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Liu

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(54) **POWER CONVERTER CONTROLLED CAPACITOR CIRCUITS AND METHODS**

(71) Applicant: **Queen's University at Kingston**, Kingston (CA)

(73) Assignee: **Queen's University at Kingston**, Kingston (CA)

(58) **Field of Classification Search**
CPC .. B60L 53/60; B60L 2210/10; B60L 2210/30; H02J 7/02; H02M 3/35; H02M 1/143
(Continued)

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H02M 3/335 (2006.01)
H02M 1/42 (2007.01)
H02M 1/14 (2006.01)

(52) **U.S. Cl.**
CPC ***H02M 1/4208*** (2013.01); ***H02M 3/335*** (2013.01); *B60L 2210/10* (2013.01); *B60L 2210/30* (2013.01)

(58) **Field of Classification Search**

USPC 320/109
See application file for complete search history.

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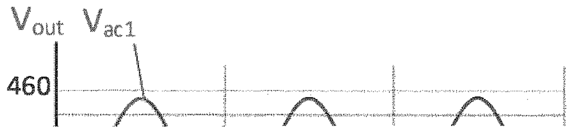
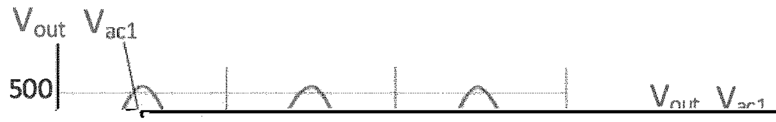
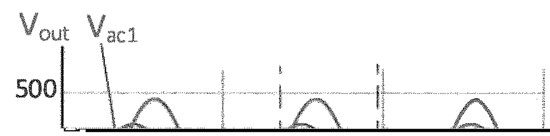
L


I_{in}
I_{out}

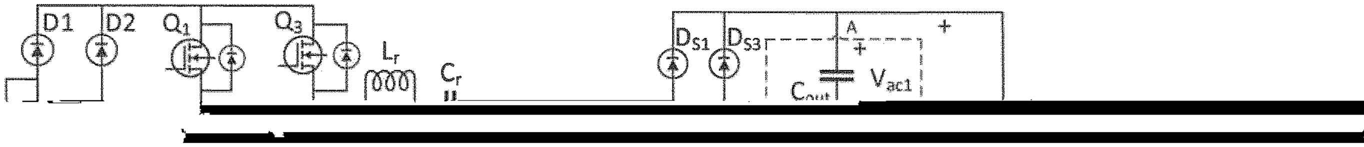

V_{out} V_{ac1}
460


V_{out} V_{ac1}
500


V_{out} V_{ac1}
500


Vout
Vac1
500


L


D1
D2
Q1
Q3
Lr
Cr
DS1
DS3
A
+
Cout
Vac1

POWER CONVERTER CONTROLLED

Thus, for the same volume, the value of a film capacitor is

This application is a 371 of International Application No. PCT/CA2019/050049 filed on Jan. 15, 2019, and claims the benefit of the filing date of Application No. 62/617,399 filed on Jan. 15, 2018, the contents of which are incorporated herein by reference in their entirety.

FIELD

This invention relates to AC-DC supplies. More specifically, this invention relates to circuit and methods for

words, if film capacitors are used to improve the reliability of the battery charger, they require 11 times the volume (or space) of the power supply, which is too large to be practicle.

SUMMARY

According to one aspect of the invention there is provided a series circuit, comprising: a capacitor having a first terminal A and a second terminal; and a power converter having a first output terminal connected to the second terminal of the capacitor and a second output terminal B;

function; wherein the series circuit operates as a capacitor

FIG. 11 shows waveforms obtained from a simulation power converter **42** (Vaux) and the output voltage Vout delivered to the load is a pure DC voltage or a substantially pure DC voltage. It is noted that the current through the

I_in ac. Based on the energy balance concept, the input

106V peak to peak). Waveform 2 is the output voltage of the power converter, Vaux. Its DC voltage value is zero and its AC voltage amplitude is same as the ripple voltage of Vac1

Vac1. Waveform 3 is the capacitor current I_cap. Its ampli

The resonant frequency of this equivalent inductor and the [redacted]

$$F_{resonant} = \frac{1}{2 \cdot 3.14 \cdot \sqrt{L_x \cdot C_{out}}} = 100\text{ Hz} \quad (7)$$

[redacted]

It is noted that if the power converter **42** is controlled by [redacted]

as an inductor with its impedance equal to the impedance of the capacitor Cout. Therefore, impedance between point A and point B is equivalent to an infinitely large capacitor.

[redacted]

as following:

Power Converter Behaves as an Equivalent Impedance

[illegible]

the following equation:

[illegible] (9)

This can also be observed from waveform 1 that the voltage

[illegible]

ripple of Vac1.

The average power the power converter takes is shown in

[illegible]

capacitor. In this way, the output voltage of the linear regulator can follow the change of the ripple voltage. FIG. 6 shows a general circuit diagram for this implementation. In this figure, the output voltage of the linear regulator [illegible]

(Vaux) has same amplitude as the voltage across Cout [illegible]

(Vac1) and is in opposite phase. It is noted that the output of the linear regulator can be both positive and negative.

Implementation Examples of Power Converter Controlled Capacitor

The previous section describes circuit configurations (circuit topologies) and control strategies of the PCCC, according to certain embodiments. This section provides further [illegible]

In the above equation, Vaux_ref is the reference voltage of the power converter (e.g., a full bridge inverter in the example that is discussed here) and the output voltage of the power converter, Vaux, follows the reference voltage [illegible]

Vaux_ref. The parameter k is a value less than 1 (one) but [illegible]

close to 1 (one). For example, if k=0.8, then 80% of the AC ripple will be removed by the power converter and 20% of the ripple will still be present between terminal A and terminal B, as shown by the following equation:

$$Vout=Vac1+Vaux=Vac1\_dc+Vac1\_rip-0.8\ Vac1\_rip=Vac1\_dc+0.2\ Vac1\_rip \quad (14)$$

[illegible]

6. The power supply of claim 5, wherein the AC-DC converter comprises a single stage power factor correction

13. The method of claim 12, further comprising sensing a voltage across the capacitor and using the sensed voltage to