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Datasheet for the decision of 24 January 2012

Case Number: T 2073/08 - 3.5.02

Application Number: 04250978.6

Publication Number: 1463190

IPC: H02M 3/335, H02M 7/537, H02M 1/10

Language of the proceedings: EN

Title of invention:
Reliable board mounted power module

Applicant:
LUCENT TECHNOLOGIES INC.

Opponent:
-

Headword:
-

Relevant legal provisions:
EPC Art. 56

Keyword:
"Inventive step - no"

Decisions cited:
-

Catchword:
-

Case Number: T 2073/08 - 3.5.02

D E C I S I O N
of the Technical Board of Appeal 3.5.02
of 24 January 2012

Appellant: (Applicant)
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Decision under appeal: **Decision of the Examining Division of the European Patent Office posted 18 June 2008 refusing European patent application No. 04250978.6 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman: M. Ruggiu
Members: M. Rognoni
P. Mühlens

Summary of Facts and Submissions

I. The appellant (applicant) appealed against the decision of the examining division refusing European patent application No. 04 250 978.6.

II. In the contested decision, the examining division found, *inter alia*, that, notwithstanding objections under Articles 84 and 123(2) EPC, the subject-matter of claim 1 then on file did not involve an inventive step over the combination of the following documents and common knowledge:

D6: US-B1-6 275 958,

D9: Yaow-Ming Chen *et al.* "Multi-Input DC/DC Converter Based on the Multiwinding Transformer for Renewable Energy Applications", IEEE Transactions on Industry Applications, Vol. 38, No. 4, July/August 2002, pages 1096 to 1104, XP011073486.

III. With the statement of grounds of appeal, the appellant filed a first set of claims 1 to 8 and a second set of "alternative" claims 1 to 8.

IV. In a communication dated 7 September 2011 summoning the appellant to oral proceedings, the Board addressed a number of issues concerning the appellant's requests and introduced the following document into the proceedings:

D10: US-B2-6 496 394.

V. In reply to the Board's communication, the appellant filed a new set of claims 1 to 8 with a letter dated 12 December 2011

VI. With a letter dated 13 December 2011, the appellant informed the Board that they would not be attending the oral proceedings set for 24 January 2012.

VII. On 24 January 2012, oral proceedings were held in the absence of the appellant.

VIII. The appellant requested in writing that the decision under appeal be set aside and that a patent be granted on the basis of claims 1 to 8 filed with letter dated 12 December 2011.

IX. Claim 1 of the appellant's request reads as follows:

"A power system for supplying power to a plurality of circuits, comprising a plurality of power supply units for providing direct current (dc) power to groups of said plurality of circuits, wherein each of said power supply units is a highly reliable power supply unit for supplying direct current power, comprising:

a transformer (225) having a first (221) and a second (211) primary winding and one secondary winding (222);

a first input power train unit (101) connected to a first source of power (201, 202), for converting dc into pulse width modulation (PWM) signals connected to said first primary winding of said transformer;

a second input power train unit (210) connected to a second source of power (203, 204), for converting dc into PWM signals connected to said second primary winding of said transformer;

an output power train unit (102) connected to the one secondary winding (222) of said transformer, said output power train unit receiving an input from said secondary winding and converting said input into a reliable output power source for supplying direct current power;

Characterized in that

said first and said second power train units are similar;

said first and said second power train units supply power on a load sharing basis;

wherein said PWM signals of said first and said second input power train units are separately controlled under the control of a single programmed controller;

wherein said controller is arranged to provide separate signals (231, 232) to said first and said second power train units in order to vary an amount of energy supplied by said first and said second power train units in response to data received from said system for optimizing use of said first and said second sources of power under normal conditions and in the presence of trouble conditions."

Claims 2 to 8 are directly or indirectly dependent on claim 1.

X. The appellant's arguments relevant to the present decision may be summarized as follows:

The invention related to a highly reliable power supply unit for supplying dc power. Normally, high reliability was considered to be reliability even in the face of troubled conditions in the unit whose reliability was being enhanced. The present application took a broader view and was directed to a system which was reliable even in the face of problems of the source of power in a larger system of which the highly reliable power unit was a part.

The subject-matter of claim 1 therefore differed from the dc power supply unit known from D9 in that claim 1 further defined the following:

- The highly reliable power supply unit for supplying dc power was comprised in a system including a plurality of circuits and at least a further highly reliable power supply unit which provided dc power to groups of this plurality of circuits.

- The power output of the first and second power train units were separately controlled under the control of a single programmed controller.

- This single programmed controller was arranged to provide separate signals to the first and the second power train units and to vary an amount of energy supplied by the first and second power train units in response to data received from the system for optimising use of the first and second sources of power under normal conditions and in the presence of trouble conditions.

The teachings of D6 as highlighted in Figure 6 were simply that it was possible to control individual power supplies feeding a common load so that those power supplies which were defective were removed from supplying power to the load. The power supplies of Figure 6 were complete, not partial power supplies as indicated by the use of the term power input train in claim 1. In fact, the various power supplies of Figure 6 were all connected to a common input power source. The arrangement according to the present invention, however, allowed for continued operation even if one of the power distribution sources was able to supply some but not all of the power needed by the target power supply and one or both power distribution sources had too high or too low voltages or an out-of-range temperature. These were conditions which might be alleviated by taking less or more power from that power distribution source. Furthermore, an office energy management controller might reduce the input power to select power supplies. On the other hand, all the teachings of document D6 referred to the possibility of shutting down a defective power supply and did not refer, as in the present application, to the readjustment of load drawn from the different input power sources.

As to D9, its teaching did not imply the necessity of using only a single controller, whereas according to claim 1 only a single controller controlled the output of each of the input power trains.

In summary, the combination of the D6 and D9 did not teach arrangements for drawing more or less power from one of the power sources in case, for example that a power source was overloaded.

Document D10 taught an arrangement for supplying reliable ac power from a plurality of power sources (inverters), which were connected in parallel to the output load. While D10 taught that different factors might be controlled to supply different amounts of power, it did not contain a teaching of how this was to be accomplished in the context of a plurality of input power trains coupled to an output train by a multi-winding transformer. Furthermore, importantly, in contrast to the present invention where one controller was used to control the outputs of all the coupled input power trains, D10 taught that each inverter had its own inverter circuit control device. Claim 1, however, went on to state that the controller provided separate signals to the input power train units. Advantageously, in accordance with the invention, the split of power production could be directly controlled, instead of relying on an indirect approach wherein one power train reduced or increased its power, and the other responded by sensing an increase or decrease in the output voltage.

In summary, the power system of the invention was not taught by the cited prior art and thus was new and involved an inventive step. As the appellant's request satisfied all the requirements of the EPC, it provided a basis for the grant of a patent.

Reasons for the Decision

1. The appeal is admissible.

2. Claim 1 relates to a power system for supplying power to a plurality of circuits, comprising a plurality of power supply units for providing direct current power to groups of said plurality of circuits. Each of the power supply units is a highly reliable power supply comprising the following features:

(a) a transformer having a first and a second primary winding and one secondary winding;

(b) a first input power train unit connected to a first source of power, for converting dc into pulse width modulation (PWM) signals connected to said first primary winding of said transformer;

(c) a second input power train unit connected to a second source of power, for converting dc into PWM signals connected to said second primary winding of said transformer;

(d) an output power train unit connected to the one secondary winding of said transformer, said output power train unit receiving an input from said secondary winding and converting said input into a reliable output power source for supplying direct current power;

(e) said first and said second power train units are similar;

(f) said first and second power train units supply power on a load sharing basis;

(g) said PWM signals of said first and said second input power train units are separately controlled under the control of a single programmed controller;

(h) said controller is arranged to provide separate signals to said first and said second power train units in order to vary an amount of energy supplied by said first and said second input power train units in response to data received from said system for optimizing use of said first and said second sources of power under normal conditions and in the presence of trouble conditions.

3.1 Document D9 (see Figure 1) relates to a "Multi-Input DC/DC Converter" (i.e. to a power supply unit according to the language of claim 1) comprising features (a) to (d) recited in the preamble of claim 1.

As shown in Figure 1, the first input-stage circuit and the second input-stage circuit have the same topology and correspond to the first and second input power train units of the power supply unit recited in claim 1 (see feature (e)).

3.2 As to feature (f), Figure 1 of D9 shows a *"two-input current-fed full-bridge dc/dc converter"* with phase-shifted pulse width modulation (PWM) control. According to D9, page 1096, right-hand column, second paragraph, this converter has*, inter alia,* the advantage that *"1) magnitudes of dc input voltages can be different; 2) dc sources can deliver power individually and simultaneously; 3) the soft-switching technology is accessible"*.

Furthermore, as explained in section II. of D9 ("OPERATION PRINCIPLE OF THE PROPOSED CONVERTER" - see in particular first and third paragraphs), the number of input-stage circuits can be increased to meet the practical requirements of multi-input dc sources. Power transfer from the input-stage circuit to the output-stage circuit can be varied as required by selecting an appropriate PWM control scheme (see D9, Figure 2).

In other words, as summed up in the abstract, output voltage regulation and power flow control is achieved by the phase-shifted PWM control.

3.3 Thus, D9 discloses a power unit comprising, or necessarily implying, also the following features expressed in the language of claim 1:

(g) the power output of the first and second power train units (*i.e.* first and second input-stage circuits) can be separately controlled under the control of a programmed controller (cf. D9, page 1097, right-hand column, last paragraph);

– said controller is arranged to vary an amount of energy supplied by said first and second power train units (cf. feature (h)).

3.4 In the appellant's view, there was no indication in D9 that a single controller controlled the PWM signals of both input trains. The fact that in D9 multiple input trains might have different input voltages was irrelevant, as in the claimed invention the important point was that only <u>a single controller</u> controlled the output of each of the input trains.

3.5 It is pointed out in D9 that the conventional PWM control scheme cannot be directly applied to the proposed multi-input dc/dc converter because of the transformer winding voltage-clamping problem (page 1097, right-hand column, second paragraph). Thus, D9 proposes a "phase-shifted PWM control scheme". Figure 6 shows a block diagram of the control circuit for the known power supply unit (see section D. Control Strategy).

As explained on page 1102, left-hand column, by *"adjusting the phase-shift percentage with proper current control signals, the regulation of the output voltage V_0 can be achieved and the balanced power flow from different input-stage circuits to the load can be obtained"*.

In particular, the *"input-stage circuit with reference current signal will provide a constant power to the load and the other input-stage circuit without the reference current signal will automatically deliver the remaining portion of the demanded output power to balance the power flow. If each power source for the input-stage circuit has to supply a specific power, ..., then both of the reference current signals should be used to transfer the demanded input power"*.

3.6 Thus, D9 teaches explicitly that the PWM signals of the first and second power train units are separately controlled under the control of a single controller programmed, for instance, to deliver the required power.

4.1 The subject-matter of claim 1 differs from the power unit disclosed in D9 essentially in that:

(i) it relates to a power system comprising a plurality of circuits and power supply units for providing direct current power to said plurality of circuits;

(ii) the controller provides control signals in response to data received from the system for using said first and second sources of power under normal conditions and in the presence of trouble conditions.

4.2 Starting from the disclosure in D9 a problem addressed by the present application can be seen in providing and controlling a power system based on the known power supply units.

5.1 D10 relates to a *"parallel operation-type uninterruptible power system"*. Figure 1 shows three power units 1a to 1c which comprise PWM controlled inverter circuits 3a to 3c and inverter control devices 5a to 5c, respectively. The three inverter circuits are connected to a common load L (see D10, column 5, lines 40 to 63).

As explained in D10, column 6, lines 39 to 58, the *"PWM control signal generating means 19a functions to output a PWM control signal which commands to gradually reduce the output voltage V_{out} outputted from the inverter circuit 3a with an increase in supply active power P_{out} fed to the load L by the inverter circuit 3a until the judging means 17a judges that the value Pout of the* *supply active power has reached the predetermined level SP before or forward of the overload condition. Thus, such a condition or state causes the inverter 7a to be gradually increased in load sharing ratio. Then, the PWM control signal generating means 19a, when the judging means 17a judges that the value Pout of the supply active power has reached the predetermined level SP forward of the overload condition, feeds the inverter 7a of the inverter circuit 3a with a PWM control signal which takes command of reducing the output voltage* V_{out} *of the inverter circuit 3a at a larger reduction ratio to keep it from falling into the overload condition. This prevents the inverter 7a from being positively increased in load sharing ratio, resulting in a load sharing ratio of each of the remaining inverters being increased"* (underlining added).

In other words, D10 essentially teaches providing a PWM control signal to a PWM-controlled power unit of a power system in response to data received from the power system in order to use the respective power sources "under normal conditions and trouble conditions" (for instance overload conditions).

5.2 According to the appellant, D10 related to a reliable ac power source. Furthermore, while D10 taught that different inverters might be controlled to supply different amounts of power, it did not contain any teaching of how this was to be accomplished in the context of a plurality of input trains coupled to an output train by a multi-winding transformer. Furthermore, D10 taught that each inverter had its own inverter circuit control device.

6.1 The application as originally filed merely recites that the control unit 220 shown in Figure 5 is controlled by a programmed controller and does not define the programmed controller as a single programmed controller. In fact, the programmed controller according to Figure 5 could also comprise a separate controller for each of the power trains, the separate controllers sharing a common input linked to the power output.

6.2 As to the teaching of D10 relating to the control of the load sharing ratio of the different inverters in order to avoid an overload condition of one of the inverters, it is evident to the skilled person that it is not dependent on the kind of load L driven by the inverters and that it may be applied to inverters connected to a multi-winding transformer and controlled by a single controller, as shown in D9.

Furthermore, although D10 does not relate to a power supply unit as recited in the preamble of claim 1, it shows that it was known before the priority data of the present application to provide separate PWM signals to each of the inverter circuits of a power system in order to vary the amount of energy supplied by each of the inverter circuits in response to data received from the power system so as to deal with a "trouble condition" such as possible overloading of one of the power sources.

6.3 In the light of general knowledge common in the field of power systems and power supply units, it was obvious to a person skilled in the art to combine a plurality of power units known from D9 into a power system for providing direct current power to a plurality of circuits and to rely on the teaching of D10 in order to optimize the parallel operation of the power units in the power system. In doing so, the skilled person would have arrived at a power system falling within the terms of claim 1 of the appellant's main request.

7. Hence, the subject-matter of claim 1 does not involve an inventive step within the meaning of Article 56 EPC.

8. In the result, the Board finds that the appellant's request does not satisfy the requirements of the EPC and that a patent cannot be granted on the basis thereof.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

C. Moser M. Ruggiu