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POWER FACTOR CORRECTION AND POWER QUALITY IMPROVEMENT IN BLDC MOTOR DRIVE USING SEPIC CONVERTER

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ABSTRACT

In this project, a (PF) Power factor correction and power quality (PQ) improvement based BLDC motor drive proposed. Normally the permanent magnet BLDC motor drive connected with the diode bridge rectifier and high value of the capacitor due to which poor power factor and higher THD (Total harmonic distortion) value at the input side To overcome this difficulty SEPIC (Single-ended primary inductance converter) converter use to optimize the PF and THD value. The converter operates in discontinuous conduction mode to get the desired result. This scheme also used for speed control of BLDC motor by controlling the VSI (voltage source inverter) feeding the BLDC drive.

INTRODUCTION

Electric systems and grids are complex dynamic systems. These systems suffer usually from unexpected or sudden changes of the currents and voltages. These changes are due mainly to the different types of linear and non-linear loads to which they are connected. In addition, to different types of accidents which can intervener into the grid. With the increasing use of power semiconductors in the most of industrial and domestic procedures, the electric grids are polluted with different harmonic currents and voltages. These harmonics affect the normal function of the most of the grid connected devices; in addition to considerable economic losses. Many classic and modern solutions have been proposed in the literary for the harmonic problems. In this chapter, the harmonic problem as one of the most common power quality problems will be presented. The different modern and traditional solutions will then be discussed.

Brushless DC motors (BLDC) have been a much focused area for numerous motor manufacturers as these motors are increasingly the preferred choice in many applications, especially in the field of motor control technology. BLDC motors are superior to brushed DC motors in many ways, such as ability to operate at high speeds, high efficiency, and better heat dissipation. They are an indispensable part of modern drive technology, most commonly employed for actuating drives, machine tools, electric propulsion, robotics, computer peripherals and also for electrical power generation. With the development of sensorless technology besides digital control, these motors become so effective

in terms of total system cost, size and reliability.

A brushless DC motor (known as BLDC) is a permanent magnet synchronous electric motor which is driven by direct current (DC) electricity and it accomplishes electronically controlled commutation system (commutation is the process of producing rotational torque in the motor by changing phase currents through it at appropriate times) instead of a mechanically commutation system. BLDC motors are also referred as trapezoidal permanent magnet motors.

Unlike conventional brushed type DC motor, wherein the brushes make the mechanical contact with commutator on the rotor so as to form an electric path between a DC electric source and rotor armature windings, BLDC motor employs electrical commutation with permanent magnet rotor and a stator with a sequence of coils. In this motor, permanent magnet (or field poles) rotates and current carrying conductors are fixed.

The armature coils are switched electronically by transistors or silicon controlled rectifiers at the correct rotor position in such a way that armature field is in space quadrature with the rotor field poles. Hence the force acting on the rotor causes it to rotate. Hall sensors or rotary encoders are most commonly used to sense the position of the rotor and are positioned around the stator. The rotor position feedback from the sensor helps to determine when to switch the armature current.

This electronic commutation arrangement eliminates the commutator arrangement and brushes in a DC motor and hence more reliable and less noisy operation is achieved. Due to the absence of brushes BLDC motors are capable to run at high speeds. The efficiency of BLDC motors is typically 85 to 90 percent, whereas as brushed type DC motors are 75 to 80 percent efficient. There are wide varieties of BLDC motors available ranging from small power range to fractional horsepower, integral horsepower and large power ranges.

PROPOSED BRUSHLESS DC MOTOR DRIVE

As described above that the electronic controller circuit energizes appropriate motor winding by turning transistor or other solid state switches to rotate the motor continuously. The figure below shows the simple BLDC motor drive circuit which consists of MOSFET bridge (also called as inverter bridge), electronic controller, hall effect sensor and BLDC motor.

Here, Hall-effect sensors are used for position and speed feedback. The electronic controller can be a microcontroller unit or microprocessor or DSP processor or FPGA unit or any other controller. This controller receives these signals, processes them and sends the control signals to the MOSFET driver circuit.

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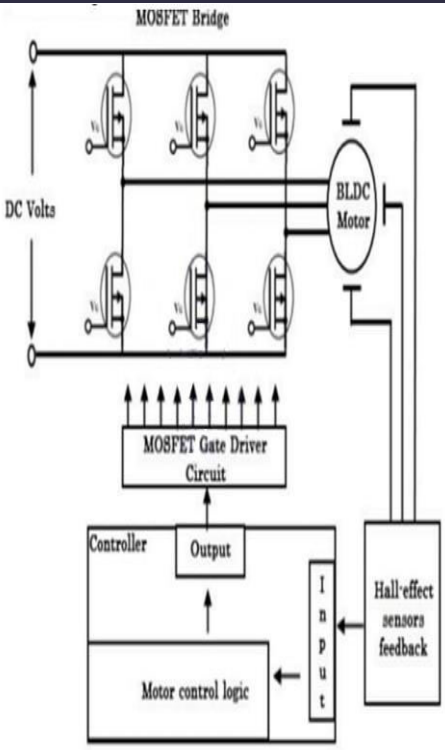

Fig 1 BLDC motor drive

In addition to the switching for a rated speed of the motor, additional electronic circuitry changes the motor speed based on required application. These speed control units are generally implemented with PID controllers to have precise control. It is also possible to produce four-quadrant operation from the motor whilst maintaining good efficiency throughout the speed variations using modern drives.

In this paper BLDC drive with and without SEPIC converter analyzed and simulate the result on Mat lab software. Without SEPIC converter THD value at the input side is high and PF is also very poor. To overcome this difficulty SEPIC converter is used

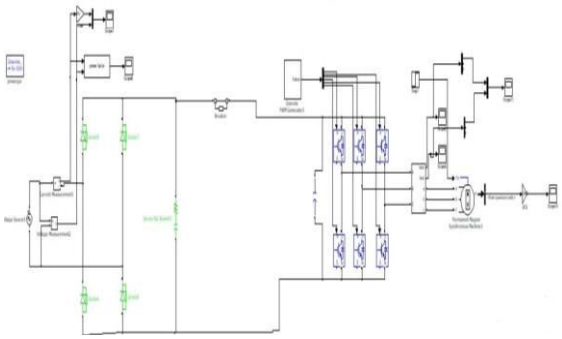

Fig 2 BLDC motor drive without SEPIC Converter

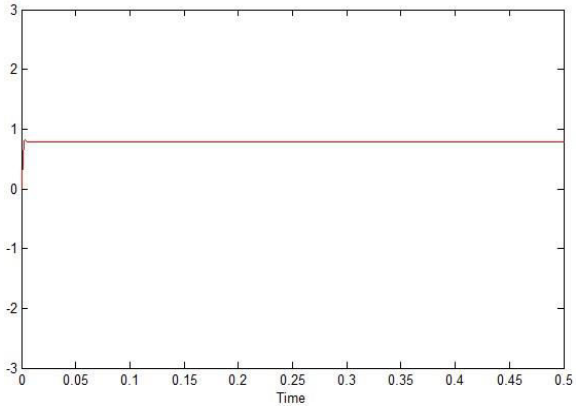

Fig 3 Power factor without SEPIC converter

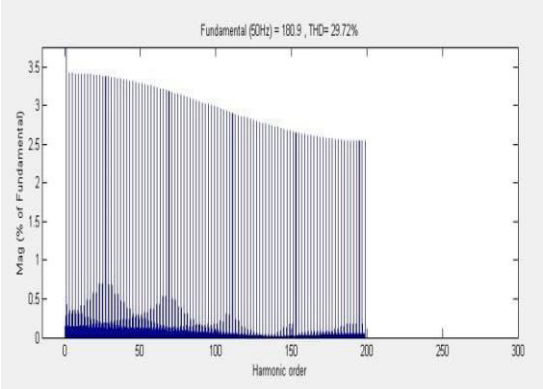

Fig 4 THD without SEPIC Converter

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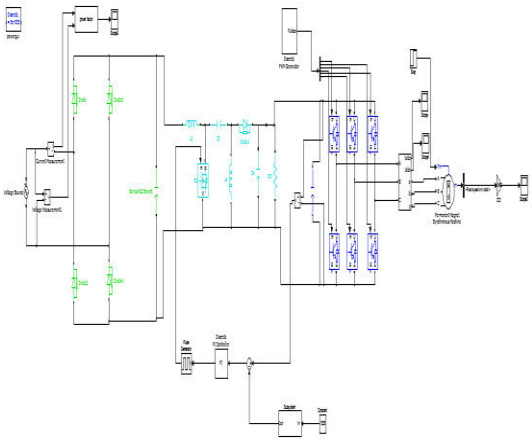

Fig 5 Proposed circuit configuration

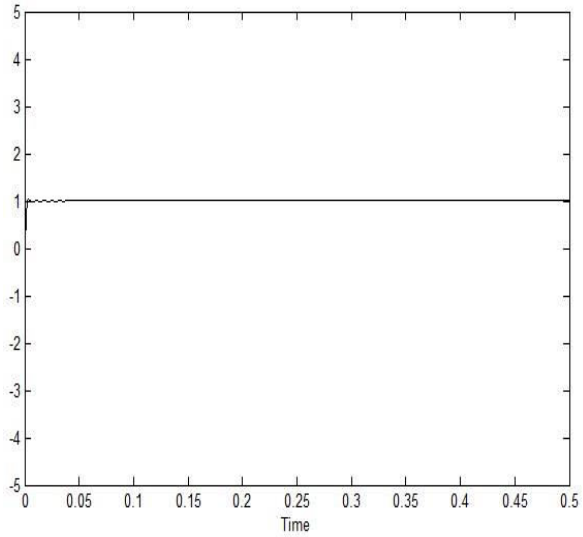

Fig 6 Power factor with SEPIC converter

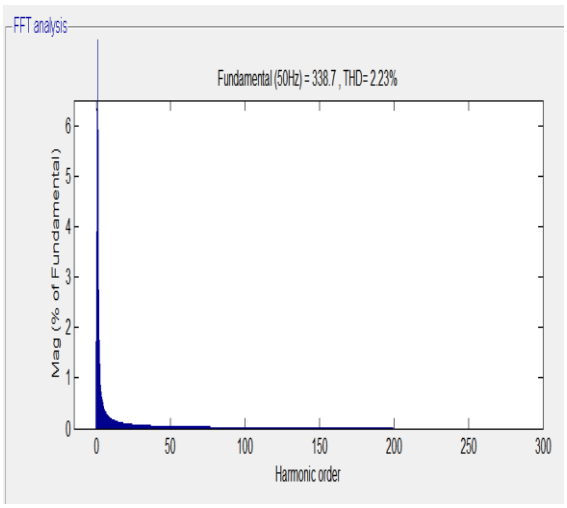

Fig 7 THD for the system

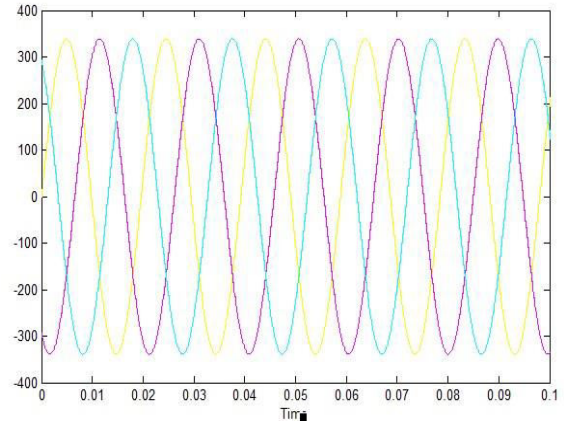

Fig 8 Inverter Voltage

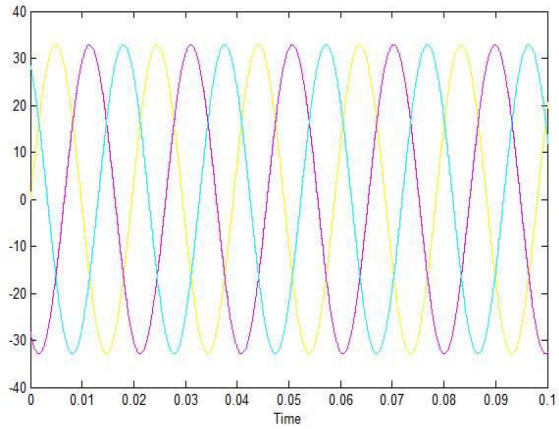

Fig 9 Inverter current

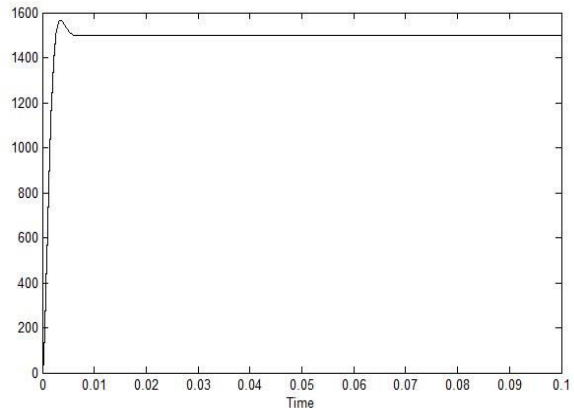

Fig 10 Motor output speed

Advantages of proposed drive are, BLDC motor has several advantages over conventional DC motors and some of

these are It has no mechanical commutator and associated problems, High efficiency due to the use of permanent magnet rotor, High speed of operation even in loaded and unloaded conditions due to the absence of brushes that limits the speed, Smaller motor geometry and lighter in weight than both brushed type DC and induction AC motors, Long life as no inspection and maintenance is required for commutator system, Higher dynamic response due to low inertia and carrying windings in the stator, Less electromagnetic interference, Quite operation (or low noise) due to absence of brushes

Disadvantages of proposed drive are, These motors are costly, Electronic controller required control this motor is expensive, Not much availability of many integrated electronic control solutions, especially for tiny BLDC motors, Requires complex drive circuitry, Need of additional sensors

Applications of proposed drive are, Brushless DC Motors (BLDC) are used for a wide variety of application requirements such as varying loads, constant loads and positioning applications in the fields of industrial control, automotive, aviation, automation systems, health care equipment's, etc. Some specific applications of BLDC motors are, Computer hard drives and DVD/CD players, Electric vehicles, hybrid vehicles, and electric bicycles Industrial robots, CNC machine tools, and simple belt driven systems, Washing machines, compressors and dryers, Fans, pumps and blowers

CONCLUSION

THD and PF value without SEPIC converter is found 113.94 % and 0.95 respectively. THD and PF value with SEPIC converter is found 4.94% and unity respectively. BLDC motor drive circuit work properly with sepic converter compare to a normal Method, which is without a converter. The output of the SEPIC converter controls the output of the BLDC motor. VSI use for only electronic commutation hence switching losses reduces and also PWM technique used for the converter. Cost of the project also reduces because of only one voltage sensor required. For future scope, this drive can use for renewable applications also.

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