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(71) Applicant (for all designated States except US): **LUCENT TECHNOLOGIES INC.** [US/US]; 600-700 Mountain Avenue, P.O. BOX 636, Murray Hill, NJ 07974-0636 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **XIE, Hairong** [CN/CN]; 5F Sunning HuanQiu Mansion, 188#, GuangZhou Road, Nanjing, Jiangsu 210024 (CN). **SHIO, Steven** [CN/CN]; 5F Sunning HuanQiu Mansion, 188#, GuangZhou Road, Nanjing, Jiangsu 210024 (CN).

(74) Agent: **CHINA SCIENCE PATENT & TRADEMARK AGENT LTD**; 25/F., Bldg. B, Tsinghua Tongfang Hi-Tech Plaza, No.1, Wangzhuang Rd., Haidian District, Beijing 100083 (CN).

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(54) Title: BASE STATION, RECEIVING SUBSYSTEM THEREOF AND SIGNAL PROCESSING METHOD USED THEREIN

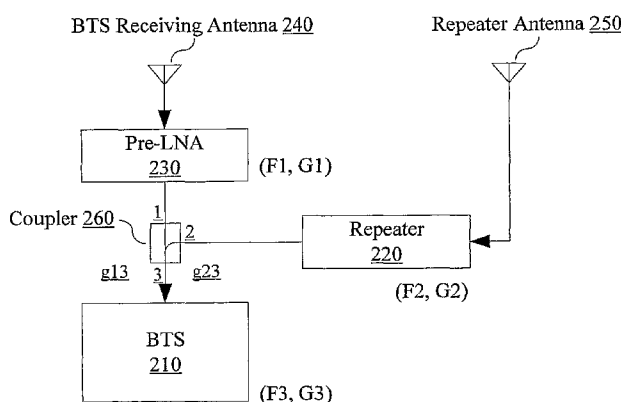


Fig. 2

(57) Abstract: The present invention provides a new solution to maintain the donor cell's receiving sensitivity when a repeater is connected with it. Thus the repeater will not affect the receiving performance of the donor cell. According to the present invention, a base station is proposed which comprises: an antenna for receiving a signal from a local cell; a pre-Low Noise Amplifier (pre-LNA) for amplifying the received signal by a predetermined gain; a coupler connected with the pre-LNA, a repeater for a remote cell and a processing unit of the base station, for coupling the signals from the pre-LNA and the repeater into the processing unit; and a processing unit for processing the signals from the coupler. According to the present invention, a corresponding receiving sub-system of the base station and a corresponding signal processing method used in the base station are also proposed. Furthermore, the present invention can also be used for general wireless system to improve the network performance.

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BASE STATION, RECEIVING SUBSYSTEM THEREOF AND SIGNAL PROCESSING METHOD USED THEREIN

BACKGROUND OF THE INVENTION

5 FIELD OF INVENTION

The present invention relates to radio communication, in particular, it relates to a base station, a receiving sub-system thereof and a signal processing method used to improve the performance of the optical or wireless repeater.

10 DESCRIPTION OF PRIOR ART

Fiber optic repeaters are widely used in the Code Division Multiple Access (CDMA) wireless network. They are cost effective; however, they also introduce some issues to the network. One of them is the shrinkage of the donor cell. Currently no approaches have been proposed for solving the issue of the shrinkage of the donor cell till now.

Basically speaking, the current repeaters are transparent to the network, and they do not change any characteristic of the signals except amplifying them. In Fig. 1, module 110 is a base station (BTS) for the donor cell. Module 120 is the repeater, which actually combines the local unit and remote unit. Antenna 140 is for the local coverage and antenna 150 is for the remote coverage. Module 160 is the coupler, which connects the BTS 110 and repeater 120. The coupler 160 has ports 1, 2 and 3. In the downlink, the repeater 120 amplifies the signals from the BTS 110 and broadcasts them to all the mobile stations. And in the uplink, the repeater 120 receives the signals from the mobile stations and feeds them to the BTS 110. Since both the signals and injected noises are amplified, the effective noise figure for the BTS 110 may rise and the sensitivity of the donor cell is deteriorated. Therefore, the shrinkage of the coverage for the donor cell is a key issue for the repeater.

Assume the modem chip in CDMA base station needs a minimum signal strength of $(E_b/N_o)_{\min}$ dB (typical 4 dB) to demodulate the reverse link signal, and the cell's noise figure is NF dB, then the reverse sensitivity of the cell is:

$$\text{Sensitivity}_1 = -174 + (BW)_{dB} + NF + (E_b/N_o)_{\min} - PG;$$

5 in which:

-174 (dBm/Hz) is the thermal noise power per Hz;

$(BW)_{dB}$ is the bandwidth, for CDMA system, the bandwidth is 1228800Hz,

so it is equal to $10\log(1228800) = 60.9$ dB;

NF is the noise figure of the cell, typical 5 dB;

10 PG is processing gain in CDMA system, it is 21 dB for 9.6Kbps bit rate.

Based on that, the cell's sensitivity is: $-174 + 60.9 + 5 + 4 - 21 = -125.1$ dBm.

After the repeater is connected with the cell, the noise figure of donor cell will be normally deteriorated at least by 3 dB, so the noise figure becomes $NF + 3 = 8$ dB,

Then we can get the sensitivity of the cell equipped with a repeater is:

$$\begin{aligned} 15 \quad \text{Sensitivity}_2 &= -174 + (BW)_{dB} + 8 + (E_b/N_o)_{\min} - PG \\ &= -123.1 \text{ dBm.} \end{aligned}$$

It means that the sensitivity will also be deteriorated by 3 dB. That is to say, the mobile needs to transmit 3 dB higher power to achieve the same cells' coverage, or with the same mobile's transmitted power, the cell's coverage is decreased by half.

20

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a pre-LNA (Low Noise Amplifier) to maintain the noise figure of the whole donor cell system after the repeater is connected. The RF requirements for the pre-LNA and the optic repeater are

25 described.

According to an embodiment of the present invention, a base station is proposed which comprises: an antenna for receiving a signal from a local cell; a pre-Low Noise Amplifier (pre-LNA) for amplifying the received signal by a predetermined gain; a coupler connected with the pre-LNA, a repeater for a remote cell and a processing unit of the base station, for coupling the signals from the pre-LNA and the repeater into the processing unit; and a processing unit for processing the signals from the coupler.

Preferably, a noise figure of the local cell is kept unchanged after the repeater is connected.

Preferably, a ratio between the predetermined gain of the pre-LNA and a gain of the repeater is determined according to a gain of the coupler from a port connected to the pre-LNA to a port connected to the processing unit, a gain of the coupler from a port connected to the repeater to the port connected to the processing unit, and noise figures of the pre-LNA, the repeater and the local cell.

Preferably, a gain of a low noise amplifier included in the processing unit is decreased by the predetermined gain provided by the pre-LNA to keep an overall system gain unchanged.

Preferably, the antenna is also used for transmitting a signal to the local cell, and the base station further comprises: a first and a second duplexers, wherein the first duplexer is connected to the antenna and the pre-LNA, the second duplexer is connected to the pre-LNA and the coupler, and the first duplexer is further connected to the second duplexer via a separated link not passing through the pre-LNA; wherein a path through the antenna, the first duplexer, the pre-LNA, the second duplexer, the coupler and the processing unit in the above order forms the receiving path of the base station, and a separated path through the processing unit, the second duplexer, the first duplexer and the antenna in the above order forms a transmitting path of the base station.

Preferably, the repeater is an optical repeater or a wireless repeater.

Preferably, the base station is used for CDMA, WCDMA, TD-SCDMA or GSM
5 scheme.

According to another embodiment of the present invention, A receiving sub-system
of a base station is proposed which comprises: an antenna for receiving a signal
from a local cell; a pre-Low Noise Amplifier (pre-LNA) for amplifying the received
10 signal by a predetermined gain; a coupler connected with the pre-LNA, a repeater
for a remote cell and a processing unit of the receiving sub-system, for coupling the
signals from the pre-LNA and the repeater into the processing unit; and a
processing unit for processing the signals from the coupler.

15 According to a further embodiment of the present invention, a signal processing
method used in a base station is proposed which comprises steps of: receiving a
signal from a local cell by an antenna of the base station; amplifying the received
signal by a predetermined gain by a pre-Low Noise Amplifier (pre-LNA) of the base
station; coupling the amplified signal from the pre-LNA and a signal from a repeater
20 for a remote cell into a processing unit of the base station, by a coupler of the base
station; and processing the coupled signal in the processing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, features and advantages of the present invention will
25 be clearer from the following detailed description about the non-limited
embodiments of the present invention taken in conjunction with the accompanied
drawings, in which:

Fig. 1, already described, is a block diagram showing a conventional connection
structure of an optical repeater;

Fig. 2 is a block diagram showing the system construction according to the present invention;

Fig. 3 is also a block diagram showing the system construction according to the present invention, but the gain g_{13} and g_{23} of the coupler have been absorbed into gains G_1 and G_2 to be represented as G_1' and G_2' respectively;

Fig. 4 is a block diagram showing the system construction according to the present invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

Hereunder, the present invention will be described in accordance with the drawings. In the following description, some particular embodiments are used for the purpose of description only, which shall not be understood as any limitation to the present invention but the examples thereof. For the sake of simplicity,, the conventional structures or constructions which are not relevant for the understanding of the invention will be omitted.

The reason for the coverage shrinkage is the increase of the noise figure of the donor cell after the repeater is connected to the cell. The present invention adds a pre-LNA (Low Noise Amplifier) into the receiving link of the BTS for the donor cell, which is shown in Fig. 2. This figure is used to explain, in a non-limiting manner, the principle of the present invention.

In Fig. 2, there are four parts: a BTS 210, a repeater 220, a coupler 260 and a pre-LNA 230 which is added according to the present invention. The noise figures (F_1 , F_2 , F_3) and gains (G_1 , G_2 , G_3) have been marked in the brackets as shown. We need get the calculation method for the effective noise figure of the combined system.

The module 260 is a passive coupler and it has three ports: ports 1, 2 and 3. Assume that the gain between port 1 and port 3 is g_{13} and the gain between port 2

and port 3 is g_{23} . According to the document from the author David F. WAIT, entitled "Thermal Noise from a Passive Linear Multiport", IEEE, MIF16, NO.9, Sep. 1968, the effective noise temperature at port 3 generated by the coupler itself, $T_{3, self}$, is:

$$T_{3, self} = (1 - g_{23} - g_{13})T_0$$

where T_0 is the reference temperature. The port 2 is connected with the repeater 220 having noise figure F_2 and gain G_2 . If the repeater 220 is terminated perfectly, the repeater 220 can generate the thermal noise temperature $T_{repeater}$:

$$T_{repeater} = T_0 F_2 G_2$$

10 If the connection of port 2 matches perfectly between the repeater 220 and coupler 260, then the thermal noise injected from port 2 to port 3, $T_{port-23}$, can be expressed as:

$$\begin{aligned} T_{port-23} &= T_{3, Self} + g_{23} * T_{repeater} \\ &= (1 - g_{23} - g_{13})T_0 + g_{23} F_2 G_2 T_0 \end{aligned}$$

15

So the effective noise figure from port 1 to port 3, $F_{port-13}$, is:

$$\begin{aligned} F_{port-13} &= 1 + \frac{T_{port-23}}{g_{13} T_0} = 1 + \frac{(1 - g_{23} - g_{13})T_0 + g_{23} F_2 G_2 T_0}{g_{13} T_0} \\ &= 1 + \frac{(1 - g_{23} - g_{13}) + g_{23} F_2 G_2}{g_{13}} \end{aligned}$$

20 Then the system in Fig. 2 can be equally described as the cascading configuration of three modules: pre-LNA 230 with the noise figure F_1 and gain G_1 , the effective module from port 1 to port 3 with the noise figure $F_{port-13}$ and gain g_{13} ; and the BTS 210 with the noise figure F_3 and gain G_3 .

According to the cascading formulas

$$F = F_1 + \frac{F_2 - 1}{G_1} + \frac{F_3 - 1}{G_1 G_2} + \frac{F_4 - 1}{G_1 G_2 G_3}$$

in which $F_1, G_1; F_2, G_2; F_3, G_3$ and F_4 are the noise figures and gains of the RF components of the cascading system, the total noise figure $F_{e,cell}$ from pre-LNA 230 to BTS 210 is:

$$\begin{aligned} F_{e,cell} &= F_1 + \frac{F_{port-13} - 1}{G_1} + \frac{F_3 - 1}{g_{13} G_1} \\ &= F_1 + \frac{(1 - g_{23} - g_{13}) + g_{23} F_2 G_2 + F_3 - 1}{g_{13} G_1} \end{aligned}$$

Using the same method, the effective noise figure $F_{e,repeater}$ for repeater is:

$$F_{e,repeater} = F_2 + \frac{(1 - g_{23} - g_{13}) + g_{13} F_1 G_1 + F_3 - 1}{g_{23} G_2}$$

The above two formulas give out the accurate calculation method for the effective noise figure of the repeater and the donor cell. In order to simplify the calculation and get the engineering results, we need to simplify the formulas.

In the real deploying environment, the coupler 260 must have the high coupler loss, so that the loss from port 1 to port 3 is very small and can be negligible. The typical loss from port 1 to port 3 is 0.2 dB and the loss from port 2 to port 3 is 40 dB. That is to say: $g_{13} = 0.955$ and $g_{23} = 0.0001$, so

$$F_{e,cell} = F_1 + \frac{0.045 + g_{23} F_2 G_2 + F_3 - 1}{g_{13} G_1}$$

$$F_{e, repeater} = F_2 + \frac{0.045 + g_{13}F_1G_1 + F_3 - 1}{g_{23}G_2}$$

The g_{13} and g_{23} actually can be "absorbed" by G_1 and G_2 to be represented as G_1' and G_2' , then we can get:

$$F_{e, cell} = F_1 + \frac{F_2G_2' + F_3 - 0.955}{G_1'} \quad \dots(1)$$

$$F_{e, repeater} = F_2 + \frac{F_1G_1' + F_3 - 0.955}{G_2'} \quad \dots(2)$$

where

$$G_1' = g_{13}G_1$$

$$G_2' = g_{23}G_2$$

where as shown in Fig. 3, F_1 and G_1' respectively denote the noise figure and gain of the pre-LNA 330, F_2 and G_2' respectively denotes the noise figure and gain of the repeater 320, and F_3 denotes the noise figure of the BTS 310; and $F_{e, cell}$ denotes the effective noise figure of the BTS 310 (from pre-LAN to donor cell), and $F_{e, repeater}$ denotes the effective noise figure of the repeater 320 (from repeater to donor cell).

The Fig. 3 can be used to show a simplified system configuration which already has absorbed g_{13} and g_{23} to G_1 and G_2 to be represented as G_1' and G_2' respectively. The section below will try to find an optimized solution for this system configuration.

Firstly, the donor cell's noise figure will be kept unchanged after the repeater is connected. Then, the noise figure of the cell 310, F_3 , shall be equal to its effective

noise figure after the repeater is connected, $F_{BTS,eff}$. Here, Equation (3) can be obtained.

$$F_3 = F_{e,cell} = F_1 + \frac{F_2 G_2' + F_3 - 0.955}{G_1'} \quad \dots(3)$$

5 Secondly, the effective noise figure of the repeater, $F_{e,repeater}$ should be minimized.

From Equations (2) and (3), we can get:

$$F_{e,repeater} = \frac{F_3 G_1'}{G_2'} \quad \dots(4)$$

10 Assuming that the gain ratio is

$$k = G_1' / G_2' \quad \dots(5)$$

Then

$$F_{e,repeater} = k * F_3 \quad \dots(6)$$

15 In order to minimize the repeater effective noise figure $F_{e,repeater}$ the gain ratio k should be minimized.

From Equations (3) and (5), Equation (7) is obtained:

$$G_2' = \frac{F_3 - 0.955}{k(F_3 - F_1) - F_2} \quad \dots(7)$$

20

The Inequality below must be fulfilled:

$$k > \frac{F2}{F3-F1} \quad \dots(8)$$

k must fulfill the inequality (8) and has the minimum value to get lowest effective noise figure of the effective repeater. F2 and F3 are the known value for the system and F1 must be a low value since it is the first stage of donor cell. After the F1 and k is specified, G2' can be calculated by equation (7). Then G1' can also be calculated. Finally, the effective noise figure of donor cell and repeater can be calculated by (1) and (2).

- 10 As an example, although the noise figure of pre-LNA cannot be accurately defined, the range should be between 1.2 dB and 1.8 dB according to the usual LNA products. Table 1 below shows the calculated results for the different noise figure of F1:

Table 1

Repeater NF (F2) dB	BTS NF (F3) dB	K(G1'/G2') Low Limit (dB)	Eff.NF (BTS) dB	Eff.NF (Repeater) dB	G1'(dB)	G2'(dB)	k (dB)
6	5	3.3	5	8.8	10.4	6.6	3.8
6	5	3.5	5	9.0	10.6	6.6	4.0
6	5	3.7	5	9.2	10.7	6.6	4.2
6	5	3.8	5	9.3	10.9	6.6	4.3
6	5	4.0	5	9.5	11.1	6.6	4.5

15

- k must be larger than the low limit in the table and must be as small as possible to keep repeater's effective noise figure lowest. In the Table 1 above, the actual k is larger than the minimal value by 0.5 dB for the headroom for the gain variation of G1' and G2'. According to the table above, using the pre-LNA method, the effective donor cell's noise figure can keep unchanged and the repeater's noise figure is only deteriorated by about 2.8 dB for the best scenario. So the donor cell receiver, which is included in the BTS as a receiving sub-system thereof, has the performance unchanged and the repeater also can get the good performance.

20

The description above only considers the receiving path, but actually the donor cell also transmits the forward link signal simultaneously. Therefore, two duplexers are needed, which is shown in Fig. 4. In Fig. 4, module 410 is the BTS for the donor cell, and module 460 is the coupler. Local unit of Optical Repeater is marked as module 4201 and the remote unit is marked as module 4202. Optical fiber is module 4203. Module 440 is the BTS transmitting/receiving antenna for local coverage, and module 450 is the repeater antenna for the remote coverage.

Pre-LNA is marked as 430, and two duplexers are added before and after the pre-LNA 430: Duplexer 470 and Duplexer 480. These two duplexers 470 and 480 can separate the transmitting path and receiving path for the donor cell so that the pre-LNA 430 can be inserted into the receiving path. Based on the above configuration, the $F1$, $G1'$ could be the total noise figure and the gain of the cascading sub-system: Duplex 480, pre-LNA 430 and Duplex 470.

During the real system implementation, the gain of LNA in the donor BTS shall be decreased by $G1'$ dB associated with the pre-LNA to maintain the same system gain budget.

Although the present invention describes the optical repeater, it can also be used for wireless repeaters, since the wireless repeaters also inject the noise to the donor cell. And although the present invention uses the CDMA optical repeater as an example, actually this solution can be used in other systems such as WCDMA, TD-SCDMA and GSM.

The above embodiments are provided for the purpose of example only, and are not intended to limit the present invention. It is to be understood by those skilled in the art that there may be various modifications or replacements to the embodiments without departing from the scope and the spirit of the present invention, and they shall fall into the scope defined by the appended claims.

What is claimed is:

1. A base station, comprising:

an antenna for receiving a signal from a local cell;

5 a pre-Low Noise Amplifier for amplifying the received signal by a predetermined gain;

a coupler connected with the pre-Low Noise Amplifier, a repeater for a remote cell and a processing unit of the base station, for coupling the signals from the pre-Low Noise Amplifier and the repeater into the processing unit; and

10 a processing unit for processing the signals from the coupler.

2. The base station according to Claim 1, wherein a noise figure of the local cell is kept unchanged after the repeater is connected.

15 3. The base station according to Claim 1 or 2, wherein a ratio between the predetermined gain of the pre-Low Noise Amplifier and a gain of the repeater is determined according to a gain of the coupler from a port connected to the pre-Low Noise Amplifier to a port connected to the processing unit, a gain of the coupler from a port connected to the repeater to the port connected to the processing unit,
20 and noise figures of the pre-Low Noise Amplifier, the repeater and the local cell.

4. The base station according to any one of Claims 1 – 3, wherein a gain of a low noise amplifier included in the processing unit is decreased by the predetermined gain provided by the pre-Low Noise Amplifier to keep an overall system gain
25 unchanged.

5. The base station according to any one of Claims 1 – 4, wherein the antenna is also used for transmitting a signal to the local cell, and

the base station further comprises:

a first and a second duplexers, wherein the first duplexer is connected to the antenna and the pre-Low Noise Amplifier, the second duplexer is connected to the pre-Low Noise Amplifier and the coupler, and the first duplexer is further connected to the second duplexer via a separated link not passing through the pre-Low Noise Amplifier;

wherein a path through the antenna, the first duplexer, the pre-Low Noise Amplifier, the second duplexer, the coupler and the processing unit in the above order forms the receiving path of the base station, and a separated path through the processing unit, the second duplexer, the first duplexer and the antenna in the above order forms a transmitting path of the base station.

6. The base station according to any one of Claims 1 – 5, wherein the repeater is an optical repeater or a wireless repeater.

7. The base station according to any one of Claims 1 – 6, wherein the base station is used for CDMA, WCDMA, TD-SCDMA or GSM scheme.

8. A receiving sub-system of a base station, comprising:

an antenna for receiving a signal from a local cell;

a pre-Low Noise Amplifier for amplifying the received signal by a predetermined gain;

a coupler connected with the pre-Low Noise Amplifier, a repeater for a remote cell and a processing unit of the receiving sub-system, for coupling the signals from the pre-Low Noise Amplifier and the repeater into the processing unit; and

a processing unit for processing the signals from the coupler.

9. The receiving sub-system according to Claim 8, wherein a noise figure of the local cell is kept unchanged after the repeater is connected.

10. The receiving sub-system according to Claim 8 or 9, wherein a ratio between the predetermined gain of the pre-Low Noise Amplifier and a gain of the repeater is determined according to a gain of the coupler from a port connected to the pre-Low Noise Amplifier to a port connected to the processing unit, a gain of the coupler
5 from a port connected to the repeater to the port connected to the processing unit, and noise figures of the pre-Low Noise Amplifier, the repeater and the local cell.

11. The receiving sub-system according to any one of Claims 8 – 10, wherein a gain of a low noise amplifier included in the processing unit is decreased by the
10 predetermined gain provided by the pre-Low Noise Amplifier to keep an overall system gain unchanged.

12. The receiving sub-system according to any one of Claims 8 – 11, further comprising:

15 a first and a second duplexers, wherein the first duplexer is connected to the antenna and the pre-Low Noise Amplifier, the second duplexer is connected to the pre-Low Noise Amplifier and the coupler, and the first duplexer is further connected to the second duplexer via a separated link not passing through the pre-Low Noise Amplifier;

20 wherein a path through the antenna, the first duplexer, the pre-Low Noise Amplifier, the second duplexer, the coupler and the processing unit in the above order forms the receiving path of the receiving sub-system.

13. The receiving sub-system according to any one of Claims 8 – 12, wherein the
25 repeater is an optical repeater or a wireless repeater.

14. The receiving sub-system according to any one of Claims 8 – 13, wherein the base station is used for CDMA, WCDMA, TD-SCDMA or GSM scheme.

30 15. A signal processing method used in a base station, comprising steps of:

receiving a signal from a local cell by an antenna of the base station;

amplifying the received signal by a predetermined gain by a pre-Low Noise Amplifier of the base station;

5 coupling the amplified signal from the pre-Low Noise Amplifier and a signal from a repeater for a remote cell into a processing unit of the base station, by a coupler of the base station; and

processing the coupled signal in the processing unit.

16. The signal processing method used in the base station according to Claim 15,
10 wherein a noise figure of the local cell is kept unchanged after the repeater is connected.

17. The signal processing method used in the base station according to Claim 15
or 16, wherein a ratio between the predetermined gain of the pre-Low Noise
15 Amplifier and a gain of the repeater is determined according to a gain of the coupler from a port connected to the pre-Low Noise Amplifier to a port connected to the processing unit, a gain of the coupler from a port connected to the repeater to the port connected to the processing unit, and noise figures of the pre-Low Noise Amplifier, the repeater and the local cell.

20

18. The signal processing method used in the base station according to any one of Claims 15 – 17, wherein a gain of a low noise amplifier included in the processing unit is decreased by the predetermined gain provided by the pre-Low Noise Amplifier to keep an overall system gain unchanged.

25

19. The signal processing method used in the base station according to any one of Claims 15 – 18, wherein the repeater is an optical repeater or a wireless repeater.

20. The signal processing method used in the base station according to any one of Claims 15 – 19, wherein the signal processing method is used for CDMA, WCDMA, TD-SCDMA or GSM scheme.

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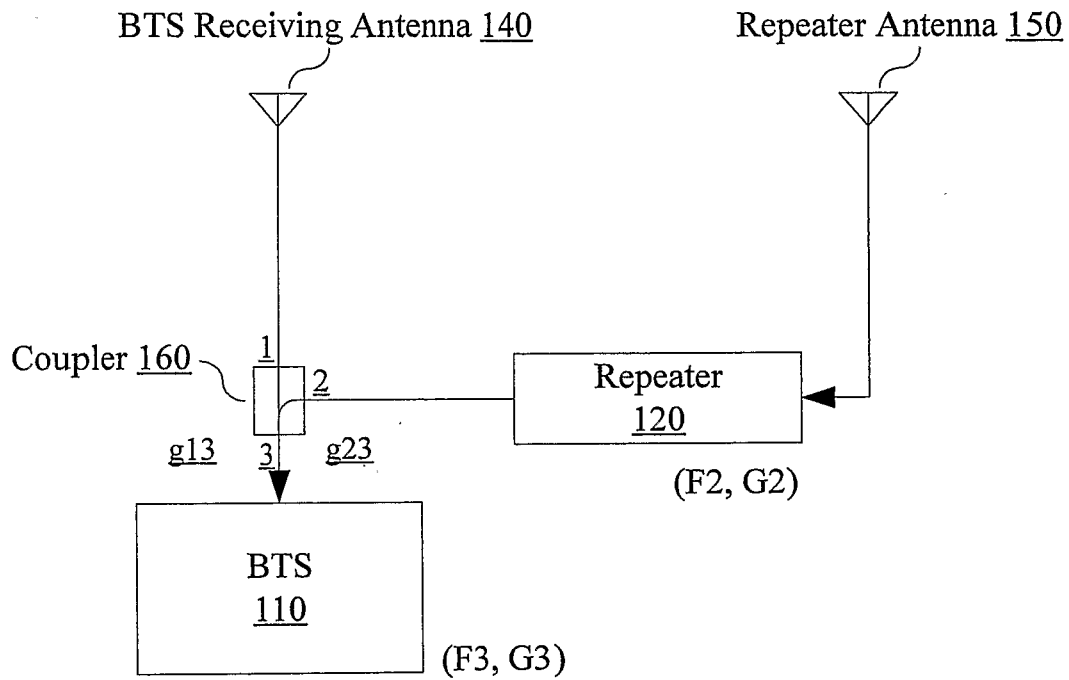


Fig. 1

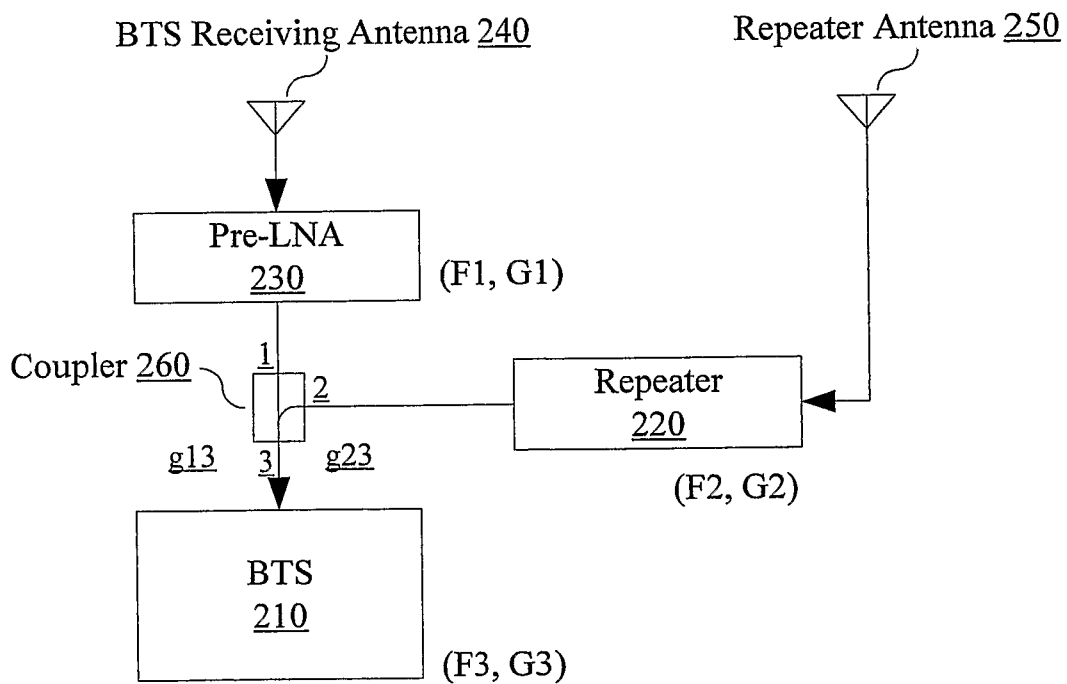


Fig. 2

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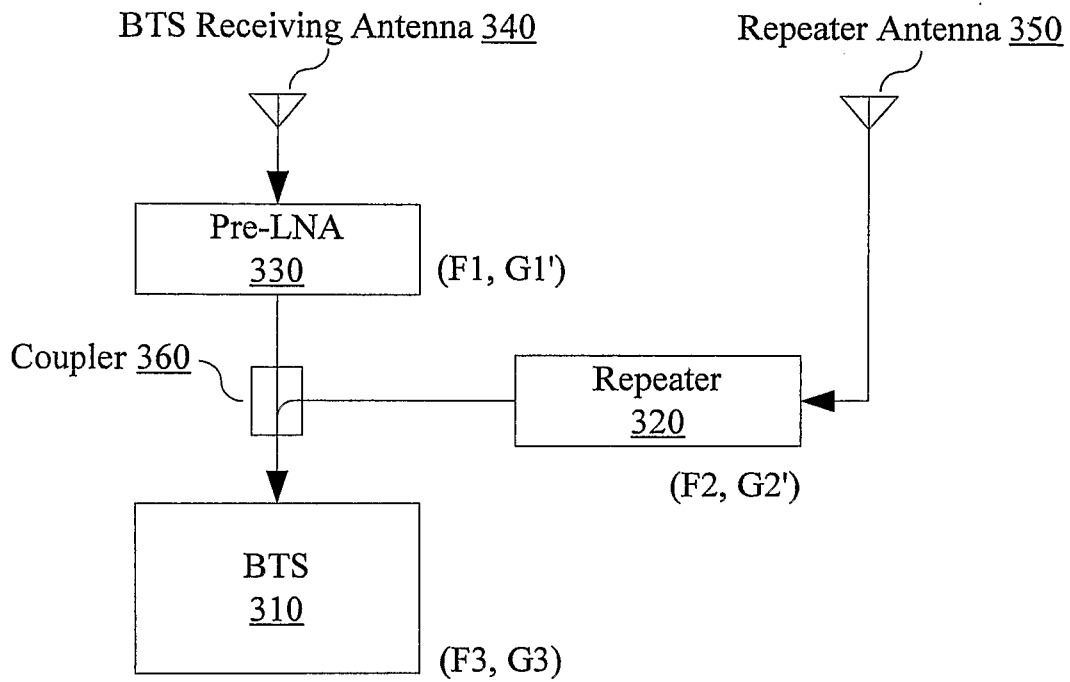


Fig. 3

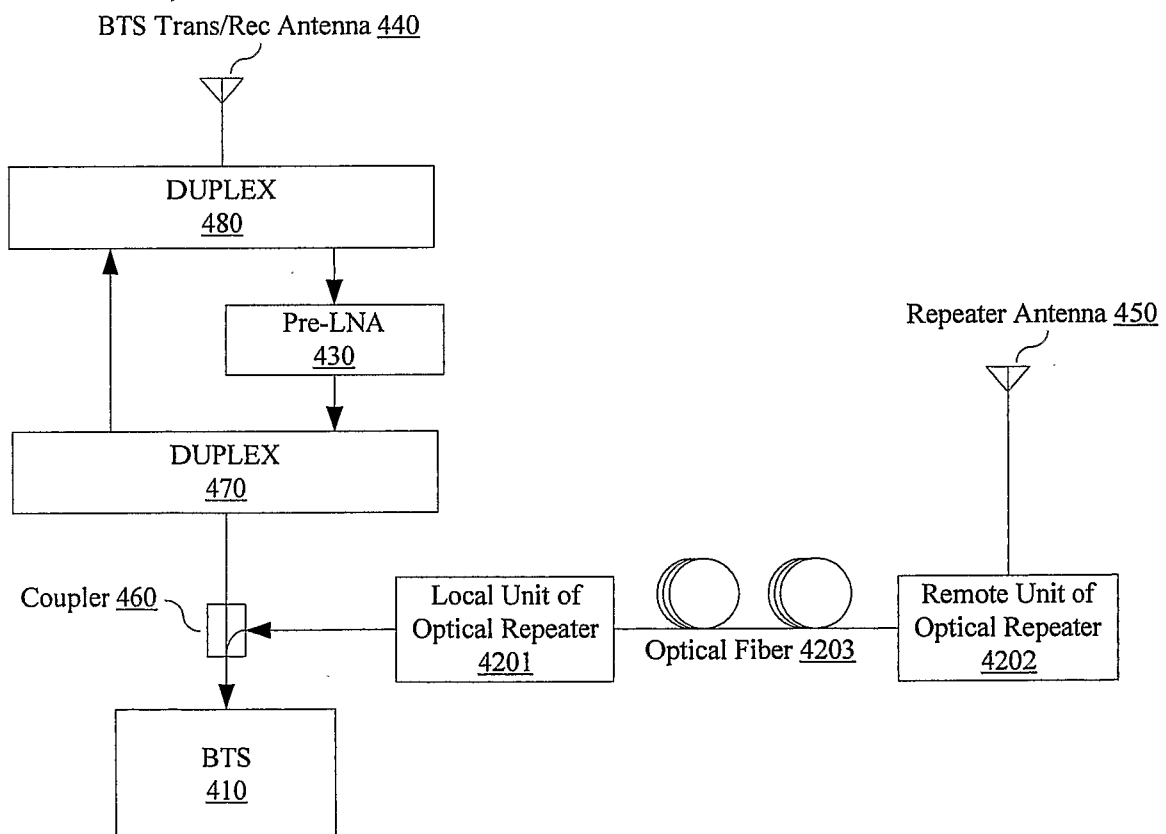


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2007/003294

A. CLASSIFICATION OF SUBJECT MATTER

H04B7/14(2006.01)i

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: H04B; H04Q; H04L

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)

WPI, EPODOC, PAJ, CNPAT, CNKI: repeater, direct w amplifier, low, noise, amplifier, LNA, coupler, BS, base w station

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	KR20060115945A (UNIV SOGANG IND COOP FOUND) 13 November 2006(13.11.2006) Page 4 line 30-page 5 line 22 of the description, figure 5 and the abstract	1-2, 6-9, 13-16, 19-20
A	CN1801667A (COMBA TELECOM SYSTEMS GUANGZHOU CO LTD) 12 July 2006(12.07.2006) The whole document	1-20
A	US2007249283A1 (BRAITHWAITE R N) 25 October 2007 (25.10.2007) The whole document	1-20
A	KR100664440B1 (SOLID TECHNOLOGIES INC) 03 January 2007(03.01.2007) The whole document	1-20

☐ 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
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Name and mailing address of the ISA/CN
The State Intellectual Property Office, the P.R.China
6 Xitucheng Rd., Jimen Bridge, Haidian District, Beijing, China
100088
Facsimile No. 86-10-62019451

Authorized officer

CUI, Aiping

Telephone No. (86-10) 62411867

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/CN2007/003294

Patent Documents referred in the Report	Publication Date	Patent Family	Publication Date
KR20060115945A	13.11.2006	None	
CN1801667A	12.07.2006	None	
US2007249283A1	25.10.2007	WO2007124103 A2	01.11.2007
KR100664440B1	03.01.2007	None	