DESIGN OF SINGLE LINE TO THREE LINE POWER CONVERTER

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Abstract

This power converter is a device that transforms single-line power to three-phase power. The proposed single line to three-line ((1φ or DC)/3φ) power-conversion system contains a power converter; zero-sequence transformer set, and filter capacitors and inductors. Generally, converters are utilized wherever the supply is single-phase to convert it into three-phase we use this type of converters. These converters are mostly used in secluded location and surcharges because of the electric utilities don't install due to cost is too high to install. Three-phase services usually require a high price due to the installation of extra equipment and meters at the transformer and also extra electric wire for transmission is required. In this paper, the single-line to three-phase converter is designed by using SIMULINK toolbox in MATLAB software.

Keywords: MOSFET, Single Line, Three Phase, Fly back Converter, MPPT.

I. Introduction

In Indian agriculture, a wide range of usage of three-phase induction motors because of its rugged in construction and cost. But the availability of the supply does not be three-phase all the time [V, VI]. In some pastoral areas, there is the availability of dc supply through solar. The cost of single-line installation is more when compare to three-line power so the electric generation company doesn't install it. Perversely we use to have a rotary converter, which uses a single-phase three induction motor and
capacitors with help of this two-phase is created and given as an input to the induction motor one end and another end three-phase output is taken. The three-phase output can be delivered by the rotor rotation. The efficiency of the converter is very less. As an option to use connected three-phase, RPC, SPC and power converter VFD are used for decades to generate single-line power to the three-phase source. The cost of installation may be a charge for the customer based on the utilization of the three-phase application due to the demand. The surcharge might be standard for every month [I, II, III]. When the three-phase power is not feasible most of the time we use phase converters. Diminished machine life caused by voltage and current unevenness, the equipment and grid will damage and get polluted due to harmonics. For the delicate equipment or various loads is used to limit the usage of power converters. The power converters that are used to provide a three-phase from single-phase power source for loads with distinct benefits over present converter technology. Several power converts technologies are available [IV, VII].

II. Proposal of the single-line to three-line power converter

The design of a single line to three-line power converter involves development in the power electronics converters with the help of rectifier, chopper, MPPT& inverter.

The conversation of both single-phase AC (230V) and DC (100V) to three-phase AC (415V) supply. The block diagram of this converter is shown in fig.1. DC SOURCE: In this converter there can be a battery of 100V or a solar panel with MPPT techniques that can generate 239V.
III. Solar panel with MPPT techniques

The photovoltaic cell is an electronic device that changes solar power into DC electrical energy whenever the light falls on PV panel, the electrons in the n-type region get excitation energy and generate the photons, because of it the flow of electron takes place. It is a basic principle of the photovoltaic effect. PV panels are made up of trivalent and pentavalent impurities. It is used as an alternative power source in the earth and as the primary battery satellites. The Schematic diagram and commensurate circuit of a photovoltaic module is on Fig.2.

Fig.2. Solar panel diagram

The resultant equivalent circuit of a Photo Voltaic system is called “four parameters model” that can be shown in circuit passion because it includes a source current, a Diode, resistances are in Fig.3.

Fig 3. Model of solar PV cell

The different voltages and currents can be achieved by the PV panel by series and parallel connection of panels and modules.

\[ I = I_{ph} - I_d - I_{sh} \]  \hspace{1cm} (1)
\[ I = I_{ph} - I_{s} \left[ \exp \left( \frac{V + I_{ph}R_{sh}}{nV_T} \right) - 1 \right] - \frac{V + I_{ph}R_{sh}}{R_{sh}} \] \tag{2}

IV. P & O Algorithm

MPPT is the maximum power point technique that includes the tracking of the peak power that is available at that instant from the PV panel.

![Flowchart of P & O algorithm](image)

MPPT technique is used in PV panel charge controllers. It’s an electronic closed-loop DC-DC converter that measures and matches the output from the PV cell and utility grid. MPPT is a non-mechanical and it tracking system that physically moves the module to make the point more directly at the sun. This technique is a digital and electronic system that continuously measures the output and varies the operating point in the module. The modern MPPT charge controller can get a 93%-95% efficient power conversion, however, with the improvement research some of the MPPT charge controller technique can even be up to 97%-99% and typically get a 20-45% gain power in winter to 10-15% gain in summer. Among the different MPPT algorithms, P & O is largely used due to its revolt implementation. The present the P & O algorithm is used in the MPPT technique. The Algorithm is a standout among al

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the most utilized techniques because of its easy implementation of the algorithm and effortlessness. The diagram of the algorithm is in Fig.4.

AC Source: AC Source means the readily available single-phase supply of 230V that is available through transmission line.

V. AC to DC uncontrolled H bridge converter

The converter used in this is an H bridge uncontrolled rectifier. The H bridge converter takes an AC voltage of 230V and uses power diodes arranged in an H bridge manner as shown in Fig. (5).

The output is taken from the top and bottom end of the H Bridge, the input is given to the two legs. The output of these need to be pulsating DC it is to be converted to synergy. DC by filters order to connect a load so that the load does not get more harmonics due the lifetime of the machine does not get reduced. Power diodes are needed to be with the required specifications the diodes have to be with the voltage and current ratings of 250V and 50A. In addition to it, we need a diode with minimal loss; therefore, diodes with less forward blocking capacity and with high reverse blocking capacity are more desirable. The drop at all times due to the internal resistance is 0.7Ω

VI. DC to DC converter

A Fly back converter is a DC converter using the inductive transformer that used as converter and isolation between source and load. The converter used in this is a normal fly back converter with an additional inductive transformer on the primary side of the fly back converter with these two different voltages can be feed to the single converter. In a switch mode, power supplies operate at a high frequency so the size of the inductive transformer is small. Since the frequency is inversely proportional to the size of the transformer. Many papers have been published on the fly back converter most of them are with a single input and single output or multi-
output. The converter used in this has double input and a single output. The circuit of a fly back converter is shown in fig.6.

Fig.6. circuit of fly back converter.

Purpose of the inductive transformer is to maintain isolation between the source side and the load side. So, the magnetizing characteristics inductive transformer is more. Unlike normal AC transformer, this inductive transform has to store energy and despite the to the load side.

VII. DC to AC six leg bridge converter

The main converter used in this is a six-leg bridge dc to ac converter. The six leg -bridge converter takes adc voltage of 239.6V and uses a 6 MOSFET’s settled in hex bridge manner as shown in Fig. 7. The output is taken from the centre of each two legs comes the line which connects to the load of 4775W. The output of these lines needs to be a balanced three-phase which is 120 degrees apart from each other and need to be an approximate sinusoidal waveform which is having a THD% of less than 5% in order to connect a load, so that the load does not get more harmonics dues the lifetime of the machine does not get reduced. It can be achieved by the perfect control technique that is used to control switching waveforms to the gate of the switches. The technique used for the control of the switches is the sinusoidal PWM techniques can be utilized for our equivalently even high-power application, MOSFETs (metal oxide field effect transistor) is need meet our specifications the switch needed minimum ratings of 415V and 30A. In combination to it, we need a switch which has minimum losses; therefore, switches desired with lower resistances. The on considering IGBT in this design there increase in the THD %, so we are using MOSFETS with a resistance of approximately 0.27Ω, but MOSFETs also have a voltage drop in all times due to the drain-source saturation required voltage, which in this case voltage loss is equal to 1.7V.

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VIII. Control of the six leg bridge converter

Sinusoidal PWM technique is used for the control of the switches the VSI.

Design parameters:

| S.no | Parameter                          | Values   |
|------|------------------------------------|----------|
| 1    | Temperature to solar panel (Tp)    | 30°C     |
| 2    | PV cells connected in series       | 60       |
| 3    | PV cells connected in parallel     | 4        |
| 4    | Output Load Resistance (R)         | 36.6 Ω   |
| 5    | Capacitance (C)                    | 0.611 µF |
| 6    | Inductance (L)                     | 0.763 mH |
| 7    | Switching frequency of PWM         | 100 KHz  |
| 8    | Proportional gain (KP)             | 0.006    |
| 9    | Integral gain (KI)                 | 5        |

In this technique, six carrier sine waves are used which are 60 degrees apart from each other so the six waves start from (0, 60,120,180,240,300), and six carrier waves are used to generate the pulses (triangular waves). The use of this technique is to increase the switching at a different time with varying in the turn on the thing that is used in this is shown in fig.16. Operation switching pulse are to be generated.
whenever the carrier wave is larger than the reference wave. With the help of this technique switching pulses are generated with different $T$.

**Table 2. Simulation Parameter of AC-DC converter.**

| S.No | Parameter                        | Value  |
|------|----------------------------------|--------|
| 1    | Input voltage (Vin)              | 230V   |
| 2    | Diode rating                     | 250V, 30A |
| 3    | Capacitance of filter (C)        | 736µF  |
| 4    | Equivalent Load Resistance (R)   | 54.6 Ω |
| 5    | Ripple percentage                | 10%    |
| 6    | Peak voltage                     | 235V   |
| 7    | Output voltage                   | 230V   |

**Table 3. Simulation Parameters of DC-DC converter**

| S.No | Parameter                          | Value    |
|------|------------------------------------|----------|
| 1    | Primary coil voltage T/F1          | 230V     |
| 2    | Primary coil voltage T/F2          | 100V     |
| 3    | Duty ratio                         | 0.165    |
| 4    | Turns ratio of T/F1                | 1:1.04   |
| 5    | Turns ratio of T/F2                | 1:2.35   |
| 6    | Capacitance (C)                    | 0.46µF   |
| 7    | Inductance (L)                     | 60mH     |
| 8    | Switching frequency                | 100KHz   |
| 9    | Output voltage                     | 240V     |

**Table 4. Simulation Parameters of DC-AC converter**

| S.No | Parameter       | Values       |
|------|-----------------|--------------|
| 1    | Voltage input (V) | 239.6V       |
| 2    | Mosfet rating   | 415V, 30A    |
| 3    | Diode rating    | 415V, 30A    |
IX. Simulation Models and Results

MATLAB/SIMULINK MODEL OF THE PHOTOVOLTAIC PANEL:

A Photovoltaic panel is simulated in the MATLAB with the input heat of 20°C and irradiance of 1000w/m². The irradiation will be varied and the corresponding output voltages and current are determined and shown in fig.9. Simulink model is shown in fig.8.

![Simulation Model](image)

Fig 8: The current– Voltage characteristics in a solar panel

The solar panel having the output is continuously monitored by MPPT algorithm by varying the duty ratio of the chopper maximum power output is drawn. The fig. 10.is output of solar panel without mppt&fig.11.is the output from the solar panel with MPPT.

X. Matlab/Simulink Model of The Single Line to Three Line Converter

An input of 230V AC and 230V DC are simultaneously given as an input to the converter and the corresponding output voltages are determined. The Simulink model of a single line to three-line power converter is shown in fig.12.the output voltage from the rectifier is shown in fig.13. The output voltage from the fly back is shown in fig.14 &fig.15.the output voltage from the single line to three-line converter is shown in fig.17.
Fig. 9 Simulink model of the single line to three line converter

Fig. 10 The Graph of output V, I & P obtained at load with MPPT

Fig. 11 Output from the H bridge rectifier
XI. Matlab/Simulink Model of The Photovoltaic Panel

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Fig. 12: Simulink Diagram

Fig. 13: Output from the secondary end of fly back converter.

Fig. 14: Output from the secondary end of additional inductive transformer.
XII. **Total harmonic distortion (THD)**

Shape of closeness of the wave forms between the outputs obtained voltage waveform and its required elementary component that is near to the sine wave. That is the ratio of harmonic component that is totally available in output voltage to the RMS value of the essential component. According to the industrial norms the permissible THD% is 5%. The THD for this converter is shown in fig.18 for R phase.
XIII. Conclusions

The conversion of a single line to three-line is observed in the form of waveforms. The THD % of the R, Y, B phase are taken through FFT analyser that is in the permissible level as per the industrial norms. The use of solar panels, batteries is to help the source even in the load sharing. When the power is available in the DC form can also be converted into the three-phase AC source, so that the use of this conversion technique is to increase the efficiency of the conversion technique is about 82% which is considerably more when compared to the other converter and this converter can be used for multiple purposes and multi-sources.

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