(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
4 June 2009 (04.06.2009)

PCT

(10) International Publication Number
WO 2009/070100 A1

(51) International Patent Classification:
H01Q 1/24 (2006.01) *H04B 1/18* (2006.01)

(21) International Application Number:
PCT/SE2008/051342

(22) International Filing Date:
25 November 2008 (25.11.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
07445044.6 30 November 2007 (30.11.2007) EP

(71) Applicant *(for all designated States except US)*: **LAIRD TECHNOLOGIES AB** [SE/SE]; Box 1146, S-164 22 Kista (SE).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **KAIKKONEN, Andrei** [SE/SE]; Basunvägen 3, S-175 48 Järfälla (SE). **LINDBERG, Peter** [SE/SE]; Norrlandsgatan 44B, S-752 29 Uppsala (SE). **ARBIN, Axel von** [SE/SE]; Bryggvägen 7, S-183 63 Täby (SE).

(74) Agents: **ROMEDAHL, Bengt** et al.; Kransell & Wennborg AB, P.O. Box 27834, S-11593 Stockholm (SE).

(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, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, 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, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*

(54) **Title:** ANTENNA DEVICE AND PORTABLE RADIO COMMUNICATION DEVICE COMPRISING SUCH ANTENNA DEVICE

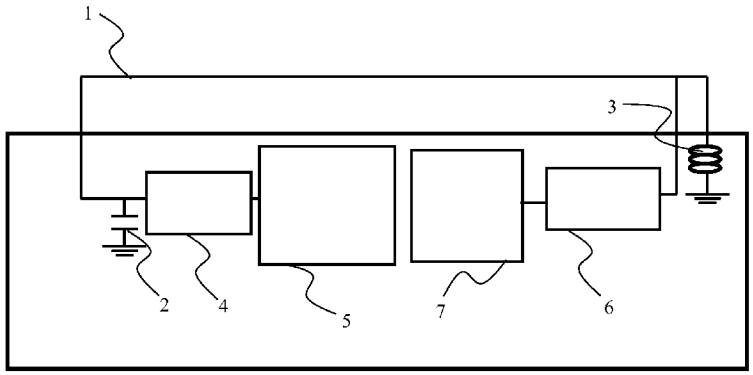

FIG. 1

(57) **Abstract:** The present invention relates to an antenna device for a portable radio communication device adapted for receiving and/or transmitting radio signals in at least a first and a second operating frequency band, said antenna device comprising a half-loop radiating element, comprising a feeding portion and a grounding portion, and arranged to operate at FM frequencies. The antenna device comprises a capacitor at said feeding portion and an inductor at said grounding portion, and said half-loop radiating element is arranged to simultaneously with FM frequencies operate at frequencies at least ten times higher than FM frequencies, wherein said capacitor is arranged to short circuit said half-loop radiating element to ground for frequencies at least ten times higher than FM frequencies and said inductor is arranged to short circuit said half-loop radiating element to ground for FM frequencies.

WO 2009/070100 A1

ANTENNA DEVICE AND PORTABLE RADIO COMMUNICATION DEVICE COMPRISING SUCH ANTENNA DEVICE

FIELD OF INVENTION

The present invention relates generally to antenna devices and more particularly to an antenna device for use in a portable radio communication device, such as a mobile phone, which antenna device is adapted for receiving radio signals having a relatively low frequency, such as radio signals in the FM frequency band.

BACKGROUND

Internal antennas have been used for some time in portable radio communication devices. There are a number of advantages connected with using internal antennas, of which can be mentioned that they are small and light, making them suitable for applications wherein size and weight are of importance, such as in mobile phones, PDA, portable computer or similar devices.

However, the application of internal antennas in a mobile phone puts some constraints on the configuration of the antenna element. In particular, in a portable radio communication device the space for an internal antenna device is limited. These constraints may make it difficult to find a configuration of the antenna device that provides for desired use. This is especially true for antennas intended for use with radio signals of relatively low frequencies as the desired physical length of such antennas are large

compared to antennas operating with relatively high frequencies.

One specific application operating in a relatively low frequency band is the FM radio application. The FM operating band is defined as frequencies between 88-108 MHz in most of the world and frequencies between 76-90 MHz in Japan. Prior art conventional antenna configurations, such as loop antennas or monopole antennas, fitted within the casing of a portable radio communication device will result in unsatisfactory operation in that the antenna either has too bad performance over a sufficiently wide frequency band or sufficient performance over a too narrow frequency band.

Instead, a conventional FM antenna for portable radio communication devices is usually provided in the headset wire connected to the communication device. This configuration with a relatively long wire permits an antenna length that is sufficient also for low frequency applications. However, if no external antenna is permitted this solution is obviously not feasible.

Further, a portable radio communication device is today many times provided with frequency operational coverage for other frequency bands then FM, such as GSM900, GSM1800, GPS, Bluetooth, WLAN and WCDMA. A portable radio communication device has limited space and it is thus desirable to, if possible, add multiple functionality to an antenna device.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an antenna device for use in a portable radio communication device, which efficiently utilizes available space of the portable radio communication device and provides for at least FM frequency band operation.

According to the present invention there is provided an antenna device for a portable radio communication device adapted for receiving and/or transmitting radio signals in at least a first and a second operating frequency band, the antenna device comprising a half-loop radiating element. The half-loop radiating element comprising a feeding portion and a grounding portion, and being arranged to operate at FM frequencies. The antenna device comprises a capacitor at the feeding portion and an inductor at the grounding portion, and the half-loop radiating element is arranged to simultaneously with FM frequencies operate at frequencies at least ten times higher than FM frequencies, wherein the capacitor is arranged to short circuit the half-loop radiating element to ground for frequencies at least ten times higher than FM frequencies and the inductor is arranged to short circuit the half-loop radiating element to ground for FM frequencies.

By utilization of two very distinct operating frequency bands both bands can operate simultaneously on the radiating element, without use of any switches or similar functionality.

The frequency band at least ten times higher than FM frequencies advantageously comprises one or more of the following frequency bands: GPS, Bluetooth, WLAN and WCDMA diversity. Particularly Bluetooth is today often desired in a portable radio communication device.

Preferably, the antenna device is further adapted for transmitting radio signals for FM frequencies, to provide e.g. the possibility to send information from the portable radio communication device to a FM receiver in a car.

Usually the half-loop antenna radiator is tuned to the frequency band at least ten times higher than FM frequencies by means of the inductor, but depending of the properties of the FM receiver and matching thereof, a capacitor may instead be needed for tuning. The inductor is however still needed for FM frequency grounding. The antenna device thus preferably comprises a second capacitor arranged parallel to the inductor.

A portable radio communication device comprising an antenna device as described above is also provided.

Further preferred embodiments are defined in the dependent claims.

BRIEF DESCRIPTION OF DRAWINGS

The present invention will become more fully understood from the detailed description of embodiments given below and the accompanying figures,

which are given by way of illustration only, and thus, are not limitative of the present invention, wherein:

FIG. 1 is a schematic diagram showing a first embodiment of an antenna device according to the present invention.

FIG. 2 is a perspective partially cut-away view of an antenna device according to the present invention mounted in a portable radio communication device.

FIG. 3 is a schematic diagram showing a second embodiment of an antenna device of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

In the following description, for purpose of explanation and not limitation, specific details are set forth, such as particular techniques and applications in order to provide a thorough understanding of the present invention. However, it will be apparent for a person skilled in the art that the present invention may be practiced in other embodiments that depart from these specific details. In other instances, detailed description of well-known methods and apparatuses are omitted so as not to obscure the description of the present invention with unnecessary details.

In the following description and claims, the term radiating element is used. It is to be understood that this term is intended to cover electrically conductive elements arranged for receiving and/or transmitting radio signals.

With reference to Figs. 1 and 2 a first embodiment of an antenna device according to the present invention is described. The antenna device comprises a half-loop radiating element 1, having a feeding portion and a grounding portion regarding FM frequencies. A half-loop antenna is a virtual loop antenna, by being provided over a ground plane device. The antenna device further comprises a capacitor 2 at the feeding portion for tuning the half-loop radiating element 1 to FM frequencies and an inductor 3 at the grounding portion.

The antenna device is further arranged to simultaneously with FM frequencies operate at frequencies at least ten times higher than FM frequencies, such as for GPS, Bluetooth, WLAN and WCDMA diversity. Preferably, the antenna device is arranged to simultaneously operate with FM frequencies and Bluetooth frequencies, which both provide much desired functions.

The capacitor 2 is arranged to short circuit the half-loop radiating element 1 to ground for frequencies at least ten times higher than FM frequencies. A capacitance of about 10-50 pF is appropriate to provide a short circuit for frequencies at least ten times higher than FM frequencies and to simultaneously tune the half-loop radiating element 1 for FM frequencies.

The inductor 3 is arranged to short circuit the half-loop radiating element 1 to ground for FM frequencies. An inductance of about less than 10 nH is appropriate

to provide a short circuit for FM frequencies, at the same time preventing short circuit for frequencies at least ten times higher than FM frequencies. The inductor 3 is further preferably used for tuning of the half-loop radiating element 1 for frequencies at least ten times higher than FM frequencies.

A portable radio communication device 10 comprising an antenna device as described above comprises a ground plane device below the half-loop radiating element 1 to provide a virtual loop antenna. The ground plane device is e.g. provided as a printed wiring board 8 of the portable radio communication device 10. The portable radio communication device 10 is further provided with a matching network or filter 4 for a FM receiver 5, and a matching network or filter 6 for e.g. a Bluetooth transceiver 7. The matching network or filter 4 for the FM receiver 5 is connected to the feeding portion of the half-loop radiating element 1. The matching network or filter 6 for the Bluetooth transceiver 7 is connected to the grounding portion of the half-loop radiating element 1.

A second embodiment of an antenna device according to the present invention is schematically shown in Fig. 3. The second embodiment of the antenna device is identical with the first embodiment of the antenna device described above apart from the following.

The antenna device is further adapted for transmitting radio signals for FM frequencies. The portable radio communication device comprises a FM transmitter 12 connected to the feeding portion of the half-loop

radiating element 1. The matching network or filter 4 for is preferably common for the FM receiver and the FM transmitter.

Further, a second capacitor 11 is preferably arranged parallel to the inductor 3, when the properties of the half-loop radiating element 1, the FM receiver 5, the matching network or filter 4, requires capacitance tuning for the Bluetooth function. The use of a second capacitor arranged parallel to the inductor 3 can also be utilized in the first embodiment described above for the same purpose.

It will be obvious that the present invention may be varied in a plurality of ways. Such variations are not to be regarded as departure from the scope of the present invention as defined by the appended claims. All such variations as would be obvious for a person skilled in the art are intended to be included within the scope of the present invention as defined by the appended claims.

CLAIMS

1. An antenna device for a portable radio communication device (10) adapted for receiving and or transmitting radio signals in at least a first and a second operating frequency band, said antenna device comprising

a half-loop radiating element (1), comprising a feeding portion and a grounding portion, and arranged to operate at FM frequencies,

characterized in that

said antenna device comprises a capacitor (2) at said feeding portion and an inductor (3) at said grounding portion, and

said half-loop radiating element (1) is arranged to simultaneously with FM frequencies operate at frequencies at least ten times higher than FM frequencies, wherein said capacitor (2) is arranged to short circuit said half-loop radiating element (1) to ground for frequencies at least ten times higher than FM frequencies and said inductor (3) is arranged to short circuit said half-loop radiating element (1) to ground for FM frequencies.

2. The antenna device according to claim 1, wherein said frequencies at least ten times higher than FM frequencies comprises one or more of the following frequency bands: GPS, Bluetooth, WLAN and WCDMA diversity.

3. The antenna device according to claim 1 or 2, wherein said antenna device is further adapted for receiving and transmitting radio signals for FM frequencies.

4. The antenna device according to any of claims 1-3, comprising a second capacitor (11) arranged parallel to said inductor (3).

5. A portable radio communication device, **characterized in** that it comprises an antenna device according to any of the preceding claims arranged over a ground plane device.

6. The portable radio communication device according to claim 5, comprising a FM receiver (4, 5) connected to said antenna device at said feeding portion and another receiver (6, 7) for frequencies at least ten times higher than FM frequencies connected to said antenna device at said grounding portion.

7. The portable radio communication device according to claim 5 or 6, comprising a FM transmitter (12) connected to said antenna device at said feeding portion.

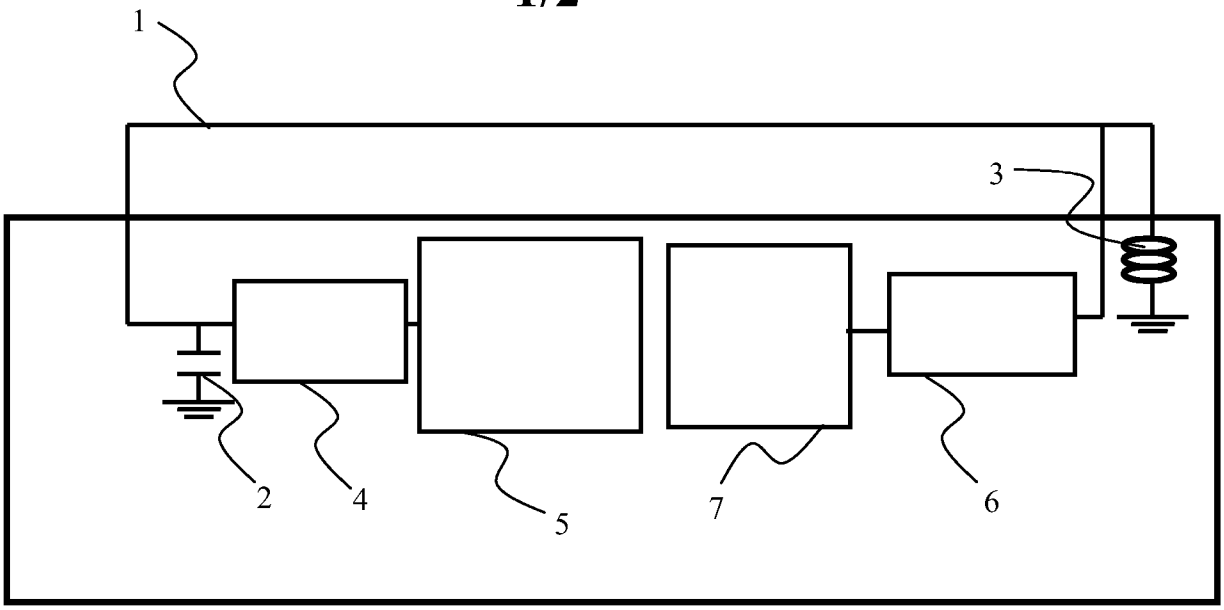

FIG. 1

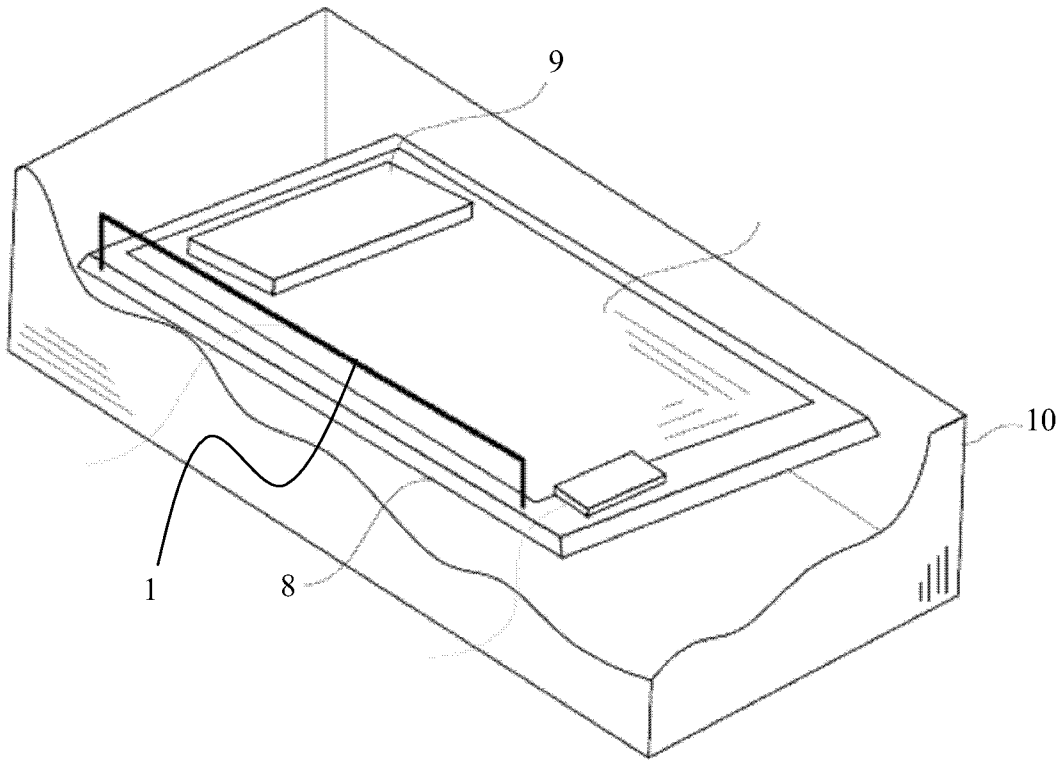

FIG. 2

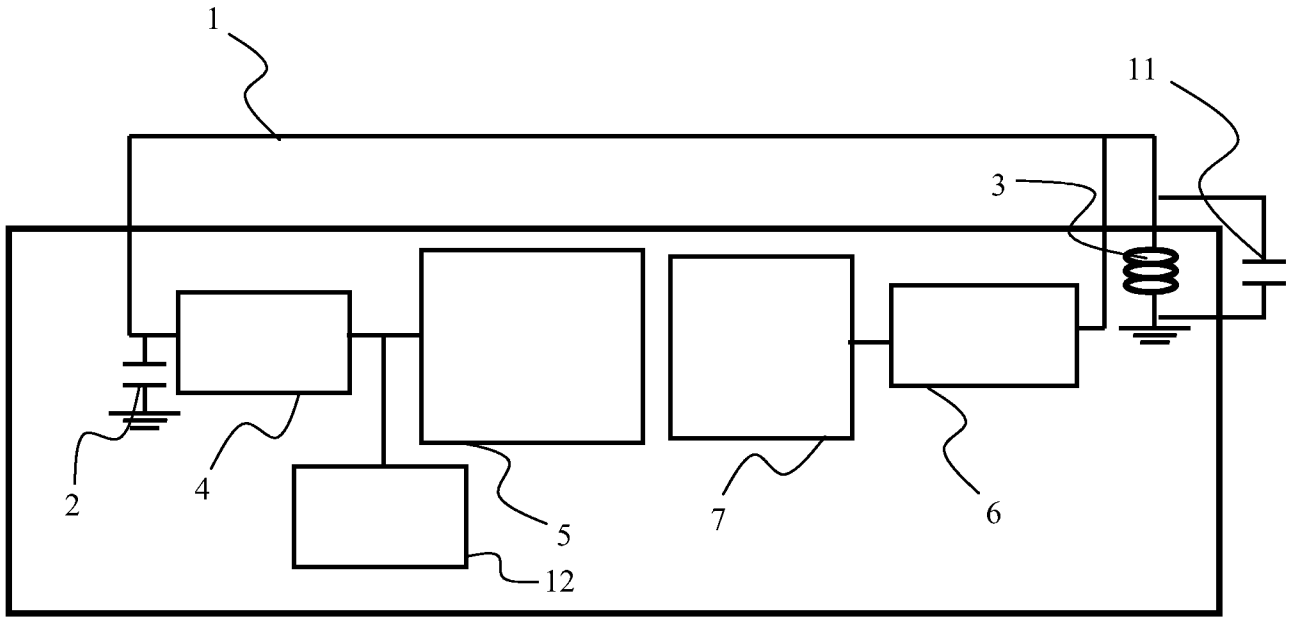

FIG. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2008/051342

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet
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: H01Q, H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5767813 A (VERMA ET AL), 16 June 1998 (16.06.1998), column 10, line 21 - column 11, line 3, figure 6A, abstract ---	1-7
A	WO 2007123454 A1 (LAIRD TECHNOLOGIES AB), 1 November 2007 (01.11.2007), abstract --- --------	1-7

☐ 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	Date of mailing of the international search report
26 February 2009	27-02-2009
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson /LR Telephone No. +46 8 782 25 00

International patent classification (IPC)
H01Q 1/24 (2006.01)
H04B 1/18 (2006.01)

Download your patent documents at www.prv.se
The cited patent documents can be downloaded at www.prv.se by following the links:

- In English/Searches and advisory services/Cited documents (service in English) or
- e-tjänster/anförda dokument(service in Swedish).

Use the application number as username.
The password is **LVRENGQJWL**.

Paper copies can be ordered at a cost of 50 SEK per copy from PRV InterPat (telephone number 08-782 28 85).

Cited literature, if any, will be enclosed in paper form.

US	5767813	A	16/06/1998	US	5485166	A	16/01/1996
				WO	9428594	A	08/12/1994
WO	2007123454	A1	01/11/2007	EP	1850475	A	31/10/2007