PCT

WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04B 7/08, H03D 7/16, H04B 7/12 A1

(11) International Publication Number: WO 99/62199

(43) International Publication Date: 2 December 1999 (02.12.99)

(21) International Application Number: PCT/EP99/03597

(22) International Filing Date: 25 May 1999 (25.05.99)

(30) Priority Data:
9811380.6 27 May 1998 (27.05.98) GB
9828044.9 18 December 1998 (18.12.98) GB

(71) Applicant *(for all designated States except US)*: NOKIA MOBILE PHONES LTD. [FI/FI]; Keilalahdentie 4, FIN-02150 Espoo (FI).

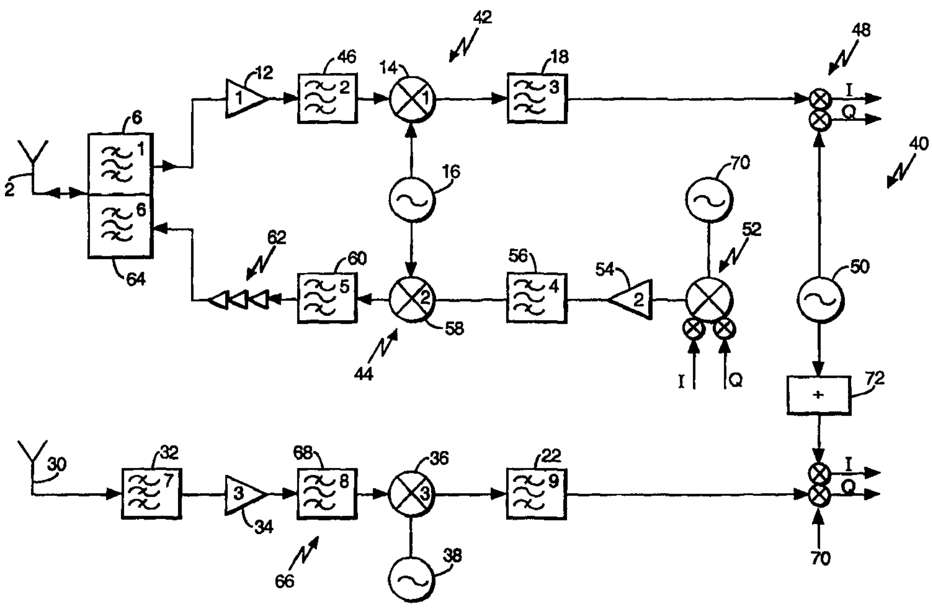
(72) Inventor; and
(75) Inventor/Applicant *(for US only)*: KUIRI, Tapio [FI/FI]; Voikukkati ID 12, FIN-90580 Oulu (FI).

(74) Agents: STYLE, Kelda, Camilla, Karen et al.; Page White & Farrer, 54 Doughty Street, London WC1N 2LS (GB).

(81) Designated States: AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, DE, DK, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).

Published
With international search report.
Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: A RECEIVER AND RECEIVING METHOD FOR WIRELESS COMMUNICATION



(57) Abstract

There is provided a receiver, and method for using such a receiver, the receiver having a first input for receiving a first signal, a first processing path coupled to the first input for processing said first signal, a second input for receiving a second signal at a second different frequency and a second processing path coupled to said second input for processing said second signal. Each of the first and second paths have means for changing the frequency of the first and second signal to different frequencies, wherein the first and second signals are changed to different frequencies and the first and second inputs are arranged to receive the first and second signals at the same time.

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.

AL	Albania
AM	Armenia
AT	Austria
AU	Australia
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BB	Barbados
BE	Belgium
BF	Burkina Faso
BG	Bulgaria
BJ	Benin
BR	Brazil
BY	Belarus
CA	Canada
CF	Central African Republic
CG	Congo
CH	Switzerland
CI	Côte d'Ivoire
CM	Cameroon
CN	China
CU	Cuba
CZ	Czech Republic
DE	Germany
DK	Denmark
EE	Estonia
ES	Spain
FI	Finland
FR	France
GA	Gabon
GB	United Kingdom
GE	Georgia
GH	Ghana
GN	Guinea
GR	Greece
HU	Hungary
IE	Ireland
IL	Israel
IS	Iceland
IT	Italy
JP	Japan
KE	Kenya
KG	Kyrgyzstan
KP	Democratic People's Republic of Korea
KR	Republic of Korea
KZ	Kazakstan
LC	Saint Lucia
LI	Liechtenstein
LK	Sri Lanka
LR	Liberia
LS	Lesotho
LT	Lithuania
LU	Luxembourg
LV	Latvia
MC	Monaco
MD	Republic of Moldova
MG	Madagascar
MK	The former Yugoslav Republic of Macedonia
ML	Mali
MN	Mongolia
MR	Mauritania
MW	Malawi
MX	Mexico
NE	Niger
NL	Netherlands
NO	Norway
NZ	New Zealand
PL	Poland
PT	Portugal
RO	Romania
RU	Russian Federation
SD	Sudan
SE	Sweden
SG	Singapore
SI	Slovenia
SK	Slovakia
SN	Senegal
SZ	Swaziland
TD	Chad
TG	Togo
TJ	Tajikistan
TM	Turkmenistan
TR	Turkey
TT	Trinidad and Tobago
UA	Ukraine
UG	Uganda
US	United States of America
UZ	Uzbekistan
VN	Viet Nam
YU	Yugoslavia
ZW	Zimbabwe

A RECEIVER AND RECEIVING METHOD FOR WIRELESS COMMUNICATION

The present invention relates to a receiver and receiving method for use in wireless communication. In particular, but not exclusively, the present invention relates to a receiver connectable to a main antenna and a diversity antenna.

In wireless telecommunication networks, the area covered by the network is divided into a plurality of cells each of which is served by a base transceiver station. Each base station is arranged to communicate with a plurality of stations located in the cell associated with the base station. These stations are typically mobile telephones or other mobile stations.

Code division multiple access (CDMA) systems have been proposed for cellular networks. IS-95 is an example of a cellular standard using CDMA. In these systems a plurality of users in a given cell will use the same frequency at the same time. The users are distinguished by different spreading codes. Different frequencies may by used in different cells. It has been proposed that CDMA systems use soft handoff. In soft handoff, a mobile station is arranged in certain circumstances to communicate with more than one base station at the same time. The same information will be sent by the different base stations but a different spreading code and/or frequency may be used for the signals transmitted by the different base stations. Typically soft handoff will occur when a mobile station is close to the edge of the cell in which the mobile station is currently located.

A diversity receiver 1 which is known is shown in Figure 1. The receiver 1 comprises a main antenna 2 connected to a first filter 6 which removes signals which fall outside the frequency range of the signals which could be received by the main antenna. The output of the first filter 6 is input to a low noise amplifier 12, the output of which is connected to a first mixer 14. The first mixer 14 receives an input from a high frequency synthesizer 16 so that the output of the first mixer 14 represents the received signal at intermediate frequencies. The output of the first mixer 16 is input to a second bandpass filter 18 which filters the output of the first mixer 16. The second bandpass filter 18 has a much narrower bandwidth than the first bandpass filter 6 and filters out unwanted signals except the desired signal which is at the intermediate frequency to which the second bandpass filter is tuned.

The receiver of Figure 1 comprises a second antenna 30 which is physically spaced apart from the first antenna 2. The second antenna 30 also receives signals and is connected to a third filter 32 which is tuned to the same frequency band as the first bandpass filter 6. The output of the third filter 32 is connected to a second low noise amplifier 34, the output of which is connected to a second mixer 36. The second mixer 36 has an input from a second high frequency synthesizer 38 so that the output of the second mixer 36 represents the received signal but at intermediate frequencies. The output of the second mixer 36 is input to a fourth bandpass filter 22 which filters the output of the second mixer 38. In a similar manner to the second bandpass filter 18, the fourth bandpass filter 22 filters out all signals except the desired signal.

The second antenna 30 is used as a diversity antenna. For example, if the signal from the base station is not strongly received by one antenna, the signal from the base station may be strongly received by the other antenna and vice versa. The signals received by the main antenna 2 and the diversity antenna 30 may be coherently combined using the maximum ratio combining technique, which gives a better performance, or, alternatively, the strongest signal selected. The combining of the signals or the selection of the strongest signal is carried out by components of the receiver which are not shown in Figure 1.

However, the inventor has recognised that there is a problem with this known arrangement particularly if the desired signals are at different frequencies. In particular to simplify the components of the receiver, the intermediate frequencies to which the second and fourth bandpass filters are tuned are the same. This means that the identical components can be used downstream of each of the mixers and in the down conversion to the baseband or to another intermediate frequency the same oscillator can be used.

The inventor has appreciated that the use of a common intermediate frequency can lead to interference, particularly when the mixers and oscillators are all in close proximity. In the known receiver shown in Figure 1, the first oscillator 16 provides a signal at a first frequency and the second oscillator provides a signal at a second, different frequency. Leakage of signal from the first oscillator can occur to the second mixer and vice versa. In practice each of the first and second antennae will receive signals at more than one frequency. The combined signal containing all of the signals received by the respective antenna will be passed to the respective mixer. All of these signals will be mixed with the signal from the associated local oscillator and will provide signals at different intermediate frequencies. The bandpass filter is tuned to the intermediate frequency of the desired signal so that only the desired signal passes through the filter. The other signals at the other intermediate frequencies are filtered out.

When leakage from the other oscillator occurs, the combined signal will be effectively mixed in each mixer with two different sets of oscillator signals. Thus two different signals may be at the intermediate frequency of the desired signal. One of these signals is the desired signal which is obtained as described hereinbefore. The other signal is initially at a different radio frequency to the desired signal but is at the same intermediate frequency due to having been mixed with the signal leaked from the other oscillator. The two different signals which are at the intermediate frequency to which the respective bandpass filter is tuned interfere. This can be a particular problem when the desired signal is weak and the interfering signal is strong.

It is an aim of embodiments of the present invention to provide a receiver which is able to avoid or at least reduce the problems of the known arrangement discussed hereinbefore.

According to one aspect of the present invention, there is provided a receiver comprising a first input for receiving a first signal; a first processing path coupled to the first input for processing said first signal; a second input for receiving a second signal at a second different frequency; and a second processing path coupled to said second input for processing said second signal, each of said first and second paths comprising means for changing the frequency of the first and second signal to different frequencies, wherein the first and second signals are changed to different frequencies and the first and second input means are arranged to receive the first and second signals at the same time.

As the first and second signals are changed to different frequencies, problems described hereinbefore can be avoided.

Preferably, the first and second frequencies are radio frequencies. The first and second frequencies may be the same or different. The first and second frequencies are preferably reduced by the changing means. In alternative embodiments of the present invention, the changing means may increase the first and second frequencies.

Each of the changing means preferably comprises mixing means for mixing the respective one of the first and second signals with a respective frequency signal from respective frequency sources. The frequency sources are preferably first and second oscillators. Typically, the frequencies provided by the first and second frequency sources will differ although in certain circumstances they might be the same.

It is preferred that at least one of the changing means of the first and second receiving paths be arranged to downconvert the frequency of the first and/or second signals to an intermediate frequency. An intermediate frequency is less than the radio frequency of the received signal but higher than the baseband frequency.

In one embodiment of the present invention, both of the first and second signals are downconverted to intermediate frequencies. One intermediate frequency is preferably an integral multiple of the other. This means that further changing means may be provided in each of the first and second processing paths for reducing the frequency of the signals at the intermediate frequency. The further changing means may each comprise a mixer. Each of the further changing means may receive a mixing frequency from a common frequency source. In this way, the number of oscillators required can be reduced. However, in alternative embodiments, the further changing means may receive frequencies from different frequency sources. The further changing means are preferably arranged to reduce the intermediate frequencies to a baseband frequency. In those circumstances, the frequencies provided by the common frequency source or two further frequency sources will be the same as the respective intermediate frequencies.

A frequency divider is preferably provided for dividing the frequency from the common frequency source to provide the intermediate frequency of one of said frequency paths and the frequency of the common frequency source is the same as the frequency of the other intermediate frequency. In this way, it is possible to use a single common frequency source, thus reducing the number of frequency sources required.

In an alternative embodiment, one of the first and second paths reduces the frequency of the respective first or second signal to an intermediate frequency whilst the other of the first and second paths is arranged to directly downconvert the received respective first or second signal to a baseband frequency signal.

Preferably, the first input is coupled to a first antenna and the second input is coupled to a second different antenna.

The receiver may have a second mode of operation in which the first and second input means from the first and second processing paths are arranged to receive first and second signals respectively, the first and second signals being at the same frequency and the changing means may be arranged in the second mode of operation to change the first and second frequencies to the same frequency.

Preferably, the receiver is arranged to receive and process code division multiple access signals. However, it should be appreciated that embodiments of the present invention can be used with any other suitable access method including time division multiple access, frequency division multiple access, space division multiple access, other spread spectrum methods and hybrids thereof.

Preferably the receiver is incorporated in a transceiver. Preferably the receiver or transceiver is incorporated in a mobile station.

According to a second aspect of the present invention, there is provided a receiver comprising a first receive arrangement comprising a first input for receiving a plurality of signals including a first desired signal and a first processing path coupled to said first input means for processing said plurality of signals; and a second receive arrangement comprising a second input for receiving the plurality of signals including a second desired signal at a second, different frequency and a second processing path coupled to the second input for processing the plurality of signals, each of said first and second paths comprises means for changing the frequencies of the signals received from the respective input so that in use the frequencies of the plurality of signals are changed to fall within first and second frequency ranges respectively, wherein the frequency changed first signal is outside said second frequency range and said frequency changed second signal is outside said first frequency range.

According to a third aspect of the present invention, there is provided a receiving method comprising the steps of receiving a first signal; processing the first signal, said processing step comprising changing the frequency of the first signal to a different frequency; receiving a second signal; and processing the second signal, said processing step comprising changing the frequency of the second signal to a different frequency, wherein the first and second signals are changed to different frequencies.

For a better understanding of the present invention and as to how the same may be carried into effect, reference will now be made by way of example to the accompanying drawings in which:

Figure 1 shows a known diversity receiver;
Figure 2 shows a schematic diagram of a part of a wireless telecommunication network in which embodiments of the present invention may by incorporated; and
Figure 3 shows a schematic view of a transceiver embodying the present invention.

Reference will first be made to Figure 2 which shows a CDMA wireless cellular network 102. The network 102 comprises a plurality of cells 104 each of which is served by a respective base transceiver station 106. Each base transceiver station 106 is arranged to send radio signals to and to receive signals from mobile stations 108 located in the cell 104 associated with the base station 106 as well as mobile stations 108 located in the edge regions of adjacent cells 104.

Reference will now be made to Figure 3 which shows an embodiment of the present invention. It should be appreciate that those components are the same as shown in Figure 1 are referred to by the same reference numeral. The transceiver 40 of Figure 3 has a main antenna 2 which is arranged to transmit and receive signals and a diversity antenna 30 which is arranged to receive signals. The diversity antenna 30 does not transmit signals. However in alternative embodiments of the present invention, the diversity antenna may also transmit signals.

The main antenna 2 is connected to a first receive processing path 42 and to a transmit processing path 44. The first receive processing path 42 will now be described. The first receive path 42 has a first bandpass filter 6 which is connected to the main antenna 2. The main antenna 2 receives a number of signals within a given radio frequency range.

The first bandpass filter 6 allows all of those signals within the given range to pass therethrough. Any noise or the like falling outside that range is filtered out by the first bandpass filter 6. Accordingly, the output of the first bandpass filter 6 will include the desired signal as well as unwanted signals at other frequencies.

The output of the first bandpass filter 6 is input to a first amplifier 12 which amplifies the received signals. The output of the first amplifier 12 is input to a second bandpass filter 46 which removes any noise signals or the like introduced by the first amplifier 12 which fall outside the given range.

The output of the second bandpass filter 46 is input to a first mixer 14. The first mixer also receives an input from a first local oscillator 16 which provides a signal at a first frequency F1. The first mixer 14 mixes the outputs of the second bandpass filter 46 with the output of the first local oscillator 16. Signals which are received by the antenna 2 and pass through the first and second bandpass filters 6 and 46 are at a radio frequency. By mixing the output of the second bandpass filter 46 with the output of the first local oscillator 16, the received signals are reduced to an intermediate frequency.

The output of the first mixer 14 is connected to the input of a third bandpass filter 18. The third bandpass filter 18 is tuned to the intermediate frequency of the desired signal. The third bandpass filter 18 has a much narrower bandwidth than the first and second bandpass filters 6 and 46. Accordingly, only the signal which is at the desired intermediate frequency is output by the third bandpass filter 18. The signals at the other intermediate frequencies are removed by the third bandpass filter 18.

The output of the third bandpass filter is input to a first mixing arrangement 48. For schematic purposes, the mixing arrangement 48 is shown as having two separate mixers. One mixer provides the I baseband component of the desired signal whilst the other mixer provides the Q baseband component of the desired signal. The first mixing arrangement 48 receives an input from a second oscillator 50 which provides a signal at the intermediate frequency to which the third bandpass filter 18 is tuned. The first mixer arrangement 48 thus mixes the desired signal at the intermediate frequency from the third bandpass filter 18 with a signal having the intermediate frequency. The output of the first mixing arrangement 48 therefore provides the desired signals at the baseband frequency.

The transmit processing path 44 will now be described. I and Q signals at the base band frequency are input to a second mixing arrangement 52. The second mixing arrangement 52 also receives an input from a further local oscillator 70. The signal received from the local oscillator 50 is at the intermediate frequency, for example 570MHz. By mixing the I and Q signals at the baseband frequency with the intermediate frequency from the further oscillator 70, an output is provided at the intermediate frequency.

The output of the second mixing arrangement 52 is input to a second amplifier 54 which amplifies the output of the second mixing arrangement 52. The output of the second amplifier 54 is input to a fourth bandpass filter 56 which removes any noise introduced by the second amplifier 54. Typically the fourth amplifier will have a bandwidth similar to that of the third bandpass filter. The output of the fourth bandpass filter 56 is input to a second mixer 58. The second mixer 58 also receives an input from the first local oscillator 16. The output of the fourth bandpass filter 56 is thus mixed by the second mixer 58 with the output from the first local oscillator 16 to provide a signal at the radio frequency. The signal will be in the range 1920-1980MHz.

The output of the second mixer 58 is input to a fifth bandpass filter 60 which removes any noise introduced by the second mixer 58. Again, the fifth bandpass filter 60 has a bandwidth similar to that of the third bandpass filter 18. The output of the fifth bandpass filter 60 is input to an amplifying arrangement 62 which amplifies the signals for transmission. Finally, the output of the amplifying arrangement 62 is input to a sixth bandpass filter 64 which removes any noise introduced by the amplifying arrangement 62. The output of the sixth bandpass filter is connected to the antenna 2 so that the signals can be transmitted. It should be appreciated that in practice the first and sixth bandpass filters 6 and 64 will define a duplex filter.

The diversity antenna 30 is connected to a second receive processing path 66. The second receive processing path 66 contains similar components to the first receive processing path 42. The diversity antenna 30 is also arranged to receive a number of signals within a given radio frequency range. It should be appreciated that the given radio frequency range may be the same as or different to that of the main antenna 2. The output of the diversity antenna 30 is connected to a seventh bandpass filter 32 which filters out any signals falling outside the given radio frequency range.

The output of the seventh bandpass filter 32 is connected to the input of a third amplifier 34 which amplifies the received signal. The output of the third amplifier 34 is connected to the input of an eighth bandpass filter 68 which filters out noise introduced by the third amplifier 34. The output of the eighth bandpass filter 68 is connected to the input of a third mixer 36. The third mixer 36 receives a signal from a third local oscillator 38. The output of the eighth bandpass filter 68 is mixed with the output of the third local oscillator 38 by the third mixer 36 to provide signals at intermediate frequencies. The output of the third mixer 36 is input to a ninth bandpass filter 22 which is tuned to the intermediate frequency of the desired signal, in a similar way to the third bandpass filter 18 of the first received processing path. The output of the ninth bandpass filter 22 thus provides the desired signal at the intermediate frequency to which that bandpass filter is tuned. The other undesired signals which are received at the same time are filtered out by the ninth bandpass filter 22. The output of the ninth bandpass filter 22 is connected to the input of a third mixing arrangement 70 which mixes the desired signal at the intermediate frequency with a signal received from a frequency divider 72. The frequency divider 72 receives the signal from the second local oscillator 50 and divides it by a factor of n to provide a signal which is at the same intermediate frequency of the signal which is output by the ninth bandpass filter 22. n may, but not necessarily be an integer. The third mixing arrangement 70 thus provides I and Q signals at the baseband frequency.

The relationship between the frequencies provided by the three local oscillators 16, 50 and 38 will now be described with reference to a specific example. The main antenna is arranged to receive signals within the range 2110-2170MHz and the first bandpass filter 6 is tuned to this range. The first local oscillator is arranged to provide signals at a frequency falling within the range 2490-2550MHz. The frequency of the first local oscillator 16 is selected so that the desired signal is always output from the first mixer 14 at the same intermediate frequency, regardless of the radio frequency of the desired signal. In the particular example, the desired signal output of the first mixer 14 will be at 380MHz. Accordingly, this is the frequency to which the third bandpass filter 18 is tuned.

In this example, the diversity antenna is arranged to receive signals falling within the range 2110-2170MHz and the third local oscillator 38 is arranged to provide signals within the range 2205-2265 MHz. Accordingly, the desired signal output by the third mixer 36 will be at the intermediate frequency of 95MHz. 95MHz is the frequency to which the ninth bandpass filter 22 is tuned. As with any of the other mixers, there is always a choice of two local oscillator frequencies which can be used to provide a given intermediate frequency. For example, the third local oscillator could alternatively provide frequencies in the range of 2015-2075 MHz to provide an intermediate frequency of 95MHz.

The second local oscillator 50 is thus arranged to provide a frequency of 380MHz. The 380MHz output of the second local oscillator 50 is input to the first mixing arrangement 48 to provide a baseband signal. The output of the second local oscillator 50 is also input to a frequency divider 72 which divides the frequency by four (n=4) to provide a 95MHz frequency signal which is input to the third mixing arrangement 70. In this way, the input to the third mixing arrangement 70 can be down converted to the baseband frequency.

The intermediate frequencies of the desired signals output by the first and third mixers 14 and 36 respectively are quite different. In this way, the problems of the prior art can be avoided.

In the preferred embodiment of the present invention, the first and third mixing arrangements 48 and 70 receive an input from a common local oscillator. However, in alternative embodiments of the present invention, separate local oscillators can be provided for the first and third mixing arrangements.

In an alternative to the example discussed hereinbefore, the main antenna 2 will also receive a signal falling outside the range 2110-2170MHz and these signals are eventually filtered out by the third bandpass filter 18. Likewise, the diversity antenna 30 will also receive signals falling outside the range 2110-2170MHz and those signals are eventually filtered out by the ninth bandpass filter 22.

The frequency of the signals provided by the first and third oscillators 16 and 38 should be carefully selected so that when the output of the third oscillator 38 is mixed with the signals output by the second bandpass filter 46, none of those signals are at the intermediate frequency of the desired signal, i.e. the frequency to which the third bandpass filter 18 is tuned. Likewise, when the output of the eighth bandpass filter 68 is mixed with the output of the first oscillator 16, it should be ensured that none of the signals are at the intermediate frequency of the desired signal i.e. the frequency to which the ninth bandpass filter 22 is tuned.

Additionally, embodiments of the present invention may also be advantageous from the point of view of the transmit side. In particular, if the second mixer 58 receives leakage signals from the third oscillator 38, the results of the mixing of the output of the fourth bandpass filter 56 with the leakage signals from the third oscillator should fall outside the bandwidth of the fifth bandpass filter 60. In the prior art described hereinbefore, the leakage signal would fall within the bandwidth of filter 60.

In the embodiment shown in Figure 3, a single intermediate frequency step is used in each of the received processing paths 42 and 66. However, in alternative embodiments of the present invention, two or more intermediate frequencies may be used. Accordingly, the radio frequency is reduced to a first intermediate frequency and then to a second lower intermediate frequency before being downconverted to the baseband frequency.

In the described embodiments of the present invention, the desired signals received by the two different antennae are at different frequencies. However, the desired signals may be at the same frequency. However, the respective intermediate frequencies would be different.

In some embodiments of the present invention, there may be two modes of operation, the first being the mode of operation described hereinbefore. In the second mode of operation, the two receive paths are arranged to receive the signals from one base station. The first and second signals from the respective antennae may be downconverted to the same or different frequencies. In this mode of operation, the first and third oscillators would provide the same frequency and the divider connected to the second oscillator would be bypassed.

In the embodiment described hereinbefore, the frequency provided by the first and third oscillators can be varied. In preferred embodiments of the present invention, the second oscillator is not required to be variable. However, in certain embodiments of the present invention, the second oscillator may be variable.

Embodiments of the present invention can also be used in situations where the main channel is used for communication with a base station whilst the diversity antenna is used to monitor the strength of signals from neighbouring base stations to assist in the making of hand-off decisions. With this arrangement, it is not necessary to interrupt the signal received in the main channel.

In some embodiments of the present invention, the two antenna may not receive signals at the same time so that at any given time, only one receive path is active.

In one modification to the embodiment described hereinbefore, the signal received from one antenna is converted to an intermediate frequency and then to a baseband frequency whilst the signal received by the other antenna is directly converted to the baseband frequency. In other words, with the signal received by the other antenna there is no conversion to an intermediate frequency.

The embodiment of the present invention has been described in the context of a receiver having two antennae. It should be appreciated that embodiments of the present invention may incorporate more than two antennae. The receiver could then use a different intermediate frequency for the signals received from the respective antennae. Alternatively, the same intermediate frequency can be used more than once but not in receive paths which are physically adjacent.

Embodiments of the present invention are applicable to any arrangement where at least two signals at different frequencies are arranged to be received by at least two different antenna and the processing paths are close enough that interference between the paths might arise.

Whilst embodiments of the present invention have been described in the context of a CDMA system, embodiments of the present invention are also applicable to other types of spread spectrum techniques.

Embodiments of the present invention may also be used in systems which use time division multiple access (TDMA), frequency division multiple access (FDMA), space division multiple access (SDMA) or hybrids of any of the access systems discussed.

Embodiments of the present invention can also be included in devices other than mobile stations. For example base stations or fixed stations may incorporate the present invention.

CLAIMS:

1. A receiver comprising:

a first input for receiving a first signal;

a first processing path coupled to the first input for processing said first signal;

a second input for receiving a second signal at a second different frequency; and

a second processing path coupled to said second input for processing said second signal,

each of said first and second paths comprising means for changing the frequency of the first and second signal to different frequencies, wherein the first and second signals are changed to different frequencies and the first and second input means are arranged to receive the first and second signals at the same time.

2. A receiver as claimed in claim 1, wherein said first said and second signals are received at different frequencies.

3. A receiver as claimed in claim 1, wherein said first said and second signals are received at the same frequency.

4. A receiver as claimed in claim 1, 2 or 3, wherein the first and second frequencies are reduced by said changing means.

5. A receiver as claimed in any preceding claim, wherein each of the changing means comprises mixing means for mixing the respective one of said first and second signals with a respective frequency signal from respective frequency sources.

6. A receiver as claimed in any of claims 1 to 5, wherein the first and second frequencies are radio frequencies.

7. A receiver as claimed in claim 6, wherein at least one of the changing means of the first and second receiving paths is arranged to down convert the frequency of the first and second

signals to an intermediate frequency.

8. A receiver as claimed in claim 7, wherein said changing means of said first and second processing paths are arranged to down convert the first and second signals to different intermediate frequencies.

9. A receiver as claimed in claim 8, wherein one intermediate frequency is a integral multiple of the other.

10. A receiver as claimed in claim 9, wherein further changing means are provided in each of said first and second processing paths for reducing the frequency of the signals at the intermediate frequency, said further changing means each comprising a mixer, each of said mixers receiving a mixing frequency from a common frequency source.

11. A receiver as claimed in claim 10, wherein the further changing means are arranged to reduce the intermediate frequencies to a baseband frequency.

12. A receiver as claimed in claim 10 or 11, wherein a frequency divider is provided for dividing the frequency from the common frequency source to provide the intermediate frequency of one of said frequency paths and the frequency of the common frequency source is the same as the frequency of the other intermediate frequency.

13. A receiver as claimed in claim 7, wherein one of said first and second paths is arranged to directly down convert one of the first or second signals to a base band frequency.

14. A receiver as claimed in any preceding claim, wherein said first input is coupled to a first antenna and said second input is coupled to a second different antenna.

15. A receiver as claimed in any one of the preceding claims,

wherein the receiver has a second mode of operation in which the first and second input means and the first and second processing paths are arranged to receive first and second signals respectively, said first and second signals being at the same frequency, the respective changing means being arranged in the second mode of operation to change the first and second frequencies to the same frequency.

16. A receiver as claimed in any one of the preceding claims wherein said receiver is arranged to receive and process code division multiple access signals.

17. A transceiver including a receiver as claimed in any preceding claim.

18. A mobile station including a receiver or transceiver as claimed in any preceding claim.

19. A receiver comprising:

a first receive arrangement comprising a first input for receiving a plurality of signals including a first desired signal and a first processing path coupled to said first input means for processing said plurality of signals; and

a second receive arrangement comprising a second input for receiving the plurality of signals including a second desired signal at a second, different frequency and a second processing path coupled to the second input for processing the plurality of signals,

each of said first and second paths comprises means for changing the frequencies of the signals received from the respective input so that in use the frequencies of the plurality of signals are changed to fall within first and second frequency ranges respectively, wherein the frequency changed first signal is outside said second frequency range and said frequency changed second signal is qutside said first frequency range.

20. A receiving method comprising the steps of:

receiving a first signal;

processing the first signal, said processing step comprising changing the frequency of the first signal to a different frequency;

receiving a second signal; and

processing the second signal, said processing step comprising changing the frequency of the second signal to a different frequency,

wherein the first and second signals are changed to different frequencies.

Fig.1.

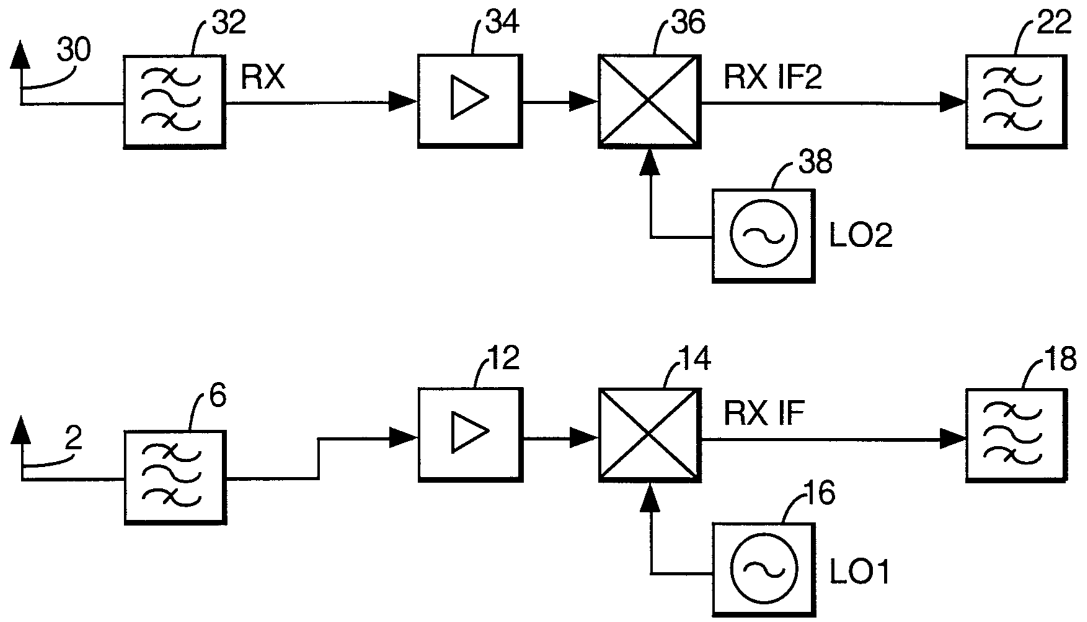

30
32
RX
34
36
RX IF2
22
38
LO2
2
6
12
14
RX IF
18
16
LO1

Fig.2.

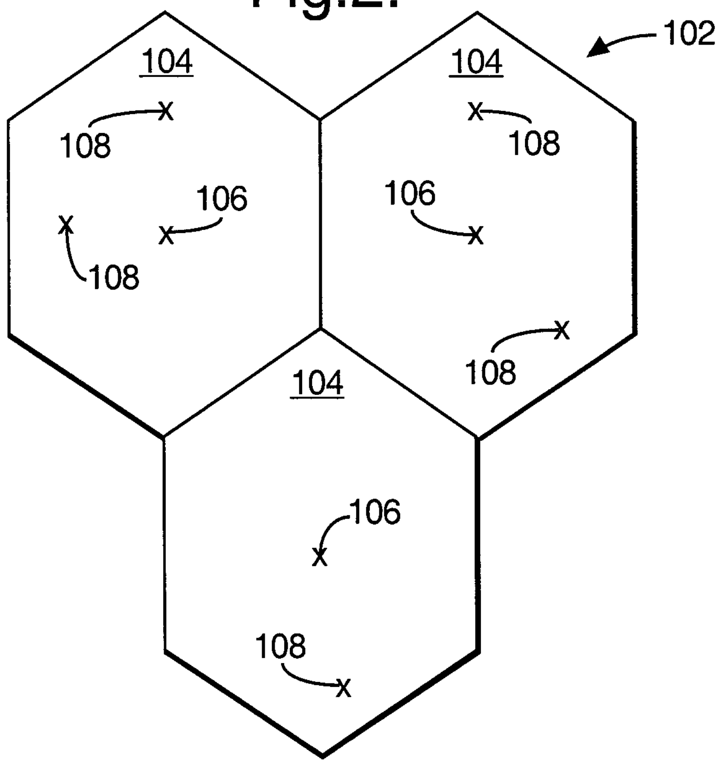
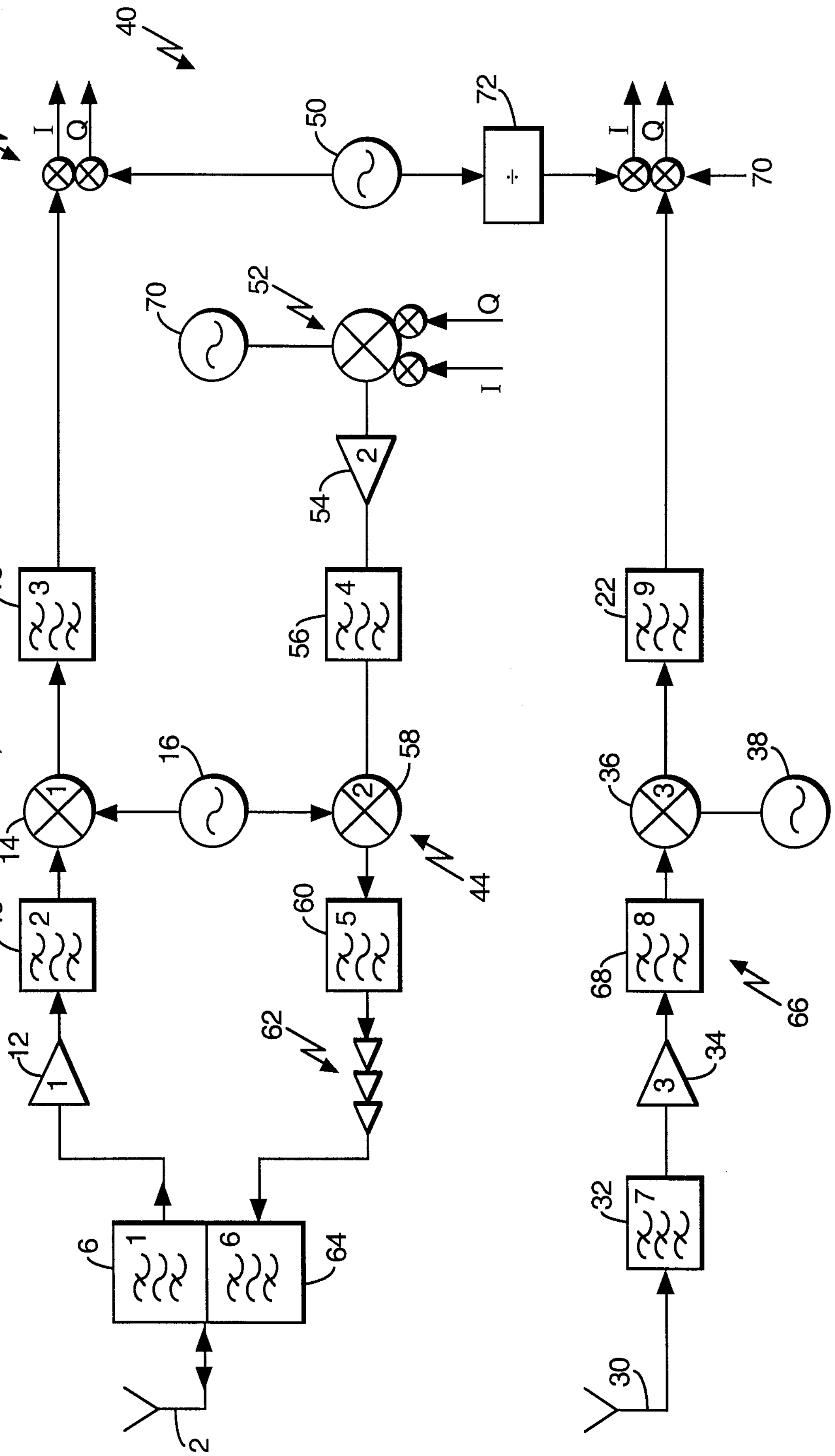

102
104
104
104
108
108
108
108
108
106
106
106

Fig.3.


40
48
I
Q
50
72
÷
I
Q
70
70
52
Q
I
54
2
18
3
56
4
22
9
42
1
16
58
2
14
36
3
38
46
2
60
5
44
68
8
66
62
12
1
34
3
6
1
6
64
32
7
2
30

INTERNATIONAL SEARCH REPORT

Inter   onal Application No
PCT/EP 99/03597

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04B7/08   H03D7/16   H04B7/12

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 6   H04B   H03D

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 practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 579 341 A (LAIRD KEVIN M ET AL) 26 November 1996 (1996-11-26) * abstract * column 4, line 13 - line 25 column 5, line 54 -column 6, line 20 claim 1; figures 2,6 ---	1,2,4-8, 14,19,20
X	US 4 856 080 A (HULKKO JAAKKO) 8 August 1989 (1989-08-08) * abstract * column 1, line 7 - line 38 column 2, line 58 -column 3, line 12 column 3, line 49 - line 59 claim 1; figure 3 --- -/--	1,2,4-8, 14,19,20

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in 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 document 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
21 October 1999	28/10/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lõpez Márquez, T

Form PCT/ISA/210 (second sheet) (July 1992)

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 739 090 A (NOKIA MOBILE PHONES LTD) 23 October 1996 (1996-10-23) * abstract * column 3, line 11 -column 5, line 4 column 5, line 55 -column 6, line 5 claim 1; figure 4 ---	1,2,4-8, 14,19,20
Y	EP 0 528 118 A (SMALL POWER COMMUNICATION SYST) 24 February 1993 (1993-02-24) column 1, line 31 - line 49 column 2, line 31 - line 52 column 5, line 37 - line 54 column 7, line 45 -column 8, line 7 claim 1; figures 1,4A,4B ---	1,2,4-8, 14,19,20
A	EP 0 305 604 A (PHILIPS NV) 8 March 1989 (1989-03-08) * abstract * column 2, line 27 - line 47 column 4, line 11 - line 30 column 4, line 44 -column 5, line 41 claim 1; figure 1 ---	1,2,19, 20
A	EP 0 782 249 A (LUCENT TECHNOLOGIES INC) 2 July 1997 (1997-07-02) * abstract * column 3, line 7 - line 32 column 5, line 17 - line 57 claim 1; figures 1,3 -----	1,2,19, 20

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter   ınal Application No
PCT/EP 99/03597

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5579341 A	26-11-1996	AU 686046 B	29-01-1998
		AU 4610696 A	24-07-1996
		AU 678124 B	15-05-1997
		AU 5294796 A	24-07-1996
		BR 9506911 A	16-09-1997
		BR 9510374 A	02-06-1998
		CA 2206311 A	11-07-1996
		CN 1142293 A	05-02-1997
		CN 1172566 A	04-02-1998
		DE 19581527 T	07-05-1997
		DE 19581876 T	27-11-1997
		EP 0800737 A	15-10-1997
		FI 963346 A	27-08-1996
		FI 972748 A	25-06-1997
		FR 2729026 A	05-07-1996
		FR 2738428 A	07-03-1997
		FR 2738429 A	07-03-1997
		GB 2301990 A,B	18-12-1996
		GB 2311916 A	08-10-1997
		IL 115823 A	06-12-1998
		JP 10512114 T	17-11-1998
		JP 10502513 T	03-03-1998
		PL 316636 A	03-02-1997
		SE 9603102 A	29-10-1996
		SE 9702156 A	29-08-1997
		TR 960822 A	21-10-1996
		US 5912927 A	15-06-1999
		WO 9621305 A	11-07-1996
		WO 9621288 A	11-07-1996
		US 5602874 A	11-02-1997
		US 5748683 A	05-05-1998
		US 5754597 A	19-05-1998
		US 5818883 A	06-10-1998
		US 5812605 A	22-09-1998
		US 5854813 A	29-12-1998
US 4856080 A	08-08-1989	FI 76227 B	31-05-1988
		AT 390701 B	25-06-1990
		CH 675041 A	15-08-1990
		DK 601987 A	19-05-1988
		NL 8702753 A	16-06-1988
		SE 466229 B	13-01-1992
		SE 8704306 A	19-05-1988
EP 0739090 A	23-10-1996	FI 951918 A	22-10-1996
		US 5822366 A	13-10-1998
EP 0528118 A	24-02-1993	JP 5102899 A	23-04-1993
		US 5369800 A	29-11-1994
EP 0305604 A	08-03-1989	AU 2179988 A	09-03-1989
		CA 1299249 A	21-04-1992
		DK 483988 A	04-03-1989
		FI 86677 B	15-06-1992
		JP 1072625 A	17-03-1989
		JP 2603700 B	23-04-1997
		KR 9615278 B	07-11-1996
		US 4903331 A	20-02-1990

INTERNATIONAL SEARCH REPORT

Information on patent family members

Inter' 'nal Application No
PCT/EP 99/03597

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0782249 A	02-07-1997	CA 2190545 A	27-06-1997
		JP 9214385 A	15-08-1997

Form PCT/ISA/210 (patent family annex) (July 1992)