(54) Title: SYSTEM AND METHODS THAT EMPLOY A BALANCED DUPLEXER

(57) Abstract: The present invention relates to systems (100) and methods that employ a novel balanced duplexer that can be utilized to facilitate concurrent signal transmission (110) and reception (120). The systems and methods can be employed within mobile devices such as cell phones and utilize two-filters (e.g., acoustic) with substantially similar input/output impedances interfaced with two couplers (e.g., 3 dB hybrid), which provide isolation and maintain the duplexer's input/output impedance. The couplers interface the filters to front/back ends such as signal processors, transmitters and receivers. The novel aspects of the present invention mitigate the need to employ external directional couplers between the duplexer and front/back ends. In addition, the two-filter topology enables employment of lower powered rated filters. The systems (100) and methods further provide for separation and isolation of transmitters (110) and receivers (120), which reduces noise coupling and enables the transmitter (110) and receiver (120) to be placed within close proximity.
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.
INTERNATIONAL SEARCH REPORT

A.  CLASSIFICATION OF SUBJECT MATTER

   IPC(7)   :   H04B 1/46
   US CL    :   455/80

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)

U.S. : 455/78, 80, 81

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)

Please See Continuation Sheet

C.  DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 6,272,329 B1 (Sawchuk) Aug. 7, 2001; see figure 1; col. 1, line 46 - col. 2, line 3; col. 3, lines 7-8; col. 3, lines 27-30.</td>
<td>1-4, 26</td>
</tr>
<tr>
<td>Y</td>
<td>US 5,982,825 (Tsujimoto) Nov. 9, 1999; see figures 1 and 4; col. 3, lines 56-59; col. 5, lines 26-29.</td>
<td>5-9, 14-17, 19-22, 27</td>
</tr>
<tr>
<td>Y</td>
<td>US 6,549,090 B2 (Crescenzi, Jr.) Apr. 15, 2003; see col. 1, lines 14-15; col. 2, lines 39-45.</td>
<td>23</td>
</tr>
<tr>
<td>Y</td>
<td>WO99/14853 (Polini) Mar. 25, 1999; see page 5, lines 6-10; page 5, line 35 - page 6, line 10.</td>
<td>24, 25</td>
</tr>
<tr>
<td>Y,P</td>
<td>US 6,710,650 B1 (Beaudin et al) Mar. 23, 2004; see col. 3, lines 18-20; col. 4, lines 31-36.</td>
<td>5-8, 15, 16, 19, 24, 25</td>
</tr>
</tbody>
</table>

\[ \text{Further documents are listed in the continuation of Box C.} \]

\[ \text{See patent family annex.} \]

* 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 published on or after the international filing date
- **L** document which may throw doubt 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

31 March 2005

Date of mailing of the international search report

8 APR 2005

Authorized officer

Vivian Chin

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Form PCT/ISA/210 (second sheet) (January 2004)
INTERNATIONAL SEARCH REPORT

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. [x] Claims Nos.: 10-13
   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:
   Please See Continuation Sheet

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:

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 require 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. [ ] 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.:

Remark on Protest
[ ] The additional search fees were accompanied by the applicant’s protest.
[ ] No protest accompanied the payment of additional search fees.
Continuation of Box II Reason 2:
Claim 10 recites the limitation "the signal power" in second line of claim 10. There is insufficient antecedent basis for this limitation in the claim.
It is unclear what is the relationship between the signal power and the first and second couplers. It is also unclear what "the signal power" encompasses (i.e. a transmitting signal power, a receiving signal power or a noise signal power).
Claims 11-13 included said limitation and do not further explain said limitation and its relationship with the first and second couplers.

Continuation of B. FIELDS SEARCHED Item 3:
USPAT, US-PGPUB
search terms: duplexer, coupler, filter