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PV Based Dc - Dc Converter with PMBL DC Motor Drive for Real Time Application

K.Pugazhenthi [1], A.Eswari [2]
[1]*UG Student, Department of EEE, IFET college of Engineering, Tamilnadu, India*
[2]*Assistant Professor, Department of EEE, IFET college of Engineering, Tamilnadu, India*

Abstract
The brushless direct current (BLDC) motor is being used in Aerospace, Naval. Military, automation and household appliances due to its advantages such as High efficiency, noiseless operation and wide speed range. The BLDC motor is innately electronic controlled and requires rotor position information for correct commutations of current. The issues with rotor position sensors have motivated research in the demesne of sensorless motor drives. Sensorless control has been active research motive for last three decades. The main components of the drive system are reference current generator, hysteresis current controller, speed controller and three phase voltage source inverter. Reference current generator generates three phase reference currents and hysteresis current controller produces switching signals based on actual motor current and reference current generated. BLDC motor speed is regulated all the way through voltage source inverter, which requires DC voltage as input. This required DC voltage is proposed to generate from solar PV Array due to its advantages such as availability of solar source, pollution free, clean and cost of the solar panel. Solar PV array provides soft starting and smooth performance of BLDC motor. The actual speed of the motor is compared with reference speed and error is processed in speed controller. The speed controller gives torque command, from which current command is determined and given as input to reference current generator along with rotor position. The Fuzzy PID Controller was designed and implemented to control the speed of BLDC motor. The well Known Ziegler Nichols closed loop tuning method is used to tune PID controller parameters, The performance was analyzed considering time domain specifications such as rise time, percentage of peak overshoot, settling time, steady-state error. The performance was also analyzed under load disturbance condition and set-speed change condition. The speed drop and recovery time were considered for analysis under load disturbance condition and peak overshoot and settling time wre considered under set-speed change condition.

Keywords: *DC Supply, BLDC motor, PMBLDCM, Luo converter, ripple, PFC, PID, Motor drive.*

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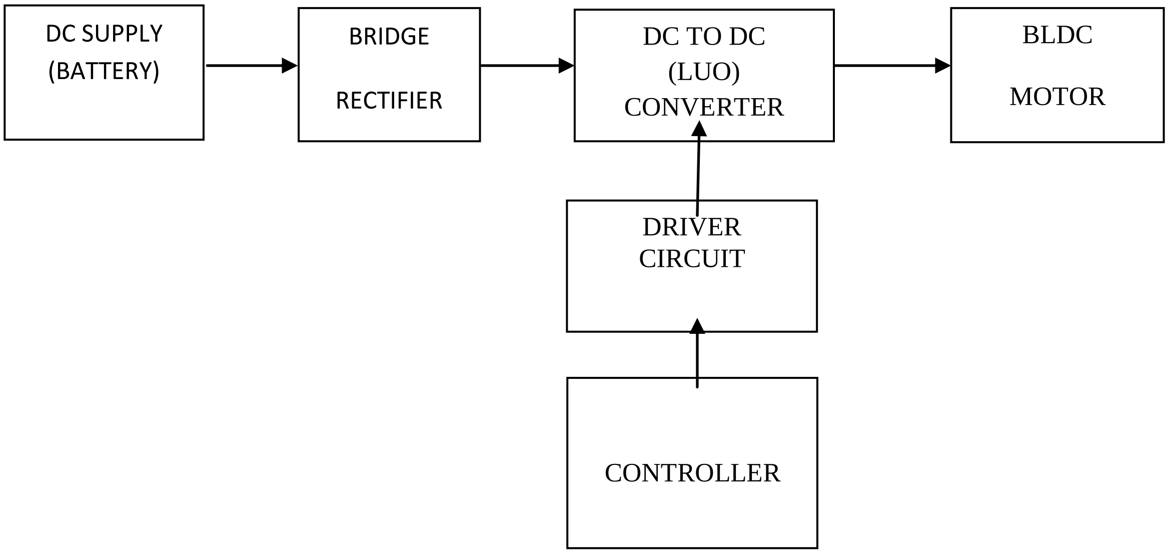
I. INTRODUCTION

The permanent magnet brushless dc motor is gaining popularity being used in computer, aerospace, military, automotive, industrial and household products because of its high torque, compactness, and high efficiency. The BLDC motor is inherently electronically controlled and requires rotor position information for proper commutations of current.

The brushless motor has been used in many applications such as computer, automatic office machine, robots for automation, drives of many electronics and miniature machine. The BLDC motor has advantages of the DC motor such as simple control, high torque, high efficiency and compactness. Also, brush maintenance is no longer required, and many problems resulting from mechanical wear of brushes and commutator are improved by changing the position of rotor and stator in DC motor.

To alternate the function of brushes and commutator, the BLDC motor requires an inverter and a position sensor that detects rotor position for proper commutation of current.

1.1.1 BLOCK DIAGRAM



1.1.2 POWER SUPPLY

The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.

A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

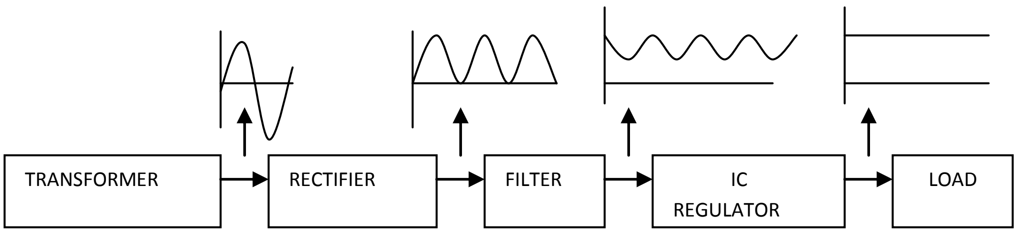


Fig-1 Block Diagram of Power supply

1.1.3 TRANSFORMER

The potential transformer will step down the power supply voltage (0-230V) to (0-12V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op–amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.

1.1.4 BRIDGE RECTIFIER

The rectifier is an electronic circuit it used to convert from AC signal into DC signal. The filter circuit is used to filter the unwanted harmonics from the voltage and given to the Inverter. The inverter is an electronic component is used to convert from DC signal into AC signal.

1.1.5 PULSE GENERATOR

The pulse generator is used to generating the triggering pulse and given to the driver circuit. The driver circuit is used to Amplify the triggering pulse and given to the Dc to AC converter.Brushless DC (BLDC) motors are referred to by many aliases: brushless permanent magnet, permanent magnet ac motors, permanent magnet synchronous motors etc.

The confusion arises because a brushless dc motor does not directly operate from a dc voltage source. However, as we shall see, the basic principle of operation is similar to a dc motor. A BLDC has a rotor with permanent magnets and a stator with windings. It is essentially a dc motor turned inside out. The brushes and commutator have been eliminated and the windings are connected to the control electronics. The control electronics replace the function of the commutator and energize the proper winding, The three phase inverter is converting the DC to AC. Its work on the conduction mode of 120 degree, The triggering units provide the required pulses to the power BJT through opto-coupler. The opto coupler are used to isolate MOSFET and triggering unit

1.1.6 BOOST (LUO) CONVERTER

AC/DC conversion is effected by a diode rectifier while the controller operates the switch to properly shape the input current ig according to its reference. The output capacitor absorbs the input power pulsation, allowing only a small ripple of the output voltage VL. The boost topology is simple, and allows low-distorted input currents and an almost unity power factor with different control techniques. The output capacitor is an efficient energy storage element, and the ground-connected switch simplifies the drive circuit.

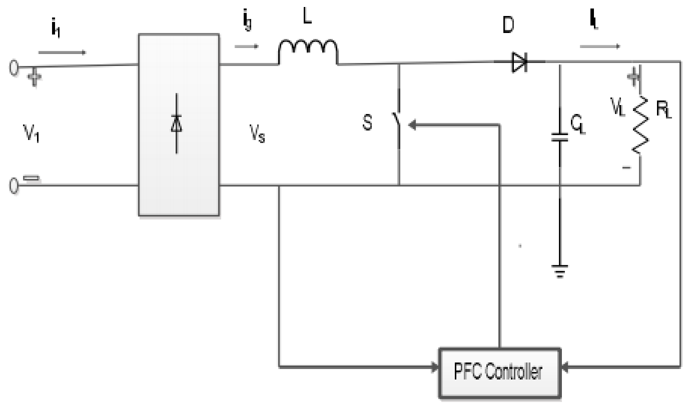


Fig.2 principle of PFC LUO converter

1.1.7 BLDC MOTOR

Permanent Magnet Brushless DC (PMBLDC) Motors, Permanent Magnet Brushless DC Motor is the special type of DC motor – Magnetic fields generated by the stator and rotor rotate at the same frequency – No slip, Rotor has no windings. BLDC motor works on the principle similar to that of a Brushed DC motor. The Lorentz force law which states that whenever a current carrying conductor placed in a magnetic field it experiences a force.As a consequence of reaction force, the magnet will experience an equal and opposite force

1.1.8 EXISTING METHOD:

Many topologies of a PFC based BLDCM drives have been developed. A boost PFC converter has been the most popular configuration for feeding BLDCM drive. A constant DC link voltage is maintained at the DC link capacitor and a PWM based VSI is used for the speed control. Hence, the switching losses in VSI are very high due to high switching PWM signals and require huge amount of sensing for its operation. These switching losses are reduced by using a concept of variable DC link voltage for speed control of BLDC motor which has presented in this project.

1.1.9 MODES OFF OPERATION:

The proposed PFC based LUO Converter operates in DICM. In DICM, the current in inductor Li becomes discontinuous in a switching period (Ts).

Mode I: Figure 3(a) shows the operation of Mode I operation of LUO converter. The switch Sw is turned ON, the energy from the supply and stored energy in the intermediate capacitor C1 are transferred to inductor Li. In this process, the voltage across the intermediate capacitor Vc1 reduces, while inductor current iLi and dc-link voltage Vdc are increased. The designed value of intermediate capacitor is large enough to hold enough energy such that the voltage across it does not become discontinuous.

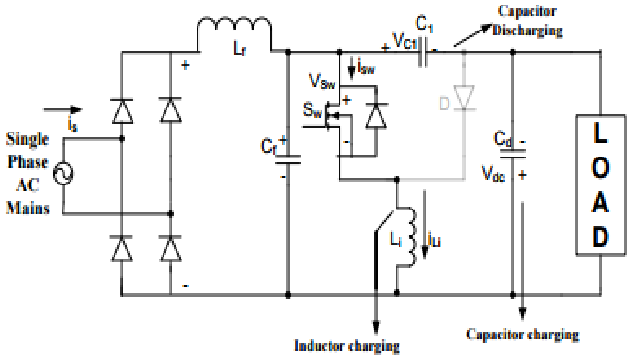


Fig. 3 (a) Mode I

Mode II: The switch is turned OFF in this mode of operation. The intermediate capacitor C1 is charged through the supply current while inductor Li starts discharging, hence voltage Vc1 starts increasing, while current iLi decreases in this mode of operation. Figure 3(b) shows the operation of Mode II operation of LUO converter. Moreover, the voltage across the dc-link capacitor Vdc continues to increase due to discharging of inductor Li.

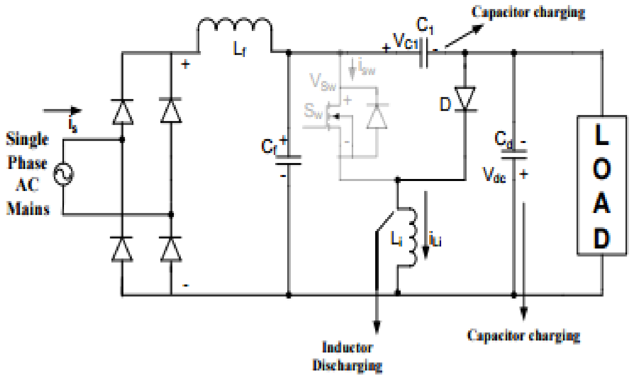


Fig. 3 (b) Mode II

Mode III: This is the discontinuous conduction mode of operation as inductor Li is completely discharged and current iLi becomes zero. Figure 3(c) shows the operation of Mode III operation of LUO converter. The voltage across the intermediate capacitor C1 to increase while dc-link capacitor supplies the required energy to the load, hence Vdc starts decreasing.

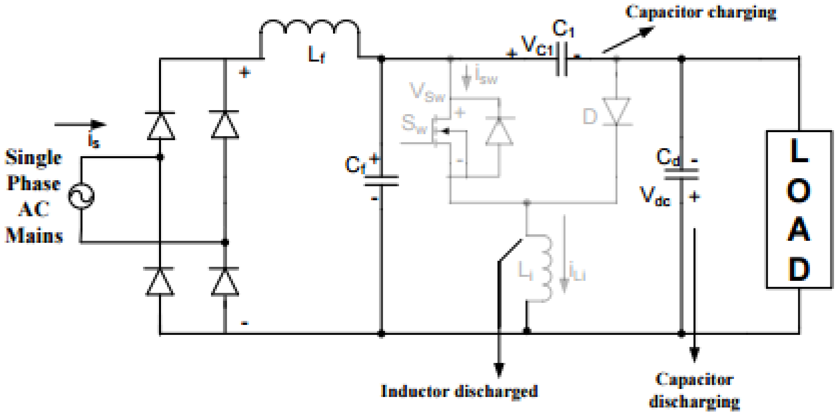


Fig. 3 (c) Mode III

II. RESULT AND DISCUSSION

The results obtained are as discussed below

SIMULATION RESULTS:

Simulation circuit plays an important role in dc to dc converter. The major advantage of going simulation is to get easy accuracy. Therefore it requires first model to be designed this simulation model represents characteristics of design, function and behaviour of the selected system. The modeling of design denotes its systems itself but simulation model represents different operations of the system changes with respect to time. Also its major role lies in the field of optimization. though, these simulation model can be studied based on computer experimentation.

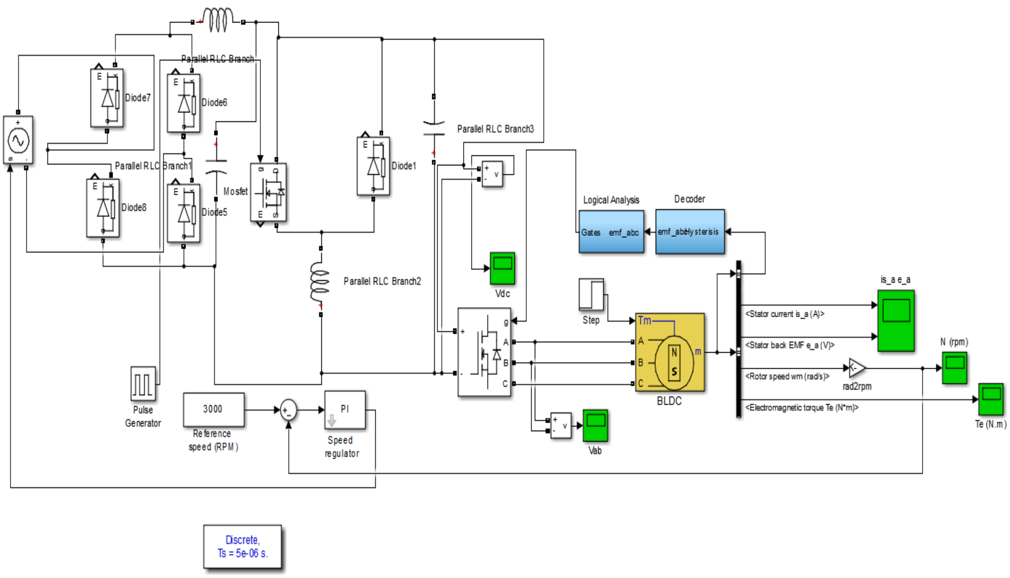


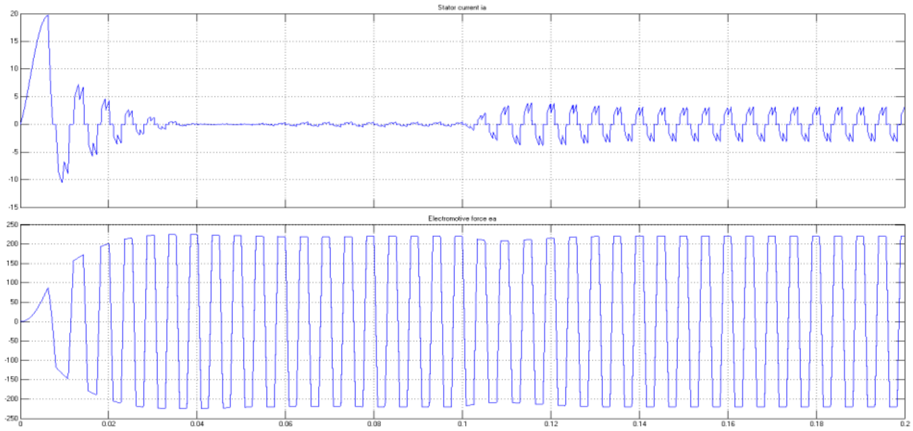
Fig.4 DC – DC (LUO) converter with PMBLDC motor drive

The above simulation diagram figure 4 represents the dc - dc converter with PMBLDC motor drive. From the above simulation circuit, switches were connected in parallel and using LUO converter we can power factor correction, maintaining the constant speed. The performances of DC – DC (LUO) converter with PMBLDC motor drive can be assessed by improving the performances converter.

OPERATING PARAMETERS

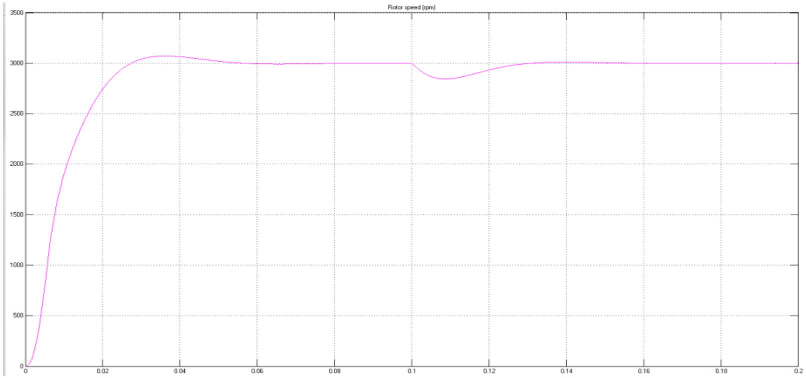
S.no	Parameters	Values
01.	PV input voltage	Vpv-200v, Ppv-10KW
02.	Boost Dc-Dc (LUO) Converter output Voltage	Vin-200V Vo-400v L1-1µH, C1 - 1000µF
03.	PM-BLDC Motor drive	Rated Voltage-400V; Current-2.5A; Rated Power: 1KW

OUTPUT OF STATOR CURRENT



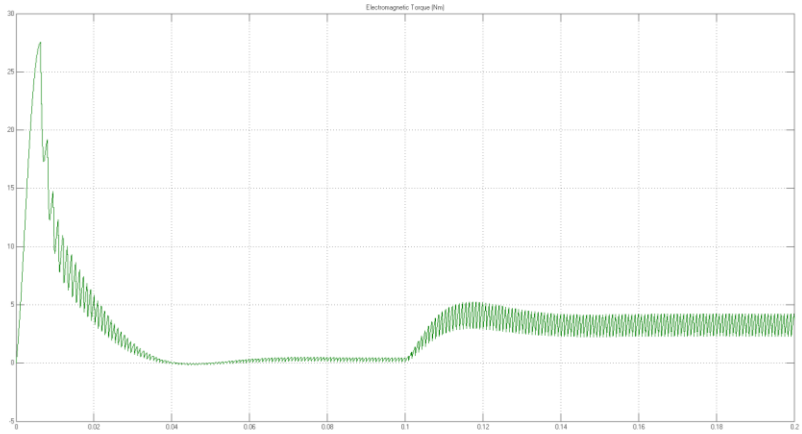
In this simulation output there is a two graph are present in it stator current,electromotive force first of all in the stator current will linearly increased and certainperiod fault is occurs the current will be saturation at time LUO converter will beregulate & boostup supply current.

OUTPUT OF ROTOR SPEED



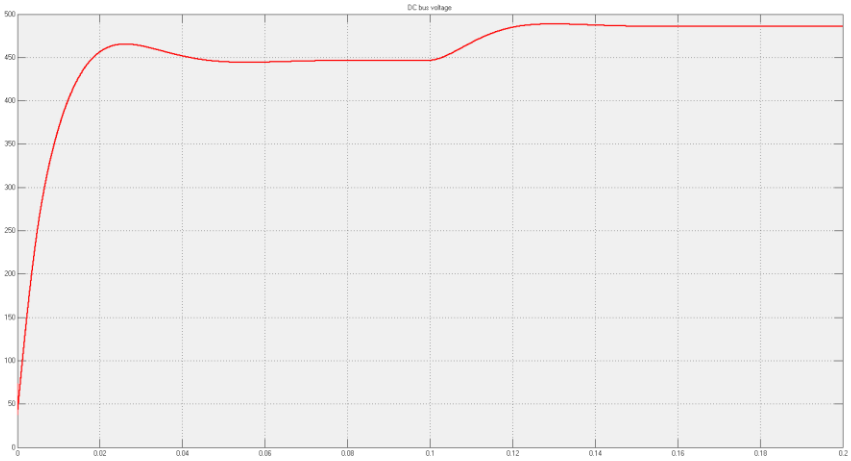
In this simulation output there will be view the Rotor Speed value, there isstarting speed will be linearly increased and than its reached the constant speed, at time of fault is occurs the speed level will be drop, LUO converter will be operated and again regulator the rotor speed its will be shown in given figure.

OUTPUT OF ELECTROMAGNETIC TORQUE



In this simulation output there will be view the Electromagnetic torque is the torque required to start the rotation of a motor, and it is generally equal to the load torque. The output electromagnetic torque produced by the armature on the air gap is the load torque at no load, and the load torque is equal to the electromagnetic torque.

OUTPUT OF DC BUS VOLTAGE (LUO CONVERTER)



In this simulation output The dc bus voltage is relative to the peak voltage of themains input. What to look for: dc bus voltage for a ac drive, the dc bus should be dc bus voltage. A dc voltage value that is too low cancause the drive to trip.

FFT ANALYSIS TO DETERMINE IN PROPOSED SYSTEM

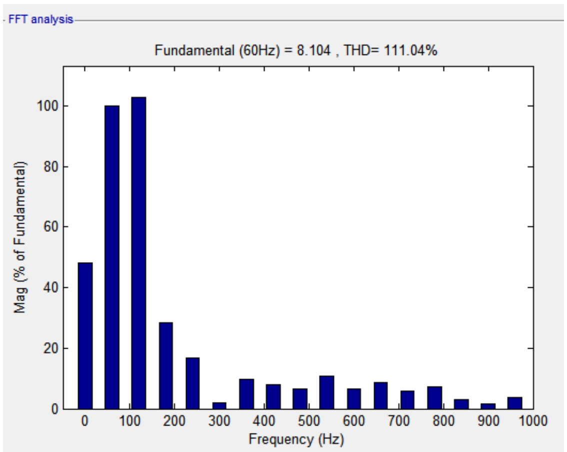


Fig.9 FFT analysis

In this proposed system, its necessary to reduce total harmonic distortion. FFTs are used to sharpen edges and create effects in static images and are widelyused to turn a number series into sine waves and graphs. The FFT quickly performs adiscreteFouriertransform(DFT),whichisthepracticalapplicationofFouriertransforms. In this figure shows the selected signal 12 cycles , FFT analysis window,(in red): 1 cycles and FUNDAMENTAL (60HZ)=8.104, THD=111.04% , The signalx-axis is time(s), y-axis is voltage, Fourier Analysis In a complex signal, the FFT helpsthe engineer to determine the frequencies that are being excited and the amplitude ateach frequency.

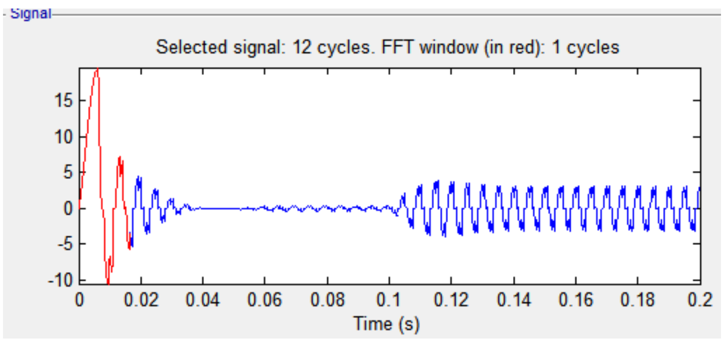


Fig.10 output waveform of 12 cycles FFT window (in red): 1cycles

It was observed that the rerun column bottom stream temperature has greater effect on the linear alkylbenzene yield than the temperature variation of the top stream. At higher temperature of both streams , lower percentage yield of average wt. % of linear alkylbenzene was obtained with that of the top stream being the lowest at 87.5% as against 93.3% for the bottom stream. The highest linear alkylbenzene yield of 99.4%was recorded at bottom stream temperature of 280^{o}C and pressure of 115Kpa.

III. CONCLUSION

This project presents the speed control of the BLDC motor through inverter. Sensor less control of BLDC motor has been developed by implementing back-EMF sensing technique to resolve the rotor position. BLDC motor speed is regulated all the way through voltage source inverter. A Photovoltaic array was designed to supply inverter fed BLDC motor. PV array provides soft starting and smooth performance of BLDC motor. An equation model of the drive system based on voltage and torque equations was developed and supplied by PV array. The transfer function model of the drive system based on transfer functions of drive component was also developed using Matlab/Simulink.

The PID controller is designed to control motor and a new tuning method: Magnitude Optimum Multiple Integration (MOMI) tuning method was developed to tune controller parameters. The performance of the drive with this method was analyzed by considering time domain specifications such as rise time, peak overshoot, settling time and steady-state error. The effectiveness of the controller was tested by introducing load disturbance and set-speed changes to the drive system. LUO Converter was designed to control the BLDC motor drive and the performance was analyzed under same conditions and results were compared with developed PID controller. LUO DC-DC Converters were developed for the optimal control of PID based BLDC motor drive. The performance of the drive system was analyzed by different objective functions formulated under each algorithm. The time domain specifications, convergence parameters and performance indices were considered for analysis and compared. Finally, Physics/Chemistry based algorithms such as Gases Brownian motion optimization algorithm and Wind driven optimization algorithm were developed for the optimal control of PID based BLDC motor drive system. The performance was analyzed under same conditions as in case of Bio-inspired algorithms and results were compared. The performance comparison of designed controllers for BLDC motor considering convergence parameters (converged step, objective value, computation time), performances indices (ISE, IAE and ITAE) by different objective functions and time domain specifications (rise time, settling time, peak overshoot and steady-state error) are presented and discussed.

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