CLAIMS

1. A method of estimating a rotor orientation of a synchronous reluctance motor at a start-up, the motor including a stator and a rotor, wherein an inductance of the rotor in rotor coordinates is represented by a rotor quadrature axis inductance component (L_q) and a rotor direct axis inductance component (L_d), at least one of the rotor inductance components being known, wherein the method comprises:

setting a value for a stator control reference;

inducing a stator flux on the basis of the stator control reference;

determining the stator flux and a stator current;

forming a first estimate of the rotor orientation on the basis of the stator flux, the stator current, and only one of the known rotor inductance components;

determining the rotor orientation on the basis of the first estimate; and

updating the stator control reference so that the stator flux follows the determined rotor orientation.

2. A method according to claim 1, wherein both of the rotor inductance components are known, and the determining of the rotor orientation comprises:

forming a second estimate of the rotor orientation on the basis of the stator flux, the stator current, and the other known rotor inductance component,

determining the rotor orientation on the basis of the first estimate and the second estimate.

3. A method according to claim 2, wherein the determining of the rotor orientation comprises:

determining a value for a correction parameter on the basis of a ratio between the rotor inductance components, and

using the correction parameter to correct a length of an orientation vector.

4. A method according to claim 2, wherein the forming of the second estimate of the rotor orientation comprises:

calculating a second rotor orientation vector from a difference between the stator flux and a product of the other known inductance component and the stator current, and

forming the second estimate on the basis of the second rotor orientation vector.

5. A method according to claim 1, wherein the forming of the first estimate of the rotor orientation comprises:

calculating a first rotor orientation vector from a difference between the stator flux and a product of the known inductance component and the stator current, and

forming a first estimate on the basis of the first rotor orientation vector.

6. A method according to claim 1, wherein the forming of the first estimate of the rotor orientation comprises:

calculating a first rotor orientation vector from the difference between the stator flux and a product of the known inductance component and the stator current, and

forming the first estimate on the basis of a ratio between an x component and a y component of the first rotor orientation vector.

7. A method according to claim 1, comprising: estimating a rotor speed of a synchronous reluctance motor on the basis of the estimated rotor orientation.

8. A method according to claim 7, wherein the estimating of the rotor speed comprises:

setting a value for a feedback speed term;

calculating a value for a feedback angle term by integrating the feedback speed term;

determining an estimate for the rotor speed on the basis of a difference between the feedback angle term and the rotor angle; and

determining a new value for a feedback speed term speed on the basis of a difference between the feedback angle term and the rotor angle.

9. A method according to claim 1, wherein the at least one of the known rotor inductance components is known prior to start-up of the motor.

10. An apparatus configured to be connected to a synchronous reluctance motor, the motor including a stator and a rotor, wherein an inductance of the rotor in rotor coordinates is represented by a rotor quadrature axis inductance component (L_q) and a rotor direct axis inductance component (L_d), at least one of the rotor inductance components being known, and wherein the apparatus comprises:

means for setting a value for a stator control reference;

means for controlling a stator flux on the basis of the stator control reference;

means for determining the stator flux and a stator current;

means for forming a first estimate of a rotor angle at a start-up on the basis of the stator flux, the stator current, and only one of the known rotor inductance components;

means for estimating the rotor angle on the basis of the first estimate; and

means for updating the stator control reference so that the stator flux follows the determined rotor orientation.

11. An apparatus according to claim 10, wherein the at least one of the known rotor inductance components is known prior to start-up of the motor.

12. A non-transitory computer-readable recording medium having a computer program recorded thereon that causes a processor of a computer processing device to perform operations of estimating a rotor orientation of a

synchronous reluctance motor at a start-up, the motor including a stator and a rotor, wherein an inductance of the rotor in rotor coordinates is represented by a rotor quadrature axis inductance component (L_q) and a rotor direct axis inductance component (L_d), at least one of the rotor inductance components being known, wherein the operations comprise:

setting a value for a stator control reference;

inducing a stator flux on the basis of the stator control reference;

determining the stator flux and a stator current;

forming a first estimate of the rotor orientation on the basis of the stator flux, the stator current, and only one of the known rotor inductance components;

determining the rotor orientation on the basis of the first estimate; and

updating the stator control reference so that the stator flux follows the determined rotor orientation.

13. A non-transitory computer-readable recording medium according to claim 12, wherein both of the rotor inductance components are known, and the determining of the rotor orientation comprises:

forming a second estimate of the rotor orientation on the basis of the stator flux, the stator current, and the other known rotor inductance component,

determining the rotor orientation on the basis of the first estimate and the second estimate.

14. A non-transitory computer-readable recording medium according to claim 13, wherein the determining of the rotor orientation comprises:

determining a value for a correction parameter on the basis of a ratio between the rotor inductance components, and

using the correction parameter to correct a length of an orientation vector.

15. A non-transitory computer-readable recording medium according to claim 13, wherein the forming of the first estimate of the rotor orientation comprises:

calculating a first rotor orientation vector from a difference between the stator flux and a product of the known inductance component and the stator current, and

forming a first estimate on the basis of the first rotor orientation vector.

16. A non-transitory computer-readable recording medium according to claim 13, wherein the forming of the first estimate of the rotor orientation comprises:

calculating a first rotor orientation vector from the difference between the stator flux and a product of the known inductance component and the stator current, and

forming the first estimate on the basis of a ratio between an x component and a y component of the first rotor orientation vector.

17. A non-transitory computer-readable recording medium according to claim 13, wherein the forming of the second estimate of the rotor orientation comprises:

calculating a second rotor orientation vector from a difference between the stator flux and a product of the other known inductance component and the stator current, and

forming the second estimate on the basis of the second rotor orientation vector.

18. A non-transitory computer-readable recording medium according to claim 13, comprising:

estimating a rotor speed of a synchronous reluctance motor on the basis of the estimated rotor orientation.

19. A non-transitory computer-readable recording medium according to claim 18, wherein the estimating of the rotor speed comprises:

setting a value for a feedback speed term;

calculating a value for a feedback angle term by integrating the feedback speed term;

determining an estimate for the rotor speed on the basis of a difference between the feedback angle term and the rotor angle; and

determining a new value for a feedback speed term speed on the basis of a difference between the feedback angle term and the rotor angle.

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20. A non-transitory computer-readable recording medium according to claim 12, wherein the at least one of the known rotor inductance components is known prior to start-up of the motor.