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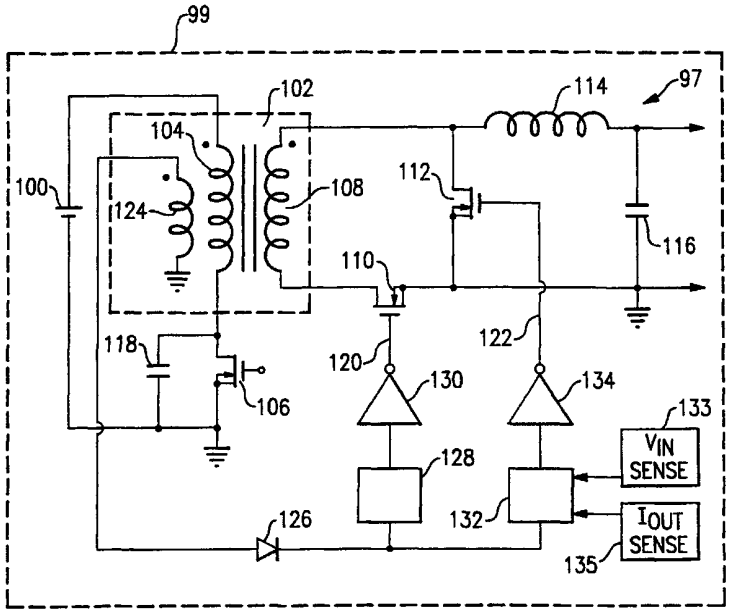
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: DRIVE CIRCUITS FOR SYNCHRONOUS RECTIFIERS



(57) Abstract: A method and system for providing synchronous rectification in power converters that includes controlling turnoff of a synchronous rectifier according to a timing signal representative of the switching time of a switch that is coupled to input of the power converter. Such a timing signal may be obtained directly or indirectly in various ways; for example, by sensing the voltage across the primary switch, or by sensing the drive voltage of the primary switch. Additional alternatives in an isolated converter having a transformer with a primary winding that is selectively coupled to the electrical power source includes sensing the primary winding voltage, for example, by directly sensing the primary voltage or by sensing the voltage across an auxiliary winding that is closely coupled to the primary winding.

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H02M3/158 H02M3/335

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)
IPC 7 H02M

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 practical, search terms used)
EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 98 54827 A (SEMI-TECH DESIGN INC.) 3 December 1998 (1998-12-03) figures 1A-3A,,11-13 ---	1,6,7, 13,14, 16,17, 19,20, 24-26
X	US 5 721 483 A (MADHAV V.KOLLURI ET AL.) 24 February 1998 (1998-02-24) abstract figure 2 column 2, line 20 - line 42 column 3, line 20 - line 26 --- -/--	1-4,6, 15,24

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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 document 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
15 February 2001	21 05. 2001

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, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	LUND M.

Form PCT/ISA/210 (second sheet) (July 1992)

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4 857 822 A (WOJCIECH A.TABISZ ET AL.) 15 August 1989 (1989-08-15) abstract figures 25,26 column 1, line 56 - line 58 column 4, line 5 - line 11 column 5, line 56 - line 58 column 7, line 18 - line 21 column 7, line 56 - line 60 column 11, line 12 - line 23 column 15, line 8 - line 44	1,2,15, 18,30-33
X	J.A.COBOS: "SElf driven Synchronous Rectification in Resonant Topologies: Forward ZVS-MRC, Forward ZCS-QRC and LCC-PRC." 1992 INTERNATIONAL CONFERENCE ON INDUSTRIAL ELECTRONICS, CONTROL, INSTRUMENTATION AND AUTOMATION, vol. 1, pages 185-190, XP000368953 San Diego, US figures 2,5-7	1,2,15, 18,30-33
X	A.VITHANAGE ET AL.: "150W board mounted power supply module using highly compact and efficient synchronous rectifiers" IEEE, pages 177-183, XP000873665	1,6,7,24
Y	figures 5,7,8	2
X	US 5 920 475 A (JEFFREY L.BOYLAN ET AL.) 6 July 1999 (1999-07-06) figure 8	1,6,24
Y	FR 2 608 857 A (SODILEC) 24 June 1988 (1988-06-24) abstract figures 1,2	2
A	US 4 922 404 A (GERALD W. LUDWIG ET AL.) 1 May 1990 (1990-05-01) abstract figure 1 column 2, line 51 -column 3, line 6 column 4, line 54 - line 58 column 5, line 22 - line 26	18,30-33

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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. [ ] Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. [X] Claims Nos.: 5, 34, 39-41
because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:
see FURTHER INFORMATION sheet PCT/ISA/210

3. [ ] Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. [ ] As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. [ ] As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. [ ] As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. [X] No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims: it is covered by claims Nos.:
1-4, 6, 7, 13-20, 24-26, 30-33

Remark on Protest

[ ] The additional search fees were accompanied by the applicant's protest.

[ ] No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-4, 6, 7, 13-20, 24-26, 30-33

   A power converter with the conduction control terminal of the rectifier device being driven OFF when the current in the rectifier device is reduced to a substantially negligible amount.

2. Claims: 8, 9,

   A power converter with the detection circuit including an auxiliary winding of the main transformer for sensing the voltage across the primary winding.

3. Claims: 10, 27

   A power converter or a method for driving a synchronous rectifier characterized by sensing the voltage across the primary switch through a capacitor.

4. Claims: 11, 28

   A power converter or a method for driving a synchronous rectifier characterized by sensing the state of a control terminal of the primary switch using a capacitor.

5. Claims: 12, 29

   A power converter or a method for driving a synchronous rectifier characterized by the detection circuit including a second transformer with a sense winding connected to the control terminal of the primary switch.

6. Claims: 21, 22, 35-37,

   A power converter or a method for driving a synchronous rectifier characterized by the use of two active switch rectifiers connected to the secondary of the transformer where one of the two switch rectifiers conducts current when the other switch rectifier is in a non-conductive state.

7. Claims: 23, 38

   A power converter or a method for driving a synchronous rectifier characterized by the power converter being a resonant reset forward converter.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

8. Claim : 42

A method for driving a synchronous rectifier characterized by driving the synchronous rectifier with a drive signal that is modulated in amplitude as a function of the output current.

9. Claim : 43

A converter that provides an output and a bias power supply with a first and second unidirectional rectifier device, each connected to an end of the secondary winding and forming a bridge for bias power supply.

10. Claims: 44, 45

A method for establishing a maximum duty cycle for a pulse width modulator characterized by the generation of a sawtooth waveform signal using two charging currents successively, determined by the use of two impedances and switching between the two impedances.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Continuation of Box I.2

Claims Nos.: 5, 34, 39-41

The applicant is concerned with a power converter with a primary switch and a rectifier device being controlled by a signal that is derived from the timing of the primary switch, eventually with some delay.
In claim 5 the applicant suddenly states that "said rectifier is driven ON based on a second timing signal that is independent of any timing signal representative of the switching time of said primary switch".
In case of no such dependency, the primary switch and the rectifier device will not work synchronously
and the two may switch ON and OFF relative to one another at any given time. A converter of that type is not covered by this application.
As the primary switch and the rectifier device are in fact operating synchronously the signal for driving the rectifier device ON is dependent on the timing of the primary switch and thus on "any signal" representative of the switching time of said primary switch.
Claim 39 is corresponding to claim 5 and is likewise subject to obscurity. Claims 40 and 41 are truly dependent on claim 39 and are as result also subject to obscurity.

Claim 34 specifies that "said synchronous rectifier conducts the output current when said switch is in the OFF state". Claim 34 is truly dependent on claim 30 stating that "said driving includes driving said synchronous rectifier OFF relative to said timing signal transition between levels corresponding to the switch switching between an ON state and an OFF state (thus switching the synchronous rectifier OFF controlled by the switch being switched OFF). Claim 34 is thus inconsistent with claim 30.

The applicant's attention is drawn to the fact that claims, or parts of claims, relating to inventions in respect of which no international search report has been established need not be the subject of an international preliminary examination (Rule 66.1(e) PCT). The applicant is advised that the EPO policy when acting as an International Preliminary Examining Authority is normally not to carry out a preliminary examination on matter which has not been searched. This is the case irrespective of whether or not the claims are amended following receipt of the search report or during any Chapter II procedure.

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