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(71) Applicant: **Sony International (Europe) GmbH**
10785 Berlin (DE)

(72) Inventor: **Müller, Guido**
85609 Aschheim-Dornach (DE)

(74) Representative: **Körber, Martin, Dipl.-Phys. et al**
Mitscherlich & Partner,
Patent- und Rechtsanwälte,
Postfach 33 06 09
80066 München (DE)

(54) Tuneable radiation shielding in multiband mobile terminals

(57) An apparatus and a method of shielding a user from electromagnetic radiation (9) emanated from a mobile telecommunication device (20) with operating components (1) having electromagnetic radiation blocking characteristics are presented, the method comprising steps for providing switchable bonds (2, 3) at different positions of an operating component (1) with electromagnetic radiation blocking characteristics, and for selectively switching the bonds (2, 3) depending on a selected operation frequency band to different RF-ground potential terminals available on at least one further operating component (4) of the telecommunication device.

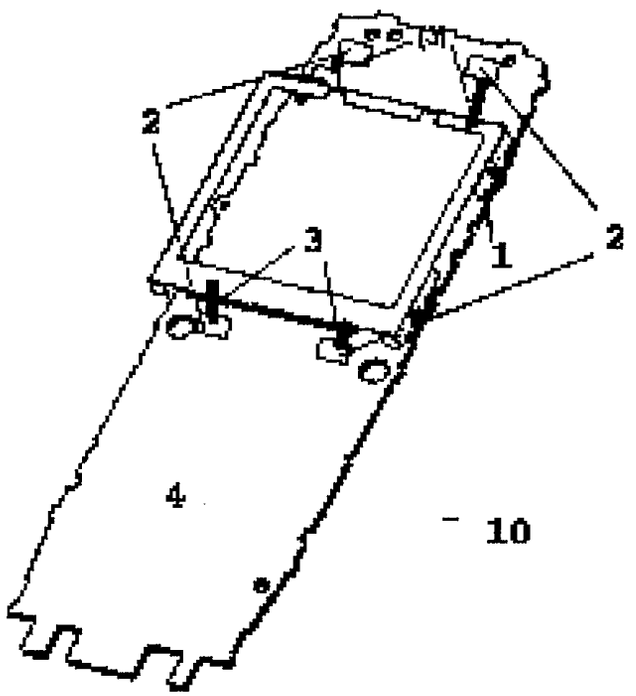

Figure 1

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Description

[0001] The present invention relates to an apparatus for mobile terminals reducing an user's exposure to radiation emanating from components of the mobile terminal like e.g. an antenna. The present invention relates in particular to radiation shielding in multiband mobile terminals.

[0002] User usually hold wireless communication devices in close contact to the ear while calling. A users brain which is then directly exposed to the electromagnetic radiation emitted from the antenna of the device hereby absorbs an amount of the emanated radiation. The absorbed energy raises the average temperature of the brain. Legislators have therefore set tolerance limits for a permissible radiation exposure intended to guarantee that no respective temporary or permanent health risk will arise from the use of mobile terminals.

[0003] An awareness for electro-smog from mobile terminals representing a general health hazard can be observed by a considerable part of the population. Mobile terminals are of course not the only source for electro-smog; indeed many electronic devices like e.g. computers, phones, TV sets, radar transmitters, and the like contribute to it.

[0004] Irrespective of the public opinion, it is not clear at the moment if the electromagnetic radiation emitted from a wireless communication device may or may not pose a potential health hazard to users of mobile terminals. Reports about wireless telecommunication devices affecting the human health are currently not leading to secure conclusions. Only one scientific study found an indication for an increase in the risk of a damage to DNA exposed to radiation of a frequency also used for mobile communication (Lai H and Singh N.P, Acute Low-Intensity Microwave Exposure Increases DNA Single-Strand Breaks in Rat Brain Cells Bioelectromagnetics, 1995,16:207-210). But it has to be admitted that the health risks for humans are still unknown.

[0005] To conclude that the use of mobile terminals will be harmless for human beings, only because there is currently no prove of the reverse will probably be wrong. Therefore, a manufacturer of wireless telecommunication devices takes care for his customers and will take appropriate measures to protect users of his mobile terminals from unnecessary radiation. From the point of view of efficient use of radiated energy, an economical use of radiated power reduces the energy consumption of the mobile as well. The operating time of a mobile terminal will be prolonged correspondingly.

[0006] To this end, JP 8 288 895 proposes an antenna arrangement consisting of two bar-shaped aerials extending from the body of a communication equipment, whereby the signal supplied to the second aerial is phase shifted in respect to the signal supplied to the first aerial by an amount adapted to suppress the emission of radio waves into the direction of a user of the communication equipment. The use of two aerials contrasts with the indispensable requirement for a compact design of modern telecommunication devices. Unfortunately the proposed system is based on the geometry of the aerials design and can therefore not be transferred to a system using patch antennas, which can advantageously be integrated into the body of a compact mobile telecommunication device.

[0007] US 5 335 366 proposes a radiation shielding apparatus for a radio transmitting device, whereby a radiation shield is disposed between a radiation component and a user to prevent unwanted exposure of the user to radiation emanating from the radiation component. The radiation shield can absorb, block and/or reflect electromagnetic wave radiation. The shielding can be placed between the radiation emanating component and the user or wrapped around that component. It is intended to absorb and/or block and/or reflect microwave energy in a frequency range of approximately 800 to 900 MHz emitted into the direction of the cranium of a user.

[0008] Radiation shields basically affect the near field of an electromagnetic radiation in the immediate vicinity of radiation emanating components like an antenna, an antenna feed, a RF-transceiver or the like. Changing to a different transmission band inevitably modifies the near field condition around the antenna. The efficiency of a radiation shield will consequently be quite different for one transmission frequency band than for another. Using only one type of a radiation shielding apparatus will definitely not fit all radiation conditions produced by a multiband wireless telecommunication device.

[0009] It is therefore an object of the present invention to provide a radiation shield of high shielding efficiency which is optimised to all frequency bands of a multiband wireless telecommunication device.

[0010] This object is achieved by a shielding arrangement as claimed in the independent claims.

[0011] In particular, the object is achieved by a method of shielding a user from electromagnetic radiation emanated from a mobile telecommunication device with operating components having electromagnetic radiation blocking characteristics, the method comprising steps for providing switchable bonds at different positions of an operating component with electromagnetic radiation blocking characteristics, and for selectively switching the bonds depending on a selected operation frequency band to different RF-ground potential terminals available on at least one further operating component of the telecommunication device.

[0012] The above object is further achieved by a mobile terminal with a radiation shielding means for shielding a user from electromagnetic radiation emanated from the mobile terminal having operating components with electromagnetic radiation blocking characteristics, operating components providing RF-ground potential terminals, switchable bonds at different positions of an operating component with electromagnetic radiation blocking characteristic, and a control means for selec-

tively switching the bonds depending on a selected operation frequency band to different RF-ground potential terminals available on at least one further operating component of the mobile terminal.

[0013] The present invention advantageously reduces the rate of energy that is absorbed by a user of a corresponding mobile telecommunication device without affecting the efficiency of the mobile terminals transceiving system. Furthermore, by utilising operating components for a radiation shielding, no space consuming extra equipment has to be incorporated into the already crammed device.

[0014] Further advantageous features are claimed in the respective sub-claims.

[0015] According to an advantageous development, at least two operating components with electromagnetic radiation blocking characteristics are arranged to achieve a parasitic coupling influencing the near field for further suppressing an electromagnetic radiation directed to a user. The coupled components advantageously interact in the near field of the antenna by modifying the power flux vector of the electromagnetic field emitted from the antenna.

[0016] The switching components of a selectively switchable bond are preferably formed by a microelectromechanical system (MEMS) and/or a field effect transistor (FET) and/or a PIN diode.

[0017] A radiation shielding according to the present invention can be used in modern mobile terminals for wireless telecommunication networks, in cordless phones and of course in all radio installations, where a user comes in close contact to components emitting electromagnetic radiation.

[0018] In the following description, the present invention is explained in more detail with respect to special embodiments and in relation to the enclosed drawings, in which

Figure 1 shows a top view of a radiation shielding apparatus according to the present invention,

Figure 2 shows a side view of a radiation shielding apparatus according to the present invention, and

Figure 3 shows the main components of a mobile terminal according to the present invention.

[0019] Figure 1 shows an implementation of a radiation shielding means 10 according to the present invention for a mobile terminal of a wireless telecommunication network. The components utilised for putting the shielding into practice are quite ordinary operating components which are present in most of today's mobile terminals. In detail, an ESD (electrostatic discharge) frame 1 providing a protective measure against electrostatic discharge is used in combination with a PCB 4 (printed circuit board) or PWB 4 (printed wiring board) on which the functional devices of the mobile terminal are mounted. Bonds 3 made from electrically conductive material connect the ESD frame 1 with different RF-ground potential terminals on the PWB 4 from different positions. Unless otherwise specified, the term 'ground potential' or 'ground' used in the following will always refer to an RF-ground potential terminal of the wireless device even when the RF-ground is not equal to a DC-ground potential. Switching elements 2 are placed between the bonds 3 and the grounds on the PCB/PWB 4 to control the electrical connection of each bond separately.

[0020] The principle sources for electromagnetic radiation in a mobile telecommunication device generally are the antennae, the antenna feed lines, and the RF-transceiver component. The exposure of a user to radiation emanated from a radio equipment is characterised by the Specific Absorption Rate (SAR), which is a measure for the rate of electromagnetic energy absorbed or dissipated in a mass of dielectric materials, such as biological tissues. Usually, SAR is expressed in watt per kilogram (W/kg) or in milliwatt per kilogram (mW/kg). With the biological absorption conditions of a user given, the SAR can be used as a synonym for the rate of emanated radiation energy absorbed in a users tissue.

[0021] It is known, that the SAR-distribution in a users body is strongly correlated with the distribution of the magnetic field ($\vec{H}$) on the PCB/PWB 4 of the mobile telecommunication device forming the source for the radiation exposure. The distribution of $\vec{H}$ is quite essentially influenced by ground return currents from the antennae and antenna feeds, respectively, to the various grounds on the PCB/PWB 4. These ground return currents are distributed over the entire PCB/PWB 4. Modifying the return current distribution on the PCB/PWB 4 will therefore modify the $\vec{H}$-field distribution of the emanated RF-radiation and thus the SAR in a users tissue. Modifying the return current distribution on the PCB/PWB 4 therefore provides a potent means for suppressing a users exposure to electromagnetic radiation emanated from a mobile terminal.

[0022] The current distribution on the PCB/PWB 4 is modified by grounding an electrically conductive component 1 in different points, and thereby provides a blocking of unwanted radiation 9 emitted into the direction of a user 8.

[0023] In the special embodiment of the present invention of Figure 1, the metallic structure of an ESD frame 1 is used as the electrically conductive component. Different electrically conductive components made e.g. from sufficiently doped semiconductor material, metal oxides, conductive polymers or any other material showing a specific resistance of about or smaller than 10^{-2} Ωcm can be used just as well. Besides just influencing the return current distribution on a PCB/PWB, an electrically conductive component also works as a block for electromagnetic radiation by absorbing and/or reflecting electromagnetic radiation. The electrically conductive components are therefore also denoted as radiation blocking components.

[0024] The electrically conductive component 1 is connected to several switching devices 2 distributed over the PCB/PWB 4 by bonds. Anything providing a good electrical contact like for instance spring contacts, pins, contact tongues, solder bumps, wire bonds, a retaining jaw or the like can be used as a bond. When a switching device 2 is turned in the conductive state, it connects the respective bond and thereby the radiation blocking component 1 to a ground potential provided on the operating component of the wireless device formed by PCB/PWB 4. In other words, the radiation blocking component 1 is grounded by means of the switching devices 2.

[0025] The resulting modification of the return current distribution depends on which RF-ground or grounds are used for grounding the component 1. It is therefore possible to control the distribution of the return currents on the PCB/PWB 4 with the switching elements 2 only and control through this the emission of unwanted electromagnetic radiation into the direction of a user. Or to put it another way, the switching components 2 in combination with the bonds 3 and the radiation blocking component 1 form a SAR modulator.

[0026] Figure 2 illustrates the arrangement for a radiation shield according to the present invention in a side view. The transceiver circuit 5 with the antenna 6 is mounted on the back side of the PCB/PWB 4. The main radiation 7 is emitted by the antenna 6 away from the user 8 holding the mobile terminal to the side of his head. The unwanted radiation 9 emanated from antenna 6 into the direction of user 8 is blocked off by a metallic box enclosing the transceiver circuit 5 grounded to one of the ground potentials available on the PCB/PWB 4. It also prevents radiation leaking from the transceiver circuit itself.

[0027] Besides the currently employed triple bands in mobile terminals with operating frequency bands ranging around 900, 1800, and 1900 MHz, new UMTS operating frequency bands ranging between 1900 and 2170 will be integrated in future devices. The distribution of the return currents on the PCB/PWB 4 will be different for each of the operating frequency bands used, so that more than one switchable bond formed by a bond 3 and a switching device 2 have to be provided for selectively adapting the SAR modulator to the respective return current distribution. For simplicity, the SAR modulator in Figure 2 is shown with just one switchable bond active.

[0028] More than one radiation blocking component 1 can be used for forming a SAR modulator. Each of these can be directly connected to the PCB/PWB 4 by switchable bonds, but alternatively some switchable bonds may be provided also or exclusively between the components 1 themselves.

[0029] The switching units 2 can be microelectromechanical systems (MEMS), field effect transistors (FETs) or PIN diodes or the like. For each bond a different switching element 2 may be used. PIN diodes are the most simple switching devices which can be employed, when a DC or low frequency voltage can be used to through-switch the device, and the switching DC potential will still provide a RF-ground potential. If this is not feasible, MEMS and/or FETs are the choice.

[0030] Apart from providing direct electrical connections between a second electrically conductive component and a first one, and/or a further operating component 4 of a mobile terminal, advantage can be taken of the parasitic coupling between a first and an adjacent second radiation blocking component 1. This is shown for the Liquid Crystal display window 11 having a metallisation, which is mounted in the front cabinet of the mobile terminal directly on top of the metallic ESD frame 1. Both components are electrically conductive and form, due to their close vicinity a parasitic coupling which interferes with the unwanted radiation component 9 such, that the radiation emitted in a users direction is considerably reduced.

[0031] Referring now to Figure 3, a mobile terminal 20 according to the present invention is shown. The radiation emanating components like e.g. the transceiver unit 5 and the antenna 6 are integrated in the wireless telecommunication device. Operating components 4 providing RF-ground potentials are connected to operating components 1 and/or 11 with radiation blocking characteristics by switchable bonds formed by bonds 3 and switching elements 2. The switching elements 2 are controlled by a control means 21, which controls the switching configuration of all switching elements according to the respective near field conditions of each operation frequency band. The control means 21 forms in combination with the switchable bonds (2 and 3) and the radiation blocking component 1 a controllable SAR modulator.

Claims

1. A method of shielding a user from electromagnetic radiation (9) emanated from a mobile telecommunication device (20) with operating components (1) having electromagnetic radiation blocking characteristics, the method comprising steps of:

   - providing switchable bonds (2, 3) at different positions of an operating component (1) with electromagnetic radiation blocking characteristics, and
   - selectively switching the bonds (2, 3) depending on a selected operation frequency band to different RF-ground potential terminals available on at least one further operating component (4) of the telecommunication device.

2. A method according to claim 1,
   characterised in
   that at least two operating components (1, 11) with electromagnetic radiation blocking characteristics

are arranged to achieve a parasitic coupling influencing the near field for further suppressing an electromagnetic radiation (9) directed to a user.

3. A mobile terminal (20) with a radiation shielding means for shielding a user from electromagnetic radiation (9) emanated from the mobile terminal, comprising

- operating components (1) with electromagnetic radiation blocking characteristics,
- operating components (4) providing RF-ground potential terminals,
- switchable bonds (2, 3) at different positions of an operating component (1) with electromagnetic radiation blocking characteristic, and
- a control means (21) for selectively switching the bonds (2, 3) depending on a selected operation frequency band to different RF-ground potential terminals available on at least one operating component (4) providing RF-ground potential terminals.

4. A mobile terminal according to claim 3, **characterised in** **that** a selectively switchable bond (2, 3) comprises a microelectromechanical system (MEMS) as a switching component (2).

5. A mobile terminal according to claim 3 or 4, **characterised in** **that** that a selectively switchable bond (2, 3) comprises a field effect transistor (FET) as a switching component (2).

6. A mobile terminal according to claim 3, 4 or 5, **characterised in** **that** that a selectively switchable bond (2, 3) comprises a PIN diode as a switching component (2).

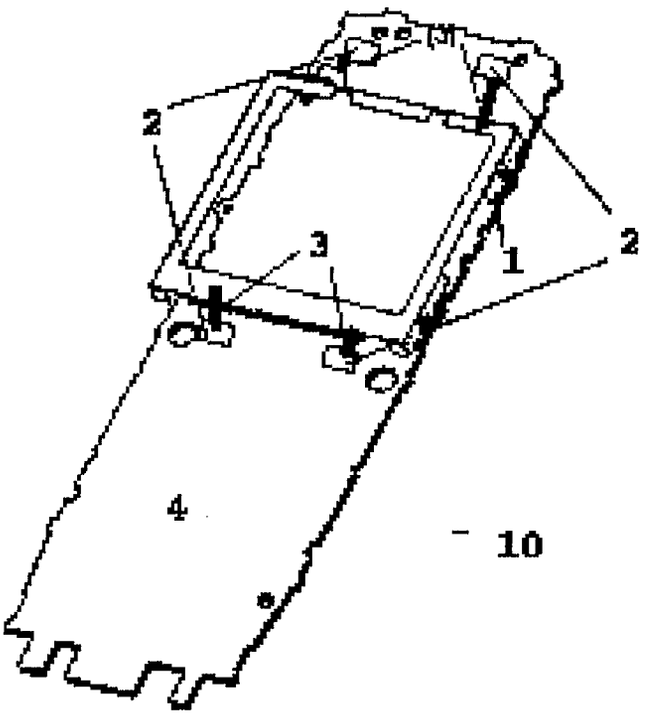

Figure 1

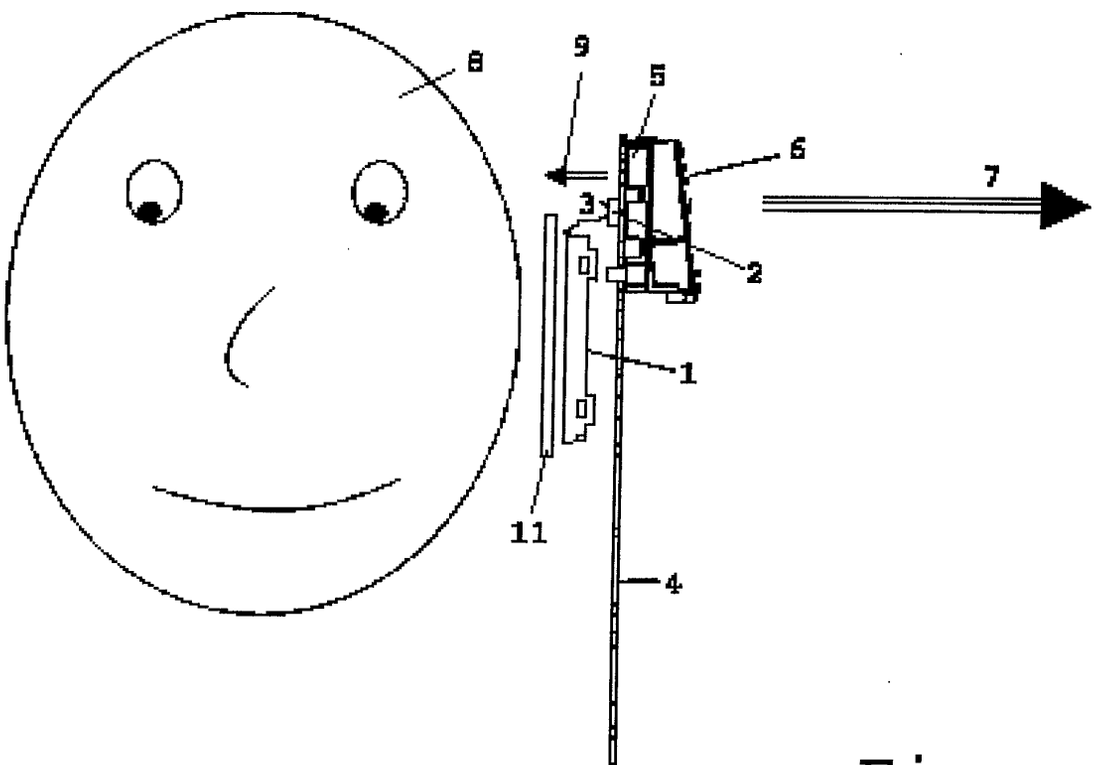

Figure 2

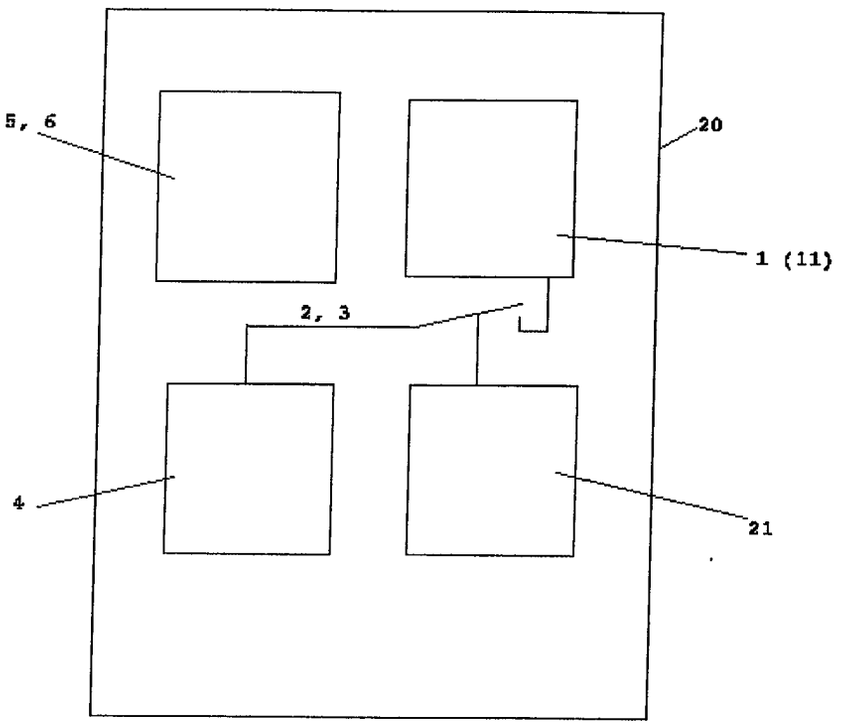

Figure 3

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EUROPEAN SEARCH REPORT

Application Number
EP 01 12 9989

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
Y	PATENT ABSTRACTS OF JAPAN vol. 1999, no. 12, 29 October 1999 (1999-10-29) -& JP 11 186841 A (MATSUSHITA ELECTRIC IND CO LTD), 9 July 1999 (1999-07-09) * abstract; figure 1 *	1-6	H01Q7/02
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Y	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 06, 22 September 2000 (2000-09-22) -& JP 2000 068736 A (TOSHIBA CORP), 3 March 2000 (2000-03-03) * abstract; figure 1 *	1,3	TECHNICAL FIELDS SEARCHED (Int.Cl.7) H01Q
Y	US 6 204 819 B1 (SADLER ROBERT A ET AL) 20 March 2001 (2001-03-20) * abstract; figures 7A,7B * * column 7, line 53 - column 8, line 21 *	1,3,4	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	7 May 2002	Saur, E

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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