COMPARATIVE STUDY OF SINGLE PHASE AND THREE PHASE AC–AC CONVERTER WITH SERIES AC LINK

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Abstract

Soft switched ac link converters can be configured as dc-dc, dc-ac, ac-ac, ac-dc. This paper proposes a single phase and three phase ac-ac converter and its comparisons. The series ac-link converter is an extension of the dc-dc Cuk converter. In this converter, an ac capacitor is the energy storage element and an inductor is added to initiate the zero-current turn-off and soft turn-on of the switches. The link current and voltage in the series ac-link power converter are both alternating. The efficiencies of the two converters are compared. Light weight and compactness, high efficiency prolonged life time; make the proposed converter, an ideal one for battery-utility interface and windmill application.

Keywords: ac-ac converter, soft switching, ac link.

I. Introduction

Variable recurrence drives commonly have utilized dc voltage or current links for power distribution between the input furthermore, yield converters and as a way to briefly store energy. The dc link based power conversion systems have a few inborn constraints. One of the imperative confinements is the high switching loss and high device stress which happen amid exchanging interims. This seriously lessens the practical switching frequencies. Additionally, while the cost, size, and weight of the fundamental voltage sourced PWM drive is attractive, difficulties with input harmonics, yield dV/dt and over-voltage, EMI/RFI, stumbling with voltage sags, and other problems significantly diminish the economic competiveness of these drives. Additional items are accessible to mitigate these problems, but may result in doubling or tripling the aggregate expenses and misfortunes, with going with substantial increments in volume and weight. In this paper the ac-link universal power converters, which are a new class of power converters, are introduced and concentrated on in subtle element. The inputs and yields of these converters may be dc, ac, single phase, or multi-
phase. Therefore, they can be utilized as a part of an assortment of utilizations, including wind power generation, and electric vehicles. A power converter is needed to connect energy storage to the grid. This converter should be capable of controlling the current or voltage at both sides. There are two common solutions for interfacing energy storage and the grid. The first solution is using two individual power converters: an inverter and a rectifier operating independently. A more reliable and compact solution is using a bidirectional inverter. The main problem associated with this converter is the existence of the dc link, which requires electrolytic capacitors. The electrolytic capacitors are very sensitive to temperature and may cause severe reliability problems, particularly at high temperatures [1]. Therefore, power converters which have dc-electrolytic capacitors are expected to have higher failure rates at higher temperatures.

Figure 1: Three Phase AC-AC Bidirectional Inverter.

Figure 2: Single Phase AC-AC Bidirectional Inverter.

In [2], a bidirectional soft-switching high-frequency ac-link inverter was introduced. This inverter is an extension of the dc–dc buck–boost converter; therefore, it is capable of both stepping up and stepping down the voltage. Several modifications have been applied to the buck–boost converter to provide the alternating link current and the soft switching of the switches. The switches are all turned on at zero voltage, and their turnoff is soft. The alternating link current and voltage eliminate the need for dc-electrolytic capacitors or bulky dc inductors. This inverter belongs to a class of partial resonantac-link converters that was originally proposed in [3]. Being universal, this converter may appear as dc–dc, dc–
ac, ac–dc, or ac–ac. Some of the applications of this converter, which is also called parallel ac-link universal power converters, have been studied in [4]–[6].

II. Principles of Operation

Being universal, the series ac-link universal converter can appear as dc-dc, dc-ac, ac-dc, or ac-ac. Figure 1 represents the schematic of the three-phase ac-ac series ac-link universal power converter. This converter includes 12 unidirectional (or 6 bi-directional) switches on the input-side switch bridge (S1–S11) and 12 unidirectional (or 6 bi-directional) switches on the output-side switch bridge (S12–S23). The link is formed by a series LC pair placed in series with the input and output switch bridges. The main energy storage component is the capacitor, the current and voltage of which are alternating. Hence, a film capacitor can be used instead of the dc electrolytic capacitor, which is commonly used in ac-ac converters. The elimination of the electrolytic capacitors results in a more reliable converter. Link inductor, L, is a small inductor added to encourage the zero current turn off of the switches. This converter needs current sources at the input and output terminals, which can be formed by placing an inductor in series with each voltage source. However, the link capacitor forms a voltage source at the link. The bidirectional converter should operate in the following modes:

1) Rectifier Mode

In the event that the dc side renewable vitality is not accessible converter operates as the rectifier feeding power to dc loads and ac side renewable vitality assets give energy to air conditioning loads. In this mode the converter acts as a rectifier and provide dc yield with less swell component by utilizing channel capacitor \( C_{dc} \).

2) Inverter Mode

If the dc side renewable energy is accessible converter works as the inverter sustaining powerto the ac loads and dc loads directly get power from renewable vitality sources. In this mode the converter go about as a fullbridge inverter and LC filter is used to get the sinusoidal output.

III. Simulation Results

In this paper the control system is delineated and emulated for three stage bidirectional AC-AC inverter utilizing MATLAB/simulink. In this the info air conditioning voltage is persistently detected by voltage sensor and thus it works the hand-off which is set by the evaluated information voltage. In the event that air conditioner information voltage is inside as far as possible the transfer gives the beat to switch An and the converteroperates as an inverter and the yield is a
sine wave with (recurrence 50Hz) less THD utilizing LC channel. Otherwise the hand-off offers pulse to switch B and converter acts as a Rectifier and the yield is unidirectional dc with a swell element under 5%.

Figure 3 : 450 v Input voltage.

Figure 4 : ACLink current.

Figure 5 : ACLink voltage.

Figure 6 : 230 v Output Voltage.
IV. Experimental Results

The Bidirectional converter is composed utilizing MOSFET (IRF640) and Microcontroller PIC 16f877a is used to control the switches in the converter and driver IC IR2110 is utilized for enhancement and isolation between controller and power circuit. In to stay away from gadget disappointment and security, the manufacture and experiments were done as a scaled down voltage level.

![Single Phase Bidirectional AC-AC Inverter](image1)

**Figure 7:** Single Phase Bidirectional AC-AC Inverter.

![Forward Output of Single Phase Bidirectional AC-AC Inverter](image2)

**Figure 8:** Forward Output of Single Phase Bidirectional AC-AC Inverter.

![Reverse Output of Single Phase Bidirectional AC-AC Inverter](image3)

**Figure 9:** Reverse Output of Single Phase Bidirectional AC-AC Inverter.
V. Conclusion

A bidirectional soft-switching ac-link inverter is introduced in this paper. This inverter belongs to a new class of power converters called SEPARCs or series ac-link universal power converters. Being universal, this converter may be configured as dc–dc, dc–ac, ac–dc, or ac–ac. In this paper, the bidirectional dc-to three-phase-ac conversion is studied. It conveys the principles of operation in both three-phase-ac-ac and single-phase-ac-to-ac conversion bidirectional inverters. The control system design of the inverter also is studied in this paper, and the three-phase bidirectional ac-ac converter is evaluated through MATLAB/Simulink results.

The control system design for Microgrid connected single phase bidirectional Inverter are proposed through experimental results. The efficiencies of the two converters are compared. Light weight and compactness, high efficiency prolonged life time; make the proposed converter, an ideal one for battery-utility interface and windmill application.

References


