SOLAR POWERED THREE PHASE MOTOR FOR VARIOUS APPLICATIONS

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Abstract—The Power electronics plays a vital role in the conversion and control of the electrical power for various applications such as heating & lightning control, electrochemical processes, DC & AC electrical machine drives, electrical welding, active power line filtering, static var compensator and many more.The main aim of the paper is to analyze and design of a current fed push pull DC-DC boost converter to integrate three phase electric motor through inverter. The regulated output which is obtained by the developed converter is fed to a typical load side inverter, and then to the various loads. To analyze the CFPP DC-DC converter in different operating cycles. The hardware circuit will be designed to test for the required output.Among the existing DC/DC converters, current-fed push-pull (CFPP) converter is a better option owing to its voltage boosting, isolation and compact characteristics.
Keywords*-Push-pull converter,inverter,three-phase electrical motor , renewable energy sources.*

1. INTRODUCTION

Power electronics as an enabling technology involved for harnessing and utilizing energy to meet the increased power demand as it is more reliable and efficient. Power electronic systems interfaces between the utility systems and consumers load to satisfy the needs. Sometimes power is generated in DC form by battery, photovoltaic cells, fuel cell or magneto hydrodynamic method, or in variable/fixed frequency ac form in a wind mill, gas turbine or diesel generator.

The utility system usually generate, transmit and distribute power at a fixed frequency (50/60)Hz and a fixed voltage is maintained at the consumers terminal. A consumer however may need power at DC or AC at the same, higher or lower in variable frequency. Frequently this power is controlled with precision.

Our electric power system was designed to move central station alternating current (AC) power, via high-voltage transmission lines and lower voltage distribution lines, to households and businesses that use the power in incandescent lights, AC motors, and other AC equipment. Today's consumer equipment and tomorrow's distributed renewable generation requires us to rethink this model. Electronic devices (such as computers, florescent lights, variable speed drives, and many other household and business appliances and equipment) need direct current (DC) input. However, all of these DC devices require conversion of the building's AC power into DC for use, and that conversion typically uses inefficient rectifiers. Moreover, distributed renewable generation (such as rooftop solar) produces DC power but must be converted to AC to tie into the building's electric system, only later to be re-converted to DC for many end uses.

Switching power supplies in the tens of kilowatt power range have been slowly replacing traditional silicon controlled rectifier (SCR) based topologies over the past several decades. High frequency operation of switching power supplies enables magnetic components to be reduced in size and weight, allow faster response times to line and load perturbations. The principle disadvantage is that the demands placed on switching devices tend to make high power switching power supplies less reliable than their SCR based counterpart. Numerous power circuit topologies are currently being deployed for high-power switch mode applications. The most common configurations consist of three power conversion stages:

- An AC to DC converter which converts the 3-phase incoming mains to a DC voltage.
- A DC to AC inverter or converter which converts the voltage on the DC bus to a high-frequency AC voltage.
- A secondary AC to DC converter which converts the high-frequency AC voltage to DC voltage.

The two AC to DC converters are very similar in function except for the operating frequencies; the converters consist primarily of rectifiers, low pass filters, and snubbers. The snubbers limit switching transient voltages and absorb energy stored from parasitic components. The second stage, the DC to AC converter, generates a high-frequency voltage which drives a transformer at a frequency generally at 20 kHz or above. The transformer is required for ohmic isolation and production of an output voltage as determined by the transformer turns ratio. The DC to AC converter is the most complex stage and there are numerous power processing topologies presently in production. DC to AC converter topologies fall into three groups: hard-switched converters, soft-switched converters, and resonant converters. The primary difference between the topologies is the switching device's load line during the commutation period (switching transition). It is during the commutation period where power devices dissipate the most power.

Hard-switched converters allow the power devices and/or snubbers to absorb commutation energy. Soft-switched converters have additional passive circuitry to shape power waveforms to reduce losses during the commutation period. The advantage of reduced commutation losses is offset with increased circuitry complexity, additional on-state losses (due to waveform modification), and sensitivity to loading conditions. Resonant power converters have highly tuned tank circuits which cause either device voltage or current to appear sinusoidal.

The advantages and disadvantages are similar to soft-switched timing is more critical than soft-switched converters. converters. Resonant power converters are second-order and timing is more critical than soft-switched converters.

2. CURRENT-FED POWER CONVERTERS

The series connected input inductor, provides instantaneous high impedance, thereby restricting sudden change in current as shown in fig. The inductor, as in Weinberg circuit, can be brought in the form of a fly back transformer, feeding either the input or the output. This flyback transformer feeds its secondary when the Push Pull transformer operates in non-overlapping mode.

However, in the overlapping mode of operation, no energy is transferred through this transformer. If it can be ensured that the push-pull switches are operating in the overlapping mode, an inductor can be safely connected in series with the input. This topology can also be derived from boost converter by inserting a transformer. Thus, this is a boost-derived topology. The very presence of series inductor at the input reduces turn-on and turn-off current transients, limits flux imbalance and restricts transformer saturation by providing instantaneous high impedance at the input. Further, there is no need of filter capacitors at the input, making the system compact and simple. There is no problem arising from long lead lengths of the input supply as this will merely add to the input inductance. But Current-fed power converter topologies are implemented less than voltage-fed converters primarily because of cost.

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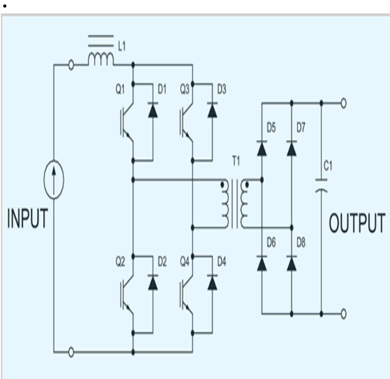
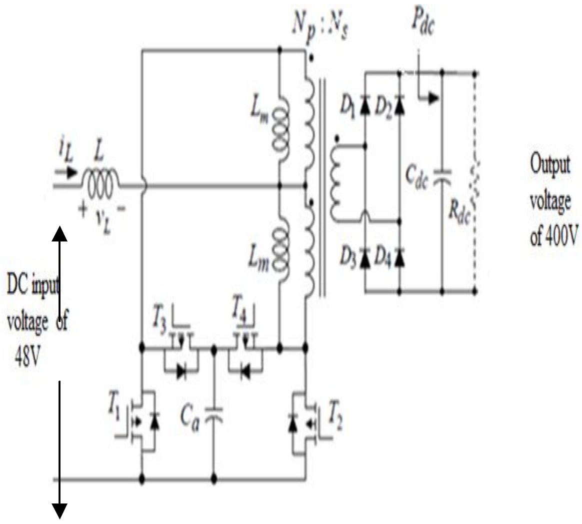


Voltage-fed converters generally have series connected power devices across an input capacitor. Abnormal switching states can permit simultaneous device conduction causing currents to increase very rapidly. In addition, voltage-fed converters can also produce DC offsets which can cause the magnetic core of the main transformer to saturate. To protect power semiconductors under these conditions, high speed fault detection is required. The protection of power semiconductors in high, electrical noise environments is difficult.

Current-fed converters are the electrical dual of voltage-fed converters and prefer a shorted state to an open state of operation. These topologies cannot create fast rising current spikes and cannot cause magnetic core saturation under erroneous conditions. Current-fed converters operate with the robustness of SCR based power supplies, but at high-frequency. Current-fed converters require an additional power processing stage which can be used for control and enhanced system protection.

3. CURRENT-FED PUSH PULL DC-DC CONVERTER

Current-fed power converters is the electrical dual of voltage-fed converters is still another, but less known and used, power circuit alternative for power conversion. The advantage of these power converters over their voltage-fed counterpart is that shoot through and half cycle symmetry cannot cause device failure or core saturation. This is characteristic of SCR based converters and one of the main reasons why current-fed converters tend to be more robust. The main disadvantage of current-fed converters is that a fourth power conversion stage is required to convert the DC bus voltage to a DC current. While the added stage results in additional complexity and losses, the power conversion stages can be made to work more efficiently.



Circuit diagram of CFPP DC-DC converter.

The current-fed push-pull DC/DC converter is shown in Fig. It has two main switches T1 and T2 and two active clamp switches T3 and T4. Switches T1 and T2 operate in complementary function. In the first half cycle the switch T1 is ON and switch T2 will be in OFF position and in next half cycle it is vice versa. Switch T3 and T4 are used to clamp the leakage inductance value when both the switches are off. When both the switches T1 & T2 are off, the voltage in the secondary transformer is zero. At this position, current in the secondary winding is equally shared. Then the voltage to the load is fed by using the output capacitor.

4. DESIGN EXAMPLE

Designing of the push pull transformer is presented in
this section through a design example. A push pull converter with the following specifications is designed to illustrate the design procedure:

Input voltage is Vin= 48V, output voltage Vo=400V, switching frequency fSW= 50 kHz, Ts=20□s, Output current Io=2.5 amps, the nominal duty ratio of the switch D= 0.76. Calculate:

Average primary current, Ip.

$$I_P = \frac{P_{ts}}{V_{in} \times \eta} \text{ [amps]}$$

Average primary voltage, V_p.

$$V_p = (V_{in} X 2D) - (I_p X R_p) \text{ [volts]}$$

The primary turns, N_p.

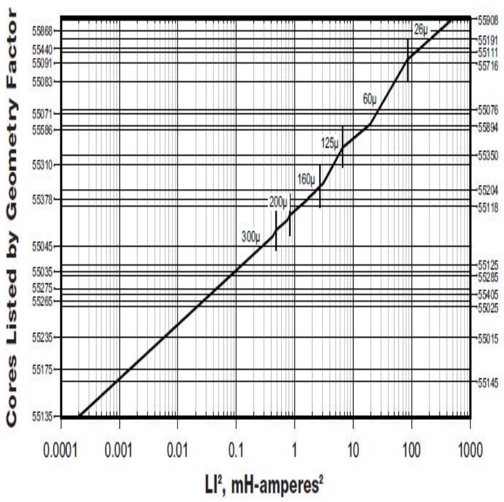
$$N_p = \frac{V_{p} \times 10^4}{k_f \times B_m \times f \times A_c}$$

The secondary turns, N_s

$$N_s = \frac{N_p (V_o + V_d)}{V_p} \times \left(1 + \frac{\alpha}{100}\right)$$

Inductor design example:

The core selection chart can be used as follows:



The magnetizing force H

$$H = \frac{0.4 \pi N I}{l_e}$$

Snubber circuit design example:

Power semiconductors are the heart of power electronics equipment. Snubbers are circuits which are placed across semiconductor devices for protection and to improve the performance. There are many different kinds of snubbers but the two most common ones are resistor-capacitor(RC) and the resistor-capacitor-diode(RCD) turn-off snubber.An RC Snubber, placed across the switch, can be used to reduce the peak voltage at turn-off and to damp the ringing. In most cases a very simple design technique can be used to determine suitable values for the snubber components (Rs and Cs).

5. THREE-PHASE SIX SWITCH INVERTERS

a. Introduction

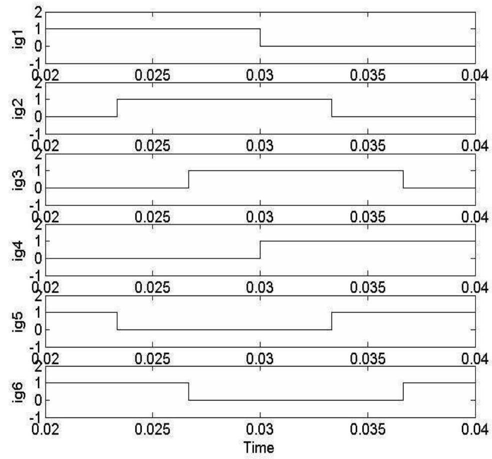
Three phase six-switch inverters are used in many industries For this reason, many researchers have been presented recently investigating different types of fault that Commonly occur in these inverters. Of these, the improvement of the output waveform and reduce harmonic distortion is very important. Therefore, using electronic devices, various types of inverters are presented with different structures, which can reduction harmonic and can Lead to improve the output voltage too. Although, this inverters increase the quality of output voltage and current, but lead to other disadvantages, including increased size, weight and price. Therefore, three phase six switch inverters are important, but these inverters have been used in particular conductive angles such as 120°, 180° and 150°.

b. Structure of three-phase inverters

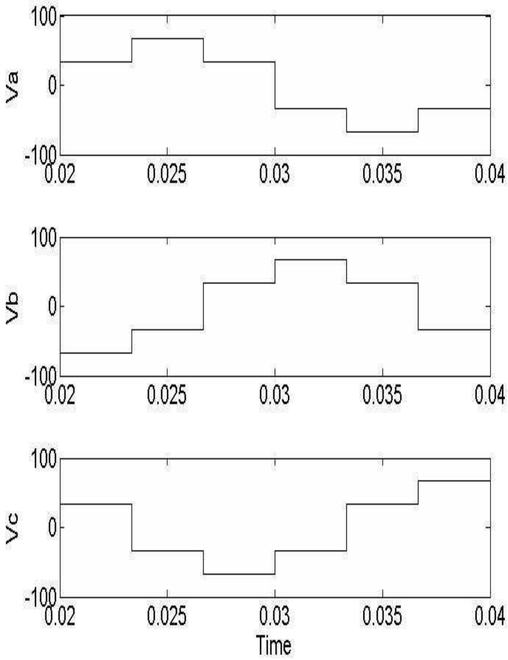
A simple three-phase inverter is shown in Figure. In some structures, the voltage source is divided into two equal parts, and the junction of these two sources, is connected to earth as a reference . Although this type of inverter voltage leads to increased levels of output voltage, but producing two same dc voltage sources is a disadvantage that will create a problem in the industry generally.

3. 180-degree conduction:

This conductive angle is used in many industries. It results in six modes for each period, considering the number of transistors, which each of them is on for a half a period. T1, T5 and T6 transistors turn on in first half time and other transistors are off. AC voltage is produce, by repeating the same process in the next modes. Figure. Shows pulses and output voltage for an ohmic load.



Pulses of 180 degree conduction



Output voltage in 180 degree conduction.

4. Changing the power factor and conductive angle

THD of the output voltage is affected by the power factor and the conductive angle usually. Power factor of load cannot be determined by the designers, and conductive is a

Facility for designer. So the suitable conductive angle is selected considering high RMS and low THD of the output voltage. Conductive angle is changed from 120° to 180° for different power factors of lead and lag loads with simulation then RMS and THD of the output voltage are measured.

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