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**D E C I S I O N**  
**of 1 July 2003**

**Case Number:** T 0280/01 - 3.5.2

**Application Number:** 95924636.4

**Publication Number:** 0769220

**IPC:** H02P 6/08

**Language of the proceedings:** EN

**Title of invention:**

Brushless DC motor using phase timing advancement

**Applicant:**

UQM Technologies, Inc.

**Opponent:**

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**Headword:**

-

**Relevant legal provisions:**

EPC Art. 123(2), 56

**Keyword:**

"Amendments - added subject-matter (no) after amendment"  
"Inventive step (yes) after amendment"

**Decisions cited:**

-

**Catchword:**

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Case Number: T 0280/01 - 3.5.2

**D E C I S I O N**  
of the Technical Board of Appeal 3.5.2  
of 1 July 2003

**Appellant:** UQM Technologies, Inc.  
425 Corporate Circle  
Golden,  
Colorado 80401 (US)

**Representative:** Colas, Jean-Pierre  
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**Decision under appeal:** Decision of the Examining Division of the  
European Patent Office posted 26 September  
2000 refusing European patent application  
No. 95924636.4 pursuant to Article 97(1) EPC.

**Composition of the Board:**

**Chairman:** W. J. L. Wheeler  
**Members:** M. Ruggiu  
B. J. Schachenmann

## Summary of Facts and Submissions

- I. The applicant appealed the decision of the examining division to refuse European patent application No. 95 924 636.4.
- II. Reasons given for the refusal were that claim 1 introduced subject-matter extending beyond the content of the application as filed, contrary to Article 123(2) EPC, and that the subject-matter of claim 1 did not involve an inventive step in the sense of Article 56 EPC in view of the following documents of the state of the art:
- D1: DE-A-3 819 064; and
- D2: WO-A-94/07301.
- III. A communication of the board cited a further document of the state of the art from the international search report:
- D3: US-A-4 546 293.
- IV. In response to the communication, the appellant amended the claims and the description of the application.

V. The appellant requests that a patent be granted in the following version:

**Description:**

Pages 5, 7, 10 and 11 as originally filed.

Pages 1, 2, 2a, 3, 4, 6, 8 and 9 filed with a letter dated 6 May 2003.

**Claims:**

No. 1, 2 and 3 filed with the letter dated 6 May 2003.

**Drawings:**

Sheets 1/8 to 8/8 as originally filed.

The appellant requests oral proceedings only for the case that the above request would be rejected.

VI. Claim 1 is now worded as follows:

"1. A brushless motor and drive system comprising:

(a) a brushless DC motor (10) comprising a stator (12) having three phase windings (A, B, C) and a rotor (16) having magnetic means (18) formed thereon;

(b) a detector (30) for detecting the position of said rotor (16) with respect to said stator (12) and generating a position signal in response thereto;

(c) a switching amplifier (24) for selectively supplying current from a source of DC voltage to respective ones of said phase windings (A, B, C) in accordance with control signals; and

(d) generating means (22) receiving said position signal and generating said control signals in accordance with said position signal, said generating means comprising pulse width modulation means and phase advance means for phase advancing timings of said control signals so as to precharge said phase windings with current;

characterised in that said generating means (22) stores information indicative of the various desired phase advance angles in comparison to the motor output power, for various speeds of the rotor, and uses this information to adjust said timings of said control signals during at least one mode of operation in which the rotational speed of the motor is such that the back EMF generated in said phase windings is at least substantially equal to the DC voltage applied from said source."

Claims 2 and 3 are dependent on claim 1.

VII. The appellant essentially argued as follows:

The feature of claim 1 that the phase advance means was for phase advancing timings of the control signals so as to precharge the phase windings with current was supported by the description as filed, see page 8, line 14 et seq, in particular line 21 et seq. Thus, the amendments to claim 1 did not contravene Article 123(2) EPC.

Document D1 was directed to conventional brushless motor operation wherein the advance of the commutation point was done to align a motor current vector with the back EMF to phase compensate for the inductive lag of the motor windings. D1 did not teach or suggest to operate at a motor speed where the back EMF was at least substantially equal to the applied voltage and precharge the winding with current under this condition.

Document D2 was not directed to a brushless DC motor, but rather to a synchronous permanent magnet motor using phase advance to achieve field weakening, that is to ensure that the back EMF remained substantially less than the applied voltage.

## Reasons for the Decision

1. The appeal is admissible.
2. *Amendments*
  - 2.1 Claim 1 as originally filed includes features (a), (b) and (c) of present claim 1. Claim 1 as originally filed also mentions means, receiving the position signal, for generating the control signals in accordance with the position signal and comprising pulse width modulation means. Furthermore, the original description (see in particular page 8, lines 14 to 24 and 30 to 35) indicates that the phase advance means is invoked to effect premature switching when the speed of the motor approaches the level where the generated back EMF is the same as the applied DC voltage or exceeds this DC voltage. According to the original description (see in particular page 8, lines 24 to 30) this results in a precharging of the winding with current. Finally, the original description indicates at page 9, lines 5 to 9, that information indicative of a graph representing the various phase advance degrees in comparison to the motor output power, for various speeds of the motor, is stored in the logic or processor 22 (which generates the control signals) and is used during the drive of the motor.

Thus, the application as filed discloses the combination of features recited in present claim 1.

2.2 The feature of present claim 2 can be found in claim 2 as filed and the feature of present claim 3 at page 3, lines 13 to 16, and page 11, lines 15 to 24, of the description as filed.

2.3 The description has been adapted to the amended claims and to mention the background art known from documents D1, D2 and D3.

2.4 The board comes therefore to the conclusion that the amendments to the application do not contravene Article 123(2) EPC.

### 3. *Novelty*

3.1 Document D3 describes a brushless motor and drive system in accordance with the pre-characterising portion of present claim 1. In the system of D3, the signals controlling switching of the current in the motor windings are phase advanced by an amount which is a function of the speed of operation.

3.2 Document D1 describes a brushless motor and drive system in which a time amount defining a phase advance can have a fixed value or a value depending on the rotational speed of the motor, the required torque or the torque characteristic.

3.3 Document D2 describes a permanently excited synchronous motor and drive system in which phase advance is used to achieve field weakening. The phase advance angle is adjusted depending on the difference between set and measured current or power values.



- 3.4 None of D3, D1, D2 and the other documents cited in the international search report and in the supplementary European search report discloses storing information indicative of the various desired phase advance angles in comparison to the motor output power, for various speeds of the rotor, or using such information to adjust the timings of the signals controlling the switching amplifier.

The subject-matter of claim 1 is therefore considered to be new in the sense of Article 54(1) EPC.

4. *Inventive step*

- 4.1 The board regards the brushless motor and drive system disclosed in document D3 as the prior art closest to the present invention. The subject-matter defined by claim 1 differs from this closest prior art especially in that the generating means stores information indicative of the various desired phase advance angles in comparison to the motor output power, for various speeds of the rotor, and uses this information to adjust the timings of the control signals. This makes it possible to adjust the timings of the control signals so that the motor output power is controlled, in particular so that a constant power characteristic is achieved. The objective problem solved by the present invention is therefore that of achieving control of the motor output power.

- 4.2 Documents D3, D1 and the other documents cited in the international search report and in the supplementary European search report are not concerned with achieving control of the motor output power.

- 4.3 In the system of document D2, the input current to a switching amplifier (converter 6) is controlled during a field weakening operation. In this mode of operation, a set input current reference is approximately equivalent to a power reference and the phase advance angle is determined (by a device 38) depending on the difference between the power reference and a measured current (see page 4, lines 18 to 27; page 9, line 25 to page 10, line 17; and Figures 2 and 3 of D2). Thus, D2 does not suggest determining the phase advance angle in dependence on both the motor output power and the speed of the motor.
- 4.4 There is therefore no suggestion in the state of the art to adjust the timings of the control signals by using, as specified in claim 1 of the present application, stored information indicative of the various desired phase advance angles in comparison to the motor output power, for various speeds of the rotor. Thus, in the judgment of the board, having regard to the state of the art, the subject-matter of claim 1 is not obvious to the skilled person, so that the invention defined by claim 1 is considered as involving an inventive step in the sense of Article 56 EPC.
- 4.5 Claims 2 and 3 are dependent claim 1, so that the subject-matter of claims 2 and 3 is also considered to be new and involve an inventive step.

## Order

### For these reasons it is decided that:

1. The decision under appeal is set aside.
2. The case is remitted to the first instance with the order to grant a patent in the following version:

#### **Description:**

Pages 5, 7, 10 and 11 as originally filed.

Pages 1, 2, 2a, 3, 4, 6, 8 and 9 filed with the letter dated 6 May 2003.

#### **Claims:**

No. 1, 2 and 3 filed with the letter dated 6 May 2003.

#### **Drawings:**

Sheets 1/8 to 8/8 as originally filed.

The Registrar:

The Chairman:

D. Sauter

W. J. L. Wheeler