



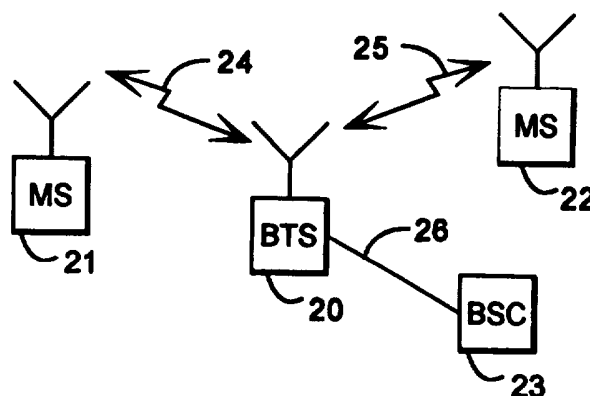
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification ⁶ : H04B 7/005	A2	(11) International Publication Number: WO 96/09696 (43) International Publication Date: 28 March 1996 (28.03.96)
(21) International Application Number: PCT/FI95/00516 (22) International Filing Date: 21 September 1995 (21.09.95) (30) Priority Data: 944395 22 September 1994 (22.09.94) FI (71) Applicant (for all designated States except US): NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistoie 1, FIN-02600 Espoo (FI). (72) Inventors; and (75) Inventors/Applicants (for US only): HONKASALO, Harri [FI/FI]; Melkonkatu 8 B 29, FIN-00210 Helsinki (FI). JOLMA, Petri [FI/FI]; Harakkakuja 6 G 49, FIN-02600 Espoo (FI). LIIMATAINEN Jukka [FI/FI]; Torikatu 64 B 224, FIN-90120 Oulu (FI). (74) Agent: TEKNOPOLIS KOLSTER OY; Oy Kolster Ab, Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).		(81) Designated States: AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, US, UZ, VN, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG), ARIPO patent (KE, MW, SD, SZ, UG). Published <i>In English translation (filed in Finnish). Without international search report and to be republished upon receipt of that report.</i>

(54) Title: A METHOD FOR CONTROLLING TRANSMITTING POWER, AND A CELLULAR RADIO SYSTEM

(57) Abstract

The invention relates to a method for controlling transmitting power in a cellular radio system comprising in each cell at least one base station (20) communicating with subscriber terminal equipments (21-22) located within its area, in which method the base station measures the power level of a signal received by it from a terminal equipment, and the terminal equipment measures the power level of a signal received by it from the base station, and reports the result to the base station. For enabling fast and accurate power control in the method of the invention, the base station (20) compares the measurement results transmitted by the terminal equipment with its own measurement results, and controls the transmitting power of the terminal equipment and its own transmitting power on the basis of the comparison of the measurement results.



FOR THE PURPOSES OF INFORMATION ONLY

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

AT	Austria	GB	United Kingdom	MR	Mauritania
AU	Australia	GE	Georgia	MW	Malawi
BB	Barbados	GN	Guinea	NE	Niger
BE	Belgium	GR	Greece	NL	Netherlands
BF	Burkina Faso	HU	Hungary	NO	Norway
BG	Bulgaria	IE	Ireland	NZ	New Zealand
BJ	Benin	IT	Italy	PL	Poland
BR	Brazil	JP	Japan	PT	Portugal
BY	Belarus	KE	Kenya	RO	Romania
CA	Canada	KG	Kyrgyzstan	RU	Russian Federation
CF	Central African Republic	KP	Democratic People's Republic of Korea	SD	Sudan
CG	Congo	KR	Republic of Korea	SE	Sweden
CH	Switzerland	KZ	Kazakhstan	SI	Slovenia
CI	Côte d'Ivoire	LI	Liechtenstein	SK	Slovakia
CM	Cameroon	LK	Sri Lanka	SN	Senegal
CN	China	LU	Luxembourg	TD	Chad
CS	Czechoslovakia	LV	Latvia	TG	Togo
CZ	Czech Republic	MC	Monaco	TJ	Tajikistan
DE	Germany	MD	Republic of Moldova	TT	Trinidad and Tobago
DK	Denmark	MG	Madagascar	UA	Ukraine
ES	Spain	ML	Mali	US	United States of America
FI	Finland	MN	Mongolia	UZ	Uzbekistan
FR	France			VN	Viet Nam
GA	Gabon				

A method for controlling transmitting power, and a cellular radio system

5 The invention relates to a method for controlling transmitting power in a cellular radio system comprising in each cell at least one base station communicating with subscriber terminal equipments located within its area, in which method the base station measures the power level of a signal received by it from terminal equipments, and a terminal equipment measures the power level of a signal received by it from the base station, and reports the result to the base station.

10 It is typical of the cellular radio environment that the propagating conditions of radio waves vary constantly. Both in the signal received by the subscriber terminal equipment and in the signal received by the base station, constant variation i.e. fading occurs as a function of time and location. In fading of the signal, two different types of phenomena may be distinguished. Fading may be either fast or slow, and both phenomena usually occur simultaneously.

15 Fast fading of the signal is caused by multipath propagation typical of a cellular radio environment, whereby a signal propagates along several different routes between the transmitter and the receiver. Signal components arriving to the receiver different ways are summed in the receiver, and, depending on the mutual phase differences between the signals components, they either amplify or attenuate each other. The level of the signal may vary considerably, up to dozens of decibels, already within a distance of less than a half a wavelength.

20 Slow fading of a signal, in turn, is caused by the fact that on the radio path, there is a varying number of factors causing additional attenuation, such

as natural obstacles, or buildings. The effect of slow fading on the signal is, as its name suggests, variation in the signal strength, which is remarkably slower than that caused by fast fading which causes strong power variations around the envelope caused by slow fading.

Due to the above-mentioned constant variation of the signal strength, the transmitting power, used by a subscriber terminal equipment in particular, must continuously be controlled, and it must be endeavoured to adjust it to a suitable value at each moment of time. The aim of power control is to keep the transmitting power of a device as low as possible, still maintaining a sufficient quality of a connection, so that the signal will not interfere with other connections, and that the power consumption of a portable terminal equipment, in particular will be small.

Controlling the transmitting power is based on controlling the power of the received signal generally carried out in the receiver. The aim is usually to control the transmitting power so that the average variation of the signal level, caused by slow fading may be compensated, since the variations caused by fast fading take place too fast so that they could be reacted to.

The combined effect of fast and slow fading, however, causes problems in power control, as it is difficult to obtain a reliable measurement result that would only indicate the attenuation caused by slow fading, since fast fading causes constant variation to the measurement results. Heretofore, rather a long measurement time has been required, during which the measurement results obtained are averaged, whereby the variations caused by fast fading may be eliminated from the measurement results.

It is previously known to carry out power control of a terminal equipment e.g. so that the base sta-

tion measures the power level it receives from the terminal equipment by averaging it for a given time, and on the basis of this processed measurement result, and specific quality parameters it sends a power control command to the terminal equipment. Measurements carried out by the terminal equipment are used for controlling the transmitting power of the base station. The above-described method is used e.g. in the European digital mobile communication network GSM. Power control of the GSM system is described in greater detail e.g. in M. Mouly, M. Pautet: The GSM System for Mobile Communications, published by the authors 1992, pp.342 - 346, which are incorporated herein by reference.

In another known technique for carrying out power control of a terminal equipment, the terminal equipment controls its own transmitting power on the basis of the signal strength received from the base station, in addition to which the base station measures the power received from the terminal equipment, and transmits power control commands to the terminal equipment. This method is disclosed e.g. in the reference EIA/TIA Interim Standard: Mobile Station-Base Station Compatibility Standard for Dual-Mode Wideband Spread Spectrum Cellular System, TIA/EIA/IS-95, July 1993.

Both of the above-mentioned methods, however, are attended by the drawback, as already mentioned before, that when reliable power control parameters are needed, the measurement results must be averaged for a relatively long time.

The object of the present invention is to provide a method for power control, by means of which method the power control parameters may be calculated quickly, and the effect of fast fading on the measurement results may be reduced without a long averaging time.

This is achieved with a method of the type set forth in the introduction, which is characterized in that the base station compares the measurement results sent by the terminal equipment with its own measurement results, and that the base station controls the transmitting power of the terminal equipment, and its own transmitting power on the basis of the comparison of the measurement results.

Another object of the invention is a cellular radio system, comprising in each cell at least one base station communicating with the subscriber terminal equipments located within its area, the base station comprising means for measuring the power level of the signal received from the terminal equipments, the terminal equipment comprising means for measuring the power level of the signal received from the base station, and means for reporting the measurement results to the base station. The cellular radio system of the invention is characterized in that the base station comprises means for comparing the measurement results sent by the terminal equipment with its own measurement results, and means for controlling the transmitting power of the terminal equipment and its own transmitting power on the basis of the comparison of the measurement results.

By means of the method of the invention, the drawbacks of prior art methods may be avoided upon eliminating the effect of fast fading on the measurement results. Power control parameters are obtained faster than has been possible heretofore, since the averaging time may be shortened in the method of the invention. The method of the invention may be used for controlling both the transmitting power of the terminal equipment and the transmitting power used by the base station.

In the following, the invention will be disclosed in greater detail with reference to the examples in the attached drawings, in which

5 Figure 1 illustrates an example of fast and slow fading,

Figure 2 illustrates a cellular radio system in which the method of the invention may be applied,

10 Figure 3 is a block diagram illustration of the base station receiver of the cellular radio system of the invention, and

Figure 4 is a block diagram illustration of the structure of a terminal equipment of the cellular radio system of the invention.

15 Figure 1 illustrates an example of fast and slow fading. The figure describes the received signal so that the horizontal axis represents time and the vertical axis represent the power level of the received signal. The power level in the receiver varies constantly, and deep fadings 10 of the power level represent fast fading, which is due to multipath propagation of signal components. The average power level 11 of a signal also varies slowly, and this is termed as slow fading, which is due to factors causing attenuation and occurring on the radio path. The aim of power control is to compensate variation of the power level caused by slow fading, in particular.

25 In the following, the method of the invention will be disclosed by way of an example of power control of the terminal equipment. Accordingly, by means of the method of the invention, the transmitting power used by the base station may also be controlled.

30 Figure 2 illustrates a part of the cellular radio system in which the method of the invention may be applied. The figure shows a base station 20 serving its own coverage area. The base station is connected via

35

a transmission link 26 to a base station controller 23. The transmission link 26 is implemented with prior art methods, such as transmission lines or a radio link. A mobile services switching centre may also function as the base station controller 23. The base station controller 23 controls the operation of the base station. In the situation shown by the figure, there are two subscriber terminal equipments 21, 22 within the coverage area of the base station, with which terminal equipments the base station has a bidirectional connection 24, 25.

The subscriber terminal equipments 21, 22 measure continuously, at given intervals the strength of the signal 24, 25 received from the base station, and report the measurement results by using prior art methods, such as control channels, to the base station. In the digital GSM system, for instance, the terminal equipments report to the base station a measurement result at intervals of 480 ms. Accordingly, the base station 20 continuously measures the signal received from each terminal equipment.

In the method of the invention, the base station compares the obtained measurement results with the measurement results reported by the subscriber terminal equipment from the same time period, and makes a decision on power control on the basis of this comparison. Other quality parameters, such as the bit-error ratio may also have an effect on power control.

The aim of the comparison of the measurement results carried out by the base station is to eliminate the effect of fast fading from the measurement results, so that it would be possible to compensate the effect of slow fading with power control. The comparison may advantageously be carried out so that in the base station, the mean value of the measurement results of the base station and the terminal equipment is calculated.

Since fast fading is independent of different directions of transmission (from the base station to the terminal equipment, and from the terminal equipment to the base station), and thus different in strength in different directions of transmission, whereas slow fading, is, in turn, similar in strength in both directions of transmission, the effect of fast fading may be reduced, and correspondingly, the effect of slow fading may be weighted as a result of averaging. Thus, the desired power control is achieved without long averaging times.

Figure 3 illustrates the base station receiver of a cellular radio system, in which the method of the invention may be applied. The receiver comprises an antenna 30 by means of which the received signals are applied to radio frequency means 31, in which the received signal is converted onto an intermediate frequency. The signal is further applied to converter means 32, in which an analog signal is converted into a digital form. The receiver further comprises detector means 33, in which the received signal is detected and from which means 33 the signal is further applied to other parts of the receiver. The receiver further comprises control means 34, in which the above-mentioned blocks are controlled and calculation is carried out. The receiver further comprises means 31, 34, in which the power of the signal received from the terminal equipment is measured, and means 34, in which the measurement result of the base station is compared with the measurement result sent by the terminal equipment along with the other signal, and means 34, for calculating a power control command to be transmitted to the terminal equipment, said power control command depending on said comparison. Accordingly, in means 34, transmission power used by the individual transmitter of the base station may also be calculated. The base station receiver also

comprises other components, such as filters and amplifiers, but they are unessential to the invention. The receiver described above is a receiver of a digital cellular radio system, but the invention may be also be applied in an analog system.

Figure 4 illustrates a terminal equipment of a cellular radio system, in which equipment the method of the invention may be applied. The terminal equipment comprises means 40 for coding the signal to be transmitted, means 41 for interleaving the coded signal, means 42 for forming a burst to be transmitted, modulating means 43, the output signal of which is applied via a transmitter unit 44 and a duplex filter 45 to an antenna 46. The terminal equipment further comprises a receiver unit 47, in which the received signal is converted onto an intermediate frequency, and converter means 48, in which the signal is converted into a digital form, means 49 for detecting the converted signal, deinterleaving means 50, and means 51 for decoding the received signal, in which means both channel and speech decoding are carried out. The terminal equipment further comprises control and calculation means 52 for controlling the operation of the other blocks mentioned above. The terminal equipment of the cellular radio system of the invention further comprises means 47, 52 for measuring the strength of the signal received from the base station, and means 40-44, 52 for transmitting the information on the measurement result to the base station. The terminal equipment also comprises other components, such as filters, but they are unessential to the invention. The above-disclosed terminal equipment is a terminal equipment of a digital cellular radio system, but the invention may correspondingly also be applied in an analog system.

Although the invention has been disclosed above with reference to the example in accordance with the attached drawings, it is obvious that the invention is not limited thereto, but it may be modified in various ways within the scope of the inventive idea set forth in the attached claims.

10

15

20

25

30

35

Claims:

1. A method for controlling transmitting power in a cellular radio system comprising in each cell at least one base station (20) communicating with subscriber terminal equipments (21-22) located within its area, in which method the base station measures the power level of a signal received by it from a terminal equipment, and the terminal equipment measures the power level of a signal received by it from the base station, and reports the result to the base station, c h a r a - c t e r i z e d in that the base station compares the measurement results sent by the terminal equipment with its own measurement results, and that the base station controls the transmitting power of the terminal equipment, and its own transmitting power on the basis of the comparison of the measurement results.

2. A method as claimed in claim 1, c h a r a - c t e r i z e d in that comparison between the measurement results of the base station (20) and the terminal equipment (21-22) is carried out by means of averaging the results.

3. A method as claimed in claim 1, c h a r a - c t e r i z e d in that the base station (20) transmits the terminal equipment (21-22) a power control command by using a fast control channel.

4. A cellular radio system, comprising in each cell at least one base station (20) communicating with the subscriber terminal equipments (21-22) located within its area, the base station (20) comprising means (31, 34) for measuring the power level of the signal received from the terminal equipments, the terminal equipment comprising means (47, 52) for measuring the power level of the signal received from the base station, and means (40-44, 52) for reporting the measurement results to the

base station, c h a r a c t e r i z e d in that the
base station comprises means (34) for comparing the
measurement results sent by the terminal equipment with
its own measurement results, and means (34) for control-
5 ling the transmitting power of the terminal equipment
and its own transmitting power on the basis of the com-
parison of the measurement results.

5. A cellular radio system as claimed in claim
1, c h a r a c t e r i z e d in that the base station
10 comprises means (34) for carrying out a comparison
between the measurement results of the base station and
the terminal equipment by averaging the results.

15

20

25

30

35

1/2

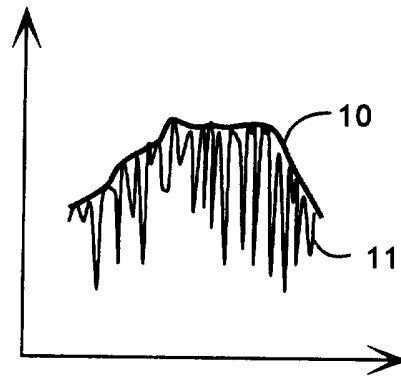


Fig. 1

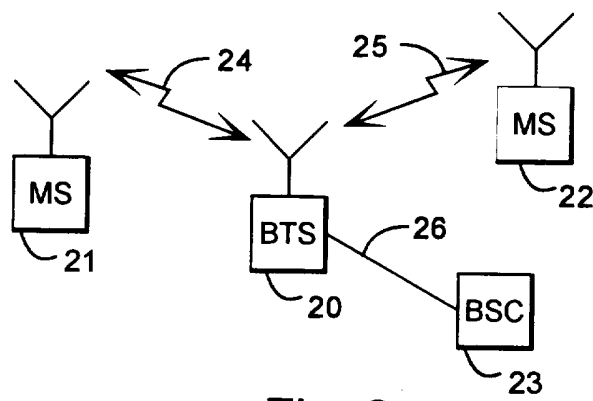


Fig. 2

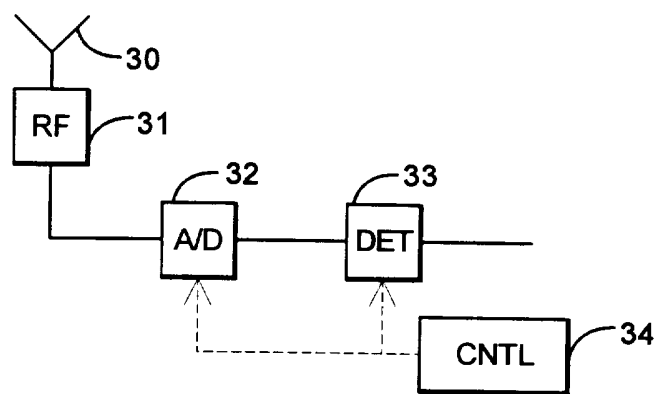


Fig. 3

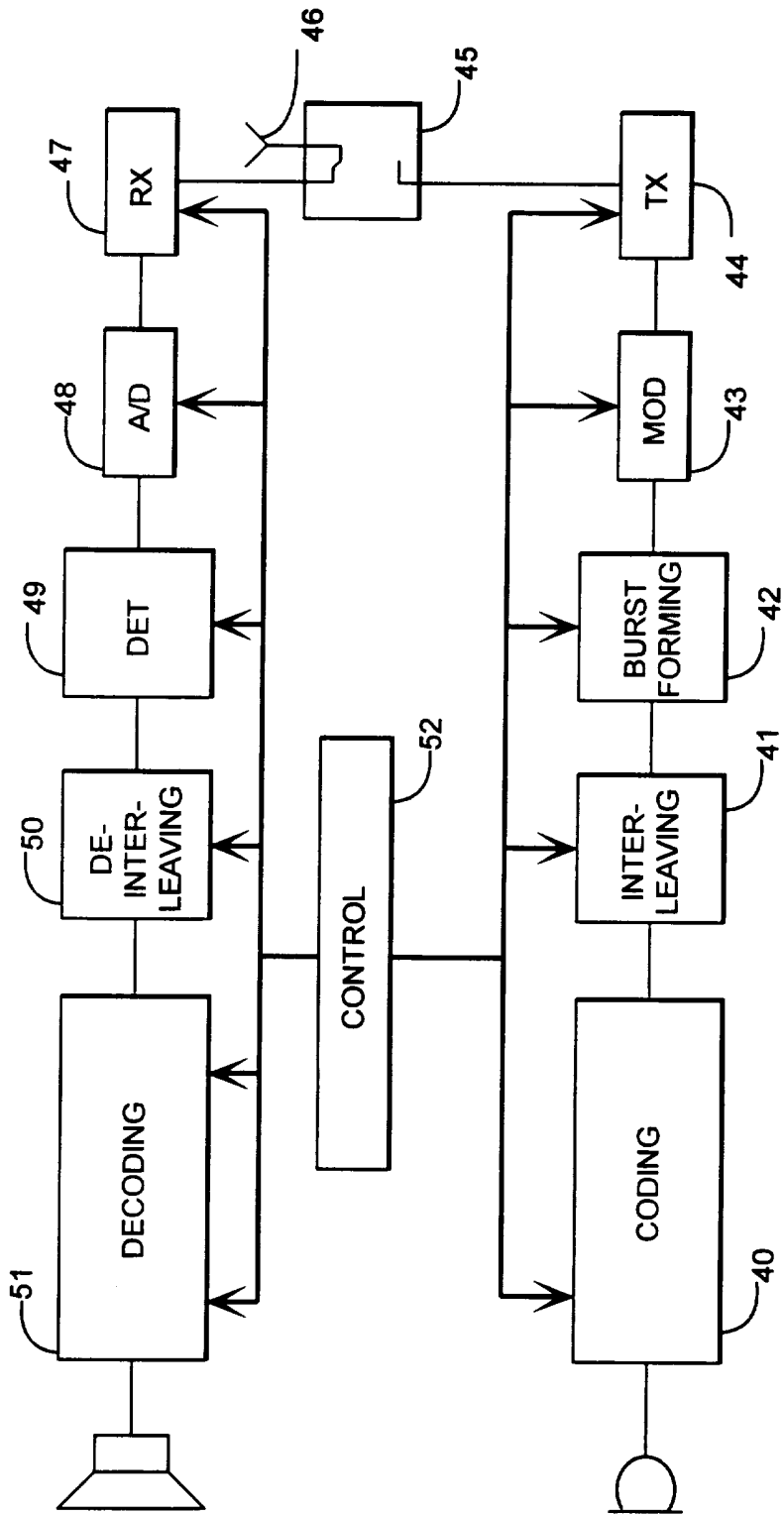


Fig. 4