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(54) **Operation of an electrical drive system**

Betrieb eines elektrischen Antriebssystems

Fonctionnement d'un système de commande électrique

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(56) References cited:
EP-A1- 1 336 547 EP-A1- 1 655 831

- **SALMASI F R: "Dual Estimators for Position and Current Sensorless SRM Drives Based on the Decomposed Model", ELECTRIC MACHINES AND DRIVES, 2005 IEEE INTERNATIONAL CONFERENCE ON MAY 15, 2005, PISCATAWAY, NJ, USA, IEEE, 15 May 2005 (2005-05-15), pages 1103-1107, XP010854577, ISBN: 978-0-7803-8987-8**
- **KROSCHER K ET AL: "Sensor fault detection and localization using decorrelation methods", SENSORS AND ACTUATORS A, ELSEVIER SEQUOIA S.A., LAUSANNE, CH, vol. 25, no. 1-3, 1 October 1990 (1990-10-01), pages 43-50, XP026548615, ISSN: 0924-4247 [retrieved on 1990-10-01]**

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Description

[0001] This invention relates to validating signals used in the operation of an electrical drive, for example a drive including an electrical machine controlled by an electronic controller. In particular, it relates to the validation of the feedback signals used to control the excitation applied to the machine.

[0002] For some considerable time, the availability of easily controlled semiconductor switches has enabled electronic control of many types of electrical machine and hence has provided drive systems whose speed is controlled by the user, rather than by the frequency of the electrical supply. All of these controllers rely, to a greater or lesser extent, on feedback signals of some sort. The parameters chosen for feedback are more likely to relate to the type of electrical machine being controlled, rather than to the application to which the machine is put, since different types of machines require different control methods.

[0003] The characteristics and operation of switched reluctance systems are well known in the art and are described in, for example, "The characteristics, design and application of switched reluctance motors and drives" by Stephenson and Blake, PCIM'93, Nürnberg, 21-24 June 1993. A general treatment of the drives can be found in various textbooks, e.g. "Electronic Control of Switched Reluctance Machines" by TJE Miller, Newnes, 2001. The machines are characterised by a singly excited, doubly salient magnetic structure which is typically free from hard magnetic material.

[0004] Figure 1 of the drawings shows a typical switched reluctance drive in schematic form, where the switched reluctance motor 12 drives a load 19. The input DC power supply 11 can be either a battery or rectified and filtered AC mains. The DC voltage provided by the power supply 11 is switched across the phase windings 16 of the motor 12 by a power converter 13 under the control of the electronic control unit 14. The switching must be correctly synchronised to the angle of rotation of the rotor for proper operation of the drive, and a rotor position detector 15 is typically employed to supply signals corresponding to the angular position of the rotor. The importance of accurate knowledge of the rotor position has encouraged the development of techniques for validation of the position feedback signals, e.g., as described in US 5723858, where sequences of digital information are monitored to validate the integrity of the signal.

[0005] Many different power converter topologies are known, several of which are discussed in the Stephenson paper cited above. One of the most common configurations is shown in Figure 2 for a single phase of a polyphase system. The phase winding 16 of the machine is connected in series with two switching devices 21 and 22 across the busbars 26 and 27. Busbars 26 and 27 are collectively described as the "DC link" of the converter. Energy recovery diodes 23 and 24 are connected to the

winding to allow the winding current to flow back to the DC link when the switches 21 and 22 are opened. A capacitor 25, known as the "DC link capacitor", is connected across the DC link to source or sink any alternating component of the DC link current (i.e. the so-called "ripple current") which cannot be drawn from or returned to the supply. In practical terms, the capacitor 25 may comprise several capacitors connected in series and/or parallel and, where parallel connection is used, some of the elements may be distributed throughout the converter.

[0006] Current feedback from the machine to the converter is generally considered essential for safe operation of the controller, and a number of techniques are known in the art. In Figure 2, a resistor 28 is connected in series with the lower switch 22 to provide a signal. Similar arrangements place the resistor in other parts of the circuit to give measurements of slightly different currents, but all of these provide a signal which is not electrically isolated from the main converter circuit. Alternatively, an isolated form of current transducer, as shown at 18 in Figure 1, can be used to provide a signal which is generally easier to use in the control system.

[0007] A polyphase system typically uses several of the "phase legs" of Figure 2, each consisting of switch and diode pairs around each phase winding, connected in parallel to energise the phases of the electrical machine. The phase inductance cycle of a switched reluctance machine is the period of the variation of inductance for the, or each, phase, for example between maxima when the rotor poles and the relevant respective stator poles are fully aligned. The voltage is applied for the duration of the conduction angle θ_c when the switches 21 and 22 are closed. The flux, which is the time integral of the applied voltage, rises almost linearly while the voltage is applied. The current in the phase winding 16 rises to a peak and then, depending on the operating point, falls. At the end of the conduction period, the switches are opened and the current transfers to the diodes, placing the inverted link voltage across the winding and hence forcing down the flux and the current to zero. At zero current, the diodes cease to conduct and the circuit is inactive until the start of a subsequent conduction period of that phase.

[0008] Various methods for dispensing with the rotor position transducer have been proposed. Several of these are reviewed in "Sensorless Methods for Determining the Rotor Position of Switched Reluctance Motors" by W F Ray and I H Al-Bahadly, published in the Proceedings of The European Power Electronics Conference, Brighton, UK, 13-16 Sep 1993, Vol. 6, pp 7-13. Some of these methods proposed for rotor position estimation in an electrically driven machine use the measurement of one or more machine parameters from which other values can be derived. For example, phase flux-linkage (i.e. the integral of applied voltage with respect to time) and current in one or more phases can be monitored (e.g. by current transducer 18 in Figure 1 or 28 in Figure 2). Position is calculated using knowledge of the

variation in inductance or flux-linkage of the machine as a function of angle and current.

[0009] "Dual estimators for position and current sensorless SRM drives based on the decomposed model", Salmasi IEEE Int Conf on Electric Machines and Drives, 15 May 2005, Piscataway, NJ, USA, pp 1103-1107, discloses estimators for either current or for rotor position and uses a measured value of a parameter to validate its estimated value.

[0010] EP-A-1655831 discloses a method of sensorless position estimation. Before the algorithm estimates position, it checks the value of the parameter to ensure that the phase is healthy. In the event of the parameter indicating that the phase is faulty, the algorithm does not attempt to estimate position from that phase, thereby avoiding the generation of faulty position data. Operation of the machine may be continued using only the healthy phases.

[0011] Whatever method is used, it is essential that the current and flux signals are accurate and reliable. A fault in a current transducer or a broken wire in the feedback path can have serious consequences for the controller. To attempt to provide protection against this, a failure detection method has been proposed as shown in Figures 3 and 4. Figure 3 shows the expected current trajectory after the voltage is applied to the phase and a current threshold I_t , which is a small fraction of the expected peak current, e.g. 2-3%. Figure 4 shows a logic circuit consisting of an AND gate 50 and a timer 52. The x and y inputs to the AND gate are driven by the gate signals of the switch(es) for the phase winding, e.g. the switches 21 and 22 of Figure 2. When the controller decides to close both of these switches, the output of the AND gate enables the timer 52 which is being driven by a clock signal. The timer will therefore count up on output line Q. The RESET line of the timer is driven by the threshold current I_t , so that when the current passes the threshold, the timer output Q is held at zero. The controller therefore expects to see the counter output rising for an initial period, but thereafter being held at zero. If this does not happen, then it is likely that a fault has occurred, e.g. the current feedback signal has been lost, a switch has failed to close, etc.

[0012] This method has proved beneficial in many applications. However, one difficulty is that the value of the output Q which denotes a fault varies widely with the particular machine being controlled: a value corresponding to 50µsec may be suitable for a small, high-speed machine, whereas a larger, slower machine may require a value of 30msec. In addition, the current may be slow to rise for some legitimate reason, e.g. if the system voltage has fallen significantly, or if the rotor is in a position where the phase inductance is at a maximum. It is therefore difficult to choose a timer output value which reliably represents a fault condition.

[0013] The present invention is defined in the accompanying independent claims. Some preferred features are recited in the dependent claims.

[0014] According to one embodiment, there is provided a method of validating signals used in the operation of a switched reluctance drive, comprising: monitoring a first signal indicative of flux in a phase of a switched reluctance machine of the drive; monitoring a second signal indicative of the flux in the phase of the machine of the drive; and validating the signals if a predetermined condition of the first and second signals is met, wherein one of the first and second signals is derived from a DC-link, supply or phase voltage signal and the other one of the first and second signals is derived from a phase current signal.

[0015] In certain situations, the validation of the signals may only be legitimately carried out within a specific part of the cycle of the electrical machine. Thus, in some embodiments the validation is limited to within a predetermined time or rotor angle after detecting the first or the second signal.

[0016] Embodiments of the invention extend to a system implementing the above methods.

[0017] The invention can be put into practice in a number of ways, some of which will now be described by way of example and with reference to the accompanying drawings in which:

Figure 1 shows a typical prior art switched reluctance drive;

Figure 2 shows a known topology of one phase for the power converter of Figure 1;

Figure 3 shows a previous method of validating a current signal.

Figure 4 shows part of a logic circuit for use with the current relationship of Figure 3;

Figure 5 shows flux and inductance waveforms in a switched reluctance machine;

Figure 6 shows current and flux waveforms in a switched reluctance machine;

Figure 7 shows a switched reluctance drive according to an embodiment; and

Figure 8 shows flux-linkage waveforms derived from, respectively by, voltage and current according to an embodiment.

[0018] Figure 5 shows a waveform of flux associated with one phase of a switched reluctance machine while operating in single-pulse mode. In the drawings and this description, the term "flux" is used for convenience. Those of ordinary skill in the art will recognise that the term "flux linkage" could equally well be used and that one quantity is simply a numerical scaling of the other. Figure 5 is idealised in that, in the flux waveform, there is no non-linearity caused by voltage drop and no noise introduced by the method of measurement used to produce the waveform. Likewise, the inductance profile of the phase winding shown is also in idealised form. In practice, the corners of the profile are rounded due to flux fringing in the air and to saturation of the ferromagnetic paths.

[0019] In a typical drive system, the flux waveform would be computed as the time integral of a voltage signal, the voltage signal representing: the DC link voltage; the applied voltage at the terminals of the winding; the difference ($v - ir$), where v , i & r represent the instantaneous phase quantities of voltage, current and resistance; or some other signal which will yield a measure of flux to the required accuracy. Figure 6 shows the current waveform corresponding to the flux waveform of Figure 5.

[0020] Figures 7 shows an embodiment in which the control unit 14' is similar to the control unit 14 of Figure 1, except that it has an additional input of phase voltage from the voltage transducer 17. The voltage input is used to provide an estimate of the phase flux. Such methods are well known in the art and are based on the time integral of voltage. This could be implemented in hardware or software to equal effect as will be readily apparent to one of ordinary skill in the art.

[0021] An embodiment will now be described, in which signals are continuously compared and validated throughout the conduction cycle of the machine. Figure 8 shows a typical output from a software integrator which is computing the flux-linkage in a machine from a signal representing the supply voltage. The step-wise feature of this first signal is a result of the finite clock cycle of the control system.

[0022] Making use of the relationship between inductance, flux-linkage and current, ($L = \psi/i$) a second signal representing flux-linkage can be computed by taking the current feedback signal and multiplying it by the inductance corresponding to the known position. This second signal, if the control system is working correctly, should match the first signal, for example be within a margin of the first signal. If it does not, then it may be assumed that an error has occurred in one or other of the voltage or current feedback signals. To avoid spurious trips due to noise spikes, integrator drift, etc, a scaling factor can be applied to one or other of the signals, as shown in Figure 8, to allow a safety margin before the validation process signals an error condition.

[0023] The advantage of this embodiment is that the feedback signals are monitored continuously during the conduction cycle.

[0024] Various considerations have to be taken into account in a practical implementation. In general, most control systems are based around a digital system such as a microprocessor or a digital signal processor, which are inevitably driven by a system clock which defines the timings of sequences of operations. It is therefore appropriate to base embodiments of the invention on these timings. In certain situations, implementing the examination of the signals in a digital circuit requires some care and a recognition of quantisation effects which may be present in either signal.

[0025] For example, if the system clock allows decisions to be taken every $80\mu\text{sec}$, the control system could validate the current signal after, say, $240\mu\text{sec}$ and continue to validate it every $80\mu\text{sec}$ until validation is no longer

er required, e.g. when the switches are opened and control of the phase current is no longer possible. The reason for the delay after the phase is energised is to allow for any noise present on a low-level current signal to be disregarded, which might otherwise give rise to false readings and possibly cause the drive to shut down.

[0026] The amount of delay can be chosen from a consideration of the parameters of the drive. The skilled person will realise that the initial rate of current increase in the phase winding depends on the rotor position, as well as on the supply voltage. In the minimum inductance position, it is likely to be some 10 to 15 times faster than it would be in the maximum inductance position. Knowing the minimum inductance, the supply voltage and the maximum allowable current in the switch(es), the maximum time allowable for validating the current data can be determined, so that remedial action can be taken, if necessary, before damage occurs.

[0027] While this fixed value of delay is acceptable in many drive systems, it is possible to refine the technique to use a variable delay which is related to the position of the rotor (and hence the position on the inductance profile, as shown in Figure 5) where a phase is energised. For example, an electric drive may also operate in a braking (generating) mode, firing the phase switches close to a maximum inductance position rather than close to a minimum inductance position as for a motoring mode.

[0028] With the position in the inductance profile of the firing angles known for a given mode, the delay between the start of energisation of a phase and the beginning of validation can be adjusted as a function of the position of energisation. Alternatively, the delay can be adjusted as a function of detected rotor position.

[0029] In the latter case, the degree of refinement available depends on the precision of the rotor position information provided in the drive system. For example, if a traditional rotor position transducer is used (as is typical of many drive systems), there are two transitions in the binary output in a cycle of each phase channel. For a typical 3-phase system, the phase signals can be combined to give rotor position within one sixth of an inductance cycle. This would allow three zones of inductance to be used to set three different delay times, rather than just using a constant value. If an encoder or resolver or some software equivalent were used, finer resolution of position would be available and so smaller steps of delay time would be possible. The benefit of these variable delay times is that tighter control of the drive system is achieved.

[0030] If the drive is operating very slowly in a chopping mode (see the Stephenson et al paper referenced above), the flux and current will be present for a relatively long time. Since the flux signal is an estimate derived by integration, there is a danger of the inherent drift in the integrator extending the apparent presence of flux and implying that flux is present after the current has decayed to zero. This can be avoided by setting a time limit, beyond which validation is not attempted. The time limit can

be easily determined from a knowledge of the integrator characteristics and will generally be in a typical range of 50-100msec.

[0031] The skilled person will appreciate that the method may be applied with equal benefit to machines operating as motors or as generators and that variations of the disclosed arrangements are possible without departing from the invention, particularly in the details of the implementation of the algorithms in the controller in hardware, firmware and/or software. While the invention has been described in terms of a rotating machine the invention is equally applicable to a linear machine having a stator in the form of a track and a moving part moving on it. The word "rotor" is used in the art to refer to the movable part of both rotating and linear machines and is to be construed herein in this way. Accordingly, the above description of several embodiments is made by way of example and not for the purposes of limitation. It will be clear to the skilled person that minor modifications can be made to the control method without significant changes to the operation described above. The present invention is intended to be limited only by the scope of the following claims.

Claims

1. A method of validating signals used in the operation of a switched reluctance drive including a switched reluctance machine (12), comprising:
 - monitoring a first signal indicative of a flux in a phase (16) of the switched reluctance machine (12);
 - monitoring a second signal indicative of the flux in the phase (16) of the switched reluctance machine (12); and
 - validating the signals if a predetermined condition of the first and second signals is met, wherein one of the first and second signals is derived by a time integral of a DC-link, supply or phase voltage signal and the other one of the first and second signals is derived by multiplying a phase current signal and phase inductance corresponding to a known position in a inductance cycle.
2. A method as claimed in claim 1 in which the predetermined condition is the first and second signal being present together.
3. A method as claimed in claim 1 or claim 2 in which the predetermined condition is the respective values of the first and second signals being within a margin of each other.
4. A method as claimed in any of claims 1 to 3, wherein the step of validating the signals is performed within

a predetermined period of time after the predetermined condition has been met.

5. A method as claimed in any of claims 1 to 4 in which the electrical drive has an operating cycle and the method further includes monitoring operation of the electrical drive and validating the signals at a predetermined point in the operating cycle.
6. A method as claimed in any of claims 1 to 5 in which the method includes energising a phase of the switched reluctance machine (12) at a position in the inductance cycle and starting to validate the signals after a delay with respect to energisation of the phase (16); the method further including determining a duration of the delay as a function of the position.
7. A system for validating signals used in the operation of a switched reluctance drive including a switched reluctance machine (12), the system comprising means for monitoring a first signal indicative of a flux in a phase (16) of the switched reluctance machine (12);
 - means for monitoring a second signal indicative of the flux in the phase of the switched reluctance machine (12);
 - means for validating the signals if a predetermined condition of the first and second signals is met, wherein one of the first and second signals is derived by a time integral of a phase voltage signal and the other one of the first and second signals is derived by multiplying a phase current signal and a phase inductance corresponding to a known position in a inductance cycle.
8. A system as claimed in claim 7, in which the predetermined condition is the first and second signal being present together.
9. A system as claimed in claim 7 or claim 8 in which the predetermined condition is the respective values of the first and second signals being within a margin of each other.
10. A system as claimed in any of claims 7 to 9 including means for limiting validation of the signals within a predetermined period of time after the predetermined condition has been met.
11. A system as claimed in any of claims 7 to 10 in which the switched reluctance drive has an operating cycle and the means for validating validates the signals at a predetermined point in the operating cycle.
12. A system as claimed in any of claims 7 to 11 in which the system includes means for energising the phase (16) of the switched reluctance machine (12) at a position in the inductance cycle; wherein the means

for validating is arranged to start validating the signals after a delay with respect to the energisation of the phase (16); the means for validating further being arranged to determine a duration of the delay as a function of the position.

Patentansprüche

1. Verfahren zum Validieren von Signalen, die beim Betrieb eines geschalteten Reluktanzantriebs einschließlich einer geschalteten Reluktanzmaschine (12) verwendet werden, aufweisend:

Überwachen eines ersten Signals, das einen Fluss in einer Phase (16) der geschalteten Reluktanzmaschine (12) anzeigt;

Überwachen eines zweiten Signals, das den Fluss in der Phase (16) der geschalteten Reluktanzmaschine (12) anzeigt; und

Validieren der Signale, wenn eine vorbestimmte Bedingung des ersten und des zweiten Signals erfüllt ist, wobei eines des ersten und des zweiten Signals durch ein Zeitintegral eines Zwischenkreises, einer Versorgung oder eines Phasenspannungssignals abgeleitet wird und das andere des ersten und des zweiten Signals durch ein Multiplizieren eines Phasenstromsignals und einer Phaseninduktivität abgeleitet wird, die einer bekannten Position in einem Induktivitätszyklus entspricht.

2. Verfahren nach Anspruch 1, wobei die vorbestimmte Bedingung darin besteht, dass das erste und das zweite Signal zusammen vorhanden sind.

3. Verfahren nach Anspruch 1 oder Anspruch 2, wobei die vorbestimmte Bedingung darin besteht, dass die jeweiligen Werte des ersten und des zweiten Signals innerhalb einer Spanne voneinander liegen.

4. Verfahren nach einem der Ansprüche 1 bis 3, wobei der Schritt des Validierens der Signale in einem vorbestimmten Zeitraum durchgeführt wird, nachdem die vorbestimmte Bedingung erfüllt ist.

5. Verfahren nach einem der Ansprüche 1 bis 4, wobei der elektrische Antrieb einen Betriebszyklus hat und das Verfahren des Weiteren das Überwachen des Betriebs des elektrischen Antriebs und das Validieren der Signale an einem vorbestimmten Punkt des Betriebszyklus beinhaltet.

6. Verfahren nach einem der Ansprüche 1 bis 5, wobei das Verfahren das Bestromen einer Phase der geschalteten Reluktanzmaschine (12) an einer Position im Induktivitätszyklus und das Beginnen mit dem Validieren der Signale nach einer Verzögerung in

Bezug auf die Bestromung der Phase (16) beinhaltet; wobei das Verfahren des Weiteren das Bestimmen einer Dauer der Verzögerung als Funktion der Position beinhaltet.

7. System zum Validieren von Signalen, die beim Betrieb eines geschalteten Reluktanzantriebs einschließlich einer geschalteten Reluktanzmaschine (12) verwendet werden, wobei das System Mittel zum Überwachen eines ersten Signals aufweist, das einen Fluss in einer Phase (16) der geschalteten Reluktanzmaschine (12) anzeigt;

Mittel zum Überwachen eines zweiten Signals, das den Fluss in der Phase der geschalteten Reluktanzmaschine (12) anzeigt;

Mittel zum Validieren der Signale, wenn eine vorbestimmte Bedingung des ersten und des zweiten Signals erfüllt ist, wobei eines des ersten und des zweiten Signals durch ein Zeitintegral eines Phasenspannungssignals abgeleitet wird und das andere des ersten und des zweiten Signals durch ein Multiplizieren eines Phasenstromsignals und einer Phaseninduktivität abgeleitet wird, die einer bekannten Position in einem Induktivitätszyklus entspricht.

8. System nach Anspruch 7, wobei die vorbestimmte Bedingung darin besteht, dass das erste und das zweite Signal zusammen vorhanden sind.

9. System nach Anspruch 7 oder Anspruch 8, wobei die vorbestimmte Bedingung darin besteht, dass die jeweiligen Werte des ersten und des zweiten Signals innerhalb einer Spanne voneinander liegen.

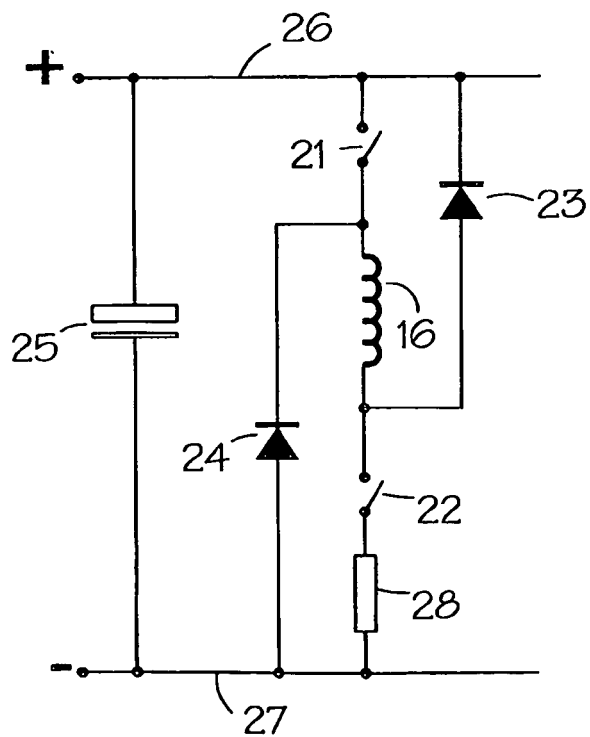
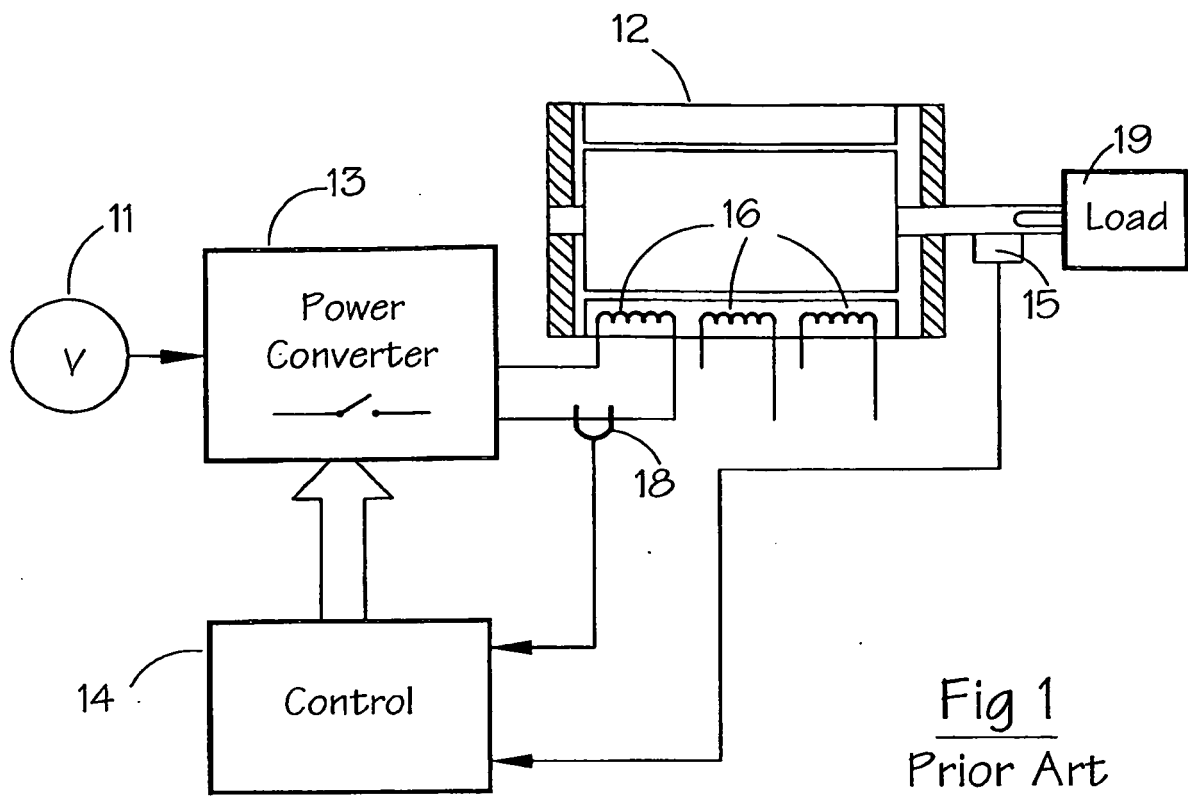
10. System nach einem der Ansprüche 7 bis 9, enthaltend Mittel zum Begrenzen der Validierung der Signale in einem vorbestimmten Zeitraum, nachdem die vorbestimmte Bedingung erfüllt ist.

11. System nach einem der Ansprüche 7 bis 10, wobei der geschaltete Reluktanzantrieb einen Betriebszyklus hat und das Mittel zum Validieren die Signale an einem vorbestimmten Punkt des Betriebszyklus validiert.

12. System nach einem der Ansprüche 7 bis 11, wobei das System Mittel zum Bestromen der Phase (16) der geschalteten Reluktanzmaschine (12) an einer Position im Induktivitätszyklus enthält; wobei das Mittel zum Validieren dafür angeordnet ist, mit dem Validieren der Signale nach einer Verzögerung in Bezug auf die Bestromung der Phase (16) zu beginnen; wobei das Mittel zum Validieren des Weiteren dafür angeordnet ist, eine Dauer der Verzögerung als Funktion der Position zu bestimmen.

Revendications

1. Procédé de validation de signaux utilisés dans le fonctionnement d'un moteur à réluctance variable comprenant une machine à réluctance variable (12),
comportant :
 la surveillance d'un premier signal indicatif d'un flux dans une phase (16) de la machine à réluctance variable (12) ;
 la surveillance d'un second signal indicatif du flux dans la phase (16) de la machine à réluctance variable (12) ; et
 la validation des signaux si une condition prédéterminée des premier et second signaux est satisfaite, dans lequel l'un des premier et second signaux est dérivé par une intégrale temporelle d'un signal de liaison à courant continu (CC), d'alimentation ou de tension de phase et l'autre des premier et second signaux est dérivé par multiplexage d'un signal de courant de phase et d'une inductance de phase correspondant à une position connue dans un cycle d'inductance.
2. Procédé selon la revendication 1, dans lequel la condition prédéterminée est que les premier et second signaux sont présents ensemble.
3. Procédé selon la revendication 1 ou la revendication 2, dans lequel la condition prédéterminée est que les valeurs respectives des premier et second signaux sont dans une marge l'un de l'autre.
4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'étape de validation des signaux est réalisée à l'intérieur d'une période de temps prédéterminée après que la condition prédéterminée a été satisfaite.
5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel le moteur électrique possède un cycle de fonctionnement et le procédé comprend en outre la surveillance du fonctionnement du moteur électrique et la validation des signaux à un point prédéterminé dans le cycle de fonctionnement.
6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel le procédé comprend la mise sous tension d'une phase de la machine à réluctance variable (12) au niveau d'une position dans le cycle d'inductance et le démarrage de la validation des signaux après un retard par rapport à la mise sous tension de la phase (16) ; le procédé comportant en outre la détermination d'une durée du retard en fonction de la position.
7. Système pour valider des signaux utilisés dans le fonctionnement d'un moteur à réluctance variable comprenant une machine à réluctance variable (12), le système comprenant des moyens pour surveiller un premier signal indicatif d'un flux dans une phase (16) de la machine à réluctance variable (12) ; des moyens pour surveiller un second signal indicatif du flux dans la phase de la machine à réluctance variable (12) ; des moyens pour valider les signaux si une condition prédéterminée des premier et second signaux est satisfaite, l'un des premier et second signaux étant dérivé par une intégrale temporelle d'un signal de tension de phase et l'autre des premier et second signaux étant dérivé par multiplexage d'un signal de courant de phase et d'une inductance de phase correspondant à une position connue dans un cycle d'inductance.
8. Système selon la revendication 7, dans lequel la condition prédéterminée est que les premier et second signaux sont présents ensemble.
9. Système selon la revendication 7 ou la revendication 8, dans lequel la condition prédéterminée est que les valeurs respectives des premier et second signaux sont dans une marge l'un de l'autre.
10. Système selon l'une quelconque des revendications 7 à 9, comprenant des moyens pour limiter la validation des signaux à l'intérieur d'une période de temps prédéterminée après que la condition prédéterminée a été satisfaite.
11. Système selon l'une quelconque des revendications 7 à 10, dans lequel le moteur à réluctance variable possède un cycle de fonctionnement et les moyens pour valider valident les signaux à un point prédéterminé dans le cycle de fonctionnement.
12. Système selon l'une quelconque des revendications 7 à 11, dans lequel le système comprend des moyens pour mettre sous tension la phase (16) de la machine à réluctance variable (12) au niveau d'une position dans le cycle d'inductance ; les moyens pour valider étant agencés pour démarrer la validation des signaux après un retard par rapport à la mise sous tension de la phase (16) ; les moyens pour valider étant en outre agencés pour déterminer une durée du retard en fonction de la position.



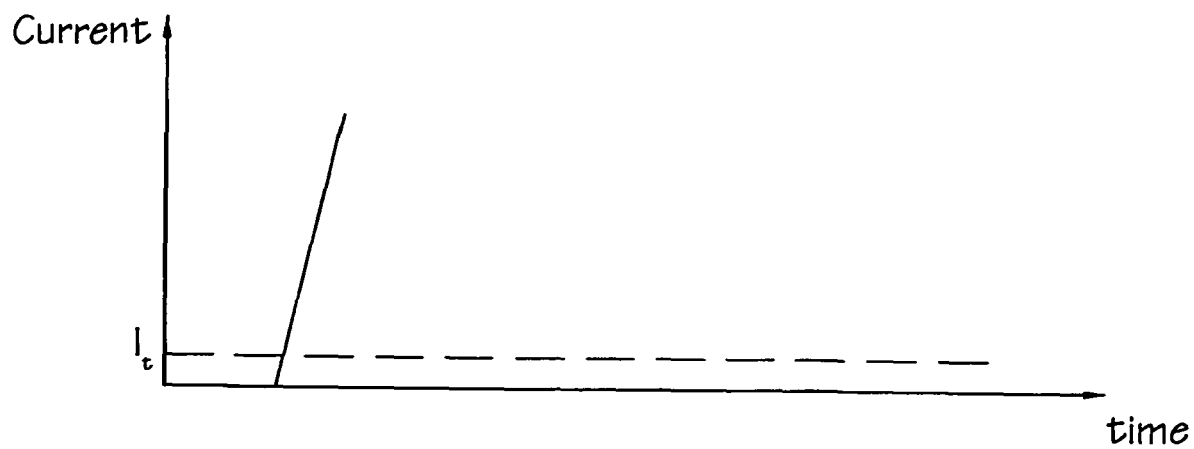


Fig 3
Prior Art

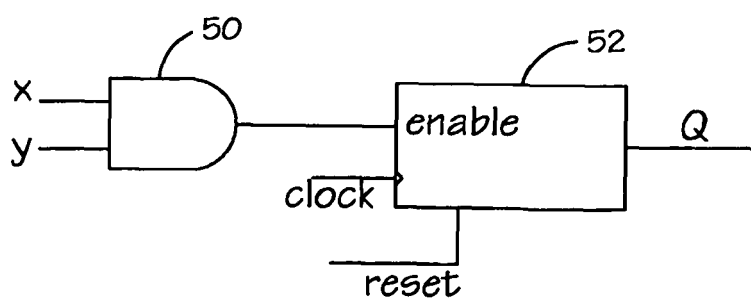


Fig 4

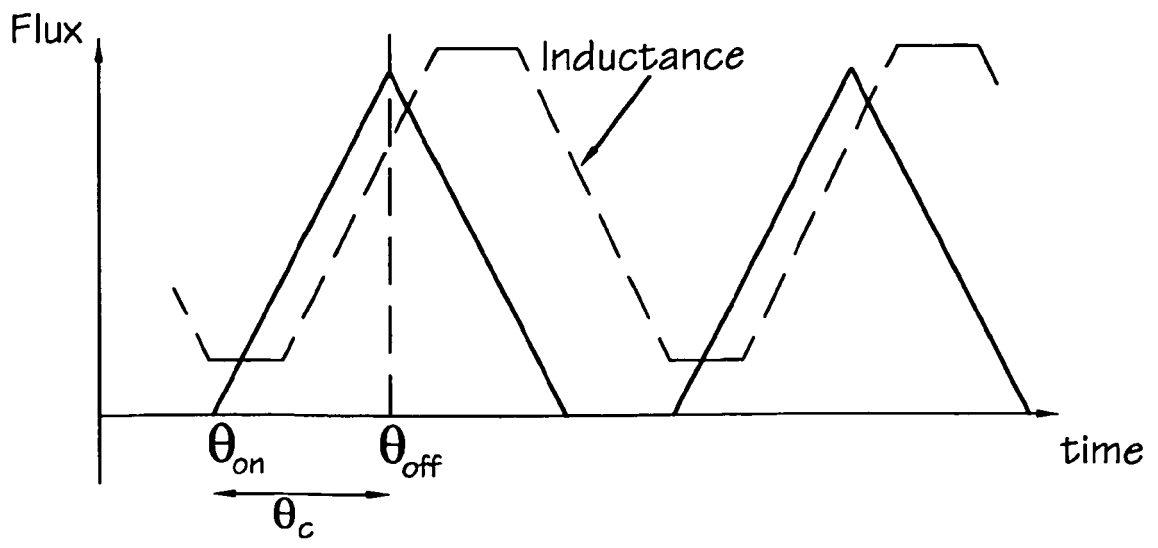


Fig 5

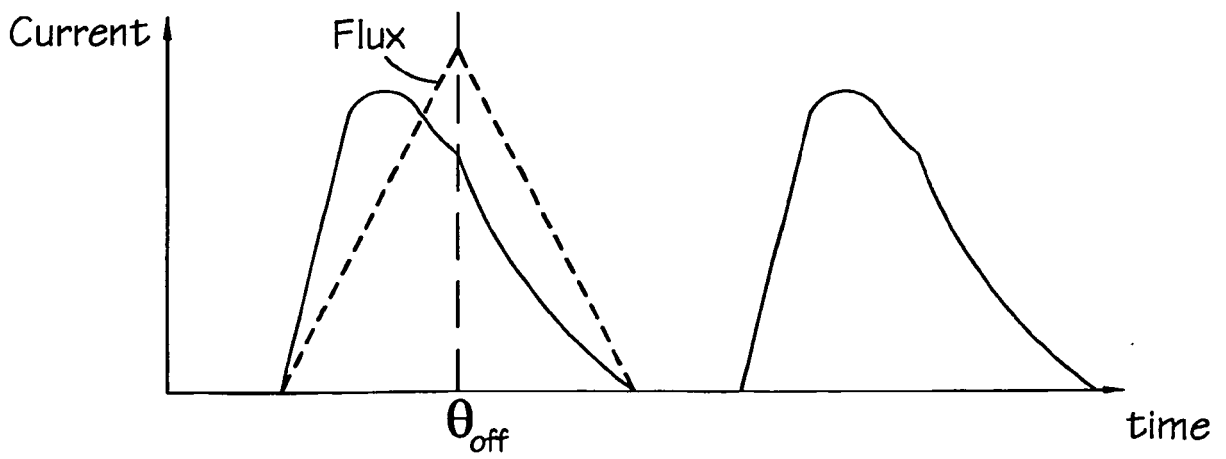


Fig 6

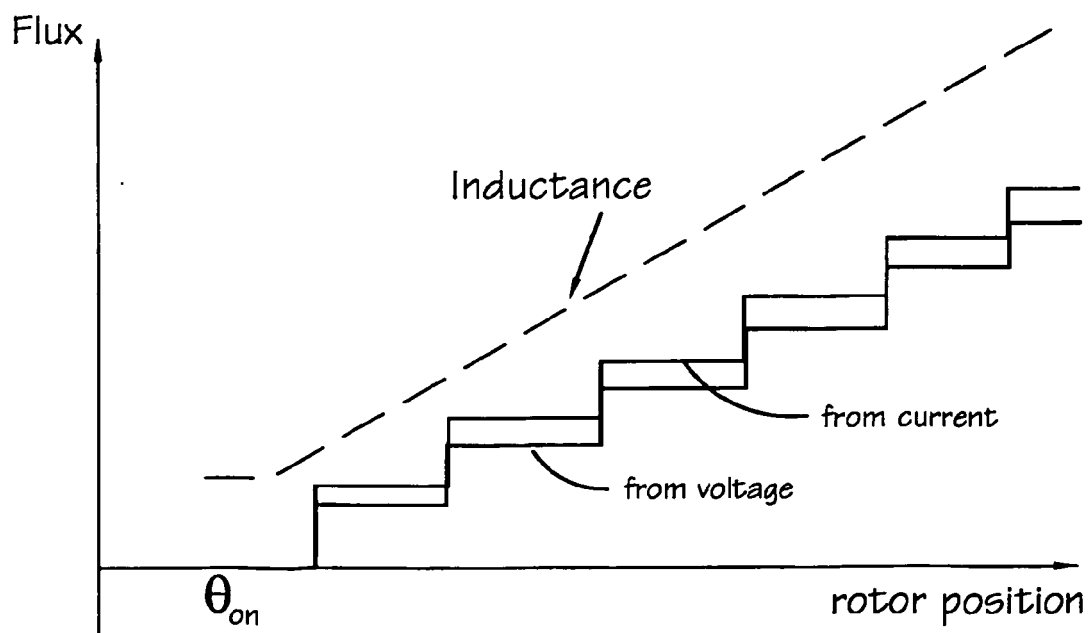
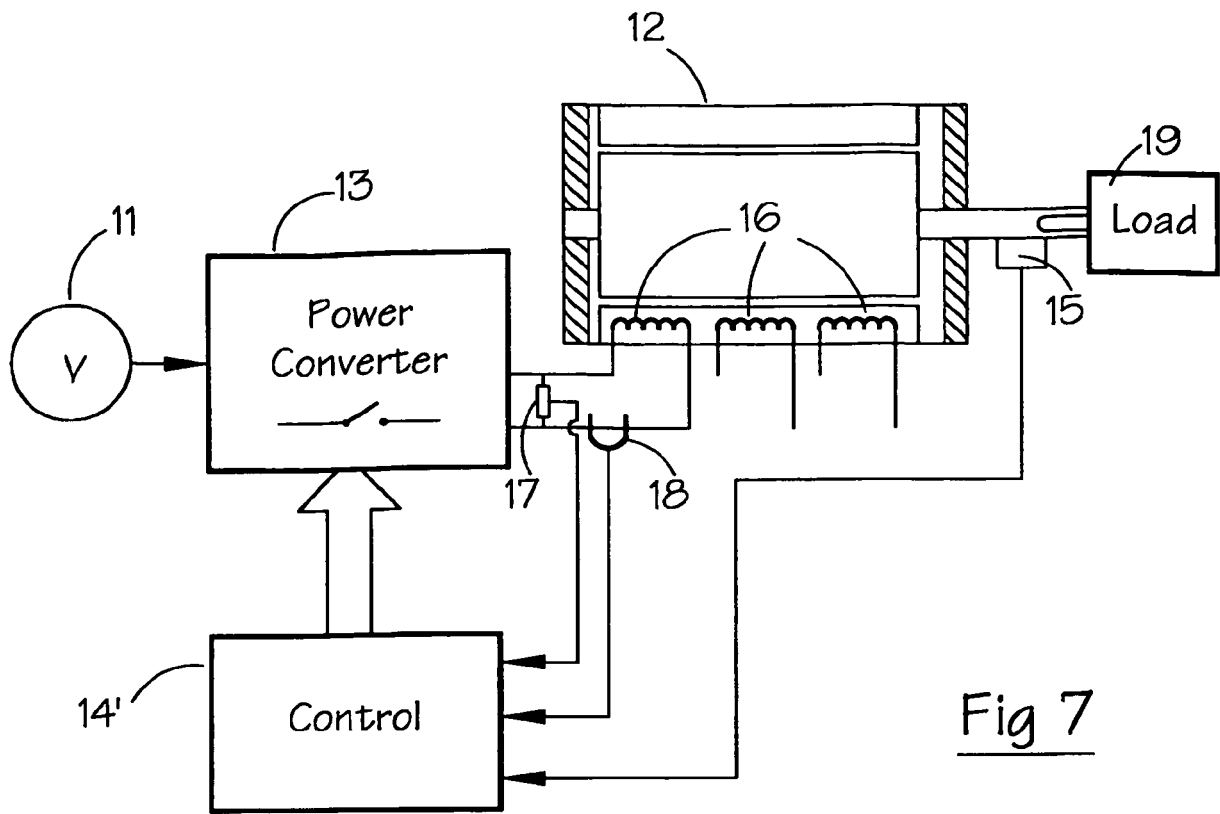


Fig 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- US 5723858 A [0004]
- EP 1655831 A [0010]

Non-patent literature cited in the description

- **STEPHENSON ; BLAKE.** The characteristics, design and application of switched reluctance motors and drives. *The characteristics, design and application of switched reluctance motors and drives*, 21 June 1993 [0003]
- **TJE MILLER.** Electronic Control of Switched Reluctance Machines. 2001 [0003]
- **W F RAY ; I H AL-BAHADLY.** Sensorless Methods for Determining the Rotor Position of Switched Reluctance Motors. *Proceedings of The European Power Electronics Conference*, 13 September 1993, vol. 6, 7-13 [0008]
- **SALMASI.** Dual estimators for position and current sensorless SRM drives based on the decomposed model. *IEEE Int Conf on Electric Machines and Drives*, 15 May 2005, 1103-1107 [0009]