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(54) **Multistandard multiband intelligent antenna system for cellular communications in multioperator environments**

Multistandard Multiband intelligentes Antennensystem für zellulare Kommunikation in einem Multi-Operator-Umfeld

Système d'antennes intelligentes multistandards et multibandes pour des communications cellulaires dans un environnement multiopérateurs

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Description

OBJECT OF THE INVENTION

[0001] The invention is related to wireless communication systems, and, in particular, to digital cellular telecommunications networks, specifically referring to an antenna system architecture that is intelligent modular and compatible, that is pluggable to any Node B or Base Station as the antenna can be shared by several operators, so that the different base stations of the latter can connect to said antenna. In addition, the compatibility implies that the antenna system architecture can be plugged to the radiofrequency (RF) interface (Fig 1a, b) & c) used together with the rest of the base station's equipment, regardless of the manufacturer, which means that it is not necessary to change or modify the base station when you wish to replace the conventional antenna with the antenna that is the object of the invention.

BACKGROUND TO THE INVENTION

[0002] The use of intelligent antennas is a very promising solution for cellular communications systems, since they allow for a substantial increase in the system's capacity. However, these antennas are integrated in the base station and they do not allow either a total modularization, in other words, increasing the number of channels in service as demand for them grows by inserting new modules, or the installation of the intelligent antenna independently from the rest of the base station. As a result, operators of a cellular system network have to predict the number of channels they are going to provide service to and if they are going to include an intelligent antenna or not, since if they decide after the installation to include this type of antenna, they would be forced to replace the entire base station by another with an antenna with these features and with the appropriate number of channels.

[0003] Another serious drawback is that this network infrastructure cannot be shared by several operators. They each have to install their own intelligent antenna, and the result of this fact is a large urban and environmental impact.

[0004] Another problem they have is that they can only support one standard of cellular communications, and an intelligent antenna cannot be shared by operators of different systems, such as the Global System for Mobile Communications (GSM) standard, the Universal Mobile Telecommunications System (UMTS) standard, the Multichannel Multipoint Distribution System (MMDS) standard, the Local Multipoint Distribution Service (LMDS) standard, and others.

DESCRIPTION OF THE INVENTION

[0005] The prior art, as described in documents (D1): "P.B. KENINGTON: Emerging technologies for software

radio. ELECTRONICS & COMMUNICATIONS ENGINEERING JOURNAL, vol. 11, no.2, April 1999 (1999-04), pages 69 - 83."; and (D2): "USB-6,317,586 B1 (HAARDT MARTIN), 13 November 2001 (200111-13)", discloses in the first case (D1), software radio architectures for receiver and transmitters applicable for handportable terminals and also for Base Stations, and in the second case (D2), wireless data transmission methods applicable for Base Stations. Clearly, in both this two cases is, as stated, applicable the prior art for the base stations, and therefore can not be applied to an intelligent modular compatible antenna system equipment, object of this invention. Moreover, the object of the present invention, though some ideas from the described prior art are used, is to provide this intelligent modular compatible antenna system achieved by demodulating, shaping the beam with the diagram adaptation criterion selected and modulating again, and the process is the same in both transmission and reception (DEREM concept), which is a standalone equipment not to be included internally to the Base Station or Node B.

[0006] The problems described above are solved by using this invention. It consists of the definition of a modular intelligent antenna system architecture that is compatible, that is pluggable to the RF interface of any Node B or Base Station, with the rest of the base station.

[0007] The intelligence refers to the possibility of the antenna having a variable radiation diagram, being capable of generating or selecting directive beams focussed on the required user.

[0008] It is modular in that it enables a gradual growth of the channels served and of the frequency bands used when demand increases, by including new radio frequency modules. It is modular in that it allows this intelligent antenna to be used by an increasing number of new operators. Moreover, it is independent and compatible with the rest of the base station, since the operator can set up one base station using a conventional sectoral antenna first (without an intelligent antenna) and then, when an increase in capacity is required, it can be replaced by the intelligent antenna that is the object of this invention. The modularization concept is based on the use of combiners (in transmission) and dividers (in reception) before and after each channel's transmission and reception. The transmission and reception are separated by duplexers. Adding new channels or using new bands can be carried out by adding new radio frequency modules in both transmission and reception.

[0009] Furthermore, it can allow the antenna to be shared by several operators, so that their different base stations connect to it. The radio software techniques also allow the shared use of the intelligent antenna by different communication standards, such as GSM, UMTS, MMDS, LMDS and others, including the processing modules required.

[0010] The compatibility refers to the possibility of using this antenna together with the rest of the base station's equipment, regardless of the manufacturer, making

it possible to use it with base stations that are not prepared expressly to use the same. In other words, it is not necessary to change the base station when you wish to replace the conventional antenna by the antenna that is the object of this invention, enables direct connection into the radiofrequency interface, both at the transmitter power amplifier output as at the receiver low noise amplifier input with the Node B or Base Station without performing any change or modification in its hardware or software. That is the multistandard intelligent modular compatible antenna system allows the direct substitution of the conventional antennas from the Node B or Base Station by means of disconnecting its coaxial connectors of the latter, and connecting instead the ones from the antenna object of this invention. This property is achieved by demodulating, shaping the beam with the diagram adaptation criterion selected and modulating again, and the process is the same in both transmission and reception (DEREM concept). In this way, the quality of the signal is improved with a processing that is transparent to the rest of the base station's equipment (e.g., Node B in UMTS terminology).

[0011] With regard to the architecture of the compatible modular intelligent antenna for cellular communications in multioperator multistandard environments, in accordance with the object of the invention, it is basically formed of: an antenna subsystem that includes the set of radiating elements, duplexers, low-noise amplifiers in reception, combining networks in transmission and dividing networks in reception, and passive control elements of the antenna diagram; an RF/IF subsystem, which includes all the analogical components associated with the transmitter and the receiver, amplifiers, frequency converters, filters, power amplifiers and A/D and D/A converters; a radio software subsystem, which includes all the channel separation processes, modulation, demodulation, filtering, coding and decoding, associated with the digital transmission and reception processes; an adaptive algorithm subsystem, which includes the digital processes associated with the signal control of the whole of the antenna, in both reception and transmission. This subsystem is very related to the previous one.

[0012] These and other features, which will be explained throughout this specification, will enable a configurable and very flexible system to be obtained, which is adaptable to every user's requirements. In this way, it can be used in the following configurations:

1. One operator - one standard. By using this configuration, you can make the most of the variable radiation diagram offered by intelligent antennas.
2. One operator - multistandard. For the case of an operator that has licences in different bands and who wishes to reuse the intelligent antenna in the same site for the systems of the different standards.
3. Multioperator - one standard. It enables several operators of a same communications standard to share the same intelligent antenna.

4. Multioperator - multistandard. It enables several operators, whether they are of the same or different communications standards, to share the same intelligent antenna.

DESCRIPTION OF THE DRAWINGS

[0013] In order to complement the description that is going to be made below and so that the invention's characteristics can be better understood, this specification is accompanied by a set of plans, as an integral part of the same, in which the following has been represented by way of example and non-limiting.

Figure 1a) shows the diagram of a conventional base station, which could belong to any cellular communications standard (GSM, UMTS, MMDS, LMDS and others). Figure 1b) shows the diagram of a conventional antenna disconnection from the Node B, or Base Station, RF interface. Figure 1c) shows the connection of the antenna subject of this invention into the Node B, or Base Station, RF interface.

Figure 2 shows the diagram of a multistandard compatible pluggable modular intelligent antenna system for cellular communications in multioperator multistandard environments, carried out in accordance with the object of the invention.

Figure 3 shows the diagram of the modular architecture of a multistandard compatible pluggable intelligent antenna system articulated to support different operators in a certain standard, carried out in accordance with the object of the invention.

Figure 4 shows the diagram of the radio frequency subsystem.

Figure 5 shows the diagram of the hardware required for the digital receiver.

Figure 6 shows the diagram of the configuration of the beam shaping subsystem using the case of the uplink for the UMTS standard as an example.

PREFERABLE EMBODIMENT OF THE INVENTION

[0014] Before going onto describing the antenna that is the object of this invention, the diagram represented in figure 1 has to be described, which corresponds to a conventional base station, including a system (1) of conventional antennas (not intelligent), a link (2), by which the signal is taken from the antenna to the equipment (3) of the base station (for example, Node B in UMTS terminology). Finally, the conventional base station mentioned is joined by a link (4) to the rest of the network (5).

[0015] However, in the same coverage area, normally in different sites, said typical base station structure would

have to be repeated as many times as there are different systems and operators. For example if you wish to cover a specific area using three GSM operators, another three UMTS operators and another three MMDS operators, you would need nine different radiating structure systems. This fact causes a great urban and environmental impact.

[0016] Solving this problem is the reason why the multistandard compatible, that is pluggable to the RF interface of any Node B or Base Station, modular intelligent antenna system for cellular communications in a multioperator, multistandard environment, the object of this invention, has been devised, with the block (6) corresponding to the general diagram of the system shown in figure 2, with reference (7) as the antenna array, which is connected to a duplexer (8), which separates the signal into the different bands used (9), with block (10) corresponding to the UMTS module, block (11) to the GSM-1800 module, with (12) as the module corresponding to the n^{th} standard. Every one of these modules has a similar structure: an RF block (13), a radio software block (14) and a beam shaping block (15). The output signals of modules (10), (11) and (12) go to the rest of the equipment (16) of every one of the base stations of the different operators of the different standards (Node B of UMTS, BTS of GSM, etc.).

[0017] As can be seen from this figure 2, the architecture presented allows the same for a multistandard compatible that is pluggable to the RF interface of any Node B or Base Station, modular intelligent antenna system to be shared by different operators that have different standards, so the architecture's modularity allows the number of operators to increase and for them to be able to support the different communications standards thanks to the flexibility provided by the radio software. Besides, given a certain standard, the compatibility concept is achieved by demodulating, shaping the beam with the criterion of adapting the diagram selected and then modulating again (DEREM concept).

[0018] Figure 3 shows the modular architecture of the a multistandard compatible, that is pluggable to the RF interface of any Node B or Base Station, intelligent antenna system particularised to support different operators in a certain standard, in which you can see a set of antennas (17) for every one of the orthogonal polarisations established in blocks (18) and (19), so that each antenna (17) is attacked by a duplexer/combiner/divider (20) which manages to separate the channels. The process for every one of them is as follows: radio frequency (RF) conversion to intermediate frequency (IF) by the converters (21); analog/digital (A/D) conversion by an analog/digital and digital/analog conversion block (22); digital demodulation by a digital transmitter/receiver block (23), and an optimum combination of the signals from the different antennas, in accordance with the shaping criterion for every channel, by a beam shaper (24). After this, the process for every channel is similar, in other words a digital modulation (23), a digital/analog conversion (22)

and a conversion from intermediate frequency to radio frequency (21). Next, the channels are combined by means of a duplexer/combiner/divider (20) to be able to provide the nodes (25) of the different operators with service. The transmission process would be analogue to the reception process, which is the one that has been explained, but the signals would flow in the opposite direction, in other words from the nodes of the different operators (25) to the antennas (17), in other words, the signal of a specific node would be divided into its different channels (20), with the process for every channel as follows: RF/IF conversion (21), A/D conversion (22), digital demodulation (23), beam shaping (24), digital remodulation (23), D/A conversion (22), IF/RF conversion (21). Then the channels (20) combine and they are transferred to the antennas (17).

[0019] The area marked with the reference (26) in figure 3, does not break the modularity, since it can be implemented by radio software techniques, and it is therefore a software that can be updated, respecting all the hardware.

[0020] Figure 4 shows the corresponding elements of the RF system, which are as follows:

27. Antenna array with cross-polarisation.

28. Duplexer: the function of this component is to separate the transmission and the reception signals that reach the antenna.

29. Low-Noise Amplifier (LNA): this is a low-noise amplifier for reception, which will be located as close as possible to the antenna connector.

30. Power amplifiers: for the transmission, they amplify, at RF frequencies, a maximum of two carriers to the level of power required. A very high linearity is required to avoid intermodulation problems between the different carriers.

31. Divider: this will deal with dividing the signal and amplifying it to enter the RF/IF stage with the power required.

32. Passive combiner: this is the component that deals with combining the signals from the RF transmitters, to then amplify them.

33. RF/IF stage: this is the stage that deals with converting RF to IF. It has the required filters, amplifiers, mixers and oscillators. For the case of the module of the UMTS standard, the bandwidth of these circuits is 5 MHz (except for the RF filter). In this stage a different design will be carried out for the Time Division Duplex (TDD) application and for the Frequency Division Duplex (FDD) application.

34. A/D and D/A converters.

35. Digital processing module: it includes an In-phase / Quadrature (I/Q) demodulator and the processing that will be carried out in radio software. At this point, there are two options for implementation. The first carries out a combination process of the two chains (main and diversity), to then reach the beam shaper. The second carries out both operations simultaneously treating the signals as coming from two independent antennas (process in diversity: it selects the optimum combination of the two input signals to obtain the best signal to noise plus interference ratio (S/N+I))

36. Modulator, generator of diversity signals.

[0021] Figure 5 shows the diagram of the hardware required for the digital receiver, which has to be accompanied by the digital process signal. Shown in said figure are the A/D converter (37), the numeric oscillator (38) of frequency (39). The output signal of said oscillator and its 90° phase shift by block (40), multiply the digital signal, which after being decimated by the block (41), gives rise to inphase (42) and quadrature (43) signals.

[0022] Figure 6 shows the configuration for the beam shaping subsystem using the case of the uplink for the UMTS standard as an example. The adaptive process subsystem is responsible for updating the array factor, using the synchronisation pilot reference signal for the shaping, which is sent via the Dedicated Physical Control Channel (DPCCH) for every one of the users. The elements this figure has are:

- (44), (45) and (46) represent the first (DPCCH_1), second (DPCCH_2) and nth (DPCCH_N) DPCCH channels, respectively.
- (47) Long code CDMA (Code Division Multiple Access) decoders. This simply consists of a multiplication by the channelization code, which identifies a specific user within a cell.
- (48) Short code CDMA decoders. This consists of a multiplication by the mix or random code which identifies every cell.
- (49) Low-pass filters.
- (50), (51) and (52) show the multipliers by the shaping weight of the first (W_1), second (W_2) and nth (W_N) array factor, respectively.
- The input signal multiplied by the array factor is subtracted from the pilot reference signal, reference DPCCH (53).
- The result of the previous operation will be the input of the block (54) in which the minimisation algorithm resides. The output of this block will be the updated weight vector (55).

[0023] Below is a detailed explanation of the a multi-standard compatible, that is pluggable to the RF interface of any Node B or Base Station, modular intelligent antenna system described, but applied to use with the

UMTS standard:

[0024] An adaptive array is going to be used as the intelligent antenna. There are four subsystems in this antenna, which are closely connected, even in some cases with regard to hardware. Figure 3 shows the diagram of the system blocks. Four subsystems can be identified in it:

1. Antenna subsystem. It includes the set of radiating elements, duplexers, low-noise amplifiers in reception, combining networks in transmission and dividers in reception and passive control elements of the antenna diagram.

2. RF/IF subsystem. It includes all the analog components associated with the transmitter and the receiver. Amplifiers, frequency converters, filters, power amplifiers and A/D and D/A.

3. Radio software subsystem. It includes all the channel separation processes, modulation, demodulation, filtering and wide-band CDMA coding and decoding, associated with the digital transmission and reception processes.

4. Adaptive algorithm subsystem. It includes the digital processes associated with the signal control of the whole of the antenna, in both reception and transmission. This subsystem is very related to the previous one.

[0025] The antenna subsystem for the UMTS adaptive array application is formed of a group of vertical linear arrays formed by coincident or alternated dual-polarised antennas. In principle, the base stations are formed of three sectors, so every one of the flat groups would replace one of those with a 120° coverage. The base element of every group will be a vertical panel of dual linear polarisation ($\pm 45^\circ$ or V/H) with vertical beam widths of around 7.5° and beam widths in the horizontal plane of 65° or 90°. For the case of a 65° beam width, the typical gain is 17 dBi.

[0026] The RF subsystem is the one that appears separated in more detail in the diagram in figure 4, although it is understood that it would all go in the same module. The components of the same are the ones mentioned in the description of the drawings.

[0027] The IF is chosen high to allow a better elimination of the image band, avoiding possible interferences. The digital conversion is carried out in IF, avoiding filtering and analog phase noise.

[0028] The radio software subsystem is formed of an A/D converter with a high capacity (e.g. 75 MHz, 12/14 bits) followed by a digital I/Q converter controlled by an NCO, such as the one shown in figure 5, in which phase noise is not created and the features are improved. The sampling is carried out at the required frequency (fs) depending on the value of the IF to fulfil the Nyquist theorem.

The NCO generates sine and cosine signals corresponding to the f_s frequency selected from the A/D converter. The frequency change only consists of writing a numeric value in the register. The signal generated does not modify its frequency, so no phase noise is introduced. Next, to decrease the sampling frequency to the frequency required for the signal's bandwidth, the M rate decimator is introduced. In our case, M should equal 16 ($f_s=70$ MHz, $f_s=80$ MHz and Bandwidth = 5 MHz). Next, the signal process cards would be sited, where the processes of spreading/unspreading would be carried out by software in order to separate every one of the channel codes, and spreading/unspreading in order to regenerate the CDMA signal again (FDD mode). Moreover, the signals separated by code multiply by the array factor weights [w] for the beam shaping for every one of the channels.

[0029] The adaptive process subsystem is responsible for calculating those weights, using the synchronisation pilot reference signal for the shaping, which is sent by the dedicated physical control channel for every one of the users. The shaping algorithm proposed here is a temporary reference one. A configuration example of this shaper for the uplink is the content in figure 6. It does not include the RAKE (receiver structure that behaves as a filter adapted to the multipath signal received, so that its detrimental effect can be combated), so the system is simplified by making the intelligent antenna, which is only directed towards the main path, responsible for the elimination.

[0030] The implementation of the downlink is carried out in the same way, bearing in mind that the channels are modulated simultaneously, partly real and partly imaginary.

[0031] A first version of this intelligent antenna has been planned for use with the UMTS standard. This implementation is modular, since it allows the number of channels used to be increased. Modularity makes it possible to provide different operators with service, and this fact means that this network infrastructure can be shared. This results in a better use of the infrastructures, as well as less visual and environmental impact. On the other hand, the system implemented enables it to be used together with any system of base stations, in other words, the system is compatible with any manufacturer of B Nodes.

Claims

1. Antenna system for cellular communications in multi-standard multioperator environments, the antenna system adapted to have a variable radiation diagram, **characterised in that** it includes an array (7) of antennas (17) and a diplexer (8) adapted to separate; the signals at the array (7) in different bands corresponding to different communication standards, the system further comprising a communication module (10),(11),(12) for each one of said

standards, each one of the communication modules (10), (11), (12) adapted to have a RF subsystem (13), a radio software subsystem (14) and beam shaping subsystem (15), wherein each one of the communication modules (10), (11), (12) is connected to a base station (16) of operators using said standards, and wherein each one of the antennas (17) is attached by a duplexer/combiner/divider (20) adapted to separate the channels, and for each channel having a radio frequency to intermediate frequency converter (21), a first analog/digital converter (22) and a digital demodulator (23), the system further comprising beam shaper (24) common for the respective digital demodulators (23) adapted to combine the signals from the antennas (17) in accordance with a shaping criterion for every channel, wherein second digital/analog converters (22) and intermediate frequency/radio frequency converters (21') for each channel are combined in a second combiner (20) from which service is provided to different nodes (25) of said different operators.

2. Antenna system according to claim 1, **characterised in that** the radio frequency subsystem includes: duplexers (28) as a means of separating the transmission and reception signals that reach the antenna; low-noise amplifiers (29) for reception; power amplifiers (30); dividers (31), responsible for dividing the signal and amplifying it to enter the radio frequency/intermediate frequency stage with the power required; passive combiners (32) by which the signals from the radio frequency/intermediate frequency converters (33) are combined for later amplification; analog/digital and digital/analog converters (34); a digital processing module (35) with an in-phase and quadrature demodulator, and a modulator (36), generator of diversity signals.

3. Antenna system according to claim 1 or 2, **characterised in that** the radio software subsystem for the digital receiver includes an analog/digital converter (37), a numeric oscillator (38) of f_o frequency (39), whose output signal and 90 degrees phase shift by a phase shifter (40) multiply the digitalized input signal, the signals then being decimated by (41), leading to in-phase (42) and quadrature (43) signals.

4. Antenna system according to any of the preceding claims, **characterised in that** it is particularised for the UMTS standard, and **in that** the beam shaping subsystem (15) includes code division multiple access decoders (47) of long code; code division multiple access decoders (48) of short code; low-pass filters (49) and multipliers (50), (51) and (52) by the shaping weight of the array factor and a block (54) where the minimisation algorithm resides, whose input is the signal from the multipliers (50), (51) and (52) appropriately combined and subtracted from the

reference (53) and whose output (55) is the updated weight vector.

5. Antenna system according to claim 1 **characterised in that**, at least one of the communication modules (10), (11), (12) is adapted to transmit and receive in the UMTS standard or in the GSM standard.
6. Operating method for an antenna system for cellular communications in multistandard multioperator environments, in which directive beams focused on the required user are generated or selected, **characterised in that** the reception process for each standard comprises the following steps :

separation of the signal at an array of antennas in different bands corresponding to different communication standards,
demodulation of the beam,
combination of the signals from the different antennas (17) and common shaping of the beam, modulation of the beam, and combination of the channels to provide service to nodes of the different operators (25).

Patentansprüche

1. Antennensystem für Mobilfunkkommunikation in einer Multistandard-Multioperator-Umgebung, wobei das Antennensystem ein variables Strahlungsmuster aufweist, **dadurch gekennzeichnet, dass** es ein Array (7) von Antennen (17) und einen Duplexer (8) zum Aufteilen der Signale an dem Array (7) in unterschiedliche Bänder entsprechend unterschiedlichen Kommunikationsstandards aufweist, wobei das System ferner ein Kommunikationsmodul (10,11,12) für jeden der Standards aufweist, wobei jedes der Kommunikationsmodule (10,11, 12) ein RF-Subsystem (13), ein Funk-Software-Subsystem (14) und ein Strahlformungs-Subsystem (15) aufweist, wobei jedes der Kommunikationsmodule (10,11,12) mit einer Basisstation (16) von die Standards benutzenden Operators verbunden ist, und wobei jede der Antennen (17) über einen Duplexer/Combiner/Teiler (20) zum Aufteilen der Kanäle verbunden ist und jeder Kanal einen Funkfrequenz/Zwischenfrequenz-Konverter (21), einen ersten Analog/Digital-Konverter (22) und einen digitalen Demodulator (23) aufweist, wobei das System ferner einen den jeweiligen digitalen Demodulatoren (23) gemeinsamen Strahlformer (24) zum Zusammenfassen der von den Antennen (17) kommenden Signale gemäß einem Formungs-Kriterium für jeden Kanal aufweist, wobei zweite Digital/Analog-Konverter (22') und Zwischenfrequenz/Funkfrequenz-Konverter (21') für jeden Kanal in einem zweiten Combiner

(20') zusammengefasst sind, von dem aus unterschiedliche Knotenpunkte (25) der unterschiedlichen Operators bedient werden.

2. Antennensystem nach Anspruch 1, **dadurch gekennzeichnet, dass** das Funkfrequenz-Subsystem aufweist: Duplexer (28) als Einrichtungen zum Aufteilen der die Antenne erreichenden Send- und Empfangssignale; zum Empfangen vorgesehene rauscharme Verstärker (29); Leistungsverstärker (30); Teiler (31) zum Aufteilen des Signals und Verstärken des Signals zwecks Eintretens mit der erforderlichen Leistung in die Funkfrequenz/Zwischenfrequenz-Stufe; passive Combiners (32) zum Zusammenfassen der von den Funkfrequenz/Zwischenfrequenz-Konvertern (33) kommenden Signale zwecks späterer Verstärkung; Analog/Digital- und Digital/Analog-Konverter (34); ein digitales Verarbeitungsmodul (35) mit phasengleichem und Quadratur-Demodulator, und einen Modulator (36), Generator von Diversity-Signalen.
3. Antennensystem nach Anspruch 1 oder 2, **dadurch gekennzeichnet, dass** das Funk-Software-Subsystem für den Digitalempfänger aufweist: einen Analog/Digital-Konverter (37), einen numerischen Oszillator (38) mit einer fo-Frequenz (39), dessen Ausgangssignal und ein mittels eines Phasenschiebers (40) um 90-Grad verschobenes Signal das digitalisierte Ausgangssignal multiplizieren, wobei die Signale dann von (41) dezimiert werden, was zu phasengleichen (42) und Quadratur-(43) Signalen führt.
4. Antennensystem nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** es für den UMTS-Standard ausgelegt ist und dass das Strahlformungs-Subsystem (15) aufweist: Codemultiplex-Vielfachzugriffs-Dekodierer (47) mit langem Code; Codemultiplex-Vielfachzugriffs-Dekodierer (48) mit kurzem Code; Tiefpassfilter (49) und Multiplizierer (50,51,52) zum Multiplizieren mit der Formungs-Gewichtung des Array-Faktors und einen Block (54), in dem sich der Minimierungs-Algorithmus befindet, dessen Eingangssignal das Signal von den Multiplizierern (50,51,52) ist, die auf geeignete Weise zusammengefasst und von der Referenz (53) subtrahiert werden und deren Ausgangssignal (55) der aktualisierte Gewichtungsvektor ist.
5. Antennensystem nach Anspruch 1, **dadurch gekennzeichnet, dass** mindestens eines der Kommunikationsmodule (10,11,12) zum Senden und Empfangen im UMTS-Standard oder im GSM-Standard vorgesehen ist.
6. Betriebsverfahren für ein Antennensystem für Mobilfunkkommunikation in einer Multistandard-Multioperator-Umgebung, bei dem auf den erforderlichen

User fokussierte Richtstrahlen erzeugt oder ausgewählt werden,

dadurch gekennzeichnet, dass

der Empfangsprozess für jeden Standard folgende Schritte umfasst:

Aufteilen des Signals an einem Array von Antennen in unterschiedliche Bänder entsprechend unterschiedlichen Kommunikationsstandards,
Demodulieren des Strahls,
Zusammenfassen der von den unterschiedlichen Antennen (17) kommenden Signale und gemeinsames Formen des Strahls,
Modulieren des Strahls und Zusammenfassen der Kanäle, um die Knotenpunkte der unterschiedlichen Operators (25) zu bedienen.

Revendications

1. Système d'antenne pour communication cellulaire dans un environnement multi-opérateur multi-standard, le système d'antenne étant apte à présenter un diagramme de radiation variable, **caractérisé en ce qu'il** inclut une matrice (7) d'antennes (17) et un duplexeur (8) apte à séparer les signaux en la matrice (7) en différents bandes correspondant à différents standards de communication, le système comprenant en outre un module de communication (10), (11), (12) pour chacun desdits standards, chacun desdits modules de communication (10), (11), (12) étant apte à comprendre un sous-système (13) RF, un sous-système (14) logiciel radio, et un sous-système (15) de formation de faisceau, tandis que chacun des modules de communication (10), (11), (12) est relié à une station de base (16) d'opérateurs utilisant lesdits standards, et tandis que chacune desdites antennes (17) est fixée à un diviseur/compositeur duplexeur (20) apte à séparer les canaux, et pour chaque canal ayant une fréquence radio au convertisseur (21) de fréquence intermédiaire, un premier convertisseur (22) analogique/numérique et un démodulateur (23) numérique, le système comprenant en outre un conformateur de rayon (24) commun avec les démodulateurs (23) numériques respectifs aptes à combiner les signaux provenant des antennes (17) selon un critère de forme pour chaque canal, tandis que les seconds convertisseurs (22') numériques/analogiques et les convertisseurs fréquence intermédiaire/fréquence radio pour chaque canal sont combinés dans un second compositeur (20') à partir duquel le service est pourvu aux différents noeuds (25) des différents opérateurs.
2. Système d'antenne selon la revendication 1, **caractérisé en ce que** le sous-système de radio fréquence inclut : des duplexeurs (28) en tant que moyens

de séparation des signaux de transmission et de réception qui atteignent l'antenne ; des amplificateurs (29) à bas bruit pour la réception, des amplificateurs de puissance (30), des diviseurs (31), sont responsables pour la division du signal et l'amplification de celui-ci pour entrer dans l'étape de fréquence radio / fréquence intermédiaire avec la puissance requise ; des combineurs (32) passifs par lesquels les signaux à partir des convertisseurs (33) fréquence radio/fréquence intermédiaire sont combinés pour amplification ultérieure ; des convertisseurs (34) analogiques/numériques et numériques/analogiques, un module (35) de processus numérique avec un démodulateur en phase et en quadrature, et un modulateur (36), générateur de signaux de diversité.

3. Système d'antenne selon la revendication 1 ou 2, **caractérisé en ce que** le sous-système logiciel radio ou le récepteur numérique inclut un convertisseur (37) analogique/numérique, un oscillateur (38) numérique de fréquence f_0 (39), dont le signal de sortie est en phase décalée de 90 degrés par un décaleur de phase (40) et multiplie le signal d'entrée numérique, les signaux étant ensuite soumis à décimation par (41), conduisant à des signaux en phase (42) et en quadrature (43).
4. Système d'antenne selon l'une des revendications précédentes, **caractérisé en ce qu'il** est conçu pour le standard UMTS et **en ce que** le sous-système (15) de formation de rayon inclut des décodeurs (47) d'accès multiple de division de code de codes longs, des décodeurs (48) d'accès multiple de division de code de codes courts ; des filtres passe-bas (49) et des multiplicateurs (50), (51) et (52) par le poids de conformation du facteur de matrices et un bloc (54) où réside l'algorithme de minimisation, et dont la sortie est le signal des multiplicateurs (50), (51) et (52) combiné de manière appropriée et soustrait de la référence (53) et dont la sortie (55) est le vecteur de poids mis à jour.
5. Système d'antenne selon la revendication 1, **caractérisé en ce qu'au moins un** des modules de communication (10), (11), (12) est apte à transmettre et recevoir dans le standard UMTS ou dans le standard GSM.
6. Méthode opératoire pour le système d'antenne pour des communications cellulaires dans des environnements multi-opérateurs multi-standards, dans laquelle des rayons directs, focalisés sur l'utilisateur, sont engendrés ou choisis, **caractérisé en ce que** le processus de réception pour chacun des standards comporte les étapes suivantes :

- séparation du signal en une matrice d'antenne

dans différentes bandes correspondant à différents standards de communication,

- démodulation du rayon,

- combinaison des signaux provenant des différentes antennes (17) et conformation commune du rayon, 5

- modulation du rayon, et combinaison des canaux pour réaliser le service en des noeuds des différents opérateurs (25).

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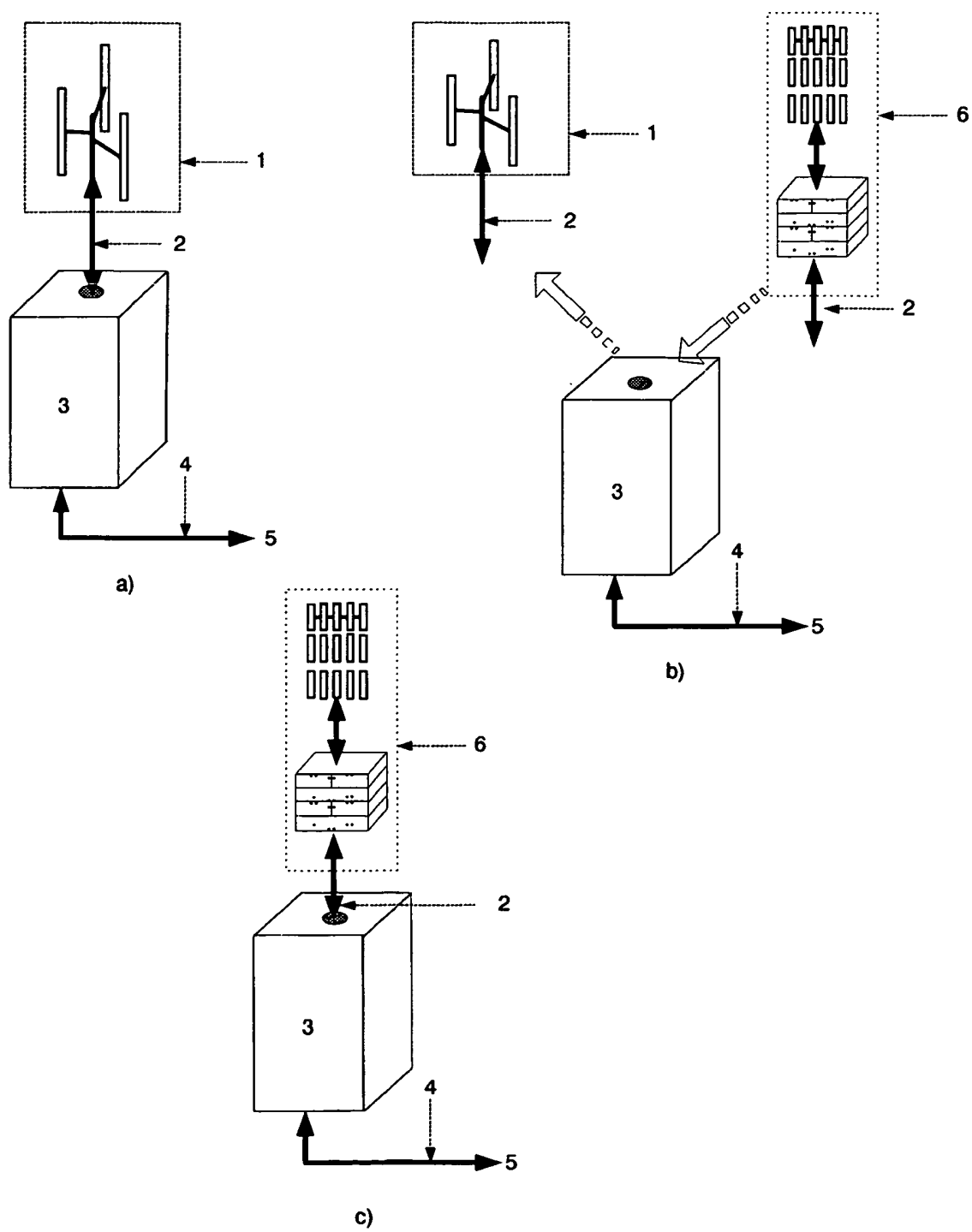


FIG. 1

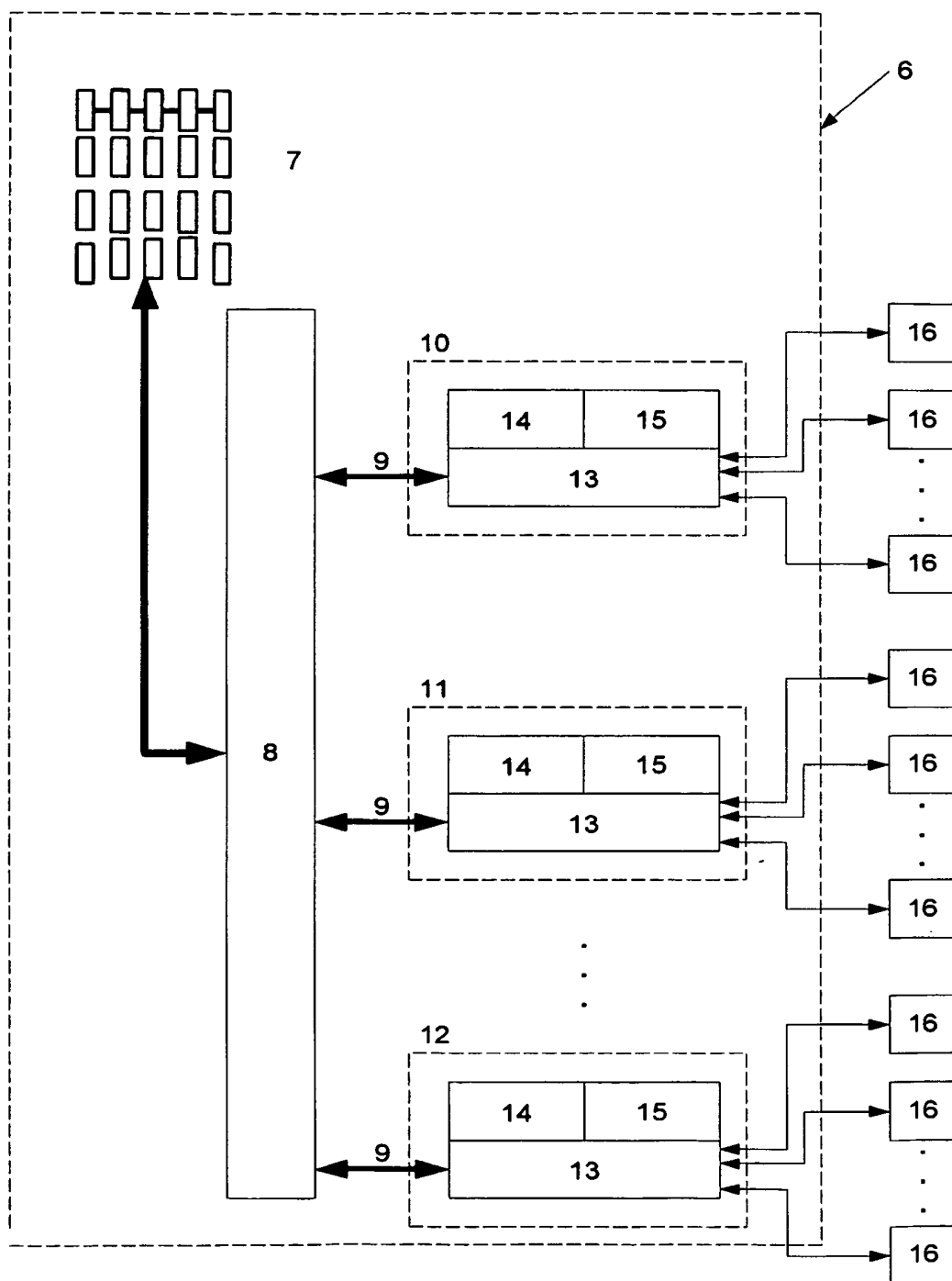


FIG. 2

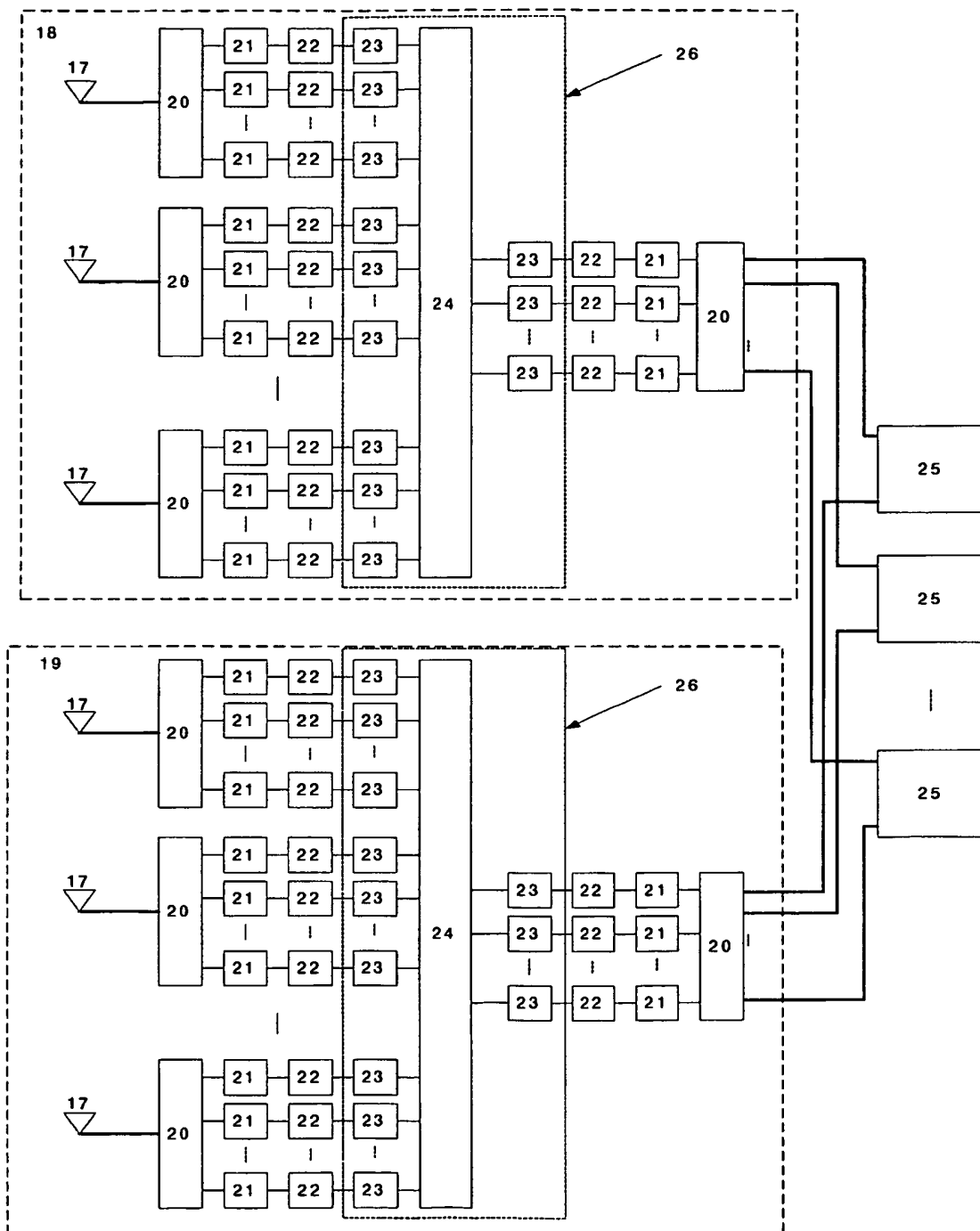


FIG. 3

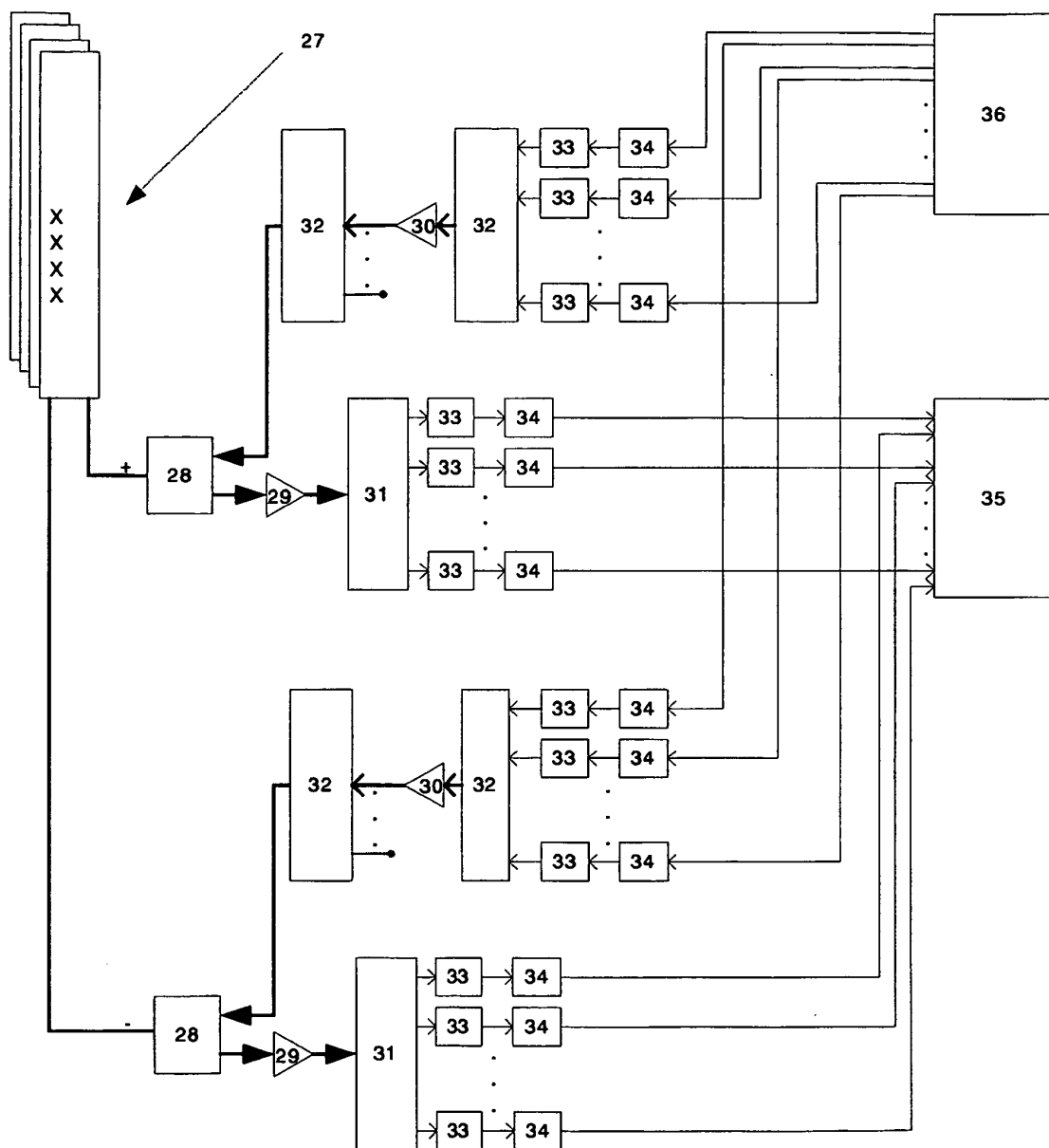


FIG. 4

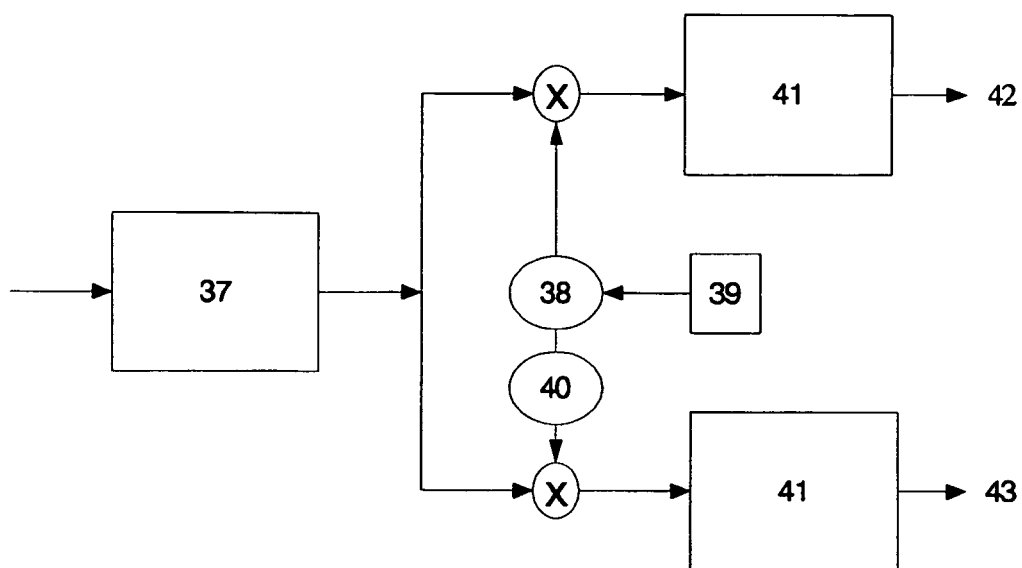


FIG. 5

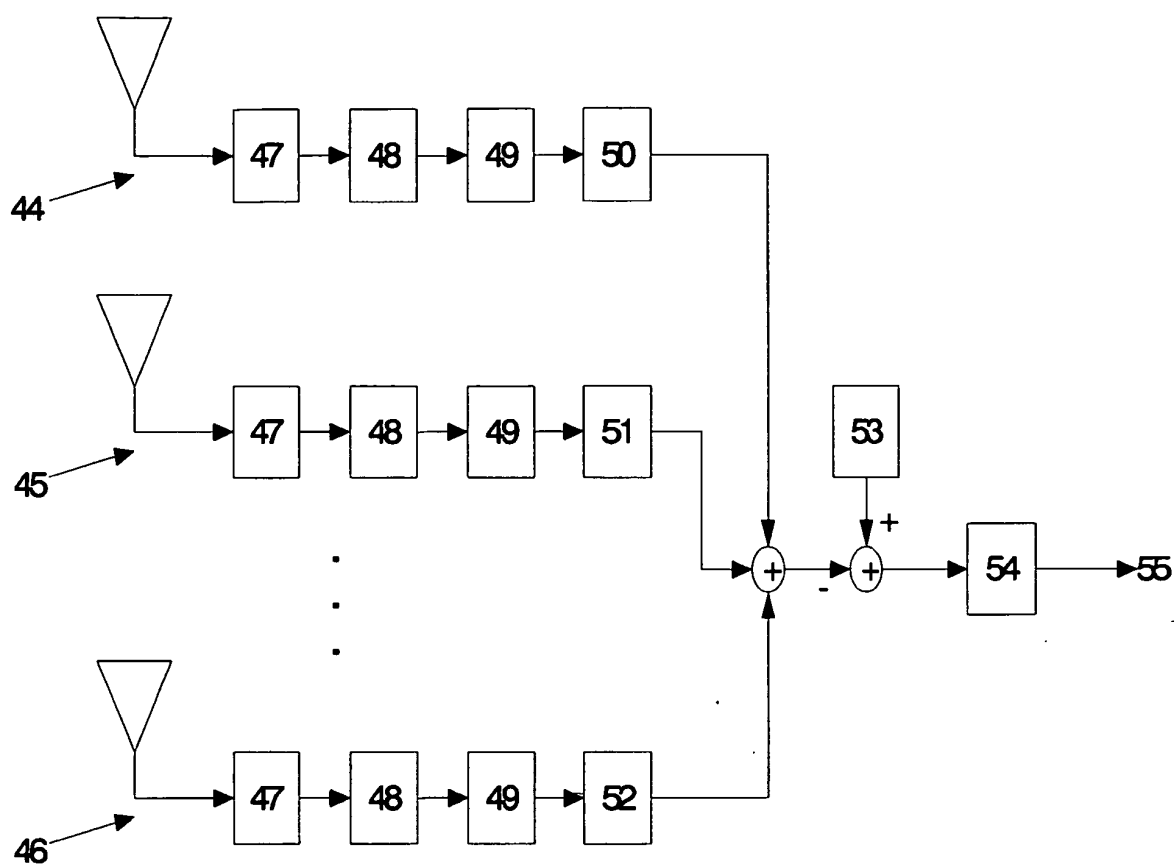


FIG. 6