



- (51) **International Patent Classification:**  
H02J 7/02 (2006.01) H02J 7/00 (2006.01)  
B60L 11/18 (2006.01)
- (21) **International Application Number:**  
PCT/US2014/011492
- (22) **International Filing Date:**  
14 January 2014 (14.01.2014)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
13/745,676 18 January 2013 (18.01.2013) US
- (71) **Applicant:** QUALCOMM INCORPORATED [US/US];  
ATTN: International IP Administration, 5775 Morehouse  
Drive, San Diego, California 92121-1714 (US).
- (72) **Inventors:** KEELING, Nicholas A.; 5775 Morehouse  
Drive, San Diego, California 92121-1714 (US). BEAVER,  
Jonathan; 5775 Morehouse Drive, San Diego, California  
92121-1714 (US). HUANG, Chang-Yu; 5775 Morehouse  
Drive, San Diego, California 92121-1714 (US).
- (74) **Agent:** ABUMERI, Mark M.; Knobbe Martens Olson &  
Bear LLP, 2040 Main Street, Fourteenth Floor, Irvine,  
California 92614 (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, BN, 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, IR, IS, JP, KE, KG, 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, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA,  
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, 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,  
KM, ML, MR, NE, SN, TD, TG).

**Declarations under Rule 4.17:**

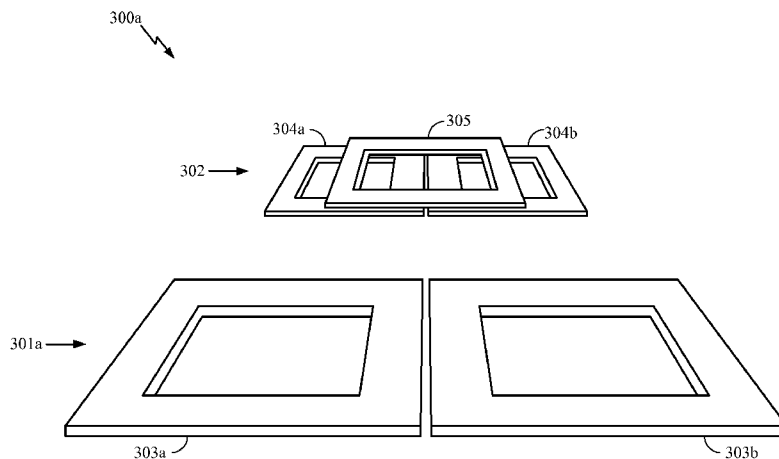
- as to applicant's entitlement to apply for and be granted a  
patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the  
earlier application (Rule 4.17(iii))

**Published:**

- with international search report (Art. 21(3))

[Continued on next page]

(54) **Title:** METHOD OF MULTI-COIL OPERATION AND OPTIMIZATION



**FIG. 3A**

(57) **Abstract:** This disclosure provides systems, methods and apparatus for wireless power transfer and particularly wireless power transfer to remote systems such as electric vehicles. In one aspect, a system comprises substantially co-planar first and second receiver coils. The system further comprises a third receiver coil. The system further comprises a controller configured to determine a current of the co-planar first and second receiver coils, a current of the third receiver coil, and a duty cycle of the wireless power transfer receiver device. The controller is configured to enable the co-planar first and second receiver coils, the third receiver coil, or the co-planar first and second receiver coils and the third receiver coil based on a comparison of the current of the co-planar first and second receiver coils, the current of the third receiver coil, and the duty cycle.

WO 2014/113391 A3



---

— *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))*

**(88) Date of publication of the international search report:**  
2 April 2015

**INTERNATIONAL SEARCH REPORT**

International application No  
PCT/US2014/011492

A. CLASSIFICATION OF SUBJECT MATTER  
INV. H02J7/02 B60L11/18 H02J7/00  
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)  
H02J B60L

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	GRANT A COVIC ET AL: "A bipolar primary pad topology for EV stationary charging and highway power by inductive coupling", ENERGY CONVERSION CONGRESS AND EXPOSITION (ECCE), 2011 IEEE, IEEE, 17 September 2011 (2011-09-17), pages 1832-1838, XP032067402, DOI: 10.1109/ECCE.2011.6064008 ISBN: 978-1-4577-0542-7 the whole document	1-41
A	WO 2007/100265 A1 (AUCKLAND UNISERVICES LTD [NZ]; BOYS JOHN TALBOT [NZ]) 7 September 2007 (2007-09-07) claims 7-11	1-41
	----- -/--	

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
- "E" earlier application or patent 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  4 February 2015	Date of mailing of the international search report  17/02/2015
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  Schneider, Gernot

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2014/011492

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	MICKEL BUDHIA ET AL: "Development and evaluation of single sided flux couplers for contactless electric vehicle charging", ENERGY CONVERSION CONGRESS AND EXPOSITION (ECCE), 2011 IEEE, IEEE, 17 September 2011 (2011-09-17), pages 614-621, XP032067220, DOI: 10.1109/ECCE.2011.6063826 ISBN: 978-1-4577-0542-7 page 618 - page 620 -----	1-41
A	WO 2012/018269 A1 (AUCKLAND UNISERVICES LTD [NZ]; COVIC GRANT ANTHONY [NZ]; BUDHIA MICKEL) 9 February 2012 (2012-02-09) page 13, line 14 - line 32 -----	1-41
A	WO 2010/090539 A1 (AUCKLAND UNISERVICES LTD [NZ]; BOYS JOHN TALBOT [NZ]; COVIC GRANT ANTH) 12 August 2010 (2010-08-12) cited in the application the whole document -----	1-41
A	US 2012/262002 A1 (WIDMER HANSPETER [CH] ET AL) 18 October 2012 (2012-10-18) paragraph [0064] - paragraph [0069] -----	1-41

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No PCT/US2014/011492
---

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2007100265 A1	07-09-2007	CN 101427454 A	06-05-2009
		EP 2005567 A1	24-12-2008
		JP 5399080 B2	29-01-2014
		JP 2009528812 A	06-08-2009
		NZ 545664 A	31-07-2008
		US 2009129126 A1	21-05-2009
		WO 2007100265 A1	07-09-2007
-----			
WO 2012018269 A1	09-02-2012	CN 103155341 A	12-06-2013
		EP 2601723 A1	12-06-2013
		JP 2013535841 A	12-09-2013
		KR 20130093616 A	22-08-2013
		US 2013285463 A1	31-10-2013
		WO 2012018269 A1	09-02-2012
-----			
WO 2010090539 A1	12-08-2010	CA 2751595 A1	12-08-2010
		CN 102362406 A	22-02-2012
		EP 2394346 A1	14-12-2011
		JP 2012517118 A	26-07-2012
		KR 20110121624 A	07-11-2011
		US 2012025602 A1	02-02-2012
		WO 2010090539 A1	12-08-2010
-----			
US 2012262002 A1	18-10-2012	CN 103477566 A	25-12-2013
		EP 2697910 A1	19-02-2014
		JP 2014518607 A	31-07-2014
		KR 20140022867 A	25-02-2014
		US 2012262002 A1	18-10-2012
		WO 2012142040 A1	18-10-2012
-----			