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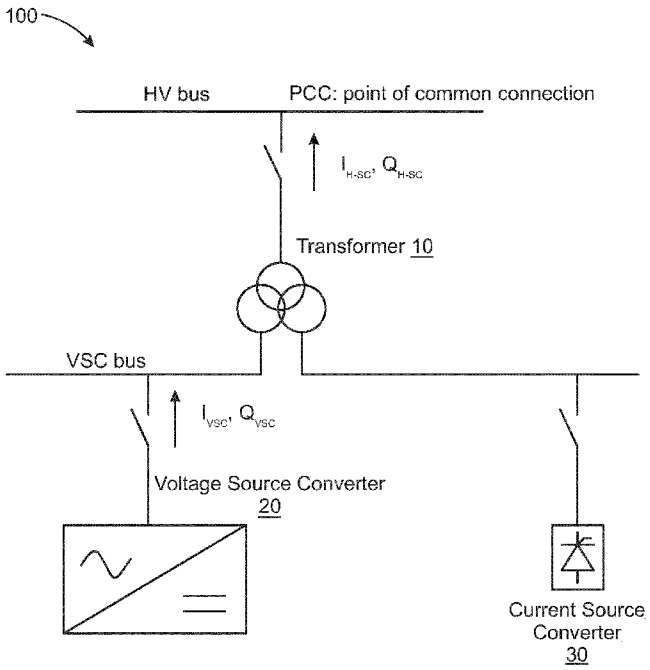


FIG. 2

(57) Abstract: Embodiments herein provide a power control system (100) for controlling reactive power and/or active power in a power network. The power control system (100) is operatively coupled to the power network at a point of common coupling, PCC. The power control system (100) comprises a transformer (10) with at least three windings, in which a primary winding of the transformer (10) being connected to an input from the power network. The power control system (100) further comprises a voltage-source converter, VSC (20), being connected to a secondary winding of the transformer (10), wherein the VSC (20) is configured to work as a source or a sink of reactive power in the power network. The power control system (100) further comprises a Current Source Converter, CSC, (30) being connected to a tertiary winding of the transformer (10) and the CSC (30) is configured to handle power imbalance in the power network. Corresponding power compensator module is also disclosed.

WO 2024/213637 A1

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POWER CONTROL SYSTEM FOR POWER NETWORK

TECHNICAL FIELD

The present disclosure generally relates to power network intended for power transmission. More particularly, it relates to a power control system for handing power imbalance in a power network.

BACKGROUND

In general, renewable energy plays a major role in moving towards a carbon-neutral energy system. Renewable energy based power transmission requires changes in how power is transmitted and distributed to have a dynamic, flexible, and stable power network/power grid. An Alternating Current, AC, Chopper can be deployed to deal with unbalancing of power in case of consumer/transmission line trips in the power network/power grid. In case of trips, excessive active power could be generated thereby rapidly increasing AC frequency. During such scenarios, the AC Chopper is used to temporarily consume the excessive active power, thereby buying time for associated generator to ramp down total power generation. Ramping down the total generation regains a balance between generated and consumed active power, thereby leading to a normal AC frequency.

Webinar document titled "Introduction to ABB Synchronous Condenser offering", Christian Payerl, ABB Motors and Generators, 2020-12-16, retrieved from the Internet – "https://library.e.abb.com/public/1fb2ec9a1eb34241924f030f47048951/Syncon_webinar__2020_Dec_presented_2020DEC.pdf", describes a power control system as a solution to improve grid strength. The power control system disclosed in the webinar document is depicted in Fig 1. As depicted in Fig. 1, the power control system 100 comprises a STATCOM (i.e., VSC) 20, and a Synchronous Condenser, SC, 40. The STATCOM 20 and the SC 40 are integrated on a single transformer 10 to handle power imbalance in the power network by dissipating excessive reactive power present in the power network due to disturbances, for example, a fault in an AC line. The STATCOM/VSC 20 in the power control system 100 is able to rapidly contribute highly controllable voltage regulation during voltage dips. During fault recovery and switching phenomena, the STATCOM 20 has the ability to quickly provide the reactive power support to maintain the system voltage within the allowed limits, thereby

handling the power imbalance. The STATCOM 20 also has a response time suitable for solving the power quality concerns, to actively dampen harmonics in the power control system 100 and voltage fluctuations that produce annoying flickering effects for industrial and domestic consumers. The SC 40 characterized by a high rotating energy with high short circuit current generation capability, is used as a main contributor to boost system inertia. Characteristics response time of the SC 40 (that is relatively fast response for large disturbances and slower response for small signal control), together with its specific overload capacity make the SC 40 very suitable to play an important role in providing voltage support in severe dips and contributing to system frequency response. The power control system 100 combines the complementary operational characteristics of both the STATCOM 20 and the SC 40 to provide highly responsive voltage and frequency regulation. Thus, by sharing the same transformer 10 between the STATCOM 20 and the SC 40, a total cost of the power control system 100 is decreased. Further, by adding separate AC breakers on STATCOM and SC bus, high redundancy is achieved. For example, even if the STATCOM 20 needs to trip, the SC 40 can still stay in operation.

Further, a current source converter, CSC, such as an AC Chopper is typically used in weak/islanded networks to absorb excessive active power, when power transmission is temporarily disturbed, like for instance during a line fault. Since, the CSC uses its own transformer to connect to the AC network and the transformer is required to have a high voltage winding, a unit cost for the CSC is relatively high. Especially when considering that through its entire lifespan the CSC is almost never used, the transformer becomes an expensive and under-utilized high voltage transformer. US2010/171472 discloses a static compensator system for providing reactive and/or active power to a power network, the static compensator system connected to an energy storage device and comprising a static compensator, a voltage source converter, and a booster converter device connected in series with the energy storage device. US2005/015182 discloses a power flow controller for controlling the flow of active and reactive power on an AC transmission line between an input and output includes first and second power converters, coupled to each other to exchange active power and coupled to the input and output.

SUMMARY

Consequently, there is a need for a cost-effective, redundant, and modular power control system for handling power imbalance in a power network that alleviates at least some of the above-cited problems.

It is therefore an object of the present disclosure to provide a power control system for controlling reactive power and/or active power in a power network, to mitigate, alleviate, or eliminate all or at least some of the above-discussed drawbacks of presently known solutions.

This and other objects are achieved by means of a power control system and a power compensator module as defined in the appended claims. The term exemplary is in the present context to be understood as serving as an instance, example or illustration.

According to a first aspect of the present disclosure, a power control system for controlling reactive power and/or active power in a power network is provided. The power control system is operatively coupled to the power network at a point of common coupling, PCC. The power control system comprises a transformer with at least three windings, in which a primary winding of the transformer being connected to an input from the power network. The power control system comprises a Voltage Source Converter, VSC, connected to a secondary winding of the transformer, wherein the VSC is configured to work as a source or a sink of reactive power in the power network. The power control system comprises a Current Source Converter, CSC, connected to a tertiary winding of the transformer and the CSC (30) is configured to handle power imbalance in the power network. Thus, a topology of the power control system creates a cost-effective, redundant, and modular station design, in which different functions such as the VSC and the CSC may relatively share a single transformer (that is an expensive high voltage transformer). Further, the topology of the power control system eliminates a requirement of a dedicated expensive high voltage transformer for the CSC to operate.

In some embodiments, the power control system further comprises a Synchronous Condenser, SC, connected to one of the tertiary winding or to a quaternary winding of the transformer, wherein the SC is configured to either generate or absorb the reactive power

to adjust voltage in power network or to improve power factor in the power network, and to add inertia.

Advantageously, three different functions such as the VSC, the CSC, and the SC may share the relatively expensive high voltage transformer for controlling the reactive power and/or the active power in the power network caused due to disturbances such as faults in an AC grid, or the like. Thereby, power imbalance in the power network may be efficiently handled.

In addition, connecting the different functions such as the VSC, the CSC, and the SC to each winding of the same transformer achieves a cost reduction compared to implementing different dedicated transformers for each function.

In some embodiments, the SC is connected to the tertiary winding of the transformer in parallel with the CSC. Thus, the CSC and the SC may be connected to same winding of the transformer, which may achieve cost reduction.

In some embodiments, the CSC is configured to stay in operation even if the VSC or the SC trips because of any fault in the power network and wherein the VSC is configured to stay in operation even if the CSC or the SC trips because of any fault in the power network. Thereby, achieving high redundancy in operation of the power control system. Any of these converters or the SC is able to work independently no matter which of other units trip.

In some embodiments, the CSC is further configured to handle the power imbalance by absorbing excessive active power in the power network. Thus, the power control system disclosed herein with the CSC may be suitable for the power network used to evacuate power from an onshore weak/islanded AC network.

In some embodiments, the CSC is an Alternating Current, AC, chopper comprising a step-down transformer, a thyristor valve, and an energy dissipation resistor.

In other embodiments, the CSC is one of a Line Commutated Converter-High Voltage Direct Current, LCC-HVDC, or a Static VAR Compensator, SVC.

In some embodiments, the VSC is a Static Synchronous Compensator, STATCOM, which is a power electronic device comprising one or more of: force commutated semiconductor devices, an Insulated Gate Bipolar Transistor, IGBT, and a Gate turn-off thyristor, GTO.

In some embodiments, the SC is a direct current, DC-excited synchronous motor.

According to a second aspect of the present disclosure, a power compensator module is provided. The power compensator module comprises a transformer with at least three windings, wherein the transformer comprises a primary winding, a secondary winding, and a tertiary winding. The primary winding is connected to an input of the power compensator module in order to receive power from a power network that comprises the power compensator module. The secondary winding is connected to a Voltage Source Converter, VSC, that works as a source or a sink of a reactive power in the power network. The tertiary winding is connected to a Current Source Converter that handles an active power in the power network. The power compensator module is configured to control at least one of active power or reactive power in the power network that comprises the power compensation module.

In some embodiments, the transformer of the power compensator module further comprises a quaternary winding. One of the tertiary winding or the quaternary winding of the transformer is connected to a Synchronous Condenser, SC, (40) that either generates or absorbs the reactive power in order to adjust voltage in the power network, or to improve power factor in the power network , and to add inertia.

Therefore, different functions such as the VSC, the CSC, and the SC may share a relatively expensive high voltage transformer in the power compensator module. As a result, the power compensator module may be cost-effective module with high reliability and availability.

In some embodiments, any of the above aspects may additionally have features identical with or corresponding to any of the various features as explained above for any of the other aspects.

Advantage of some embodiments is that the power control system/power compensator module disclosed herein may be used for renewable energy integration, utilizing HVAC and/or HVDC transmission.

Other advantages may be readily apparent to one having skill in the art. Certain embodiments may have some, or all of the recited advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

The foregoing will be apparent from the following more particular description of the example embodiments, as illustrated in the accompanying drawings in which like reference characters refer to the same parts throughout the different views. The drawings are not necessarily to scale, emphasis instead being placed upon illustrating the example embodiments.

Fig. 1 discloses a circuit diagram of an example power control system comprising a Voltage Source Converter, VSC/Static Synchronous Compensator, STATCOM, and a Synchronous Condenser, SC, integrated on a single transformer according to the prior art;

Fig. 2 discloses a circuit diagram of an example power control system according to some embodiments; and

Figs. 3A, 3B, and 3C disclose different topologies of an example power compensator module configured for controlling reactive power and/or active power in a power network according to some embodiments.

DETAILED DESCRIPTION

Aspects of the present disclosure will be described more fully hereinafter with reference to the accompanying drawings. The apparatus and methods disclosed herein can, however, be realized in many different forms and should not be construed as being limited to the aspects set forth herein. Like numbers in the drawings refer to like elements throughout.

The terminology used herein is for the purpose of describing particular aspects of the disclosure only and is not intended to limit the invention. It should be emphasized that the term “comprises/comprising” when used in this specification is taken to specify the presence of stated features, integers, steps, or components, but does not preclude the presence or addition of one or more other features, integers, steps, components, or groups thereof. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise.

Fig. 2 discloses a circuit diagram of an example power control system for controlling reactive power and/or active power in a power network, according to some embodiments. The power control system 100 referred herein is operatively coupled to a power network. In some examples, the power network may be connected to renewable sources such as large windfarm, photovoltaic, PV, sources, or the like, for supporting high power onshore and offshore renewable energy transmissions.

One of the common requirements among the high power renewable energy transmissions is a need to absorb/dissipate excessive reactive power or active power present in the power network during disturbances such as faults in a line, grid, or the like. The excessive reactive power or active power may cause power imbalance in the power network.

In some examples, according to the prior art, Flexible Alternating Current Transmission System, FACTS, devices such as a Static Synchronous Compensator, STATCOM, a Static Var Compensator, SVC, or any other similar dynamic reactive power compensation devices can be used to absorb the reactive power, which further handles the power imbalance in the power network. In some examples, according to the prior art as disclosed in Fig. 1, the power control system is provided to absorb the reactive power during a fault in the power line of the power network, wherein the power control system comprises a STATCOM/Voltage Source Converter, VSC, and a Synchronous Condenser, SC, integrated on a single transformer. In some examples, according to the prior art, the power control system comprises a Current Source Converter for absorbing the active power to handle the power imbalance in the power network. However, a dedicated high voltage transformer is required for an operation of the Current Source Converter, CSC. If the CSC is almost never used in its

lifespan, then the dedicated high voltage transformer becomes an expensive and under-utilized high voltage transformer.

Therefore, according to embodiments herein, a cost-effective, redundant, and modular power control system 100 is provided for handling power imbalance in the power network. The power control system 100 is operatively coupled to the power network at a point of common coupling, PCC.

As depicted in Fig. 2, the power control system 100 comprises a transformer 10, a VSC 20, and CSC 30.

In some examples, the transformer 10 referred herein may be a high voltage transformer. The transformer 10 comprises at least three windings. Among the at least three windings of the transformer 10, a primary winding of the transformer 10 is connected to an input from the power network at the PCC.

In some examples, the VSC 20 referred herein may be a STATCOM. The STATCOM may be a power electronic device, which comprises one or more of: force commutated semiconductor devices, an Insulated Gate Bipolar Transistor, IGBT, and a Gate turn-off thyristor, GTO.

The VSC 20 is connected to a secondary winding of the transformer 10. The VSC 20 is configured to work as a source or a sink of reactive power in the power network. Thus, the VSC 20 may handle power imbalance in the power network by generating or absorbing the reactive power present in the power network.

The CSC 30 is connected to a tertiary winding of the transformer 10. The CSC 30 is configured to handle power imbalance in the power network. The CSC 30 may handle the power imbalance in the power network by absorbing excessive active power in the power network.

Therefore, different functions such as the VSC 20 and the CSC 30 may share a relatively expensive high voltage transformer 10 for controlling the reactive power and/or active power present in the power network due to disturbances such as fault in the AC line, an inverter AC grid, or the like. As the VSC 20 and the CSC 30 share the single transformer 10, a need for a dedicated transformer for the VSC 20 and the CSC 30 may be eliminated. As a

result, a cost of the power control system 100 may be reduced and high redundancy may be achieved.

In some embodiments, the power control system 100 may further comprise a Synchronous Condenser, SC, (40), (not shown in Fig. 2). The SC may be connected to one of the tertiary winding or to a quaternary winding of the transformer 10. The SC may be configured to either generate or absorb the reactive power to adjust voltage in the power network, or to improve power factor in the power network, and to add inertia.

In some embodiments, the power control system 100 may act as a power compensation module. Various topologies of the power compensator module are explained in conjunction with Figs. 3A, 3B, and 3C.

Figs. 3A, 3B, and 3C disclose different topologies of an example power compensator module 300 configured for controlling reactive power and/or active power in a power network. In some embodiments, the power control system disclosed in Fig. 2 may act as the power compensator module 300. The power compensator module 300 is configured to control at least one of active power or reactive power in the power network that comprises the power compensator module 300. Sudden active power or reactive power imbalances may occur in the power network due to disturbances such as fault in an AC line, AC grid, or the like.

In some embodiments, as depicted in Fig. 3A, the power compensator module 300 comprises the transformer 10. The transformer 10 comprises three windings, a primary winding, a secondary winding, and a tertiary winding.

The primary winding is connected to an input of the power compensator module 300 in order to receive power from the power network. In some examples, the input may be a PCC in the power network. In embodiments disclosed herein, the primary winding of the transformer 10 may be referred as a PCC winding and other windings of the transformer 10 may be referred as non-PCC windings.

The secondary winding of the transformer 10 is connected to the VSC 20. The VSC 20 works as a source or a sink of a reactive power in the power network. In some examples, the VSC 20 may include a STATCOM. The STATCOM may be a power electronic device, which

comprises one or more of: force commutated semiconductor devices, an Insulated Gate Bipolar Transistor, IGBT, and a Gate turn-off thyristor, GTO.

The tertiary winding of the transformer 10 is connected to the CSC 30. The CSC 30 handles an active power in the power network. The CSC 30 may handle the power imbalance by absorbing excessive active power in the power network. In some examples, the CSC 30 may include an Alternating Current, AC, chopper that comprises a step-down transformer, a thyristor valve, and an energy dissipation resistor. In other examples, the CSC 30 may include a Line Commutated Converter-High Voltage Direct Current, LCC-HVDC, or a Static VAR Compensator, SVC.

In some embodiments, as depicted in Fig. 3B, the tertiary winding of the transformer 10 may be connected to the SC 40, which is arranged in parallel with the CSC 30. Advantageously, connecting the SC 40 and the CSC 30 to the same winding of the transformer 10 achieves a cost reduction compared to connecting the SC 40 and the CSC 30 individually to separate windings of the transformer 10.

The SC 40 may either generate or absorb the reactive power in order to adjust voltage in the power network or to improve power factor in the power network. In some examples, the SC 40 may be a DC-excited synchronous motor/synchronous condenser, SC. The SC is a rotating mechanical mass.

In some embodiments, any of the VSC 20, CSC 30, or the SC 40 may be configured to stay in operation even if any of the other device trips because of any fault in the power network. Vice versa is also true.

In some embodiments, as disclosed in Fig. 3C, the power compensator module 300 comprises the transformer 10 with four windings, a primary winding, a secondary winding, a tertiary winding, and a quaternary winding. In some examples, voltage levels of three non-PCC windings such as the secondary, tertiary, and quaternary windings may be designed freely according to their respectively functional design requirements. In other examples, number of turns or turn ratio of three non-PCC windings such as the secondary, tertiary, and quaternary windings may be designed freely according to their respectively functional design requirements.

The primary winding of the transformer 10 is connected to the input of the power compensator module 300 (i.e., at a PCC) in order to receive power from the power network that comprises the power compensator module 300.

The secondary winding of the transformer 10 is connected to the VSC 20 that works as the source or the sink of the reactive power in the power network.

The tertiary winding and quaternary winding of the transformer 10 may be connected to the CSC 30 and the SC 40, respectively. The CSC 30 is configured to handle power imbalance in the power network by absorbing the active power in the power network. The SC 40 is configured to either generate or absorb the reactive power to adjust voltage in the power network or to improve power factor in the power network, and to add inertia.

In some embodiments, any of the VSC 20, CSC 30, or the SC 40 may be configured to stay in operation even if any of the other device among these is tripped because of any fault in the power network. Vice versa is also true.

Thus, the power compensator module 300 disclosed herein may be a cost-effective modular design with high reliability and availability, as various functions such as the VSC 20, the CSC 30 and optionally the SC 40 share the single high voltage transformer 10 for controlling the reactive power and/or active power in the power network. As a result, power imbalance or voltage may be adjusted efficiently in the power network.

In addition, the power compensator module 300 may be used for renewable energy integration with HVAC and/or HVDC transmission.

The foregoing description of the specific embodiments will so fully reveal the general nature of the embodiments herein that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. Therefore, while the embodiments herein have been described in terms of preferred embodiments, those skilled in the art will

recognize that the embodiments herein can be practiced with modification within the scope of the disclosure.

CLAIMS:

1. A power control system (100) for controlling reactive power and/or active power in a power network, the power control system (100) being operatively coupled to the power network at a point of common coupling, PCC, the power control system (100) comprising:

a transformer (10) with at least three windings, in which a primary winding of the transformer (10) being connected to an input from the power network;

at least one Voltage Source Converter, VSC, (20) being connected to a secondary winding of the transformer (10), wherein the VSC (20) is configured to work as a source or a sink of reactive power in the power network; and

at least one Current Source Converter, CSC, (30) being connected to a tertiary winding of the transformer (10), wherein the CSC (30) is configured to handle power imbalance by absorbing excessive active power in the power network.

2. The power control system (100) according to claim 1, further comprising

at least one Synchronous Condenser, SC, (40) connected to one of the tertiary winding or to a quaternary winding of the transformer (10), wherein the SC (40) is configured to provide dynamic reactive power to improve power factor in the power network, and to add inertia.

3. The power control system (100) according to claim 2, wherein the SC (40) is connected to the tertiary winding of the transformer (10) in parallel with the CSC (30).

4. The power control system (100) according to any of the preceding claims, wherein the CSC (30) is an Alternating Current, AC, chopper comprising a step-down transformer, a thyristor valve, and an energy dissipation resistor.

5. The power control system (100) according to any of the claims 1-3, wherein the CSC (30) is one of a Line Commutated Converter-High Voltage Direct Current, LCC-HVDC, or a Static VAR Compensator, SVC.

6. The power control system (100) according to any of the preceding claims, wherein the VSC (20) is a Static Synchronous Compensator, STATCOM which is a power electronic device comprising one or more of: force commutated semiconductor devices, an Insulated Gate Bipolar Transistor, IGBT and a Gate turn-off thyristor, GTO.

7. The power control system (100) according to any of the claims 2-6, wherein the SC (40) is a Direct Current, DC-excited synchronous motor.

8. A power compensator module (300), comprising:

a transformer (10) with at least three windings, wherein the transformer (10) comprises:

a primary winding of the transformer (10) being connected to an input of the power compensator module (300) in order to receive power from a power network that comprises the power compensator module (300);

a secondary winding of the transformer (10) being connected to a Voltage Source Converter, VSC, (20) that works as a source or a sink of reactive power in the power network, and

a tertiary winding of the transformer (10) being connected to a Current Source Converter, CSC, (30) that handles power imbalance by absorbing excessive active power in the power network, and

wherein the power compensator module (300) is configured to control at least one of active power or reactive power in the power network that comprises the power compensator module (300).

9. The power compensator module (300) according to claim 8, further comprising a quaternary winding of the transformer (10), wherein one of the tertiary winding or the quaternary winding of the transformer (10) is connected to Synchronous Condenser, SC, (40), that provides dynamic reactive power to improve power factor in the power network , and to add inertia.

10. The power compensator module (300) according to claim 9, wherein the SC (40) is connected to the tertiary winding of the transformer (10) in parallel with the CSC (30).

11. The power compensator module (300) according to any of the claims 8-10, wherein the CSC (30) is an Alternating Current, AC, chopper comprising a step-down transformer, a thyristor valve, and an energy dissipation resistor.

12. The power compensator module (300) according to any of the claims 8-10, wherein the CSC is one of a Line Commutated Converter-High Voltage Direct Current, LCC-HVDC, or a Static VAR Compensator, SVC.

13. The power compensator module (300) according to any of the claims 8-12, wherein the VSC (20) is a Static Synchronous Compensator, STATCOM, which is a power electronic device comprising one or more of force commutated semiconductor devices, Insulated Gate Bipolar Transistor, IGBT, Gate turn-off thyristor, GTO.

14. The power compensator module (300) according the any of the claims 9-13, wherein the SC (40) is a Direct Current, DC-excited synchronous motor.

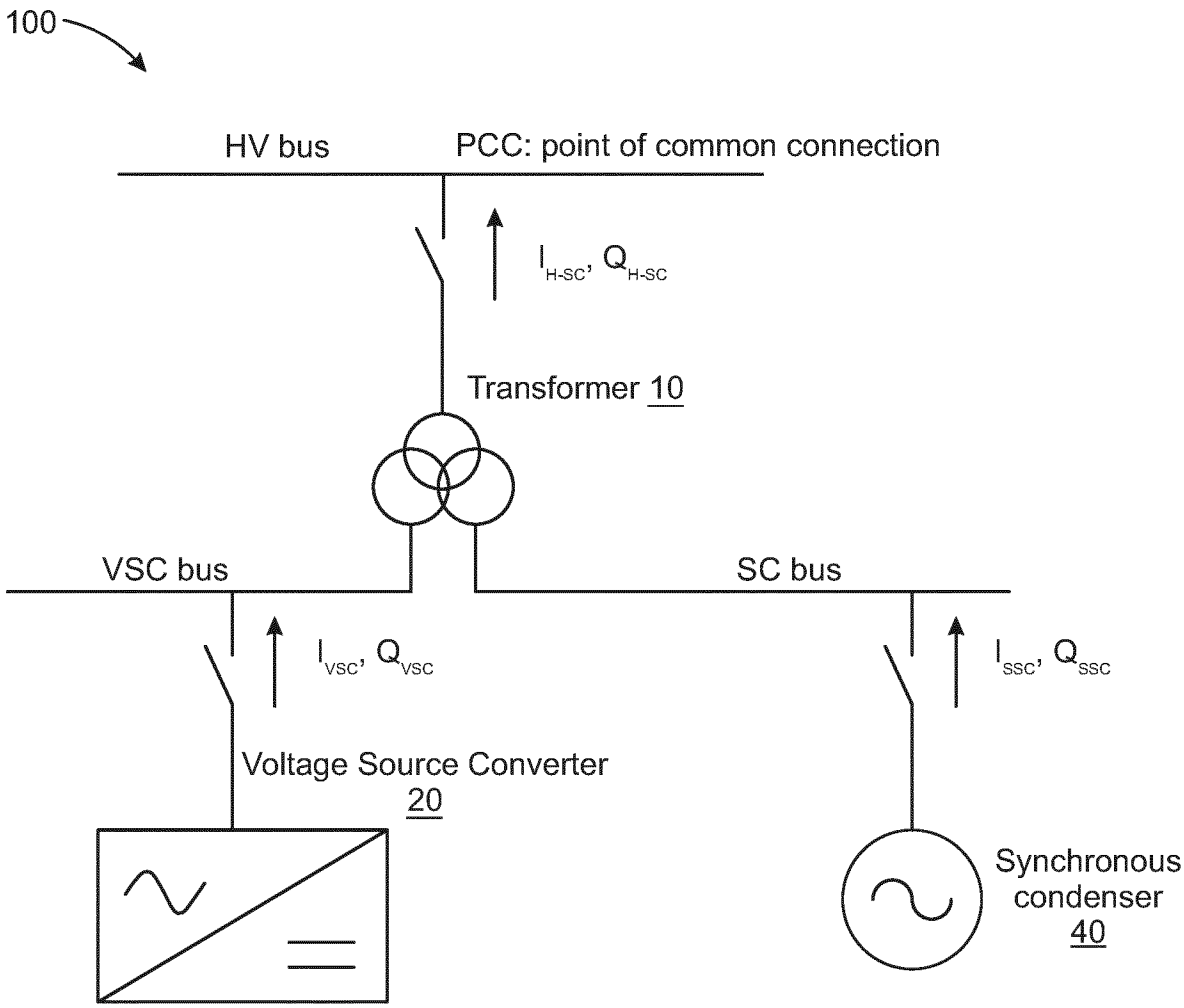

100
HV bus
PCC: point of common connection
I_{H-SC}, Q_{H-SC}
Transformer 10
VSC bus
SC bus
I_{VSC}, Q_{VSC}
I_{SSC}, Q_{SSC}
Voltage Source Converter
20
Synchronous
condenser
40

FIG. 1

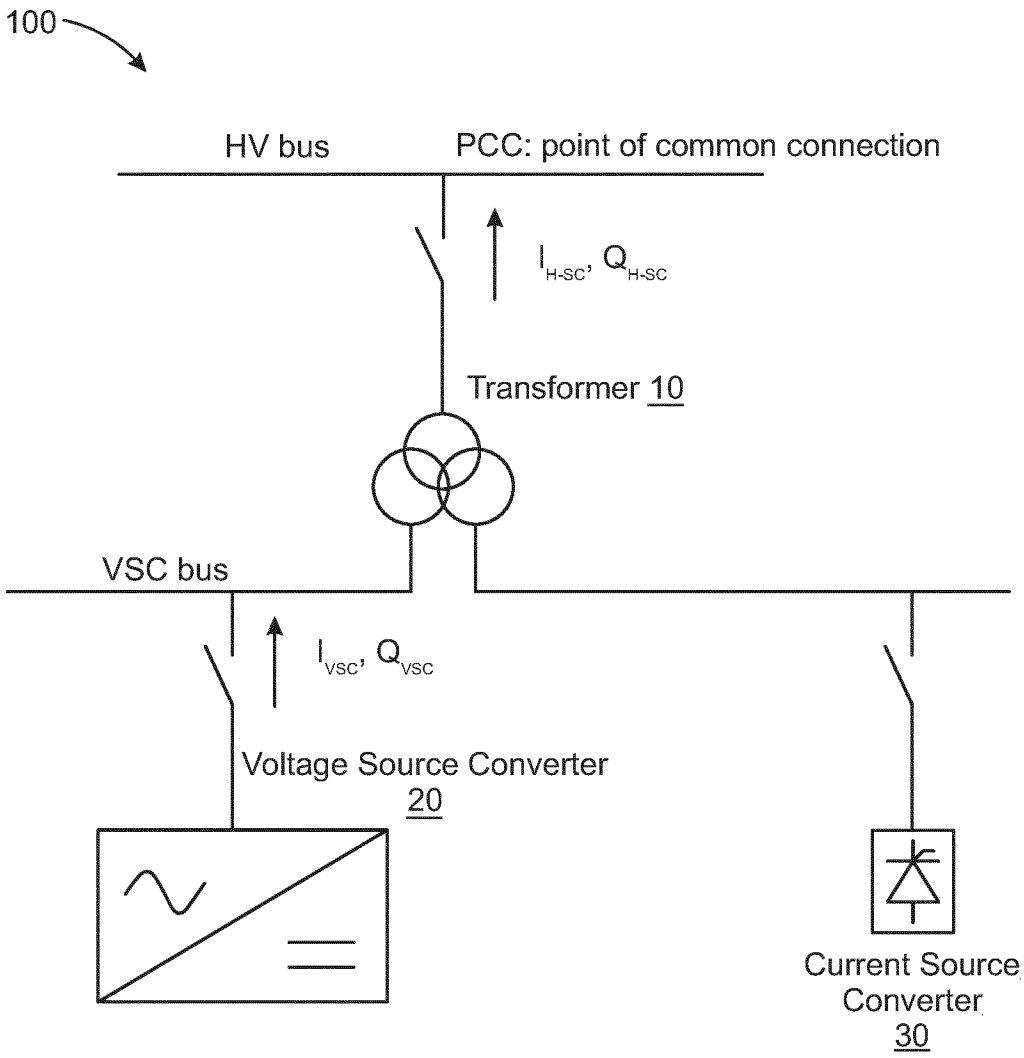

100
HV bus
PCC: point of common connection
I_{H-SC}, Q_{H-SC}
Transformer 10
VSC bus
I_{VSC}, Q_{VSC}
Voltage Source Converter
20
Current Source
Converter
30

FIG. 2

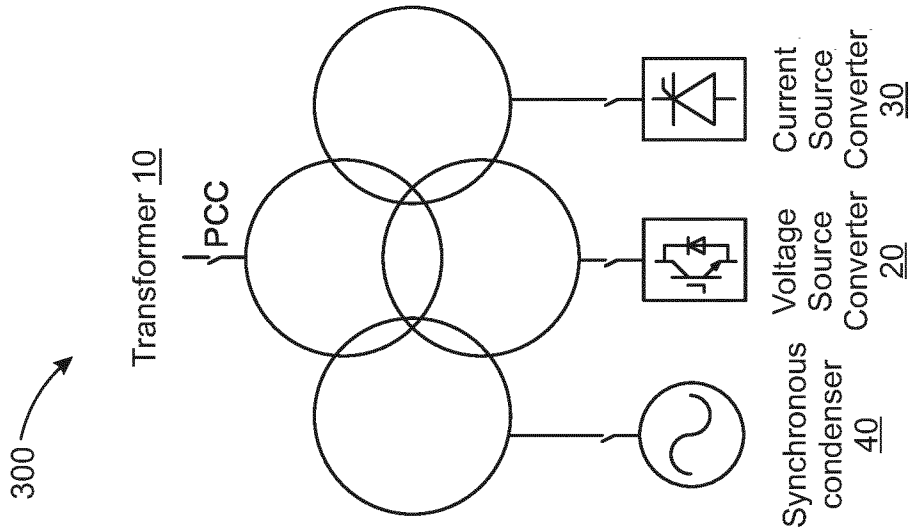


FIG. 3A

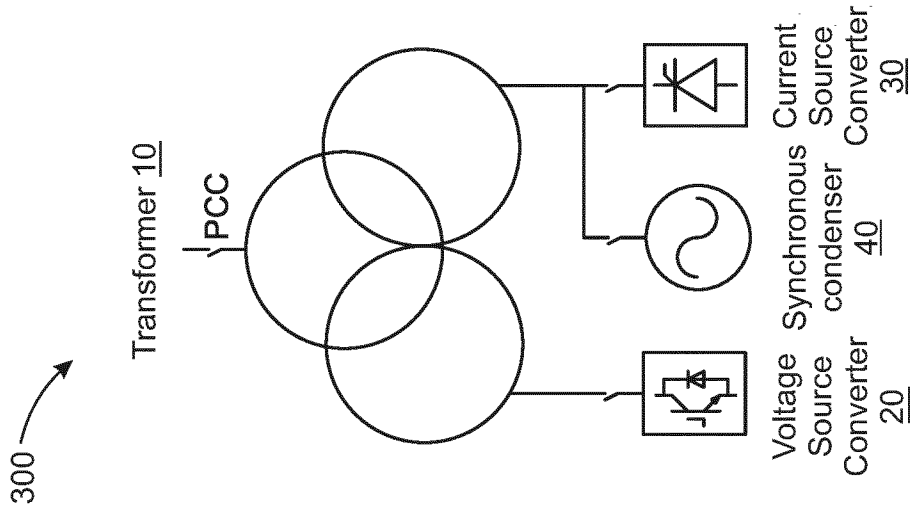


FIG. 3B

FIG. 3C

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2024/059839

A. CLASSIFICATION OF SUBJECT MATTER
INV. H02J3/32 H02J3/38 H02J3/46
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
H02J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2010/171472 A1 (ANGQUIST LENNART [SE]) 8 July 2010 (2010-07-08) the whole document -----	1-14
A	US 2005/015182 A1 (BEBIC JOVAN [CA] ET AL) 20 January 2005 (2005-01-20) the whole document -----	1-14

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance;; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance;; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
7 May 2024	27/05/2024

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Hunckler, José

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/EP2024/059839

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2010171472 A1	08-07-2010	AT E533220 T1	15-11-2011
		CN 101803139 A	11-08-2010
		EP 2191550 A1	02-06-2010
		ES 2375101 T3	24-02-2012
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		WO 2009033506 A1	19-03-2009
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		CA 2504435 A1	21-05-2004
		CN 1732606 A	08-02-2006
		EP 1573878 A1	14-09-2005
		PT 1573878 T	11-07-2016
		US 2005015182 A1	20-01-2005
		WO 2004042889 A1	21-05-2004