



(51) International Patent Classification:

*H01Q 1/24* (2006.01)     *H01Q 9/04* (2006.01)  
*H01Q 5/00* (2006.01)     *H01Q 9/42* (2006.01)

(21) International Application Number:

PCT/IB2011/002214

(22) International Filing Date:

20 April 2011 (20.04.2011)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

12/764,826     21 April 2010 (21.04.2010)     US

(71) Applicant (for all designated States except US): **PULSE FINLAND OY** [FI/FI]; Takatie 6, FI-90440 Kempele (FI).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **KORVA, Heikki** [FI/FI]; Mannikonmutka 5, FI-91910 Tupos (FI). **ANNA-MAA, Petteri** [FI/FI]; Vesakuja 5, FI-90460 Oulunsalo

(FI). **RAAPPANA, Ari** [FI/FI]; Piimaperantie 142, FI-90820 Kello (FI).

(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, RO, RS, RU, 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, 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,

[Continued on next page]

(54) Title: DISTRIBUTED MULTIBAND ANTENNA AND METHODS

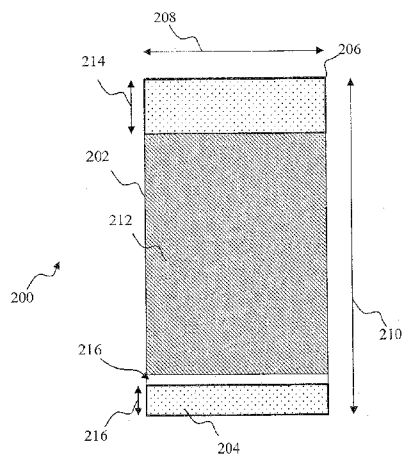


FIG. 2A

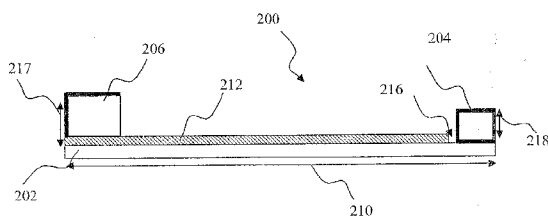


FIG. 2B

(57) Abstract: A distributed multiband antenna intended for radio devices, and methods for designing manufacturing the same. In one embodiment, a planar inverted-F antenna (PIFA) (206) configured to operate in a high-frequency band, and a matched monopole (204) configured to operate in a low-frequency band, are used within a handheld mobile device (e.g., cellular telephone). The two antennas are placed on substantially opposing regions of the portable device. The use of a separate low-frequency antenna element facilitates frequency-specific antenna matching, and therefore improves the overall performance of the multiband antenna. The use of high-band PIFA reduces antenna volume, and enables a smaller device housing structure while also reducing signal losses in the high frequency band. Matching of the low-frequency band monopole antenna is further described.

WO 2011/161550 A3



SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,  
GW, ML, MR, NE, SN, TD, TG).

— 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))

**Declarations under Rule 4.17:**

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

**(88) Date of publication of the international search report:**  
10 May 2012

**Published:**

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

## INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2011/002214

| A. CLASSIFICATION OF SUBJECT MATTER<br>INV. H01Q1/24 H01Q5/00 H01Q9/04 H01Q9/42<br>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)<br>H01Q   |   |                       |
| 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)<br>EPO-Internal, INSPEC, 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   | JP 2004 040596 A (MATSUSHITA ELECTRIC IND CO LTD) 5 February 2004 (2004-02-05)<br>page 8, paragraph 37 - paragraph 40<br>figures 22A, 22B<br>abstract<br>-----  | 1-12,20,<br>21,24-28  |
| X   | EP 1 806 907 A1 (MATSUSHITA ELECTRIC IND CO LTD [JP]) 11 July 2007 (2007-07-11)<br>column 4, line 57 - column 10, line 10<br>figures 1-9<br>abstract<br>-----   | 1-12,<br>20-28        |
| A,P   | EP 2 237 129 A2 (TOSHIBA KK [JP])<br>6 October 2010 (2010-10-06)<br>column 4, line 30 - column 8, line 3<br>figure 4<br>abstract<br>-----   | 1-12,<br>20-28        |
| <input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 document 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<br><br>16 December 2011   | Date of mailing of the international search report<br><br>21/03/2012  |                       |
| Name and mailing address of the ISA/<br>European Patent Office, P.B. 5818 Patentlaan 2<br>NL - 2280 HV Rijswijk<br>Tel. (+31-70) 340-2040,<br>Fax: (+31-70) 340-3016    | Authorized officer<br><br>von Walter, Sven-Uwe  |                       |

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2011/002214

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 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.  Claims Nos.:  
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:
  
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 No. III Observations where unity of invention is lacking (Continuation of item 3 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 fees, this Authority did not invite payment of additional fees.
  
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.  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.:  
1-12, 20-28

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- 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: 1-12, 20-28

Multiband antenna apparatus having two antennas disposed at opposing ends of a ground plane and communication device thereto

---

2. claims: 13-16

Method of operating three antennas

---

3. claims: 17-19

Stripline antenna matching circuit feeding an antenna element

---

4. claim: 29

Reduced-size mobile radio device defined by placing antenna elements at opposing regions

---

**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No

PCT/IB2011/002214

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date          |
|--|------------------|-------------------------|---------------------------|
| JP 2004040596                          | A                | 05-02-2004              | NONE                      |
| EP 1806907                             | A1               | 11-07-2007              | EP 1806907 A1 11-07-2007  |
|  |                  | JP 4372158 B2           | 25-11-2009                |
|  |                  | US 2009131129 A1        | 21-05-2009                |
|  |                  | WO 2006046714 A1        | 04-05-2006                |
| EP 2237129                             | A2               | 06-10-2010              | CN 101853980 A 06-10-2010 |
|  |                  | EP 2237129 A2           | 06-10-2010                |
|  |                  | JP 4856206 B2           | 18-01-2012                |
|  |                  | JP 2010239211 A         | 21-10-2010                |
|  |                  | US 2010245265 A1        | 30-09-2010                |