms obtain as shown in output waveform.



CONCLUSION:

In summary, modeling approach of single phase half wave controlled rectifier has been presented in this paper. The simulation result for above modeling approach is also presented.

The pros and cons for modeling and simulation are also discussed which help students to gain complete overview of single phase half wave controlled rectifier modeling and simulation at the perspective of system for AC-DC converter. The presented models also contribute to the development of single-phase half wave-controlled rectifier design, simulation, analysis and education tool.

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View Article Full Text: PDF (13113KB)

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PROJECT- 04

DATE: 03/07/2018

OBJECTIVE: Simulation and analysis of speed control of DC MOTOR using BJT H-Bridge**.**

SOFTWARE USED: MATLAB R2017a

ABSTRACT:

DC Motor speed control is carried out by use of Four Quadrant Chopper drive. Insulated Gate Bipolar Transistors are used for speed control of the motor and the IGBT triggering is carried out by use of PWM converters under various loading conditions and by varying armature voltage and field voltage. The above-mentioned experiment was again carried out using Thyristors and a comparative study was made.

INTRODUCTION:

DC motors are used extensively in adjustable-speed drives and position control applications. Their speeds below the base speed can be controlled by armature-voltage control. Speeds above the base speed are obtained by field-flux control. As speed control method for DC motors are simpler and less expensive than those for the AC motors, DC motors are preferred where wide speed range control is required. DC choppers also provide variable dc output voltage from a fixed dc input voltage. The Chopper circuit used can operate in all the four quadrants of the V-I plane. The output voltage and current can be controlled both in magnitude as well as in direction so the power flow can be in either direction. The four-quadrant chopper is widely used in reversible dc motor drives. By applying chopper, it is possible to implement regeneration and dynamic braking for dc motors.

THEORY:

The four-quadrant chopper with four switching devices where diodes are connected in anti-parallel with the switching devices is also referred to as full bridge converter topology. The input to the full bridge converter is fixed magnitude dc voltage Vdc. The output of the converter can be a variable dc voltage with either polarity. The circuit is therefore called as four quadrant chopper circuit or dc to dc converter. The output of the full bridge converter can also be an ac voltage with variable frequency and amplitude in which case the converter is called as dc- to-ac conversion (Inverter). In a full bridge converter when a gating signal is given to a switching device either the switching device or the diode only will conduct depending on the directions of the output load current.

SWITCHING MODES OF FOUR QUADRANT CHOPPER:

The switches in the four-quadrant chopper can be switched in two different modes such that:

• The output voltage swings in both directions i.e., from +Vdc to –Vdc. This mode of switching is referred to as PWM with bipolar voltage switching.

• The output voltage swings either from –zero to +Vdc or zero to –Vdc. This mode of switching is referred to as PWM with unipolar voltage switching.

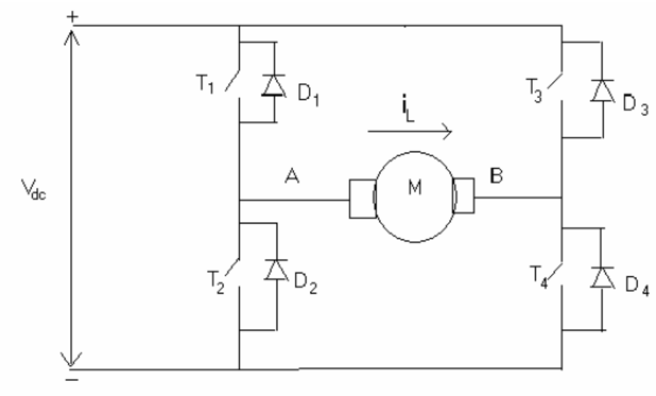


Fig 1.2: Four quadrant chopper circuit

OPERATION OF THE FOUR QUADRANT CHOPPER WITH BIPOLAR VOLTAGE SWITCHING:

The operation of the circuit as a four-quadrant chopper with bipolar voltage switching is explained, referring to the circuit diagram of Fig 1.2. When the switches T1 and T4 are turned ON by applying gating signals simultaneously, the load voltages Vdc with terminal 'A' positive and the load current IL flows in the direction from A to B. Because of the load inductance, the current cannot change instantaneously. The load voltage V will now be – Vdc since the conduction of the diode D3 will connect the load terminal B to the (+) ve terminal of the source. As the load voltage is negative and the current is still positive, the power is negative. The power now flows from the load to the source. This corresponds to the operation of chopper circuit in the fourth quadrant. This operation in the fourth quadrant will continue as long as the current is positive. When T1 and T4 are off, T3 and T2 can be turned ON. When the current passes through zero, the devices T3 and T2 can be turned on, and the load current becomes negative. The load current now passes through T3 and T2 with current direction in the load as from B to A. this brings the operation of the chopper in the third quadrant. Turning of the T3 and T2 will bring in the conduction of the diode D1 and D4 and the operation of the chopper circuit in the second quadrant. The operation of the chopper in the first and third quadrant corresponds to power flow from the source to the load, and is considered to be forward power flow. The operation in the fourth and second quadrant corresponds to reverse power flow. The relevant waveforms showing the operation of full bridge converter in all the four quadrant is shown in the fig 2

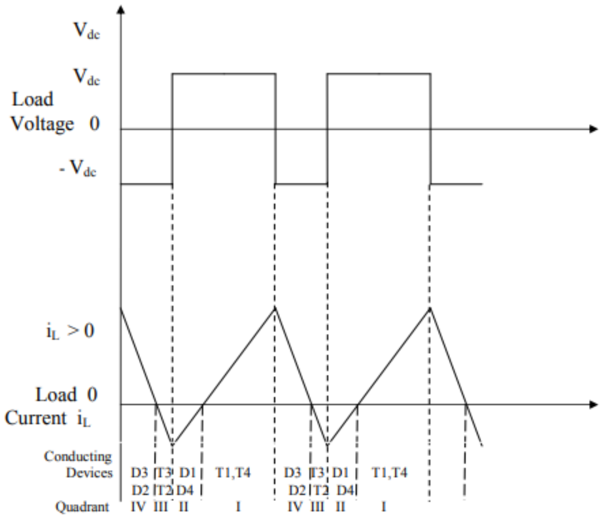


Fig.1.3 Load Voltage and Current with Inductive Load & Load Current $i_L > 0$ (positive)

GENERATION OF GATING SIGNALS:

The gating signals for the switches in the four-quadrant chopper are derived by comparing a triangular wave with a control voltage level. The generation of gating signals for a unipolar voltage switching is shown in fig 1.4. The triangular carrier waveform is compared with the control voltage (+) ve and (-) ve. the pulse generated by comparing +v with triangular carrier is used to turn on T1and its compliment is used to turn on T2. The pulse generated by comparing -ve with triangular carrier is used to turn on T3 and its complement is used to turn on T4. The voltage varies from –Vtri to +Vtri. The fig. below shows the schematic of the generator of gating signal for the four-quadrant chopper with unipolar switching. A triangular carrier wave of frequency around 2 Khz is Conducting Devices D3 T3 D1 T1, T4 D3 T3 D1 T1, T4 D2 T2 D4 D2 T2 D4 Quadrant IV III II I IV III II I Contents xii generated. The triangular wave is compared with +Vc and –Vc in comparator 1 and comparator 2 respectively. The output of the comparator-1 gives the gating signal to T1 and its complement gives the gating signal T2. The output of the comparator-2 gives the gating signal to T3 and its complement gives the gating signal to T4.

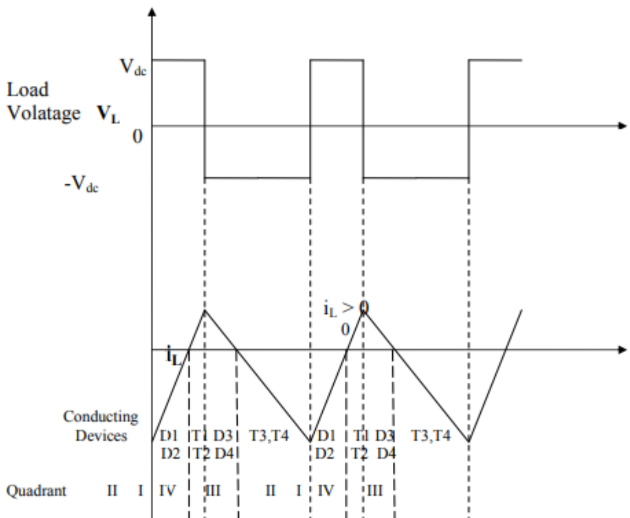


Fig 1.4. Load Voltage and Current with Inductive Load and Load Current $i_L < 0$ (negative)

CIRCUIT DISCRIPTION:

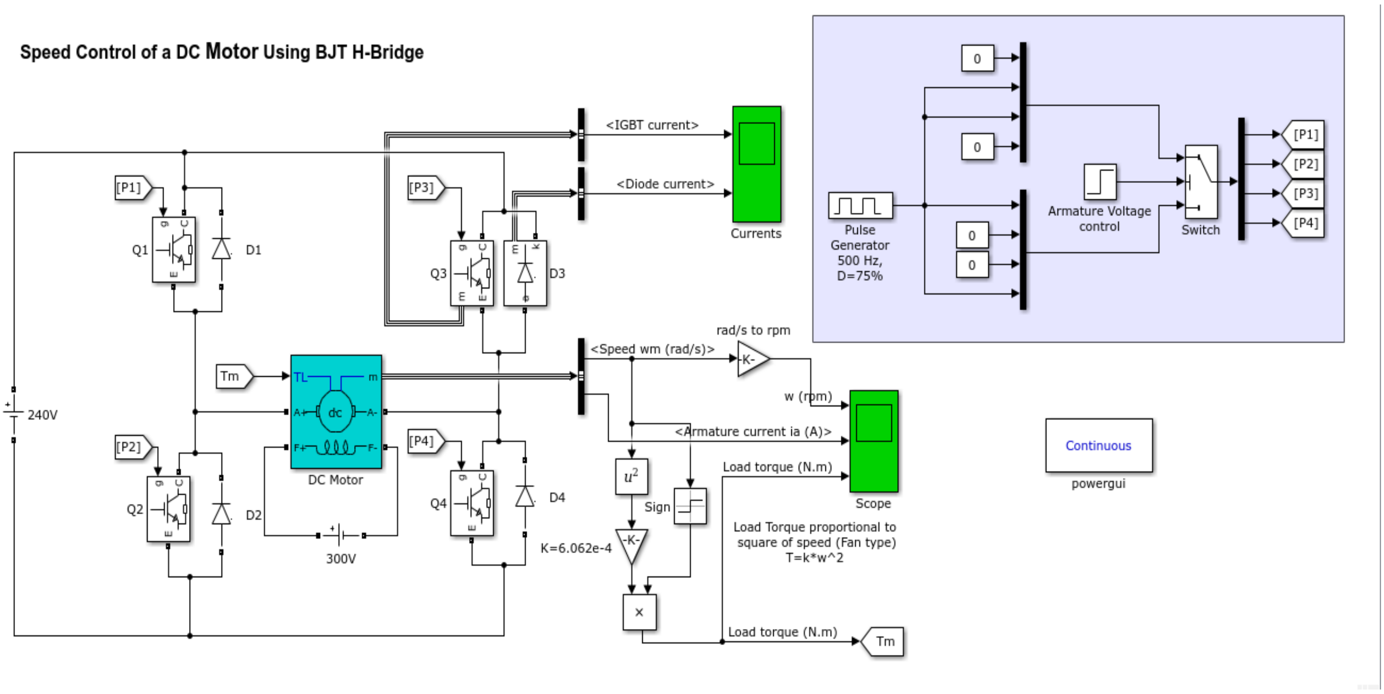
The Bipolar Junction Transistor (BJT) when used for power switching applications, operates as an IGBT. When it is conducting (BJT operating in the saturated region), a forward voltage Vf is developed between collector and emitter (in the range of 1 V). Therefore, the IGBT block can be used to model the BJT device.

The IGBT block does not simulate the gate current controlling the BJT or IGBT. The switch is controlled by a Simulink signal (1/0). The DC motor uses the preset model (5 HP 24V 1750 rpm). It simulates a fan type load (where Load torque is proportional to square of speed). The armature mean voltage can be varied from 0 to 240 V when the duty cycle (specified in the Pulse Generator block) is varied from 0 to 100%.

The H-bridge consists of four BJT/Diode pairs (BJT simulated by IGBT models). Two transistors are switched simultaneously: Q1 and Q4 or Q2 and Q3. When Q1 and Q4 are fired, a positive voltage is applied to the motor and diodes D2-D3 operate as free-wheeling diodes when Q1 and Q4 are switched off. When Q2 and Q3 are fired, a negative voltage is applied to the motor and diodes D1-D4 operate as free-wheeling diodes when Q2 and Q3 are switched off.

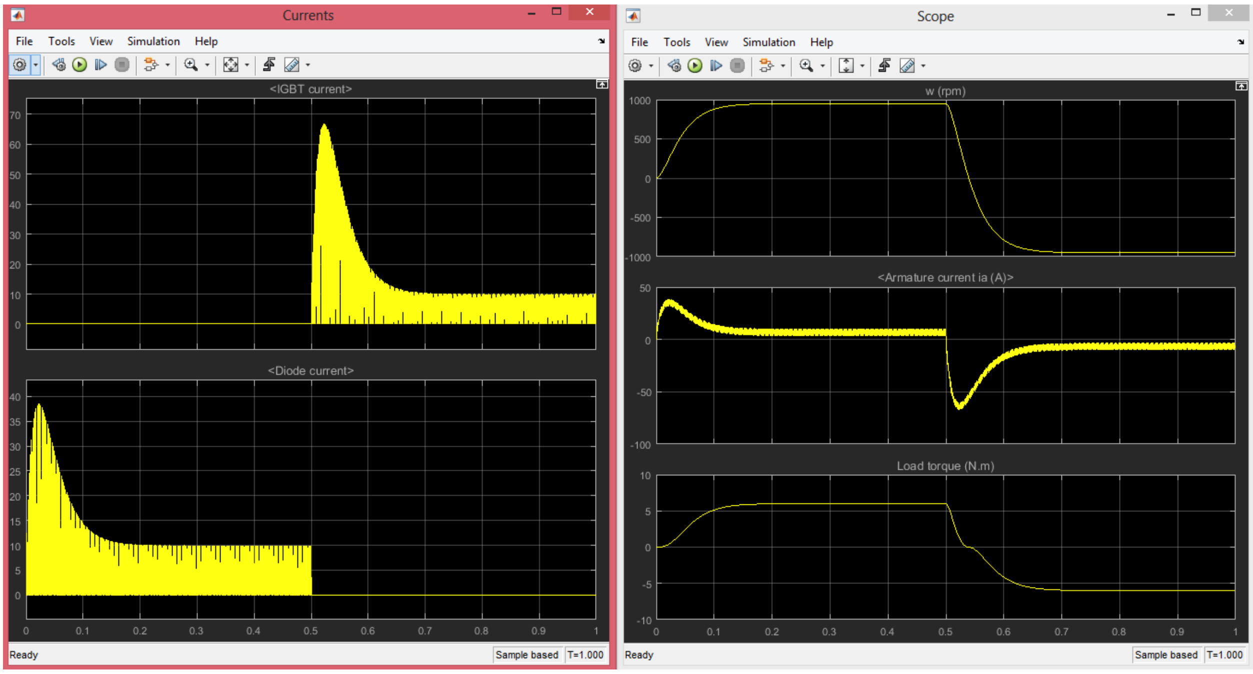
CIRCUITRY MODEL:

The motor starts in the positive direction with a duty cycle of 75% (mean DC voltage of 180V). At t= 0.5 sec., the armature voltage is suddenly reversed and the motor runs in the negative direction.



RESULT:

'Scope' shows motor speed, armature current and load torque and 'Currents' shows currents flowing in BJT Q3 and diode D3.



CONCLUSION:

Speed control of dc motor using IGBT based Four Quadrant Chopper drive was carried out and following conclusions were made 1. Speed varies directly with armature voltage by keeping field voltage constant. 2. Speed varies inversely with field voltage by keeping armature voltage constant. 3. Armature voltage control gives the speed below the base speed whereas field control gives the speed control above the base speed. 4. Armature current vs Speed at constant flux gives a drooping characteristic. Though it should have been a straight line parallel to x-axis but due to saturation effect there is slight decrease in speed and shows a drooping characteristic. 5. The IGBT based circuit gives smoother control over the entire speed range as compared with the SCR based circuit. 6. IGBTs feature many desirable properties including a MOS input gate, high switching speed, low conduction voltage drops, high current carrying capability, and a high degree of robustness. 7. Devices have drawn closer to the 'ideal switch', with typical voltage ratings of 600 - 1700 volts, on-state voltage of 1.7 - 2.0 volts at currents of up to 1000 amperes, and switching speeds of 200 - 500 ns. 8. The availability of IGBTs has lowered the cost of systems and enhanced the number of economically viable applications. 9. The insulated gate bipolar transistor (IGBT) combines the positive attributes of BJTs and MOSFETs. BJTs have lower conduction losses in the on-state, especially in devices with larger blocking voltages, but have longer switching times, especially at turn-off while MOSFETs can be turned on and off much faster, but their on-state conduction losses are larger, especially in devices rated for higher blocking voltages. Hence, IGBTs have lower on-state voltage drop with high blocking voltage capabilities in addition to fast switching speeds

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PROJECT- 05

DATE: 28/06/2018

OBJECTIVE: Simulation and analysis of Inverting and non-inverting amplifier using op-amp.

SOFTWARE USED: MATLAB R2017a

ABSTRACT

It is often necessary in signal analysis to measure an output voltage from a system. In many cases, this voltage is too small to take an accurate measurement or use as a trigger to start another functions. In these cases an operational amplifier can be used in order to boost the output signal to a level where it can be utilized. The amount that an input signal is amplified is determined by a relationship between the external registers, capacitors and transistors are used to form an integrated circuit which allows the op-amp to be used as a single component.

This paper presents a comprehensive modeling, simulation and analysis of Inverting and non-inverting amplifier using op-amp. The modeling approach is demonstrated with functional block in Simulink environment. The modeling and simulation Results for above approach is presented and the pros and cons of modeling is discussed. It contributes to electronic curriculum delivery that help students to gain complete view of modeling, simulation and computational implementation of inverting and non-inverting amplifier at the perspective of electronic circuit theory. The presented models also contribute to the development of inverting and non inverting amplifier design, simulation, analysis and hardware implimentation.

While designing op-amp circuits, one has to be careful about output saturation – if the gain or input signal is high enough to drive output beyond the supply voltage(Vcc and Vee), the amplifier goes into saturation and output is limited to supply voltages.

INTRODUCTION:

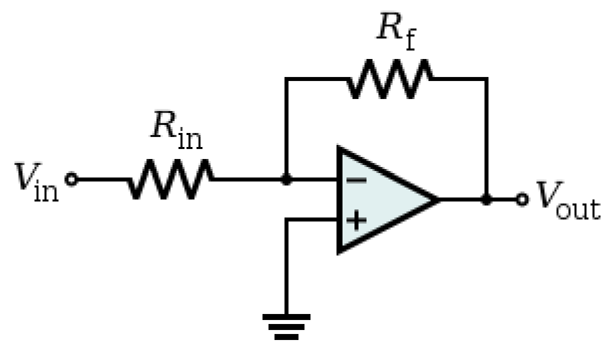
Operational amplifiers are linear devices that have all the properties required for nearly ideal DC amplification and are therefore used extensively in signal conditioning, filtering or to perform mathematical operations such as add, subtract, integration and differentiation.

An operational amplifier, or op-amp for short, is fundamentally a voltage amplifying device designed to be used with external feedback components such as resistors and capacitors between its output and input terminals. These feedback components determine the resulting function or “operation” of the amplifier and by virtue of the different feedback configurations whether resistive, capacitive or both, the amplifier can perform a variety of different operations, giving rise to its name of “Operational Amplifier”.

An operational amplifier is basically a three-terminal device which consists of two high impedance inputs. One of the inputs is called the Inverting Input, marked with a negative or “minus” sign, (–). The other input is called the Non-inverting Input, marked with a positive or “plus” sign (+).

LITERATURE SURVEY/THEORY:

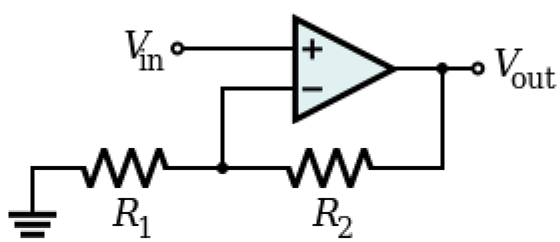
Inverting amplifier



An inverting amplifier is a special case of the Differential amplifier in which that circuit's non-inverting input V_2 is grounded, and inverting input V_1 is identified with V_{in} above. The closed-loop gain is R_f / R_{in} hence

$$Vo = -(Rf/Rin) * Vi$$

Non-inverting amplifier



A non-inverting amplifier is a special case of the Differential amplifier in which that circuit's inverting input V_1 is grounded, and non-inverting input V_2 is identified with V_{in} above, with $R_1 \gg R_2$. Referring to the circuit immediately above,

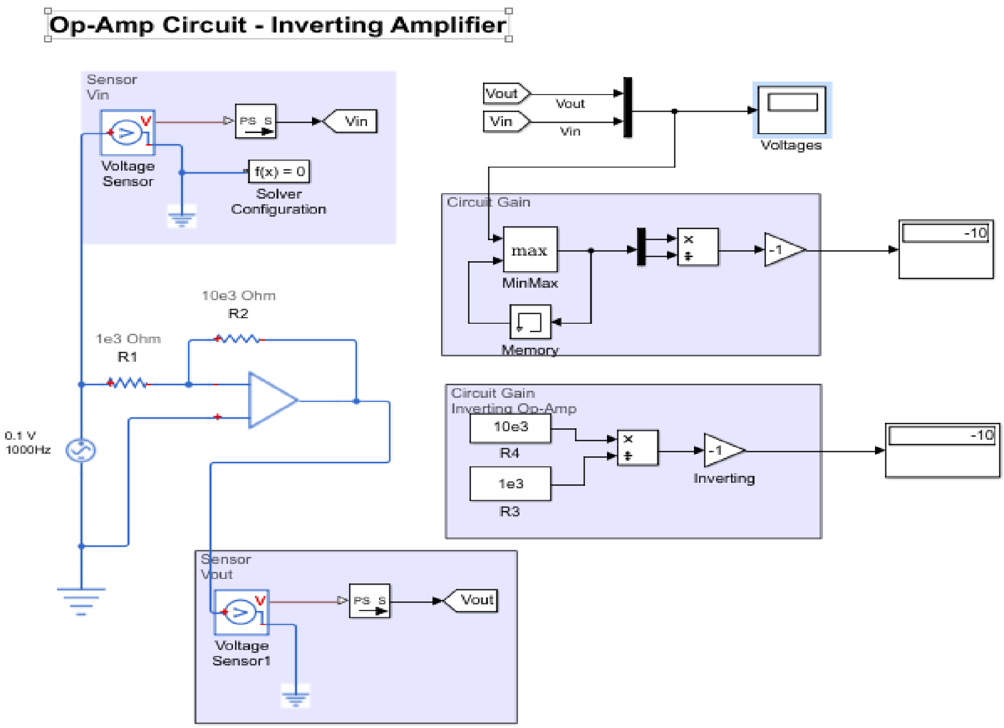
$$Vout = (1+R2/R1) * Vin$$

CIRCUITRY MODELING:

Circuitry modeling is the fundamental approaches for the modeling electronic system. It is a graphic representation of the system in term of schematic circuit diagram which comprise of components that interconnected with each other to form the system. circuit diagram is consider an indispensable piece of information for any electronic system design. It allows the electronic system to be implemented and easily duplicate in term of tangible physical hardware

OP-AMP CIRCUIT - INVERTING AMPLIFIER:

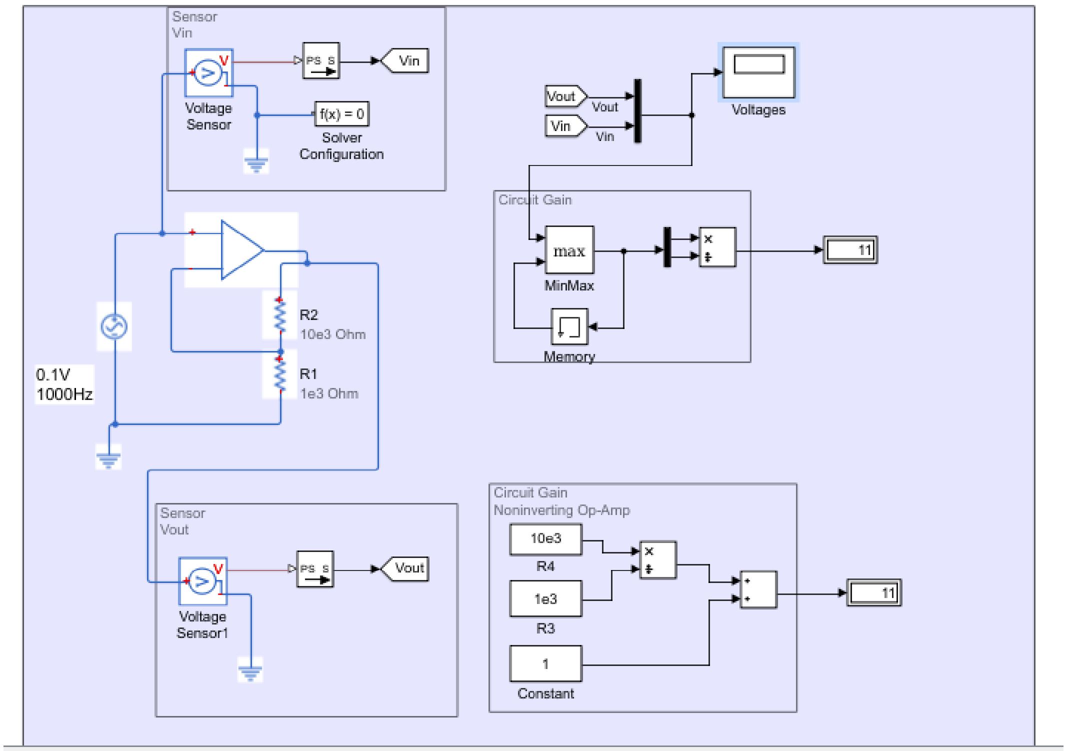
This model shows a standard inverting op-amp circuit. The gain is given by -R2/R1, and with the values set to R1=1K Ohm and R2=10K Ohm, the 0.1V peak-to-peak input voltage is amplified to 1V peak-to-peak. As the Op-Amp block implements an ideal (i.e. infinite gain) device, this gain is achieved regardless of output load.



OP-AMP CIRCUIT- NONINVERTING AMPLIFIER:

Non-inverting Op-amp circuit. The gain is given by 1+R2/R1, and with the values set to R1=1K Ohm and R2=10K Ohm, the 0.1V peak-to-peak input voltage is amplified to 1.1V peak-to-peak. As the Op-Amp block implements an ideal (i.e. infinite gain) device, this gain is achieved regardless of output load.

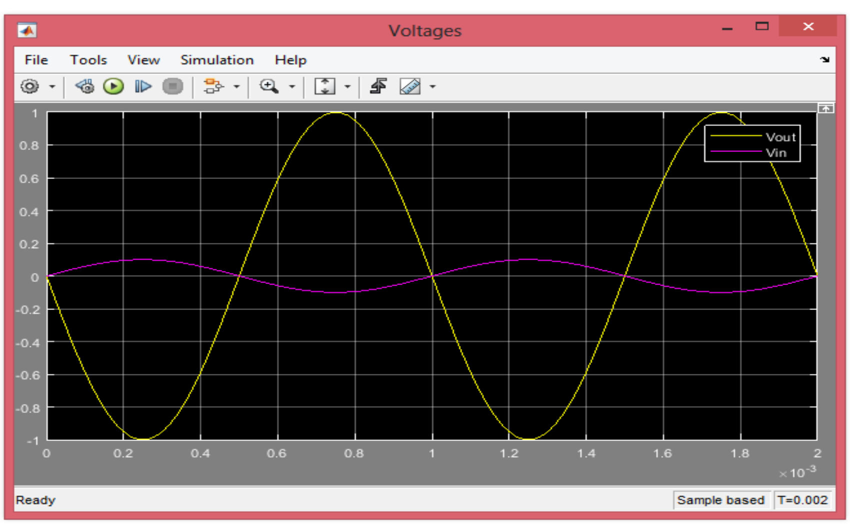
Op-Amp Circuit - Noninverting Amplifier



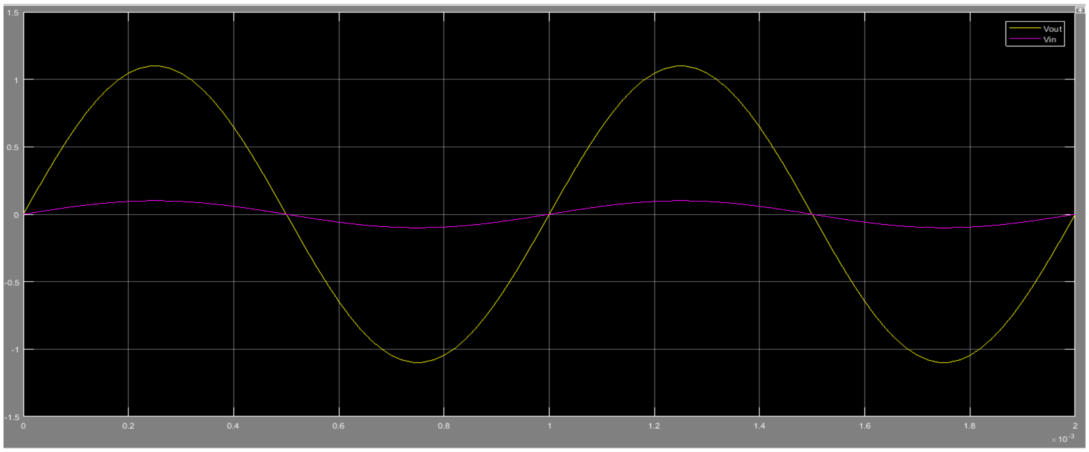
OUTPUT:

The result obtained at scope for both inverting and noninverting Amplifiers are:

1.SCOPE OUTPUT-INVERTING AMPLIFIER



2.SCOPE OUTPUT- NONINVERTING AMPLIFIER:



CONCLUSION:

Op-amps are extremely important electronic devices that facilitate the use of output signals . By using a ratio of two resistors to achieve a desire gain, an output voltage proportional to the input voltage can be determined and mearsured. The test done for this experiment show the accuracy and preferred output that can be attained through the use of an op-amp.

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SUMMER INTERNSHIP PROGRAM IN ELECTRICAL ENGINEERING
(SIPEE-2018)

Organised by

Department Of Electrical Engineering

Motilal Nehru National Institute of Technology

Allahabad-211004

A
Report
ON
POWER SUBSTATION VISIT
(Teliarganj 132/33kV)

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Substation

The substation consists of the following equipments

- Incoming lines
- Outgoing lines
- Control room (control and protection panel)
- Transformers (main power transformer & auxiliary transformer)
- Circuit breaker, isolators, relay and metering panels
- CT's, PT's, Power cables and control cables
- Station service equipments such as lightning arresters, auxiliary battery supply
- Compressed air system
- Station earthing system
- Communication equipment such as carrier equipment telephone system etc.

Classification

The classification of the types of substations depends on following factors

According to service requirement

- Transformer substation
- Switching substation
- Power factor correction substation
- Voltage frequency changer substation

According to constructional features

- Indoor substation
- Outdoor substation
- Underground substation
- Pole mounted substation

Various Equipments Details

Equipments	Function	Remarks
Bus bars	Various incoming and outgoing circuits are connected to the bus bars. They receive power from incoming circuits and deliver power to the outgoing circuits.	• Flexible ACSR or alloyed aluminium stranded bus bars supported from two ends by strain insulators.
Surge arrester (lightning arrestor)	Surge arresters discharge the over voltage surges to earth and protect the equipment insulation from switching surges and lightning surges.	• Connected generally between phase conductor and ground • Located as the first equipment as seen from the incoming overhead lines and also near transformer terminals

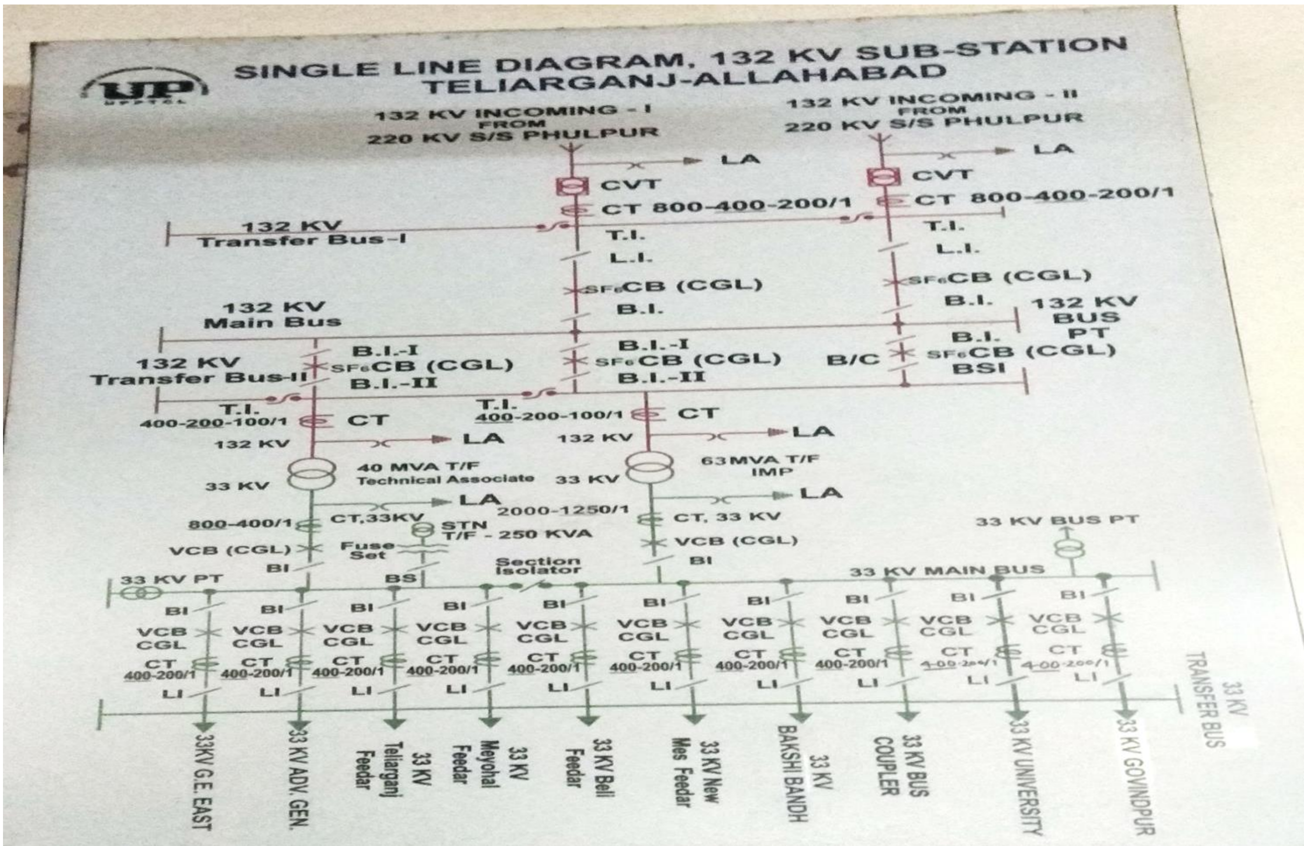
		phase go ground
Isolators	To provide isolation from live parts for the purpose of maintenance.	• Located at the each side of circuit breaker. • Does not have any rating for current breaking and making.
Earth switch	Discharge the voltage on the circuit to the earth for safety.	• Mounted on the frame of the isolators. • Located generally for each isolator and each bus section.
Current transformer	Stepping down the current for measurement, protection and control.	• Protective CTs • Measuring CTs • Location decided by protective zone and measurement requirement
Voltage transformer	Stepping down the voltage for measurement, protection and control.	• Electromagnetic • Capacitive VT(CVT) • Location on feeder side of circuit breaker

Teliarganj substation (132/33KV)

The 132/33 KV Teliargang sub-station is located opposite one of the famous landmarks of Allahabad (City of sangam) namely Old Canton. The sub-station is one of the several 132/11 KV sub-station in Allahabad. All equipment and system is earthed properly through GI strips of 25X6 mm and 150X6 mm via earth electrode which in turn is connected to earth-mat.

The sub-station is having two 132KV incoming supply. These two incoming supply is coming from Phoolpur- 1 & 2 sub-station through XLPE (Cross Linked Poly-Ethylene) cable’s. These cables are 660sq.mm, 3-phase single core copper cable. These cables are designed according to required voltage, creapage and rain .At present the station bay (area under an overhead structure) is being extended to provide another 66 KV line to serve as another alternate 66 KV source since both the present feeders are from the same station. The present two incoming feeders are used alternatively (one at a time). The station peak load is 24 megawatts and handle about 3, 25000 units every day.

Single line diagram of 132/33 KV substation

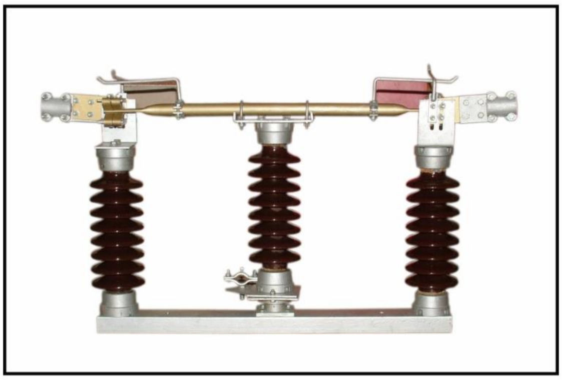


Lightening Arrester

The lightening or surge arresters (L.A) used in the sub-station is rod gap type. These are used for the protection of power system equipment. The surge arrester used here is of 45 KV. The XLPE cable coming from Subramanyapura sub-station terminates here through L&T-type clamps. The surge arresters are mounted on the platform which is earthed by GI strip and through the earthed electrode it is connected to earthing-mat. The XLPE cables terminating on these arresters are earthed by another single core cable on to the GI strip. The conductor used from LA’s to line bus is ACSR wolf conductor.

Isolators

The isolator is132 KV incoming line Gang Operating Switch (GOS). The main purpose of the isolator is to carry out maintenance work after line clearance. The isolators are mounted on the lattice structures and are earthed by GI strips to earth electrode which in turn is connected to earthling mat. The first line isolators are always provided with the earth or grounding switch. This grounding switch is provided to carry out maintenance work. Whenever there is any work required to carry out in the system we put operate the earth switch so that the whole system will be at ground potential. In some isolators there is mechanical interlocking provided so that the earth switch cannot be operated when the system is in line. If this is done than the whole system will be at high risk and havoc is created. There are two types of isolator:-



- **Single Break Isolator:**
  - ✓ This isolator is used where the line current is less than 200 A.
- **Double Break Isolator:**
  - ✓ This isolator is used when the line current is more than 200 A. The isolators are always designed on the fault current.

SF6 Circuit Breaker

The 132 KV SF6 circuit breaker comes after the isolator. In this breaker SF6 (Sulphur Hexafluoride) gas is used. In this breaker the arc quenching is done by SF6 gas whereas the air is used for tripping and spring loading purpose. SF6 gas is considered to be very good arc quenching property. The pressure maintained in SF6 cylinder is 6 kg/cm2 and in air cylinder is 15 kg/cm2. There is one compressor installed inside the breaker cabin whenever the pressure of air drops below 15 kg/cm2 it starts automatically.

There are two types of SF6 breaker:-

- **Single break**
  - ✓ This is used for 66 and above. In this the female contact is fixed and male contact is movable and is non-electric conductor.
- **Double break**
  - ✓ This is used for 220 KV and above. In this the live part is kept at ground potential. The tripping time in this breaker is 10-20ms and charging time is 100ms. The top most part used for connection and central portion hold conductor called interrupter. The pressure inside interrupter is around 6kg/cm2 .There are two DC coils present one is for tripping and other is for back protection (in case the first one fails to operate).

One of the several advantages of using SF6 is that the loss of gas is very minimum and it can go up to 2 years without stopping.

Some of the safety features of this breaker are as follows:-

- ✓ DC failure safety (breaker trips itself whenever dc fails and fails to obey any command.
- ✓ Air pressure below 12 kg/cm2 cylinder automatically starts.
- ✓ Interrupter is designed at 6 kg/cm2.
- ✓ Tripping and charging is done by quick action spring.

Transformer

There are two one of 40MVA and another of 63 MVA Dyn11 vector group 132/33kv class transformers. Feeding supply through double circuit of ring main

Transformer rating 16/20 MVA (66/11 KV) 19/31.5 MVA(66/11 KV)	**40 MVA (132/33 KV)** **63 MVA (132/33 KV)**
Vector group	Dyn11
Bushing	Oil impregnated condenser bushing (132 KV)
Cooling fans	40 MVA 8 no’s 63 MVA 10 no’s
Conservator tank	2 no’s For active part For OLTC
Breather	Silica gel breather

Protection of Transformer

The type of a protective gear for a Transformer depends upon several factors such as:

- Type of Transformer
- Size of Transformer

One of the Common Protection is Buchholz Relay Protection

Buchholz Relay

Buchholz Relay is installed between the Transformer and the Conservator tank and is used to give warning in case of less severe internal faults in oil immersed Transformer and to disconnect the Transformer from the main supply in case of severe Internal faults. It is practically used on all oil immersed Transformer having rating more than 750kva.It is used in conjunction with some form of electrically operated protective gears because it provides protection against Transformer Internal faults and does not respond to external bushing or cable connection faults.

CTR Fire Protection system

Transformer is also protected from fire during any abnormal fault condition. Well adequate clearance is maintained between the two transformers in the substation. Main equipment used for this is the water emulsified fire extinguisher which takes care of the abnormal conditions. During these fault conditions CTR has equipment which does not allow the oil passage from the top portion of the conservator tank when it senses any abnormal temperature difference

❖ Various monitoring conditions employed in CTR fire protection scheme
  - Differential relay trip
  - Pressure relief valve trip
  - Buchholz Protection
  - Fire detector trip
  - Transformer trip
  - Line fault differential trip
  - Line fault PRV

Auxiliary transformer

Back up transformer is also maintained in the substation through which supply is fed to the control panel equipment's and for lighting purpose.

Specifications of the auxiliary transformer: 410/55-0-55 V/ 500 VA

Control room

Monitoring of the entire substation can made from the control room. In this all the preliminary actions for the improvement or for any fault clearing conditions can be monitored.