



(51) International Patent Classification:

H02M 3/157 (2006.01) H02M 3/158 (2006.01)  
G05F 1/62 (2006.01) H03F 3/195 (2006.01)  
H02M 3/156 (2006.01) H03H 1/02 (2006.01)

(21) International Application Number:

PCT/US2011/061599

(22) International Filing Date:

21 November 2011 (21.11.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

61/418,183 30 November 2010 (30.11.2010) US  
13/158,874 13 June 2011 (13.06.2011) US

(71) Applicant (for all designated States except US): **MICRO-CHIP TECHNOLOGY INCORPORATED** [US/US]; 2355 West Chandler Blvd., Chandler, AZ 85224-6199 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CLEVELAND, Terry** [US/US]; 1958 Dutchtown Road, Endicott, NY 13760 (US). **ELLISON, Clifford** [US/US]; 8462 Vieley Road, Campbell, NY 14821 (US). **DEARBORN, Scott** [US/US]; 24109 State Route 167, Brackney, PA 18812 (US). **PAZUL, Keith** [US/US]; 239 West Myrna Lane, Tempe, AZ 85284 (US).

(74) Agent: **SLAYDEN, Bruce, W., II**; King & Spalding LLP, 401 Congress Ave., Suite 3200, Austin, TX 78701 (US).

(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))

[Continued on next page]

(54) Title: EFFICIENCY-OPTIMIZING, CALIBRATED SENSORLESS POWER/ENERGY CONVERSION IN A SWITCH-MODE POWER SUPPLY

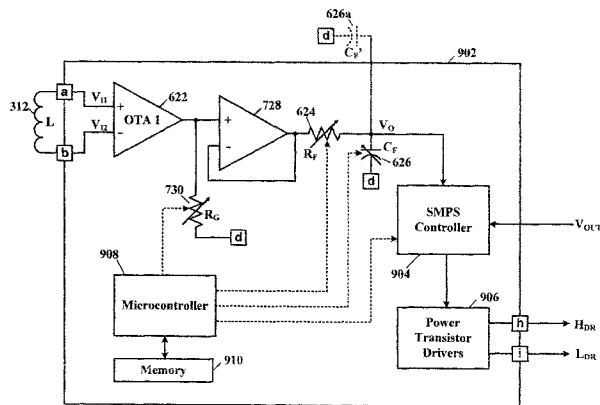


FIGURE 9

(57) Abstract: An intelligent pulse width modulation (PWM) controller adapts a switch mode power supply (SMPS) system's operating parameters to optimize efficiency, remove hot spots and isolate faults by integrating a microcontroller, PWM digital circuits and analog circuits into a single integrated circuit, e.g., a mixed signal device, thereby reducing the number of external connections, silicon die area and integrated circuit packages. A lossless inductor current sense technique integrates a matched, tunable complementary filter with the intelligent SMPS controller for accurately measuring current through the power inductor of the SMPS without introducing losses in the power circuit. The complimentary filter is adjusted by the microcontroller to significantly reduce the effects of component tolerances, accurately measuring the power inductor current for precise closed loop control and over current protection. The frequency pole and gain of the complimentary integrated filter can be adjusted on the fly in order to adapt to dynamically changing operating conditions of the SMPS system.

WO 2012/074806 A3



---

— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))* — *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

**Published:**

— *with international search report (Art. 21(3))*

**(88) Date of publication of the international search report:**  
27 December 2012

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/US2011/061599

**A. CLASSIFICATION OF SUBJECT MATTER**  
 INV. H02M3/157 G05F1/62 H02M3/156 H02M3/158 H03F3/195  
 H03H1/02  
 ADD.  
 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)  
 G05F H02M H03F H03H

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 practicable, search terms used)  
 EPO-Internal

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009/146634 A1 (AUDY JONATHAN MARK [US]) 11 June 2009 (2009-06-11)	1,13
Y	paragraphs [0039], [0044], [0047], [0062], [0050] - [0056], [0085]; figures 1-6	2-12,14,15
X	US 2007/236287 A1 (BERNACCHIA GIUSEPPE [IT] ET AL) 11 October 2007 (2007-10-11)	1,13
Y	paragraphs [0054], [0078]; figures 3,9,14	2-12,14,15
Y	US 2009/096533 A1 (PAUL SUSANNE A [US] ET AL) 16 April 2009 (2009-04-16)	2-12,14,15
	paragraphs [0076], [0107], [0110]; figures 1-20	
Y	US 2007/236281 A1 (CICALINI ALBERTO [US]) 11 October 2007 (2007-10-11)	2-12,14,15
	paragraph [0030]; figures 1,2,4,8	

Further documents are listed in the continuation of Box C.

See patent family annex.

\* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance	"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
"E" earlier application or patent but published on or after the international filing date	"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
"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)	"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
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family
"P" document published prior to the international filing date but later than the priority date claimed	

Date of the actual completion of the international search <b>22 October 2012</b>	Date of mailing of the international search report <b>29/10/2012</b>
---	---

Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer <b>Kanelis, Konstantin</b>
--	--

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2011/061599
---

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2009146634	A1	11-06-2009	NONE
-----			
US 2007236287	A1	11-10-2007	DE 102006013524 A1 04-10-2007
			US 2007236287 A1 11-10-2007
			US 2010244803 A1 30-09-2010
-----			
US 2009096533	A1	16-04-2009	US 2009096533 A1 16-04-2009
			WO 2009052283 A2 23-04-2009
-----			
US 2007236281	A1	11-10-2007	CN 101496278 A 29-07-2009
			EP 2005587 A2 24-12-2008
			JP 2009533903 A 17-09-2009
			KR 20090025203 A 10-03-2009
			US 2007236281 A1 11-10-2007
			WO 2007118167 A2 18-10-2007
-----			