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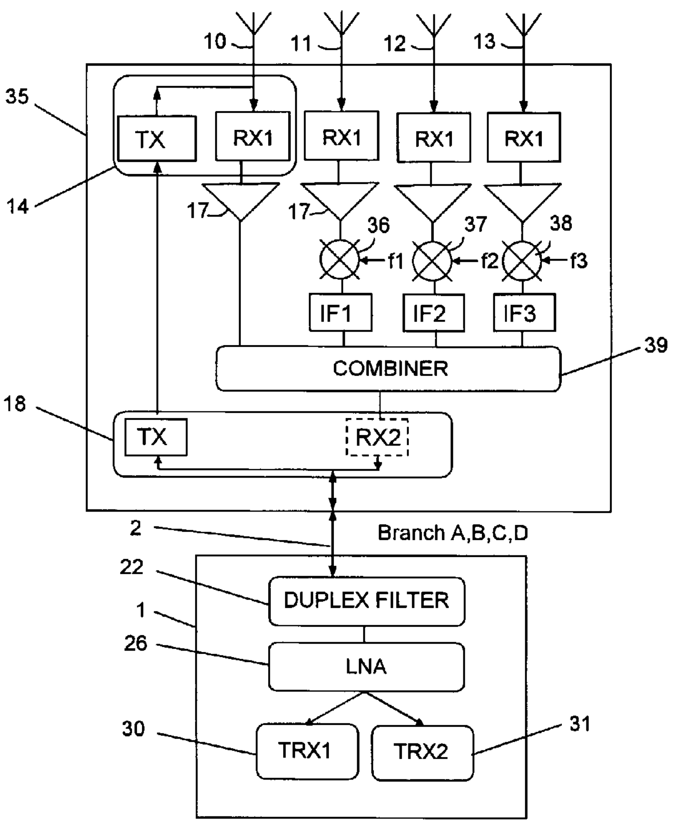
(54) Title: METHOD, DEVICE, BASE STATION AND SITE FOR REDUCING THE NUMBER OF FEEDERS IN AN ANTENNA DIVERSITY DIVERSITY SYSTEM.



(57) Abstract: A method, device and system for reducing the number of feeders (2, 3) between a radio base station (1) and an antenna diversity arrangement (10, 11, 12, 13) at which RF signals of the same frequency are received. In a tower mounted amplifier (45) individual RF signals from some or all of the antennas are frequency converted into intermediate frequency (IF) signals on mutually different intermediate frequencies which are combined and forwarded to the radio base station on a reduced number of feeders. In the radio base station the combined signal is split into individual signals amongst which the IF signals are frequency transformed to a signal suitable for diversity processing.

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TITLE

An antenna diversity system

TECHNICAL FIELD OF THE INVENTION

The invention generally relates to tower-mounted amplifiers (TMA) and antenna diversity. In particular the invention relates to a method and arrangement for reducing the number of feeders from an antenna diversity system to a radio base station.

DESCRIPTION OF RELATED ART

Antenna diversity is used in order to improve reception (or transmission) of transmitted radio signals. There are many kinds of diversity, such as time diversity, space diversity, polarisation diversity and combinations thereof. Space and polarisation diversity reduces the effects of fading received radio signals.

An antenna diversity systems comprises at least two antennas arranged at a distance from each other or with different polarisation. In case of receive diversity the signal (RX signal) from a distant transmitter is received on the two or more antennas. In case of transmitter diversity the transmit signal (TX signal) is transmitted on the two or more transmit antennas to which the transmitter is connected. In the following the antennas of a diversity arrangement are called diversity antennas. It is possible to send and receive on the same antenna by connecting a duplex filter to the antenna, the duplex filter separating the TX and RX signals from each other. Signals are transported between an antenna and a transceiver (TRX) on a feeder. In prior art diversity arrangements a feeder and its associated antenna is referred to as a diversity branch or simply branch. In the context of the present invention a diversity branch comprises a diversity antenna and the devices the signal received on this antenna passes.

In the following diversity in connection with reception will be discussed. The RX signals from the diversity antennas are subjected to diversity processing in order to obtain an enhanced signal. Diversity processing may for example be to select the antenna signal which is strongest, or to add the signals and further process the resulting signal.

Each RF signal received at an diversity antenna arrangement is connected to respective tower-mounted amplifiers (TMAs) from which the amplified signal is transported in an individual diversity branch containing a feeder, typically a coaxial cable, which is connected to a transceiver TRX in the radio base station. Several branches are connected to one TRX. The TRX may be provided with a diversity receiver for demodulation and diversity signal processing.

A tower mounted unit is sometimes called a mast head amplifier. It should be noted that these units need not be mounted in a tower, but may be mounted on poles, walls of buildings, building roofs etc. The same goes for the diversity antennas. The invention is therefore not restricted to amplifiers mounted in towers. A tower mounted amplifier (TMA) is just a name under which a device of this kind is known to the man skilled in the art.

Fig. 1 discloses a prior art site comprising a radio base station (RBS) 1, feeders 2-5 extending between the radio base station and TMAs 6-9. Each TMA is connected to a respective diversity antenna 10-13. The TMAs are all identical and in the following reference is therefore only made to TMA 6. The antenna 10 is connected to a duplex filter 14 comprising a transmitter part (TX) 15 and a receiver part (RX) 16. An RF amplifier 17 amplifies the received filtered RX signal and supplies it to another duplex filter 18 which comprises a transmitter part (TX) 19 and a receiver part (RX) 20. receiver part (RX) 20.The function of a duplex filter is to separate the TX signal from the RX signal and prevent the TX signal from leaking over into the receiving chain 21. Signals received on antenna 10, 11, 12 and 13 respectively and processed in TMA 6, 7, 8 and 9 respectively follow a diversity branch A, B, C and D respectively.

The radio base station 1 comprises duplex filters 22-25 and low noise amplifiers 26-29 (LNA), one for each TMA. The heart of the radio base station is the transceiver units 30, 31 (TRX1, TRX2). Depending on the capabilities a transceiver has and the traffic capacity a radio base station is designed for, there may be just one TRX or many more transceivers than the two shown.

The arrangement shown in Fig. 1 is called 4 way diversity with 4 feeders.

In Fig. 2 a frequency spectrum illustrating the range of frequencies that can pass through the RX filter 22, this range being the full RX band 32 allotted the service. The radio channel on which the RX signal to a transceiver is received and the TX signal is transmitted from the same transceiver is called a user channel. Since there are two transceivers shown in Fig. 2 there are two user channels, each shown with a small rectangle. The frequency band the user channels occupy is called a user band and this is indicated at brace 33. In each one of the four branches a respective user band is present and it is the same (in terms of kHz) in all branches. A feeder, however, is capable to transport signals on all the frequencies up to several GHz including the full RX band 32. It is thus apparent that the feeder in each branch is utilized with poor efficiency.

In principle one TRX is sufficient to diversity process the four RX signals and obtain the enhanced RX signal. A radio base station is however designed to handle large traffic volumes and therefore, and also for safety reasons, it comprises many TRXes. The output of each LNA is for this reason connected to all transceivers of the radio base station, as is shown by the various arrows, collectively shown at 34.

US 6,505 014 discloses a base station with an antenna diversity system connected to a multi coupler from which the antenna signals are fed to the respective receivers in individual feeders.

A drawback with the prior art is that each branch requires its own feeder. A diversity antenna system with many antennas will thus require as many feeders as there are antennas. Feeders are expensive. They are also heavy. Antennas are less expensive. Therefore, systems comprising many diversity antennas are prohibitive from economical point of view although they would be beneficial from reception quality point of view.

SUMMARY OF THE INVENTION

One object of the invention is to reduce the number of feeders compared with prior art and provide a method device, radio base station and system in accordance with claims 1, 7, 11 and 12.

A characteristic feature of the invention is to move/frequency translate an RX signal received on one diversity antenna to a non used frequency and to consolidate/combine the frequency translated signal with an RX signal, that has not been frequency translated, and to forward the resulting composite signal on a single feeder to the radio base station.

Depending on the radio system in which the invention is used the meaning of "frequency" and "signal frequency" may be different. A preferred implementation of the invention is cellular mobile radio systems such as WCDMA, GSM, AMPS, NMT. The bandwidth of an WCDMA signal is 5 MHz, in GSM 200 kHz, in AMPS 30 kHz and in NMT 25 kHz. It is the signal with these respective bandwidths that is frequency translated to another non-used (by this RBS) part of the frequency band. In WCDMA the 5 MHz signal comprises voice and/or data from several users, in the GSM system the 200 kHz signal comprises voice and/or data from up to eight (8) users, in AMPS and NMT the 30 and 25 kHz signals comprise voice and/or data from one (1) user. Thus, in practice, the signal frequency is a frequency band.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1. is a block diagram of a prior art 4 way diversity system

Fig. 2. is a frequency diagram illustrating the prior art diversity system of Fig. 1,

Fig. 3. is a block diagram of a first embodiment of a 4 way diversity system in accordance with the invention,

Fig. 4. is a frequency diagram illustrating the first embodiment of the invention,

Fig. 5. is a block diagram of a second embodiment of a 4 way diversity system in accordance with the invention, and

Fig. 6. is a frequency diagram illustrating the second embodiment of the invention,

Fig. 7. is a block diagram of a third embodiment of the invention,

Fig. 8. is a frequency diagram illustrating the third embodiment of the invention,

Fig. 9. is a modification of the first embodiment,

Fig. 10. is a frequency diagram associated with modification in Fig.9,

Fig. 11. is a block diagram of a fourth embodiment of the invention,

Fig. 12. is a frequency diagram illustrating the fourth embodiment,

Fig. 13. is a block diagram of a fifth embodiment comprising a separate frequency converter unit, and

Fig. 14. is a frequency diagram associated with the frequency converter unit.

DETAILED DESCRIPTION OF EMBODIMENTS

Fig. 3 illustrates an embodiment of the invention. Elements similar to those in Figs. 1 and 2 bear the same reference designations. A novel tower mounted amplifier 35 comprises frequency converters 36,37, 38, each one connected to a respective antenna 11, 12 and 13 in order to move the frequency of the received RF antenna signal to a respective non-used frequency by mixing the RF antenna signal with a respective reference signal f1, f2, and f3 of a predetermined frequency. The signal received on antenna 10 is not moved in frequency. The reference signal may be a continuous wave signal, CW signal, a signal from a local oscillator or any equivalent.

The reference signal does not occupy a frequency band. Accordingly, the signal definition given above does not apply to the reference signal. A frequency converter is a device which as input receive the RX antenna signal and mixes it with the reference signal in order to obtain a frequency translated signal on an intermediate frequency (IF). The output of each frequency converter is connected to a respective band pass filter IF1, IF2 and IF3. The amplified non-converted, original, radio signal received on antenna 10 in diversity branch A, and each IF signal in the respective branches B, C and D enters a combiner 39 wherein they are combined into a composite signal which is passed to a band pass filter RX2 in duplex filter 18. The duplex filter is connected to feeder 2. Accordingly the composite signal comprising the signals in the respective diversity branches A-D is forwarded to the radio base station 1 on a single feeder.

Filter IF1 prevents IF signals from converters 37 and 38 to leak into diversity branch B. Filters IF2 and IF3 have similar functions.

Fig 4 is associated with Fig. 3 and is a frequency spectrum illustrating signals at different locations in the TMA and in the feeder. The user band is shown at 33 and the three intermediate frequencies are shown at 40, 41 and 42. This time the feeder is utilized with three times the efficiency provided with the prior art arrangement shown in Figs. 1 and 2.

In the shown embodiment the received radio signals are up converted to IF frequencies above the user band 33. The IF frequencies are mutually different, i.e. the three IF signals at the output of the frequency converters lie at different IF frequencies.

The frequency range passed by filters RX1 is shown at 43. The frequency range passed by filter RX2 is denoted the full RX band. Note that the IF frequencies must fall within a non-used part of the full RX band. In the shown embodiment the up converted IF signals should fall to the right of the frequency range 43 passed by filters RX1. In a situation where the frequency range 43 falls more to the right in Fig. 4, as shown by the dashed brace 44 the IF signals should fall to the left of the dashed brace in order not to interfere with the user band 33. The RX signals are thus down converted to an IF below the user band 33. Situations may occur in which the IF signals fall on either side of the user band.

The arrangement in Fig. 3 provides 4 way diversity with 1 feeder.

At the radio base station the signals carried by the feeder pass the duplex filter 22, the low noise amplifier 26 and enter the transceiver 30 in which they are split into four RX chains. The signals associated with diversity branches B, C and D are frequency converted. The signals in each of the diversity branches A-D are subjected to diversity processing. Diversity processing may take place in a diversity receiver.

The arrangement shown in Fig. 5 is similar to Fig. 3, but this time the tower mounted amplifier 45 comprises only one frequency converter 36. In combiner 39 the original signal in diversity branch A is combined with the IF signal in branch B into a composite signal which is forwarded to the radio base station on the single feeder 2. This arrangement provides 2 way diversity with 1 feeder. The frequency spectrum in the single feeder 2 is shown in Fig. 6.

An arrangement providing 4 way diversity with 2 feeders is shown in Fig. 7. This arrangement is achieved by doubling the arrangement shown in Fig. 5 and uses two TMAs 45. The feeders 2, 4 from the two TMAs are connected to a respective duplex filter in the radio base station. As indicated above it is in principle possible to use one TRX only, but in practice the radio base station comprises several transceivers. It should be understood that both feeders 2 and 4 carry the same two user bands 33 and the same intermediary frequencies 40-42 The frequency diagram shown in Fig. 8 is thus identical for the two feeders.

An advantage with the TMA embodiments in which the direct antenna signal is consolidated with the IF signals and the resulting composite signal is forwarded on a single feeder to the radio base station is that the existing radio base stations need not be modified, since they already comprise frequency converters by which the IF signals plus the direct RF signals are transformed into the second IF frequency.

With the arrangement in accordance with the invention is achieved that the diversity signals are forwarded to the radio base station on a reduced number of feeders as compared to prior art where there are as many feeders as diversity antennas and each diversity signal is forwarded on a feeder of its own.

Fig. 9 illustrates a modification of the embodiment shown in Fig. 3 wherein all antenna signals are frequency converted. An additional frequency converter 46 is used and is inserted in diversity branch A of antenna 10. In this embodiment four IF signals are consolidated into composite signal which is forwarded to the radio base station on the single feeder 2. This provides 4 way diversity on 1 feeder. In this embodiment the radio base station comprises only one duplex filter, one low noise amplifier and one transceiver, although this has not been shown in the drawing. Since only one transceiver is used, only one user channel is used on the user band and therefore there no double rectangles are shown in the frequency diagram in Fig. 10. In this embodiment the signals passed by filters RX1 may be on a level of some GHz (10^9), and the IF signals on the feeder on a level of some MHz (10^7). The reference frequencies f1-f4 fall in a frequency range in-between.

A modification of the arrangements shown in Figs. 5 and 7 is to frequency convert all diversity antenna signals and use an additional frequency converter similar to frequency converter 46 in the embodiment of Fig. 9.

In Fig. 11 the RX signals the signals on antennas 11, 12 and 13 are subjected to a first frequency translation in frequency converters 36, 37, 38 (f1, f2, f3 could be on the same frequency, but in that case f5, f6, f7 must have different frequencies) which are connected to filters IF1, IF2 and IF3. The RX signal on antenna 10, however, is not subjected to any frequency translation in the TMA. A feature of the Fig. 11 embodiment is that the frequency translated IF signals on the outputs of filters IF1, IF2 and IF3 are subjected to a second frequency translation in frequency converters 47, 48, 49 by mixing them with a second set of reference signals f5, f6 and f7 and filter the resulting signals in IF filters RX3, RX4 and RX5 connected to the frequency converters 47-49. The direct, original, antenna signal passes filter RX1 in the duplex filter 14, the low noise amplifier 17 and a second filter RX1, similar to RX1 in the duplex filter 14 and is combined, in combiner 39, with the twice frequency converted signals at the output of filters RX3-RX5. The composite signal in all diversity branches is forwarded on the single feeder 2 to the radio base station.

The reference signals f5-f7 are so selected that the signals at the output of filters RX3-RX5 fall on frequencies, shown at brace 50 in Fig.12, adjacent to the frequency, shown at brace 51, of the filtered direct signal. This embodiment allows for use of SAW (surface acoustic wave) filters IF1-IF4 with steep characteristics and accurate pass band frequencies.

Fig. 13 illustrates an embodiment comprising a frequency converter unit 52 connected between the tower-mounted amplifier 35 and the radio base station 1. The frequency converter unit is used together with radio base stations that do not have a sufficient amount of frequency converters to frequency convert the split up signals into one and the same frequency so as to provide for diversity processing of the split up signals.

In Fig. 13 the TMA 35 is similar to the one shown in Fig. 9 but the notations used for filters and reference frequencies differ. The composite signal comprising the IF signals on the different IF frequencies are fed to the frequency converter unit 52 on the single feeder 2.

The frequency converter unit 52 comprises a duplex filter 53 with a filter TX and a filter 54 (RX2-5). The duplex filter is connected to frequency converters 55-58 of which 55 is connected to a duplex filter 59 and 56-58 are connected to a respective filter 60-62. The RX filter of the duplex filter 59 and filters 60-62 are all similar to filters RX1 in TMA 35. The reference signals f5-f8 are selected so that the resulting frequency converted signals at the outputs of the frequency converters 55-58 all are of the same frequency. The filtered frequency converted signals appear at the outputs of the frequency converter unit and are adapted for diversity processing.

A frequency diagram of the signals appearing in the feeder and the frequency converter unit 52 is shown in Fig. 14. The frequency diagram for the composite signal in feeder 2 is the same as the one shown in Fig. 9. Note that the RX1 signal in the diagram illustrates the four output signals from the frequency converter unit.

Although not shown in the drawings it should be understood that a non-shown noise reducing filter is inserted after the low noise amplifier 17 in diversity branch A, that is the branch carrying the original, non-frequency translated RX signal.

In many of the above described embodiments of the invention the filter RX2 and RX2-5 respectively may be omitted provided the RX 2- RX 5 filters at the outputs of the frequency converters prevent their respective signals from leaking over into an adjoining diversity branch.

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CLAIMS

1. A method for reducing the number of feeders between a radio base station (1) and a diversity antenna arrangement comprising at least two antennas (10-13) each adapted for reception of individual RF signals, said RF signals all being at the same frequency **characterized by** converting one or more received antenna signals into a corresponding number of IF (intermediate frequency) signals by mixing with a first set of a corresponding number of reference signals (f1-f4), and forwarding one of the IF signals together with either a non-converted, original, antenna signal and/or with other converted IF signals to the base station on a reduced number of feeders (2, 4).

2. A method in accordance with claim 1 wherein the diversity antenna arrangement comprises n (n=integer) antennas **characterized by** converting all received antenna signals except one into IF signals and forwarding the non-converted antenna signal together with all IF signals to the radio base station on a single feeder, thus providing n-way diversity with one (a single) feeder.

3. A method in accordance with claim 1 wherein the diversity antenna arrangement comprises n (n=integer) antennas **characterized by** converting all received antenna signals and forwarding them to the radio base station on a single feeder thus providing n-way diversity with one (a single) feeder.

4. A method in accordance with claim 1, **characterized by** converting the IF signals to second IF frequencies by mixing them with a second set of reference signals (f5-f7) in order to obtain a second set of IF signals which are forwarded on the reduced number of feeders.

5. A method in accordance with claim 1 wherein the diversity antenna arrangement comprises a first (10) and a second (11) antenna **characterized by** converting the antenna signal on the second antenna into an IF signal and forwarding the IF signal together with the non-converted antenna signal on the first antenna to the radio base station on a single feeder (2) , thus providing 2-way diversity with one (a single) feeder.

6. A method in accordance with claim 1 wherein the diversity antenna arrangement comprises a first (10), second (11), third (12) and fourth (13) antenna **characterized by** converting the RF signals from the second and

fourth antennas into a first and second IF signals, both of the same intermediate frequency, forwarding the non-converted antenna signal on the first antenna together with the first IF signal on a first feeder to the base station, and forwarding the non-converted antenna signal on the third antenna together with the second IF signal on a second feeder to the base station, thus providing 4 way diversity with two feeders (2, 4).

7. A method in accordance with any of claims 1 to 5 **characterized by** converting, at the radio base station, the IF signals into other IF signals, all on the same intermediate frequency, by mixing them with a set of reference signals (f5-f8) and subjecting the twice frequency converted signals on the common intermediate frequency to diversity signal processing.

8. A device for reducing the number of feeders between a radio base station (1) and a diversity antenna arrangement comprising at least two diversity antennas (10-13) each adapted for reception of individual RF signals, said RF signals all being of the same frequency **characterized by** one or more frequency converters (36-38) each adapted to convert a respective antenna signal to a respective intermediate frequency signal (IF signal) by mixing it with a predetermined frequency (f1, f2, f3 or f4), a combiner (39) combining one of the IF signals with either a non-converted antenna signal and/or with other of the IF signals to form a composite signal which is forwarded to the radio base station on a reduced number of feeders (2, 4).

9. A device in accordance with claim 8, wherein an RX signal from a diversity antenna follows a diversity branch (A-D) **characterized by** providing a frequency converter (36-38) in each diversity branch except one.

10. A device in accordance with claim 8 , wherein an RX signal from a diversity antenna follows a diversity branch (A-D) **characterized by** providing a frequency converter (46, 36-38) in each diversity branch

11. A device in accordance with claim 7, **characterized by** a second set of frequency converters (47-49) adapted to convert the first set of IF signals into a second set of IF signals for transport to the radio base station on the reduced number of feeders.

12. A device in accordance with claim 7 or 8 wherein there are two diversity antennas (10, 11), one (10) of which is connected to a first duplex filter (14) so as to provide for reception and transmitting **characterized by** a single frequency converter (36) converting the antenna signal from the second antenna (11) to an intermediate frequency to form an IF signal, the combiner (39) combining the original RX signal from the first antenna (10) with the IF signal into a composite signal, and a single feeder (2) forwarding the composite signal to the base station, thus providing 2-way diversity with one (a single) feeder (2).

13. A device in accordance with claim 9 **characterized by** duplicating the device in order to provide a device comprising four antennas (10-13) and two feeders (2,4), thus providing 4-way diversity with two feeders.

14. A frequency converter unit for use with at least one feeder (2) on which a plurality of signals at mutually different frequencies are transported, **characterized by** a corresponding plurality of frequency converters (55-58) for converting the signals into a corresponding number of signals all at the same frequency (RX1).

15. A radio base station comprising a transceiver (TRX) with a plurality of frequency converters adapted to provide frequency translated signals, called diversity signals, all at the same frequency and means for signal processing the diversity signals in order to obtain an enhanced signal **characterized by** means connected to the input of the transceiver and adapted to receive from one feeder at least one intermediate frequency signal (IF signal) together with either a non-frequency translated RF antenna signal and/or other converted IF signals, and to supply said latter signals to respective ones of said frequency converters so as to provide said diversity signals.

16. A site comprising a radio base station (RBS), at least a tower-mounted unit (TMA) with filters (14) and RF amplifiers (17), at least two antennas (10-13) for providing diversity, and at least a feeder (2, 4) extending between the TMA and the RBS for exchange of RX and TX signals, the signals received by the antennas being RF signals which all are of the same RX frequency **characterized by** at least one frequency converter (36-38) provided in the TMA

and connected to one of the diversity antennas in order to convert the antenna's RF signal into an IF signal at a non-used frequency, and a combiner (39) combining the IF signal with either a non-converted RF antenna signal and/or other converted IF signals into a composite signal which is applied to said feeder, thereby providing a reduced number of feeders.

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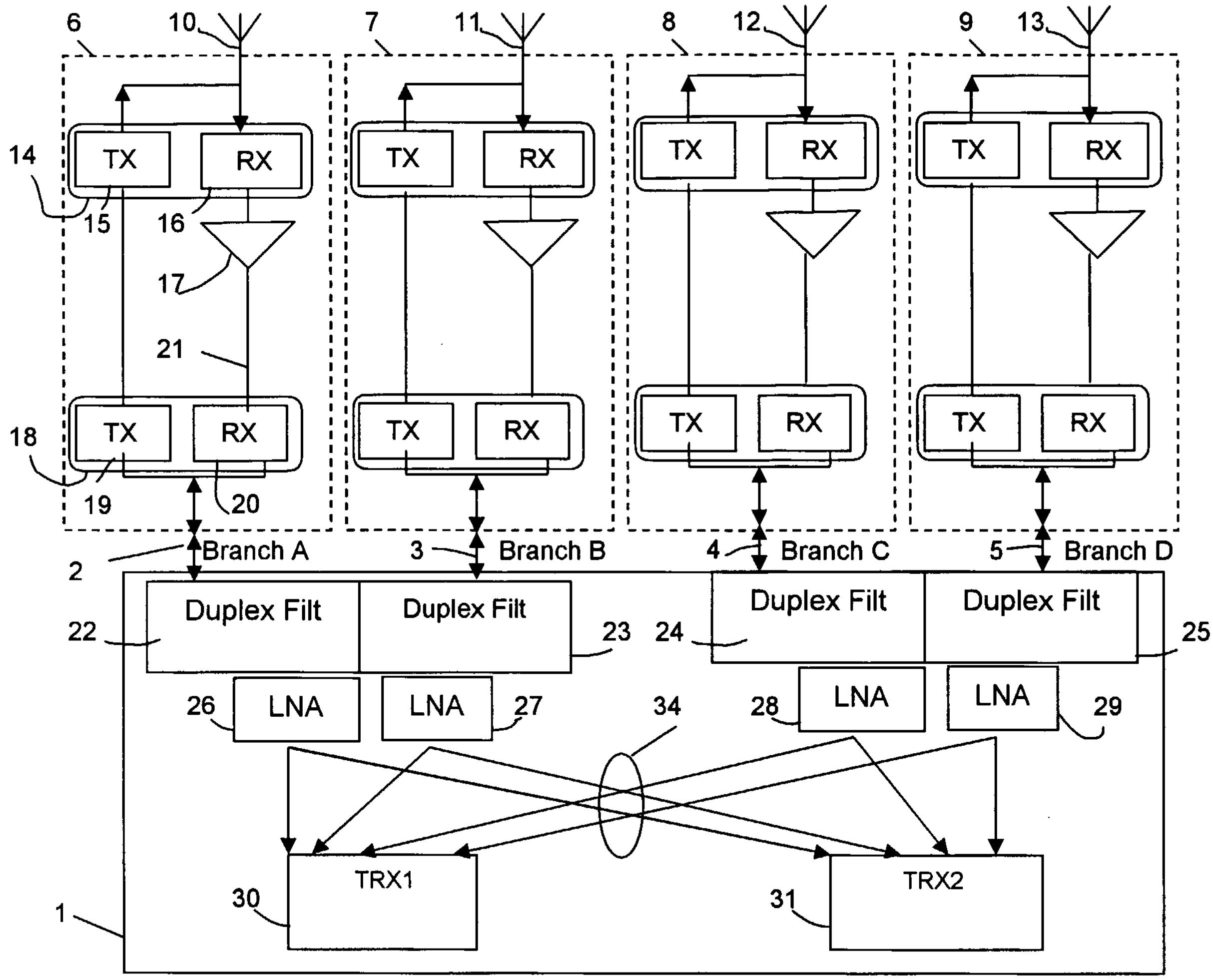

6
10
7
11
8
12
9
13
14
TX
RX
15
16
17
21
18
19
20
Branch A
Branch B
Branch C
Branch D
2
3
4
5
Duplex Filt
Duplex Filt
Duplex Filt
Duplex Filt
22
23
24
25
LNA
LNA
LNA
LNA
26
27
28
29
34
TRX1
TRX2
30
31
1

FIG 1

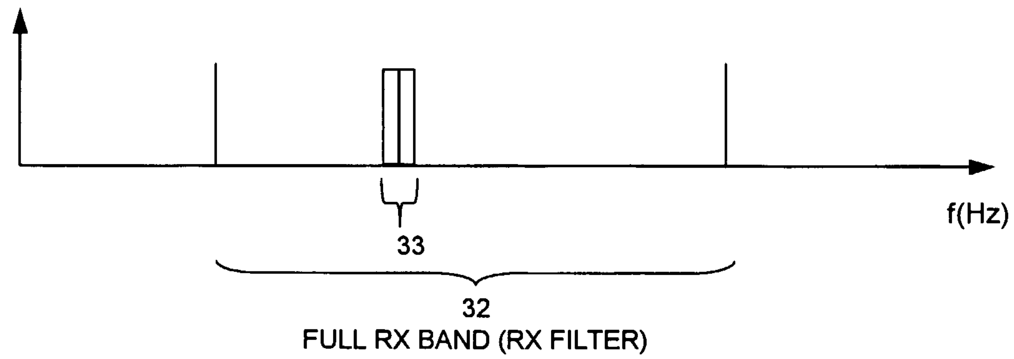

f(Hz)
33
32
FULL RX BAND (RX FILTER)

FIG 2

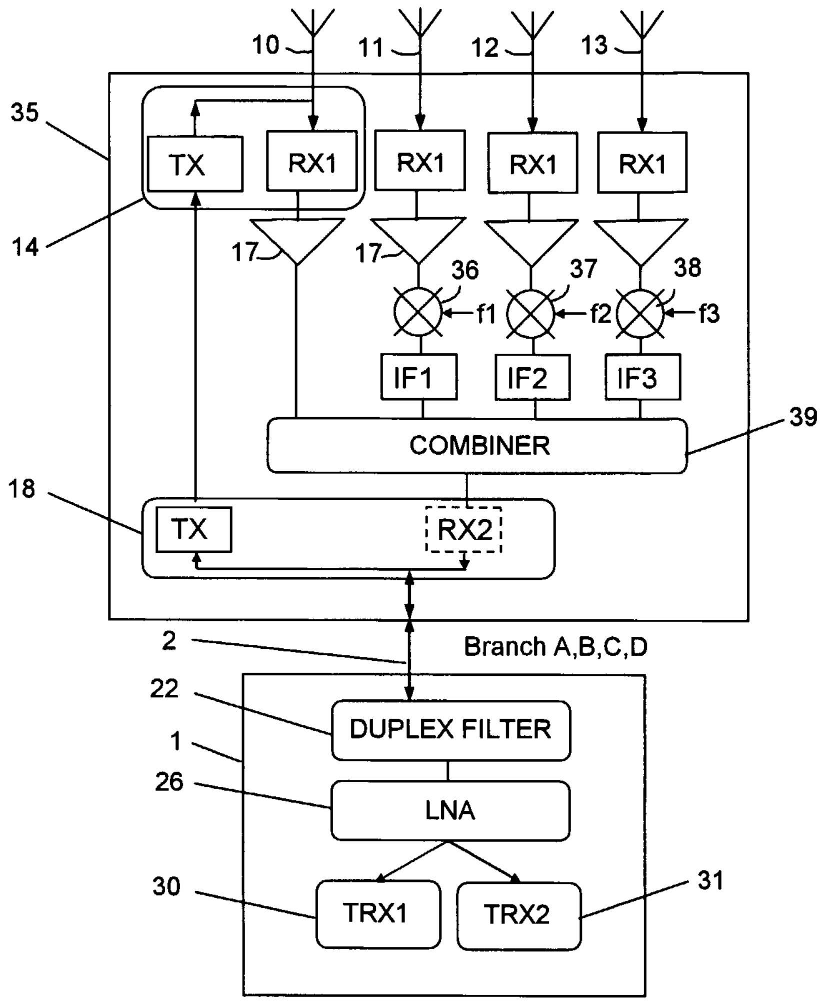

10
11
12
13
35
TX
RX1
RX1
RX1
RX1
14
17
17
36
37
38
f1
f2
f3
IF1
IF2
IF3
COMBINER
39
18
TX
RX2
2
Branch A,B,C,D
22
DUPLEX FILTER
1
26
LNA
30
TRX1
TRX2
31

FIG 3

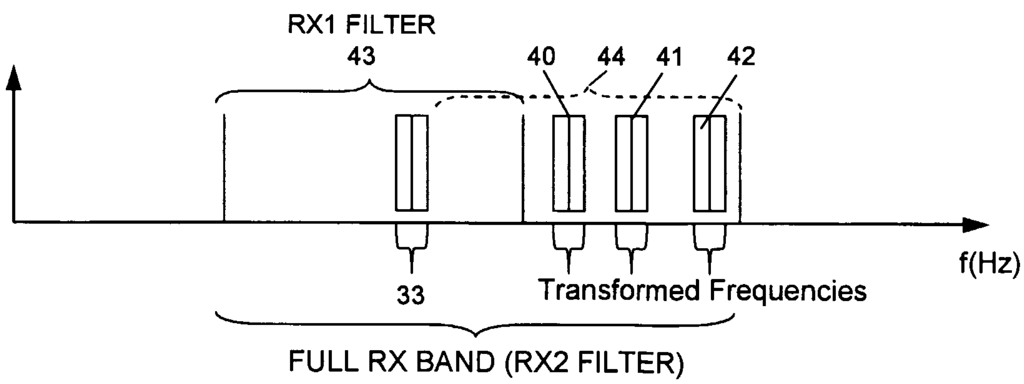
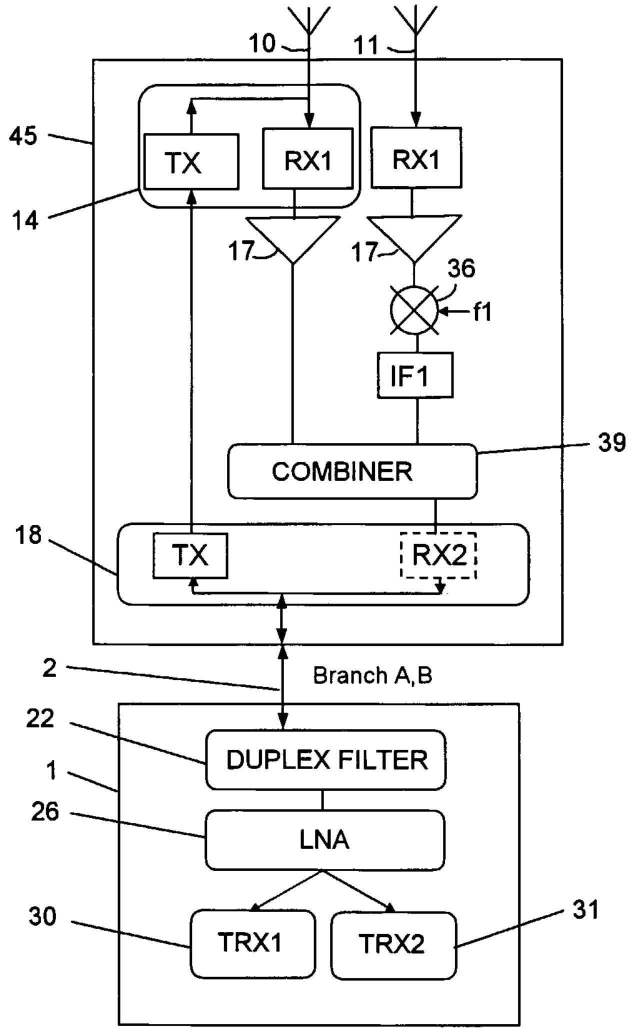

RX1 FILTER
43
40
44
41
42
33
Transformed Frequencies
f(Hz)
FULL RX BAND (RX2 FILTER)

FIG 4


10
11
45
TX
RX1
RX1
14
17
17
36
f1
IF1
COMBINER
39
18
TX
RX2
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Branch A,B
22
DUPLEX FILTER
1
26
LNA
30
TRX1
TRX2
31

FIG 5

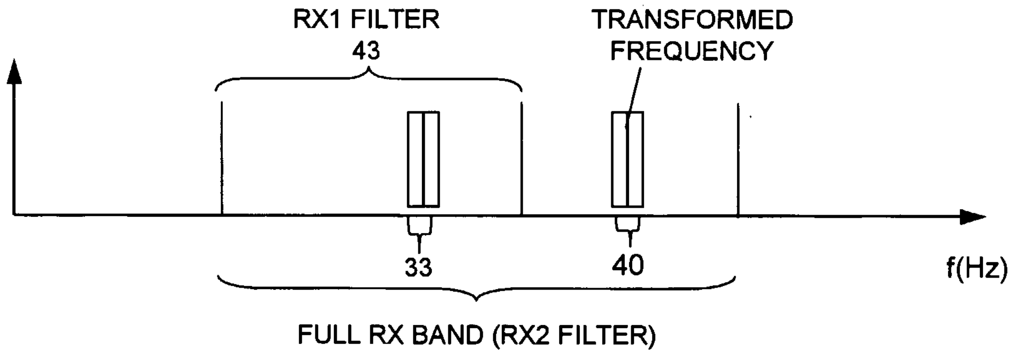
RX1 FILTER
43
TRANSFORMED
FREQUENCY
33
40
f(Hz)
FULL RX BAND (RX2 FILTER)

FIG 6

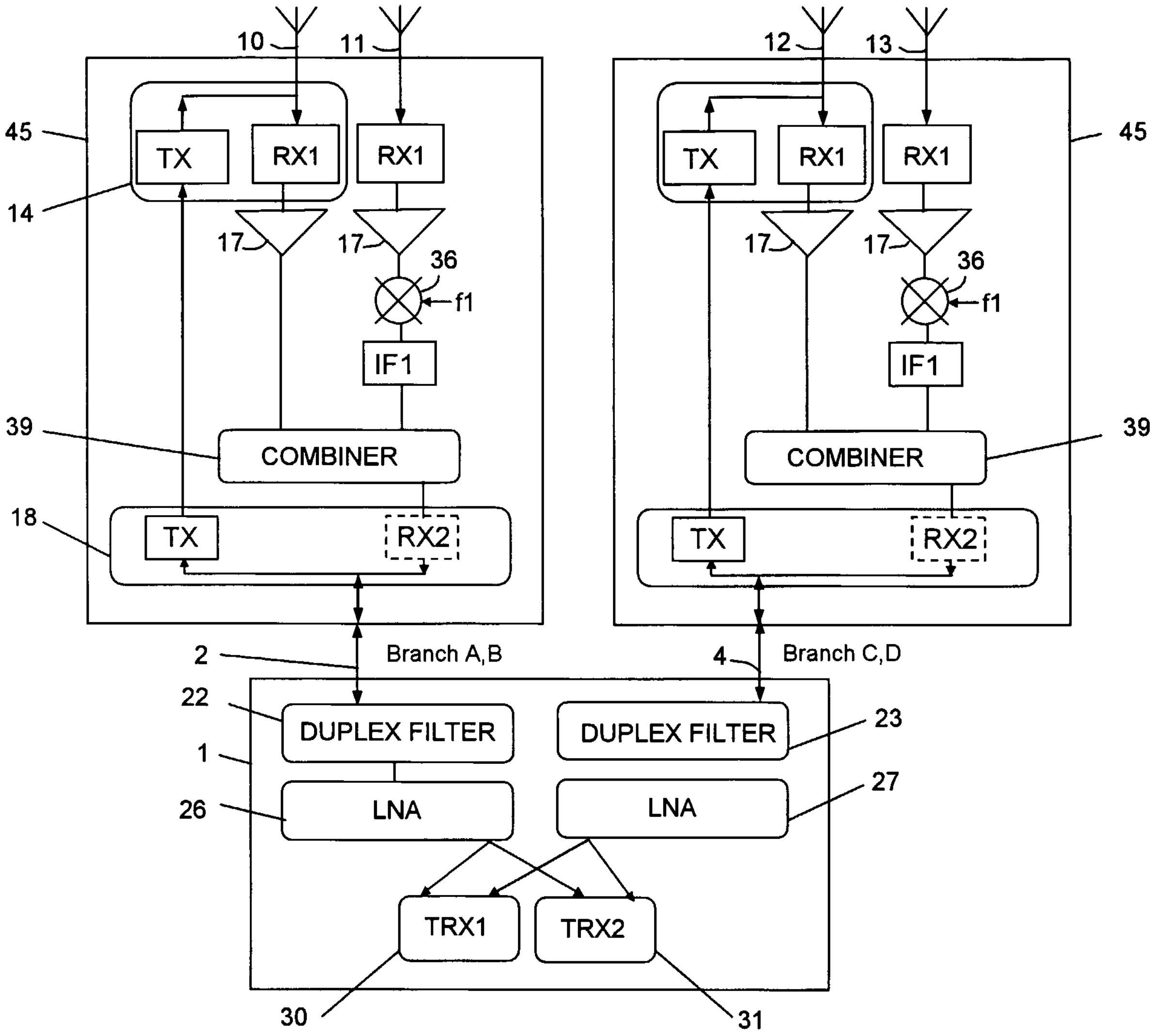
10
11
12
13
45
45
TX
RX1
RX1
TX
RX1
RX1
14
17
17
17
17
36
36
f1
f1
IF1
IF1
39
39
COMBINER
COMBINER
18
TX
RX2
TX
RX2
2
Branch A,B
4
Branch C,D
22
DUPLEX FILTER
DUPLEX FILTER
23
1
LNA
LNA
26
27
TRX1
TRX2
30
31

FIG 7

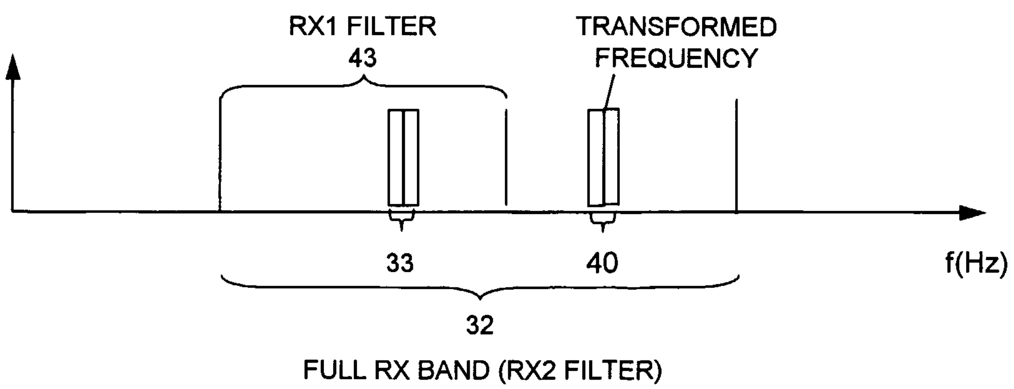
RX1 FILTER
43
TRANSFORMED
FREQUENCY
33
40
f(Hz)
32
FULL RX BAND (RX2 FILTER)

FIG 8

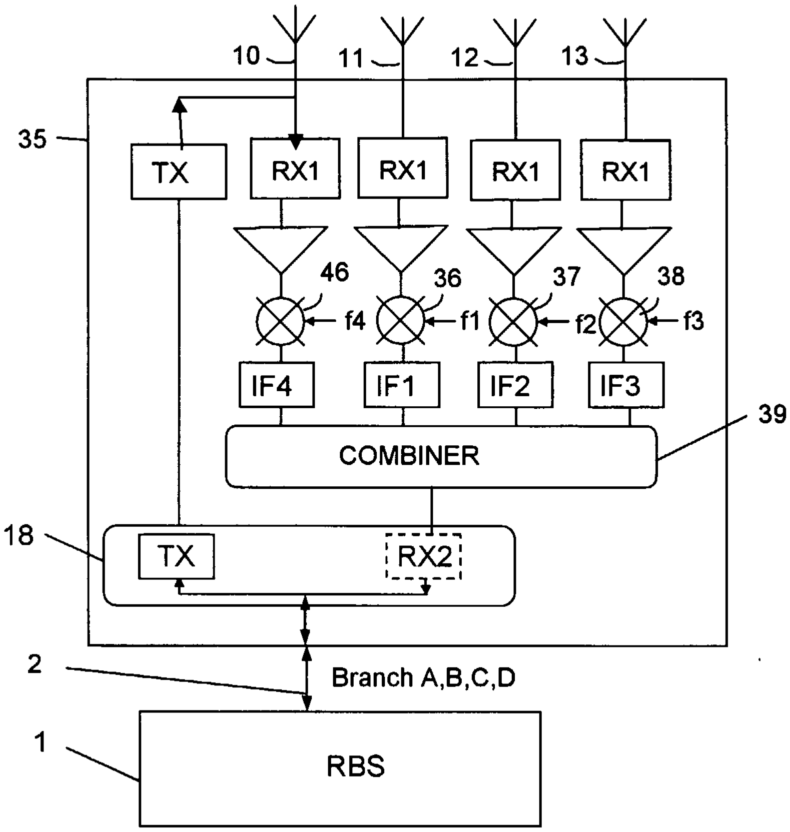
10
11
12
13
35
TX
RX1
RX1
RX1
RX1
46
36
37
38
f4
f1
f2
f3
IF4
IF1
IF2
IF3
39
COMBINER
18
TX
RX2
2
Branch A,B,C,D
1
RBS

FIG 9

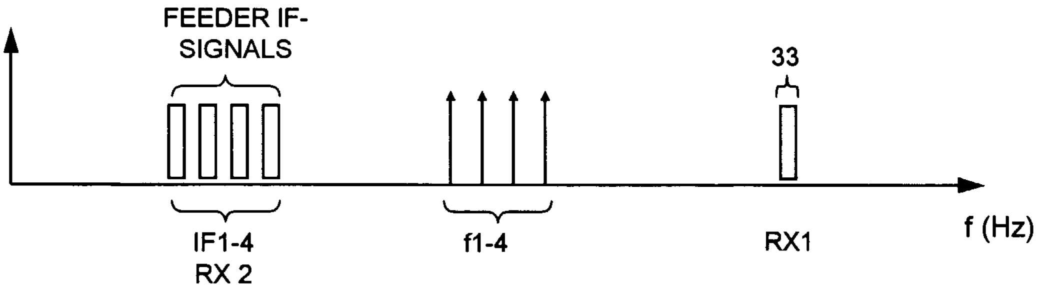
FEEDER IF-
SIGNALS
33
IF1-4
RX 2
f1-4
RX1
f (Hz)

FIG 10

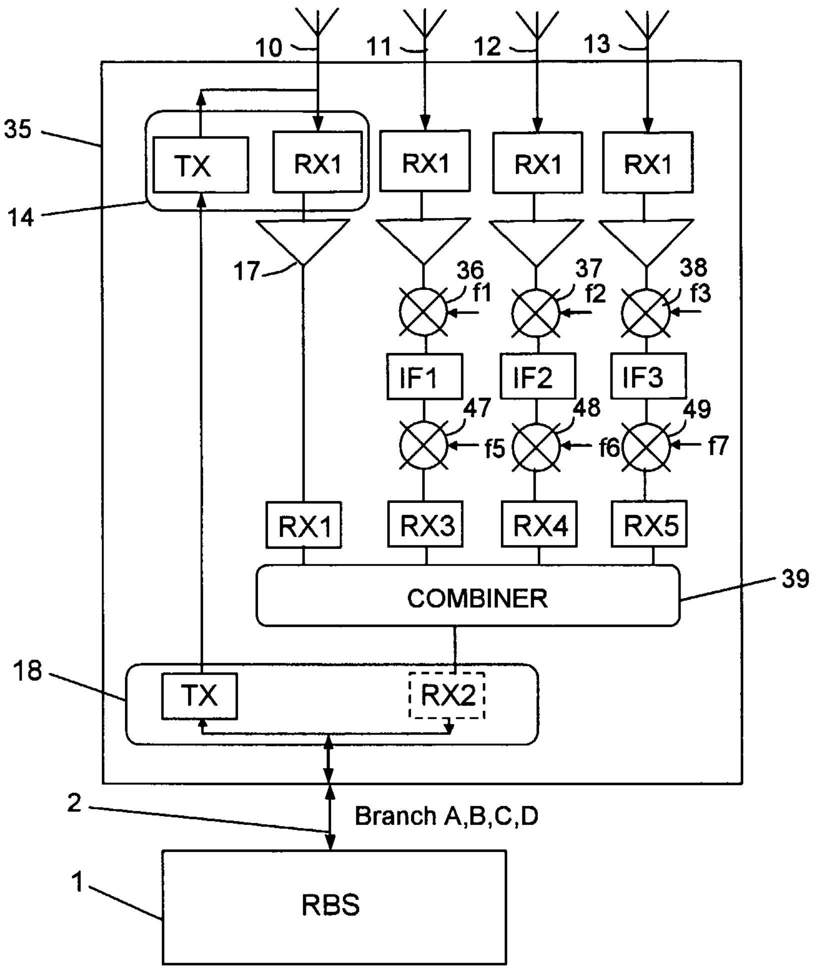
10
11
12
13
35
TX
RX1
RX1
RX1
RX1
14
17
36
f1
37
f2
38
f3
IF1
IF2
IF3
47
48
49
f5
f6
f7
RX1
RX3
RX4
RX5
COMBINER
39
18
TX
RX2
2
Branch A,B,C,D
1
RBS

FIG 11

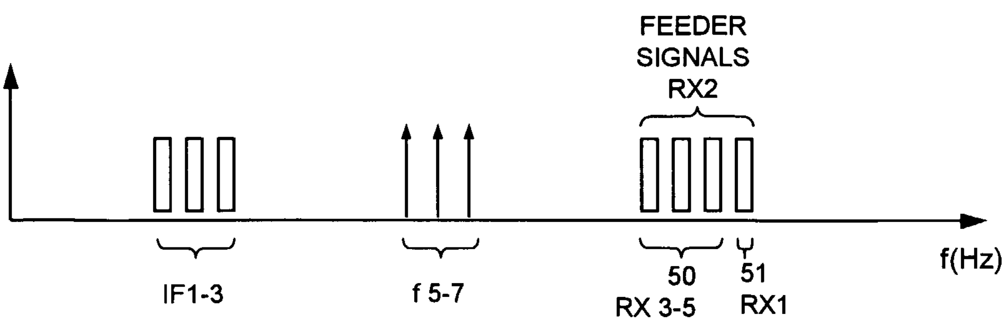
FEEDER
SIGNALS
RX2
IF1-3
f 5-7
50
RX 3-5
51
RX1
f(Hz)

FIG 12

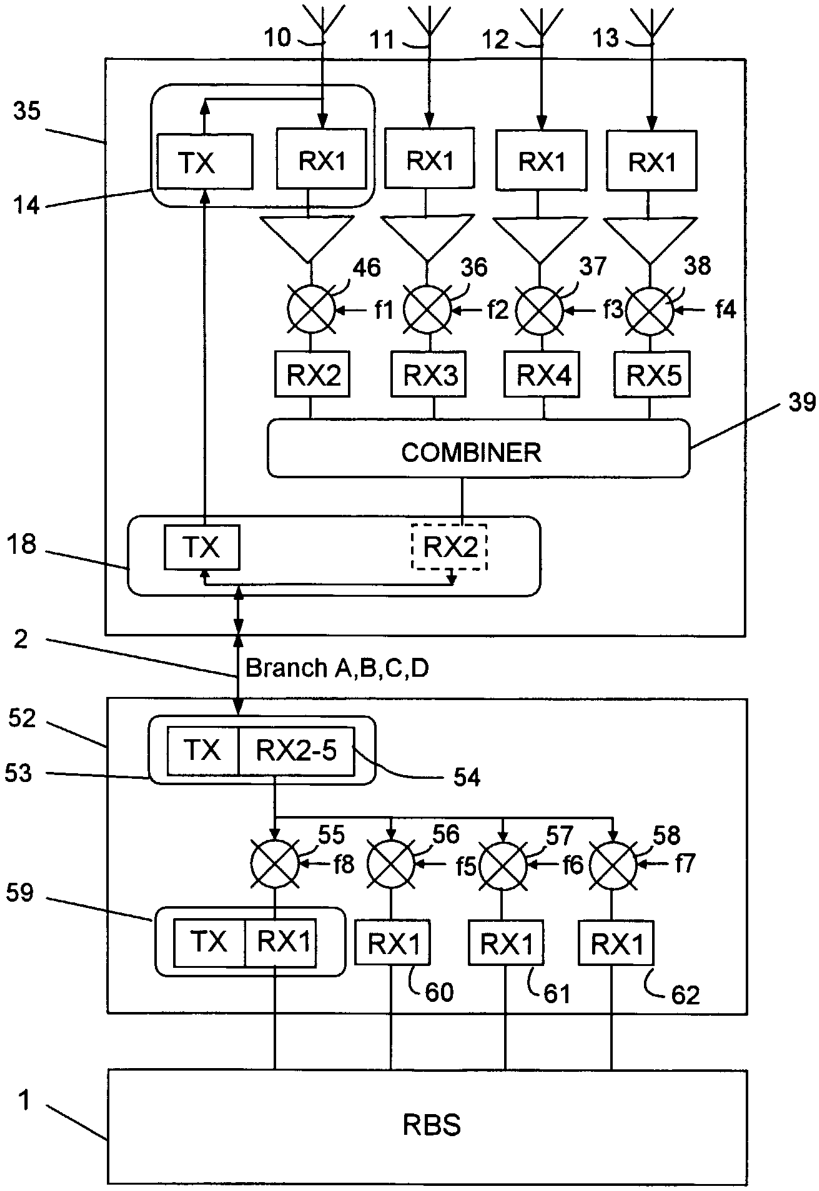
10
11
12
13
35
14
TX
RX1
RX1
RX1
RX1
46
36
37
38
f1
f2
f3
f4
RX2
RX3
RX4
RX5
39
COMBINER
18
TX
RX2
2
Branch A,B,C,D
52
53
TX
RX2-5
54
55
56
57
58
f8
f5
f6
f7
59
TX
RX1
RX1
RX1
RX1
60
61
62
1
RBS

FIG 13

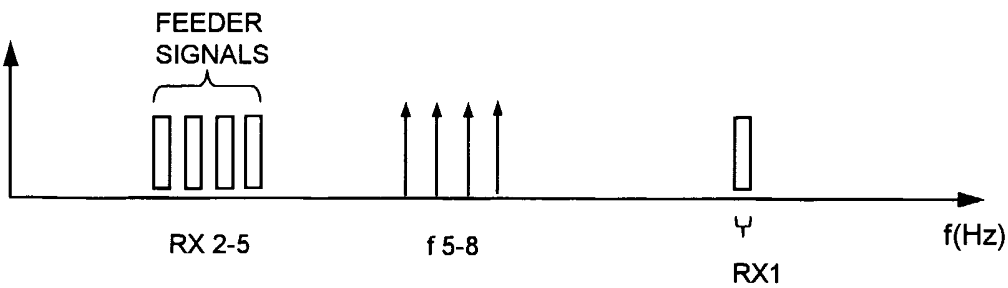
FEEDER SIGNALS
RX 2-5
f 5-8
RX1
f(Hz)

FIG 14

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 2004/000359

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/00 // H01Q 21/30, H04B 7/08

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)

IPC7: H01Q, H04B

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

SE,DK,FI,NO classes as above

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

EPO-INTERNAL, WPI DATA, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9926317 A1 (RADIO DESIGN INNOVATION TJ AB), 27 May 1999 (27.05.1999), abstract, page 1, line 12 - line 40; page 2, line 29 - page 3, line 11, claim 6, figure 5 --	1-16
A	US 5280472 A (GILHOUSEN ET AL), 18 January 1994 (18.01.1994), abstract, figure 1, column 11, line 50 - column 12, line 27 --	1-16
A	US 6047199 A (DEMARCO), 4 April 2000 (04.04.2000), abstract, column 3, line 1 - line 13 -- --------	1-16

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
30 Sept 2004	11-10-2004
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer ÅSA RYDENIUS/BS Telephone No. +46 8 782 25 00

WO	9926317 A1	27/05/1999	AU	9770998	A	07/06/1999
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