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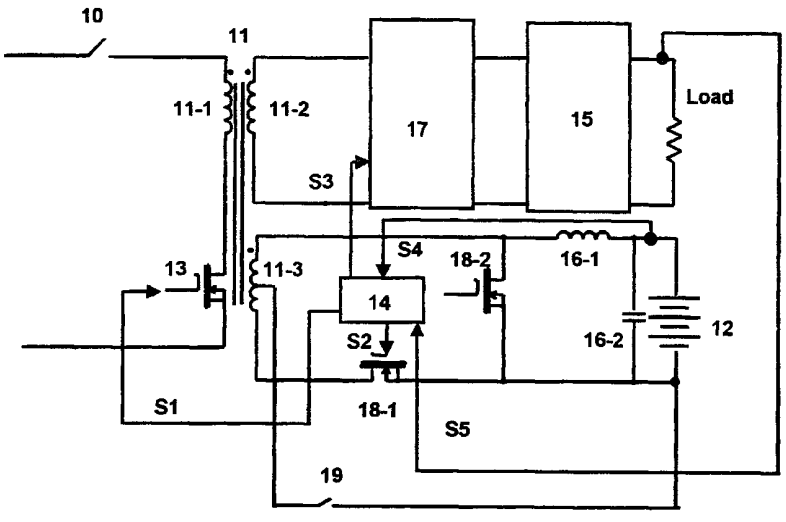
(54) Title: MULTI-OUTPUT SWITCHED POWER CONVERTER PROVIDING AN UNINTERRUPTED VOLTAGE AT ONE OUTPUT




(57) Abstract: Multi-output switched power converter providing an uninterrupted voltage at one output and that is connected to a power source through input terminals. The switched converter includes a transformer (11) that comprises a first primary winding (11-1), a first secondary winding (11-2) connected in cascade with a first rectifier (17) and with a first filter (15) whose output is connected to a load. A second secondary winding (11-3) is connected in cascade with a second rectifier, comprising a second switching element (18-1) and a third switching element (18-2), and with a second filter, comprising a choke (16-1) and a capacitor (16-2), whose output is connected to a battery (12). A first control circuit (14) is adapted for regulating the first switching element (18-1) to permit the battery (12) to discharge through the second secondary winding (11-3), transferring energy to the first secondary winding (11-2), during those periods when the energy supply from the power source fails.

WO 01/48899 A2

# MULTI-OUTPUT SWITCHED POWER CONVERTER PROVIDING AN UNINTERRUPTED VOLTAGE AT ONE OUTPUT

## OBJECT OF DE THE INVENTION

The present invention relates to a multi-output switched power converter that supplies uninterruptedly a regulated voltage to at least one load such as an electric and/or electronic equipment. The load is generally connected to one main output of the switched power converter.

The switched power converter also charges an energy accumulator that is generally connected to one auxiliary output thereof. This energy accumulator is employed for the purpose of ensuring the supply of power to the load in the event of failure in the supply of power from a main source of electric power, connected to the input of the multi-output switched power converter, which is of special application, but not exclusively, in a telecommunication system.

## STATE OF THE ART

In much electronic equipment it is necessary to guarantee continuity of service and, consequently, in the power supplied. To this end, it is possible to employ a first switched converter for feeding the load, a battery as a power storage device, and a second switched converter for adapting the battery power to the requirements of the electronic equipment. Both switched converters can be in series in the power supply line.

In a second case, a multi-output switched power converter is capable of supplying a DC stabilised voltage to various loads, one of them being an electric accumulator or battery, and each one of the loads being connected, respectively, to one output of the switched power converter. Consequently, in the event of failure of the input source, the battery is discharged through an independent switched power converter, which feeds power to the telecommunications equipment.

In a third case, it is employed a multi-output switched power converter having a transformer with at least one primary winding and a set of secondary windings, so that each secondary winding has a transformer relationship with one output of the switched power converter, respectively.

In this case a single switched power converter is employed that includes a transformer, so that the battery is charged through a first secondary winding and is discharged through a second secondary winding.

There is at least a third secondary winding for the provision of the feed output of the battery, which is discharged to provide backup power to the switched power converter in the event that an electric power source ceases to supply it at the input to the switched power converter.

Thus, the switched power converter is capable of continuing to feed in an uninterrupted manner at least one load connected to the main output of the switched power converter.

In brief, the battery uses two auxiliary windings of the multi-output switched power converter, one when it is charging and the other when it is discharging; consequently, there is a duplication of components which results in a greater size, weight, complexity and cost of the multi-output switched power converter.

In some embodiments, the control of this discharge secondary winding is achieved by means of a control block independent of that used for the control of the charge secondary winding, this being described in the book "Practical switching power supply design", section 12.4 "A 60-W, Off-Line Flyback Converter with Battery Backup", pages 227 to 233, by Marty Brown (1990, by Academic Press, Inc.).

Consequently, there is a need to develop a multi-output switched power converter that employs one of its outputs, that is a single secondary winding, both for charging and for discharging of the battery, thereby achieving a reduction in the size, weight, complexity and component count, and an improvement in the overall performance of the multi-output switched power converter.

## CHARACTERISATION OF THE INVENTION

An object of the invention is to overcome the redundancies existing in the previously described state of the art; consequently, the multi-output switched power converter performs both tasks of charging and discharging a battery by means of a single secondary winding, which relates to one of its outputs, as well as to a single control element.

During normal operation of a power source, power is fed from some input terminals of the switched power converter to its outputs. The latter transforms the received power by managing the operation of a first switching element connected in series with a primary winding of a transformer, and produces a pulsed voltage in each of the secondary windings that the

transformer has. Each secondary winding relates to one output of the multi-output switched power converter, and is connected in cascade with a rectifier stage directly connected to a type of load by means of a filter in order to provide a stabilised DC voltage.

In the event of failure of the power source, the battery facilitates backup power through its corresponding secondary winding, this being the same as that with which it is charged.

A first control circuit, such as a pulse width modulator PWM, is adapted to manage the operation of the first switching element for carrying out the charging of the battery and of the load connected to the main output.

This first control circuit can be located both in the primary circuit and in the secondary circuit of the transformer, it being consequently necessary to isolate by means of a pulse transformer (or other device with an equivalent functionality) a control signal of some switching element.

In brief, the auxiliary output connected to the battery acts as primary circuit of the main output of the multi-output switched power converter in the event of temporary outages of the power source.

## BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed explanation of the invention is given in the following description, based on the figures attached, in which:

- figure 1 shows the electric circuit diagram of a preferred configuration of a multi-output switched power converter according to the invention,
- figure 2 shows the path followed by the power flow in the event that a power source supplies power to the multi-output switched power converter according to the invention, and
- figure 3 shows the path followed by the power flow in the event that a battery supplies power to the multi-output switched power converter according to the invention.

## DESCRIPTION OF THE INVENTION

Figure 1 shows a preferred embodiment of a multi-output switched power converter that transforms an input voltage supplied from a power source, such as an alternating current AC mains distribution network, a DC voltage source, or others, into a set of stabilised DC output voltages.

The multi-output switched power converter comprises a switchable element 10 connected in series with a first end of a primary winding 11-1 of a

transformer 11, which has at least a first secondary winding 11-2 that relates with a main output of the switched converter that is connected to a load and/or a power distribution system, and a second secondary winding 11-3, with a predetermined first number of turns, which relates to an auxiliary output of the switched converter that is connected to an electric accumulator, such as a battery 12. Consequently, a pulsed type alternating voltage is produced in each secondary winding of the transformer 11.

Then, the multi-output switched power converter supplies DC voltage via both the main and the auxiliary outputs. Depending on the topology chosen for implementing the multi-output switched power converter, it is possible to implement the main output according to different conversion topologies, such as a forward type configuration, a flyback configuration, or others.

To facilitate a better description of the invention a forward or direct conversion topology has been chosen to serve here as an example, it being possible to employ other conversion topologies.

Thus, the multi-output switched power converter consists of a primary circuit that comprises the switchable element 10 connected to the primary winding 11-1 of the transformer 11, the second end of which being connected in series with a first switching element 13.

A secondary circuit comprises at least two outputs, one is the main output connected directly to a load and the other is an auxiliary output connected directly to the battery.

The main output comprises the first secondary winding 11-2 connected in cascade with a first rectifier stage 17, which includes one or various switching elements, the output of which being connected in cascade with a first filter stage 15, producing at its output the smoothed DC voltage that is fed directly to the load.

The auxiliary output comprises the second secondary winding 11-3 connected in cascade with a second rectifier stage, which includes a second switching element 18-1 and a third switching element 18-2, connected in cascade with a second filter stage, which comprises a choke 16-1 and a capacitor 16-2, its output being connected directly to the battery 12.

A first control circuit 14, such as a pulse width modulator PWM, serves to manage the operation of the first switching element 13 by means of

a first control signal S1 that is applied to a control terminal of the first switching element 13.

When the first switching element 13 is conducting, the voltage supplied from the power source is applied to the primary winding 11-1, inducing a first pulsed type alternating voltage in the first secondary winding 11-2, being suitably rectified and smoothed. Similarly, a second pulsed type alternating voltage is induced in the second secondary winding 11-3, being suitably rectified and smoothed. In this manner the power flows from the input to the load and to the battery 12 in a direct manner (see figure 2).

Depending on the configuration of the first rectifier 17 (forward or flyback) and of the second rectifier 18-1, 18-2, the first control circuit 14 is adapted for generating a second control signal S2 that is applied to a control terminal of the second switching element 18-1, and a third control signal S3 suitable for carrying out the control of the switching elements included in the first rectifier 17.

When the first switching element 13 is in open circuit, the current shall continue flowing towards the load and the battery 12, since both the free-flow switching element of the first rectifier stage 17 and the third switching element 18-2 are forced to conduct.

Likewise, during this period if the multi-output switched converter includes a demagnetising or reset circuit (not shown), the magnetising energy stored in the transformer 11 shall be removed by means of the reset circuit. Said reset circuit is known for an expert in the state of the art.

In brief, the switched power converter transforms the power received from the power source, by management of the first switching element 13, into a set of stabilised DC voltages suitable for the load and the battery 12.

According to an object of the invention, during the charging process of the battery 12 the first control circuit 14 carries out the regulation of the DC voltage corresponding both to the main output and to the auxiliary output, by means of a first voltage sample S4 of the battery 12.

In the event that the power source should fail, the first switching element 13 is put out of operation and, consequently, the battery 12 has to supply the backup power for the multi-output switched converter to continue supplying a DC regulated voltage to its main output. Therefore, at this moment the auxiliary output constitutes the primary circuit of the multi-output

switched converter, and there is a predetermined transformation ratio between the first secondary winding 11-2 and the second secondary winding 11-3 (see figure 3).

During the operation in discharge mode of the battery 12, the first control circuit 14 carries out the regulation of the DC voltage corresponding to the main output by means of a second voltage sample S5 of the main output, or else use is made of some other regulation criterion of those known to an expert in the matter.

The first control circuit 14 is prepared to manage the operation of the second switching element 18-1 so that during the absence of voltage supplied from the power source, the operation of the second switching element 18-1 is similar to the operation of the first switching element 13 described above.

The first control circuit 14 can be implemented in various forms, it being possible to locate it both in the secondary circuit and in the primary circuit. It is also possible to feed it from a third secondary winding (not shown).

The switchable element 10 located in the primary circuit prevents, during the operation in discharge mode of the battery 12, power being fed to the power source connected to the input of the multi-output switched power converter.

Returning to figure 1, the switchable element 10 can be a diode, although in other possible embodiments it can be a switching element, such as a transistor, a field effect transistor MOSFET, or others.

In the case of using a forward topology in both main and auxiliary outputs, and the battery 12 being working in discharge mode, the second secondary winding 11-3 has a number of turns less than the predetermined first number of turns, since one end of the battery 12 is connected to an intermediate tap of the second secondary winding 11-3 by means of a fourth switching element 19; consequently, the second secondary winding 11-3 during the charge of the battery 12 has a greater number of turns than during the discharge thereof.

CLAIMS

1. - **Multi-output switched power converter providing an uninterrupted voltage at one output** that includes a transformer (11) comprising a first primary winding (11-1), a first secondary winding (11-2) connected in cascade with a first rectifier (17) and with a first filter (15) and whose output is connected to a load; a second secondary winding (11-3), with a predetermined first number of turns, that is connected in cascade with a second rectifier, including a second switching element (18-1) and a third switching element (18-2), and with a second filter, including a choke (16-1) and a capacitor (16-2), and whose output is connected to a battery (12); and a power source being connected to some input terminals of the multi-output switched power converter, **characterised** in that it comprises a first control circuit (14) adapted for managing the first switching element (18-1), with the purpose that the battery (12) discharges through the second secondary winding (11-3), transferring energy to the first secondary winding (11-2), during those periods in which the supply of power from the power source fails.

2. - **Multi-output switched power converter** according to claim 1, **characterised** in that the first control circuit (14) is adapted for generating a second control signal (S2) that is applied to a control terminal of the second switching element (18-1).

3. - **Multi-output switched power converter** according to claim 2, **characterised** in that the first control circuit (14) receives a second sample (S5) of the load voltage in order to generate the second control signal (S2).

4. - **Multi-output switched power converter** according to claim 1, **characterised** in that the first control circuit (14) receives a first voltage sample (S4) of the battery (12) in order to generate a first control signal (S1) and the second control signal (S2), for the purpose of managing a first control element (13) while the power source is supplying power.

5. - **Multi-output switched power converter** according to claim 1, **characterised** in that in the event that the first rectifier (17) is implemented in a form similar to the second rectifier, and the first filter (15) is implemented in a form similar to the second filter, the second secondary winding (11-3) has a number of turns less than the predetermined first number of turns during the discharge of the battery (12).

**6. - Multi-output switched power converter** according to claim 5, **characterised** in that one end of the battery (12) is connected to an intermediate tap of the second secondary winding (11-3).

**7. - Multi-output switched power converter** according to claim 6, **characterised** in that the end of the battery (12) is connected to the intermediate tap of the second secondary winding (11-3) through a fourth switching element (19), which is managed by means of the first control circuit (14).

**8. - Multi-output switched power converter** according to claim 1, **characterised** in that a switchable element (10) connected between an end of the first primary winding (11-1) and an end of the power source, is on open circuit during the discharge of the battery (12).

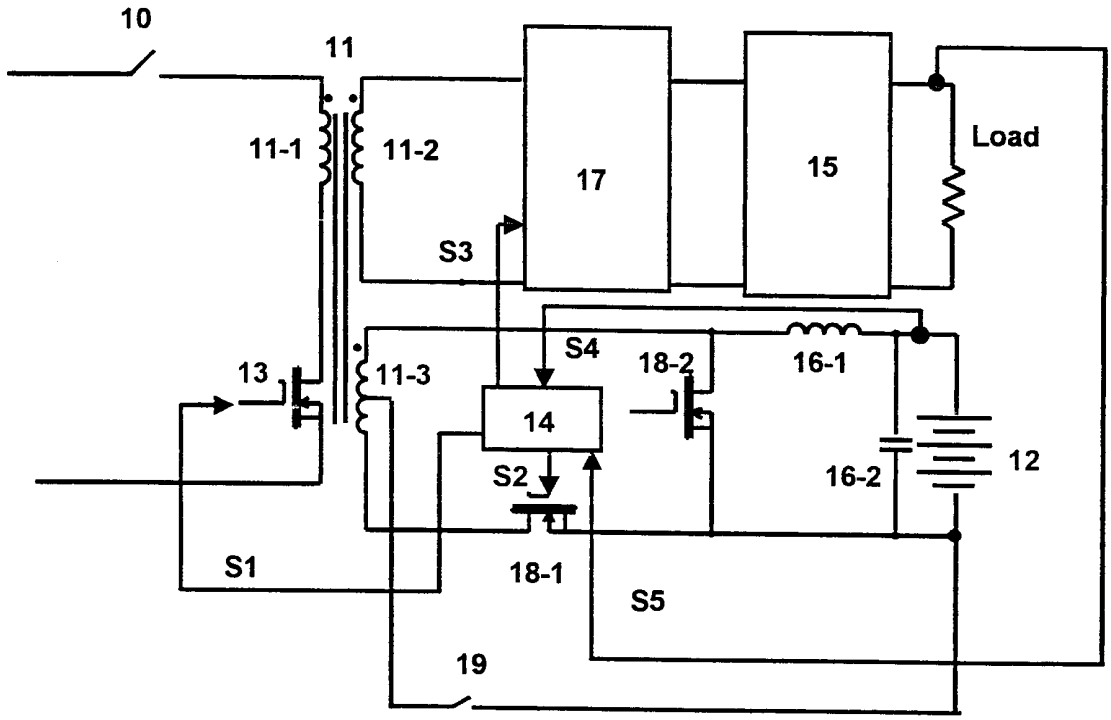

10
11
11-1
11-2
17
15
Load
S3
S4
18-2
16-1
13
11-3
14
12
S2
16-2
S1
18-1
S5
19

Fig. 1

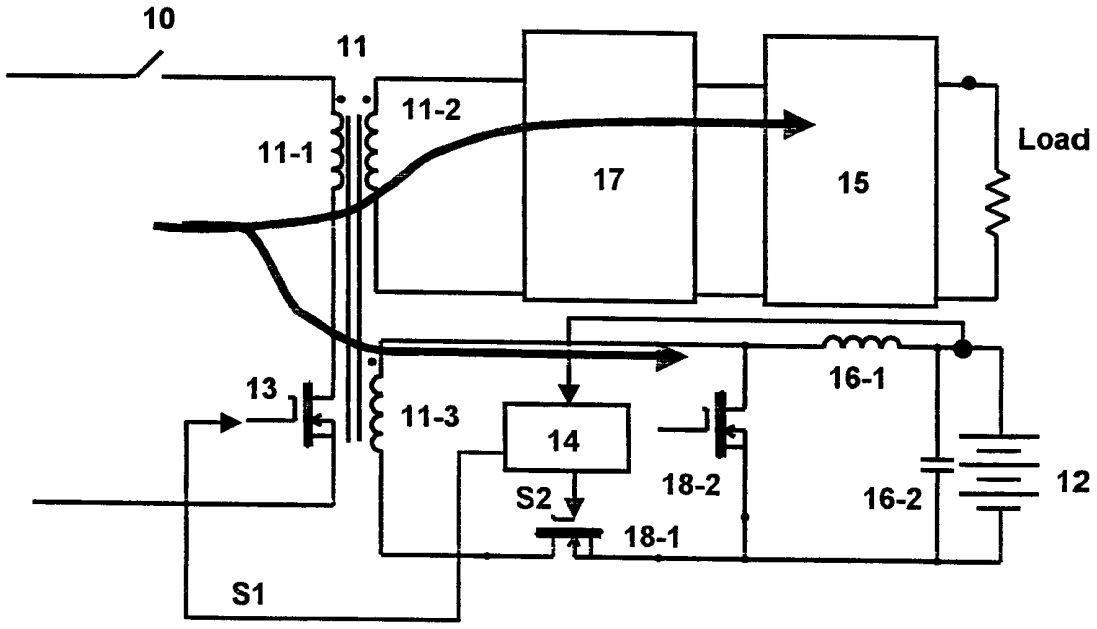

10
11
11-2
11-1
17
15
Load
16-1
13
11-3
14
18-2
S2
16-2
12
18-1
S1

FIG. 2

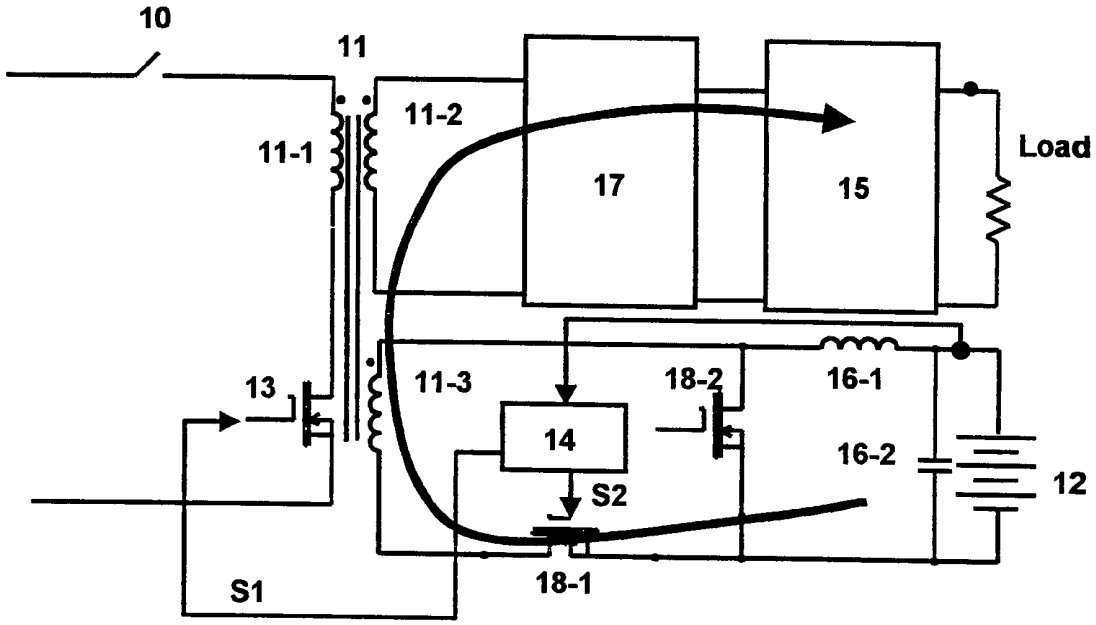



FIG. 3