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(54) **Method and system for polarization alignment of an earth station antenna with the polarization axis of a satellite antenna**

Verfahren und System zur Polarisationsausrichtung einer Bodenstationantenne mit der Polarisationsachse einer Satellitenantenne

Procédé et système pour l'alignement de polarisation d'une antenne de station terrestre avec l'axe de polarisation d'une antenne de satellite

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US-A- 4 060 808 **US-A- 4 146 893**
US-A- 4 264 908 **US-B1- 6 300 900**

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Description

[0001] The invention relates to a method for the polarization alignment of an antenna of an earth station with the polarization axis of the antenna of a satellite emitting linearly polarized beacon signals and a system for putting into practice said method.

[0002] For each newly installed earth station antenna, operators are requested to perform an initial polarization alignment and subsequent continuous verification of it. Two methods are actually used for such a polarization alignment. The first one utilises a central site, such as the Hub, to monitor a co-polar and cross-polar components of the signal from the earth station under test, using a good quality spectrum analyser. The second method requires the use of a spectrum analyser at each earth station.

[0003] However, these two methods are not adapted for being used in small earth stations, called very small aperture terminals (VSAT).

[0004] Systems for polarization alignment and polarization correction are further known from document US-A-4 060 808. According to that document, an automatic correction of depolarization effects such as Faraday rotation, satellite caused rotation and rain is steadily requested, especially in two-way communication systems where the same antenna is used at different frequencies for receiving and transmitting communications. The polarization alignment is achieved by the rotation of an orthogonal coupler relative to the horn of an antenna and the coupler in turn is rotated by rotation of the entire microwave circuit built into the polarization rotating assembly. Further, a local generator provides a first control signal which varies as a function of the typical rotation of the polarization of a transmitted wave at the one frequency band. The local generator also provides a second control signal which varies as a function of the typical rotation of the polarization of a received wave at the second frequency band. Driven means responsive respectively to the first or to the second control signal cause the rotation of the corresponding polarization angle of the antenna system in order to correct for the Faraday rotation.

[0005] According to document US-A-4 264 908, adapted polarization separation is necessary for increasing the data capacity of communication systems. However, in a typical communication system, the received polarizations are rarely completely separated due to cross polarization crosstalk from various sources such as rain, non-perfect antennas, and ionospheric propagation. In order to reduce crosstalk, polarization correction is performed by a network comprising a lossless phase shift section, and orthogonalization section, and an analog automatic control section. The lossless phase shift section includes rotatable differential phase shifters and an orthomode transducer for separating the two polarized signals into their respective channels. The orthogonalization section comprises two sets of crosscouplers with mechanically ganged variable directional couplers, and the analog automatic control section includes means for detecting two different frequency CW tones to form control signals for controlling the rotatable differential phase shifters and the two sets of crosscouplers.

[0006] Still another system for compensating for cross polarization coupling in a dual-polarization satellite communication system is described in document US-A-4 056 893. In that system, two polarized waves of the same frequency and orthogonal to each other are alternately transmitted as a pilot wave from an earth station at a predetermined period. The two polarized waves are sent back to the earth station. In order to obtain compensation for a cross polarization coupling, an amplitude ratio and a phase difference between the same polarized wave components of the two signals of the received pilot signal are detected. The polarization compensation is then performed either in the down link or in the up link.

[0007] However, these three polarization correction systems are not adapted either for being used in small earth stations and especially in automatically operated earth stations.

[0008] The object of the invention is to develop a polarization alignment method and system for low cost VAST earth station which is simple to operate.

[0009] For realizing this object, the method according to the invention is characterized by the features of claim 1.

[0010] The system for putting into practice the method is characterized by the features of claim 6.

[0011] The invention will be better understood and its objects, features, details and advantages will appear more clearly in the following explanatory description referring to the annexed schematic diagram cited as mere examples illustrating two embodiments of the invention and in which :

- Figure 1 is a block diagram of a first embodiment of the invention, and
- Figure 2 is a block diagram of a second embodiment of the invention.

[0012] The invention concerns small earth stations, i.e. VSAT stations, having an antenna the polarization axes of which are to be aligned with the polarization axes of the satellite antenna to which the station shall transmit. Accordingly an initial polarization alignment is to be performed and subsequent continuous verification of it.

[0013] The invention is based upon the finding that the satellite beacon signal coming from the satellite can be used for the polarization alignment of the antenna of the VSAT earth station and in particular the cross polar component of

the received beacon signal. This beacon signal is used to feed a device that is easy to interface to the typical feed sub-systems of any VSAT station. The output of the device consists of a variable level which is obtained from the processing of the beacon signal and which can be used for instance in order to activate visual or audible indications. These indications will notify un-experienced operators whether or not the VSAT station is correctly aligned and will guide the operator in reestablishing nominal, optimum, cross-polarization alignment conditions, despite of the non-visibility of the up-link carrier spectrum at the control center of the VSAT stations. Since this device should be a low cost device simple to operate, the electronic components to integrate in this device are all commercially available and low cost.

[0014] The first embodiment of the polarization alignment system according to the invention, in accordance to figure 1, comprises, downstream from the antenna feed 1 an orthomode transducer 2 having an RX port and a TX port. The co-polar component of the beacon signal is available at the RX port and aligned along the RX carrier and hence the cross-polar beacon component is available at the TX port and aligned along the VSAT TX carrier. However, it is to be noted that it is possible to operate the system also in the opposite polarization, by using a simple switch as will be shown below.

[0015] The beacon signal components are picked up by means of wave guide couplers with a high directivity in order to not affect the RX port and to properly isolate the TX high power amplifier from the system. Therefore, the cross-polar path or branch comprises a coupler which should be a diplexer 4 or a combination of a circulator and a band-pass filter and the co-polar branch or pass comprises a coupler 5 which is a normal coupler with a pass-band filter. In both cases, the band-width of the pass-band filter is dimensioned in such a way to let the beacon pass, taking into account the beacon short and long term frequency deviations. To amplify both the co-polar and cross-polar signals, each branch comprises a low noise amplifier (LNA) respectively 6 and 7. Between the inputs of both LNAs 6 and 7 is mounted a switch 8 for operating the system in the opposite polarization, as indicated above.

[0016] The beacon cross-polar signal component is mixed with two components of the same reference co-polar beacon signal component coming from the output of a phase locked loop (PLL) 10. The PLL is connected to the output of the LNA 7. The PLL 10 reduces the noise induced by the beacon frequency variations. The beacon cross-polar component is mixed by a first mixer 11 with the co-polar component coming from the PLL 10 and by a second mixer 12 with the co-polar beacon component made phase-orthogonal by providing a $\lambda/4$ delay line 14 between the output of the PLL 10 and the input of the mixer 12. The step of mixing the cross-polar signal with two components of the same reference co-polar beacon signal, but phase-orthogonal to each other allows to achieve a maximum sensitivity and is to avoid that different phase delays along the two branches of the system could result in orthogonal signals in same conditions and hence to give a notch of error signal. In fact, the mixing of the cross-polar component with the reference co-polar component is equivalent to a scalar product which is equal to 0 when the phase shift between the relevant vectors is 90° . Thus at the outputs of the two mixers the following signals are obtained :

$$I = kA \cdot X \cdot \cos.\beta$$

$$Q = kA \cdot X \cdot \cos.(90-\beta) = kA \cdot X \cdot \sin \beta.$$

[0017] These two cross-polar components I and Q are applied each through a narrow band pass filter respectively 15 and 16 to an adder-integrator device 18 which produces the scalar product signal $(I^2 + Q^2)^{1/2}$, which is the beacon cross-polar signal cleaned from frequency and phase ambiguities. This scalar product is applied to a first input of a comparator 19 the second input of which is coupled to the output of an integrator 20 receiving the output of the PLL 10.

[0018] Thus, the scalar product at the output of the device 18 is compared with the co-polar beacon signal component used as a bench mark to compensate for the beacon level variations due to propagation effects.

[0019] The resulting comparison signal at the output of the comparator 19 which is a voltage level will be used to activate audible/visible alarm means 22 or a switch 23 for switching off the radio unit power supply which is coupled to the diplexer 4 and indicated in 25. For completing the description of the figure 1, it is to be noted that the output of the coupler 5 is applied through a band-pass filter 27 to a low noise block down converter (LNB) 28.

[0020] The system has been described above as operating in the case that the signal transmitted from the VSAT station is in the opposite polarization of the received (co-polar) beacon. To make the device capable of operating also when the VSAT station is transmitting in the X polarization, i.e. receiving in the polarization opposite to the received beacon signal, the switch 8 is inserted in the system between the inputs of the two low noise amplifiers 6 and 7. This switch inverts the connection between the ports of the OMT 2 and the inputs of the co-polar and cross-polar branches of the device. The switch can be obtained by a stripline or microstrip network including properly polarised PIN diodes.

[0021] A second embodiment of the invention is shown on figure 2. This embodiment comprises an orthomode trans-

ducer (OMT) such as the OMT 2 of figure 1 coupled to an antenna feed 1 and comprising the ports RX and TX at which are available respectively the co-polar beacon signal component and the cross-polar beacon signal component. The RX port branch comprises a low noise block down converter (LNB) 13 and the TX branch includes a diplexer 31 coupled to a low noise block down converter (LNB) 32. These LNBs are phase-locked loop (PLL) LNB with an external reference oscillator.

[0022] The output of the RX branch LNB 30 is splitted at 33 into two lines, a first line 34 which is made available for an external L band receiver and another line 35 which is coupled to a second down converter 36 comprising a local oscillator 37, a mixer 38 and before and behind this mixer a filter respectively 39 and 40.

[0023] The LNB 32 is also coupled to a second down converter of the same kind as the down converter 36 and carrying the reference 36' with a mixer 38' and input and output band-pass filters 39' and 40'.

[0024] The local oscillator 37 is provided with a reference oscillator 42 which is also used as a reference oscillator for the LNBs 30 and 32. A DC/reference injector module 42, 42' is inserted between each LNB and the second down converter 36 and 36'.

[0025] It is to be noted that the filters of the down converters are used for the selection of the beacon signal and the attenuation of the other signal received by the antenna.

[0026] The outputs of the second down converters 36 and 36' are coupled to a dual channel DSP coherent receiver. The down converted signal in the band of few hundreds of kHz at the output of the converter 36 is applied to the main channel of the DSP coherent receiver 45 where it is used to synchronise a numerically controlled oscillator (NCO) 46 that demodulates both the co-polar and cross-polar down converted beacon signal components at the outputs of the down converters 36 and 36' by multiplication followed by digital filtering.

[0027] More precisely, the output of the down converter 36 is coupled to an analogue-digital converter (A/D) 47 the output of which is connected to the NCO 46 and a coherent amplitude demodulator the output of which is coupled through a filter 49 to the co-polar input of an integrator and amplitude comparator 50.

[0028] The output of the down converter 36' is coupled through an analogue-digital converter 47' to a coherent I/Q demodulator 51 the I output and the Q output of which are each coupled through a filter 52 to a I and Q input of comparator 50.

[0029] The proposed solution to downconvert the co-polar and cross-polar beacon signal to few hundreds of kHz will allow a digital implementation of the amplitude comparison between the two signals.

[0030] Due to the very low signal to noise factor of the beacon cross-polar component, it will be necessary to implement a coherent demodulation to extract the amplitude information related to the beacon signals. These demodulators are realized by means of multiplication of the signal to be detected, converted into digital format, with a sinusoidal signal with the same frequency and phase as the first one, but fixed amplitude. The latter signal will be obtained by synchronizing the NCO 46 to the input co-polar beacon signal component that is less noisy than the cross-polar beacon signal component because of its higher level.

[0031] The same NCO sinusoidal signal will be used to demodulate the cross-polar beacon signal obtaining the detection of both the in phase and in quadrature components of the signal. The quadrature demodulation will avoid the holes in the signal detection due to the different phase between the co-polar branch and the cross-polar branch.

[0032] The signals obtained from the multiplication are digitally filtered by the filters 49 and 52 in order to eliminate the double frequency term catching the only baseband component that contains the amplitude information A_{co} for the

co-polar signal component and (I_{cx}, Q_{cx}) for the cross-polar component. The comparison between $\sqrt{I_{cx}^2 + Q_{cx}^2}$ and a fraction of A_{co} will activate the alarm for the polarization misalignment to be corrected manually by the operator. The polarization misalignment alarm means are indicated in 55.

[0033] It results from the foregoing that the system proposed by the invention is suitable to let the operator know the deviation from the antenna polarization alignment and then to manually restore the right condition. The system allows also to check and to optimize the reception of the beacon on the reference polarization at any time during the operations of the earth station.

[0034] The invention provides also the possibility, in case of a specific application named SKYPLEX to digitally encode the polarization alignment signal and to incapsulate it via a suitable interface in the message packets emitted by the earth station to the satellite, so that the polarization misalignment information can be received and decoded at a central supervision and management station controlling all earth stations.

Claims

1. Method for the polarization alignment of an antenna of an earth station with the polarization axis of the antenna of a satellite emitting linearly polarized beacon signals, the cross-polar component of the received linearly polarized

beacon signal being used as information representative of an antenna polarization misalignment, **characterized in that** a polarization misalignment signal is developed by comparison of the co-polar and cross-polar beacon signal components, said development comprising the steps of

- deriving a co-polar beacon signal component i.e. a component of the polarization that the antenna of the satellite is intended to radiate and a cross-polar beacon signal component i.e. a component of the polarization orthogonal to the co-polarization ;
- mixing the cross-polar signal component with two phase orthogonal components of the same co-polar signal components ;
- adding the two mixed signals so that a scalar product signal is produced which represents the beacon cross-polar signal cleaned from frequency and phase ambiguities ;
- comparing said scalar product signal with the co-polar beacon signal used as a bench mark and finally
- using the resulting comparison signal which is a variable voltage level to activate audible/visible alarm means for signalling depolarization.

2. Method according to claim 1, **characterized in that** a polarization misalignment signal is developed by comparison of the co-polar and cross-polar beacon signal components.

3. Method according to claim 2, **characterized in that** said polarization misalignment signal is a variable level signal such as a voltage signal and is used to activate visual or audible indicator means.

4. Method according to claim 3, **characterized in that** said visual and audible indicator means are activated when said voltage level is greater than a predetermined threshold level.

5. Method according to any of the foregoing claims, **characterized in that** said polarization misalignment signal is digitally encoded and incapsulated in the message packets emitted by the earth station to a satellite, in order to be received and decoded by a central supervision and management station.

6. System for putting into practice the method according to any of claims 1 to 5, **characterized in that** it comprises an orthomode transducer (2) having a TX port at which is available the cross-polar component of the beacon signal and a RX port at which is available the co-polar component of the beacon signal, **in that** the cross-polar path comprises mixer means (11, 12) for mixing the cross-polar with two phase orthogonal components of the same reference co-polar beacon component and an adder-integrator device (18) for producing a scalar product signal therefrom which is clear from frequency and phase ambiguities and **in that** it comprises a comparator (19) receiving at its inputs said scalar product signal and the output of an integrator (20) receiving the co-polar beacon component coming from a phase locked loop (10), said comparator (19) producing the polarization misalignment signal.

7. System for putting into practice the method of any of claims 1 to 5, **characterized in that** it comprises an orthomode transducer (21) having a TX port and a RX port at which are available respectively the cross-polar and the co-polar beacon signal components, down converter means (30, 32, 36, 36') for down converting the cross-polar and the co-polar beacon signal components to a band of a few hundreds of KHz the down converted signal components being received by A/D converters (47, 47') the outputs of which are connected to a numerically controlled oscillator (46) demodulating both the co-polar and the cross-polar down converted beacon signal components and to coherent demodulator means (48, 51) adapted to extract the amplitude and crosspolar I and Q information related to the beacon signal components, as well as amplitude and integrator comparator means (50) receiving at its inputs the coherent amplitude demodulator (48) and the crosspolar demodulator (51) means and producing said polarization misalignment signal.

8. System according to any of claims 6 and 7, **characterized in that** it comprises a switch means (8) for switching between operation modes where the earth station transmits in a linear polarization which is orthogonal to the polarization of the received beacon signal and in the same polarization as the latter.

Patentansprüche

1. Verfahren zur Polarisationsausrichtung einer Antenne einer Bodenstation mit der Polarisationsachse der Antenne eines Satelliten, die linear polarisierte Bakensignale aussendet, wobei die kreuzpolare Komponente des empfangenen linear polarisierten Bakensignals als Information verwendet wird, die einen Versatz der Antennenpolarisation

darstellt, **dadurch gekennzeichnet, dass** ein Polarisationsversatzsignal durch einen Vergleich der ko- und kreuzpolaren Bakensignalkomponenten entwickelt wird, wobei diese Entwicklung folgende Schritte umfasst

- Ableiten einer kopolaren Bakensignalkomponente, d.h. einer Komponente der Polarisation, welche die Antenne des Satelliten abstrahlen soll, und einer kreuzpolaren Bakensignalkomponente, d.h. einer Komponente der Polarisation, die zur Kopolarisation orthogonal ist;
- Mischen der kreuzpolaren Signalkomponente mit zwei phasenorthogonalen Komponenten der gleichen kopolaren Signalkomponenten;
- Addieren der beiden gemischten Signale, so dass ein Skalarproduktsignal erzeugt wird, welches das kreuzpolare Bakensignal darstellt, das von Frequenz- und Phasenunbestimmtheiten bereinigt ist;
- Vergleichen des Skalarproduktsignals mit dem kopolaren Bakensignal, das als Bezugspunkt verwendet wird, und schließlich
- Verwenden des sich ergebenden Vergleichssignals, das ein variables Spannungsniveau ist, um akustische/optische Alarmmittel zu aktivieren, um eine Depolarisation zu melden.

2. Verfahren nach Anspruch 1, **dadurch gekennzeichnet, dass** ein Polarisationsversatzsignal durch einen Vergleich der ko- und kreuzpolaren Bakensignalkomponenten entwickelt wird.
3. Verfahren nach Anspruch 2, **dadurch gekennzeichnet, dass** das Polarisationsversatzsignal ein Signal mit variablem Pegel ist, wie etwa ein Spannungssignal, und verwendet wird, um optische oder akustische Anzeigemittel zu aktivieren.
4. Verfahren nach Anspruch 3, **dadurch gekennzeichnet, dass** die optischen und akustischen Anzeigemittel aktiviert werden, wenn der Spannungspegel größer ist als ein vorherbestimmter Schwellenpegel.
5. Verfahren nach einem der vorhergehenden Ansprüche, **dadurch gekennzeichnet, dass** das Polarisationsversatzsignal digital kodiert und in die Nachrichtenpakete eingekapselt wird, die von der Bodenstation an einen Satelliten ausgesendet werden, um von einer zentralen Überwachungs- und Verwaltungsstation empfangen und dekodiert zu werden.
6. System zum Umsetzen des Verfahrens nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** es einen Orthomode-Wandler (2) umfasst, der über einen Sendeanschluss (TX), an dem die kreuzpolare Komponente des Bakensignals ansteht, und über einen Empfangsanschluss (RX), an dem die kopolare Komponente des Bakensignals ansteht, verfügt, dass der kreuzpolare Weg Mischmittel (11, 12), um die kreuzpolare mit zwei phasenorthogonalen Komponenten derselben kopolaren Bezugsbakenkomponente zu mischen, und eine Addier-Integrier-
vorrichtung (18), um daraus ein Skalarproduktsignal zu erzeugen, das von Frequenz- und Phasenunbestimmtheiten frei ist, umfasst, und dass es einen Vergleichler (19) umfasst, der an seinen Eingängen das Skalarproduktsignal und die Ausgabe eines Integriergeräts (20) empfängt, das die kopolare Bakenkomponente empfängt, die aus einem Phasenregelkreis (10) stammt, wobei der Vergleichler (19) das Polarisationsversatzsignal erzeugt.
7. System zum Umsetzen des Verfahrens nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** es folgendes umfasst: einen Orthomode-Wandler (21), der über einen TX-Anschluss und einen RX-Anschluss verfügt, an denen jeweils die kreuzpolaren und die kopolaren Bakensignalkomponenten anliegen, Abwärtswandlernmittel (30, 32, 36, 36') zum Abwärtswandeln der kreuzpolaren und der kopolaren Bakensignalkomponenten auf ein Band von wenigen hundert kHz, wobei die abwärts gewandelten Signalkomponenten von A/D-Wandlern (47, 47') empfangen werden, deren Ausgänge an einen numerisch gesteuerten Oszillator (46), der die beiden ko- und kreuzpolaren abwärts gewandelten Bakensignalkomponenten demoduliert, und an kohärente Demodulatormittel (48, 51), die geeignet ist, um die Amplitude und kreuzpolaren I- und Q-Informationen zu entnehmen, die sich auf die Bakensignalkomponenten beziehen, angeschlossen sind, sowie Amplituden- und Integrationsvergleichsmittel (50), die an ihren Eingängen die kohärenten Amplitudendemodulatormittel (48) und die kreuzpolaren Demodulatormittel (51) empfangen und das Polarisationsversatzsignal erzeugen.
8. System nach einem der Ansprüche 6 und 7, **dadurch gekennzeichnet, dass** es Umschaltmittel (8) umfasst, um zwischen Betriebsarten umzuschalten, wobei die Bodenstation in einer linearen Polarisation, die zur Polarisation des empfangenen Bakensignals orthogonal ist, und in der gleicher Polarisation wie dieses aussendet.

Revendications

1. Procédé pour l'alignement de polarisation d'une antenne d'une station terrestre avec l'axe de polarisation de l'antenne d'un satellite émettant des signaux de balise polarisés linéairement, la composante de polarisation croisée du signal de balise polarisé linéairement reçu étant utilisée en tant qu'informations représentatives d'un défaut d'alignement de polarisation d'antenne, **caractérisé en ce qu'un** signal de défaut d'alignement de polarisation est développé par comparaison des composantes de signal de balise de polarisation parallèle et de polarisation croisée, ledit développement comprenant les étapes consistant à :
 - déduire une composante de signal de balise de polarisation parallèle, c'est-à-dire, une composante de la polarisation que l'antenne du satellite est destinée à rayonner et une composante de signal de balise de polarisation croisée, c'est-à-dire, une composante de la polarisation orthogonale à la polarisation parallèle ;
 - mélanger la composante de signal de polarisation croisée avec deux composantes à phases orthogonales des mêmes composantes de signal de polarisation parallèle ;
 - additionner les deux signaux mélangés de sorte qu'un signal de produit scalaire soit produit qui représente le signal de balise de polarisation croisée duquel les ambiguïtés de fréquence et de phase ont été retirées ;
 - comparer ledit signal de produit scalaire avec le signal de balise de polarisation parallèle utilisé en tant que repère, et finalement
 - utiliser le signal de comparaison résultant qui est un niveau de tension variable pour activer des moyens d'alarme audibles/visibles pour signaler une dépolarisation.
2. Procédé selon la revendication 1, **caractérisé en ce qu'un** signal de défaut d'alignement de polarisation est développé par comparaison des composantes de signal de balise de polarisation parallèle et de polarisation croisée.
3. Procédé selon la revendication 2, **caractérisé en ce que** ledit signal de défaut d'alignement de polarisation est un signal de niveau variable tel qu'un signal de tension et est utilisé pour activer des moyens d'indication visuels ou audibles.
4. Procédé selon la revendication 3, **caractérisé en ce que** lesdits moyens d'indication visuels et audibles sont activés lorsque ledit niveau de tension est supérieur à un niveau de seuil prédéterminé.
5. Procédé selon l'une quelconque des revendications précédentes, **caractérisé en ce que** ledit signal de défaut d'alignement de polarisation est encodé numériquement et encapsulé dans les paquets de message émis par la station terrestre vers un satellite, afin d'être reçu et décodé par une station centrale de supervision et de gestion.
6. Système pour mettre en pratique le procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce qu'il** comprend un duplexeur à quatre accès (2) ayant un port TX auquel la composante de polarisation croisée du signal de balise est disponible et un port RX auquel la composante de polarisation parallèle du signal de balise est disponible, **en ce que** le trajet de polarisation croisée comprend des moyens de mélange (11, 12) pour mélanger la polarisation croisée avec deux composantes à phases orthogonales de la même composante de balise de polarisation parallèle de référence et un dispositif d'addition-intégration (18) pour produire un signal de produit scalaire à partir de celles-ci duquel les ambiguïtés de fréquence et de phase ont été retirées, et **en ce qu'il** comprend un comparateur (19) recevant à ses entrées ledit signal de produit scalaire et la sortie d'un intégrateur (20) recevant la composante de balise de polarisation parallèle provenant d'une boucle verrouillée en phase (10), ledit comparateur (19) produisant le signal de défaut d'alignement de polarisation.
7. Système pour mettre en pratique le procédé selon l'une quelconque des revendications 1 à 5, **caractérisé en ce qu'il** comprend un duplexeur à quatre accès (21) ayant un port TX et un port RX auxquels les composantes de signal de balise de polarisation croisée et de polarisation parallèle sont respectivement disponibles, des moyens de conversion-abaissement (30, 32, 36, 36') pour convertir-abaisser les composantes de signal de balise de polarisation croisée et de polarisation parallèle dans une bande de quelques centaines de KHz, les composantes de signal converties-abaissées étant reçues par des convertisseurs analogique-numérique (47, 47') dont les sorties sont connectées à un oscillateur commandé numériquement (46) démodulant à la fois les composantes de signal de balise de polarisation parallèle et de polarisation croisée converties-abaissées et à des moyens de démodulation cohérente (48, 51) adaptés pour extraire les informations I et Q d'amplitude et de polarisation croisée concernant les composantes de signal de balise, ainsi qu'à des moyens d'intégration et de comparaison d'amplitude (50) connectés à leurs entrées à des moyens de démodulation d'amplitude cohérente (48) et de démodulation de polarisation croisée (51) et produisant ledit signal de défaut d'alignement de polarisation.

8. Système selon l'une quelconque des revendications 6 et 7, **caractérisé en ce qu'il** comprend des moyens de commutation (8) pour commuter entre des modes de fonctionnement où la station terrestre émet une polarisation linéaire qui est orthogonale à la polarisation du signal de balise reçu et dans la même polarisation que cette dernière.

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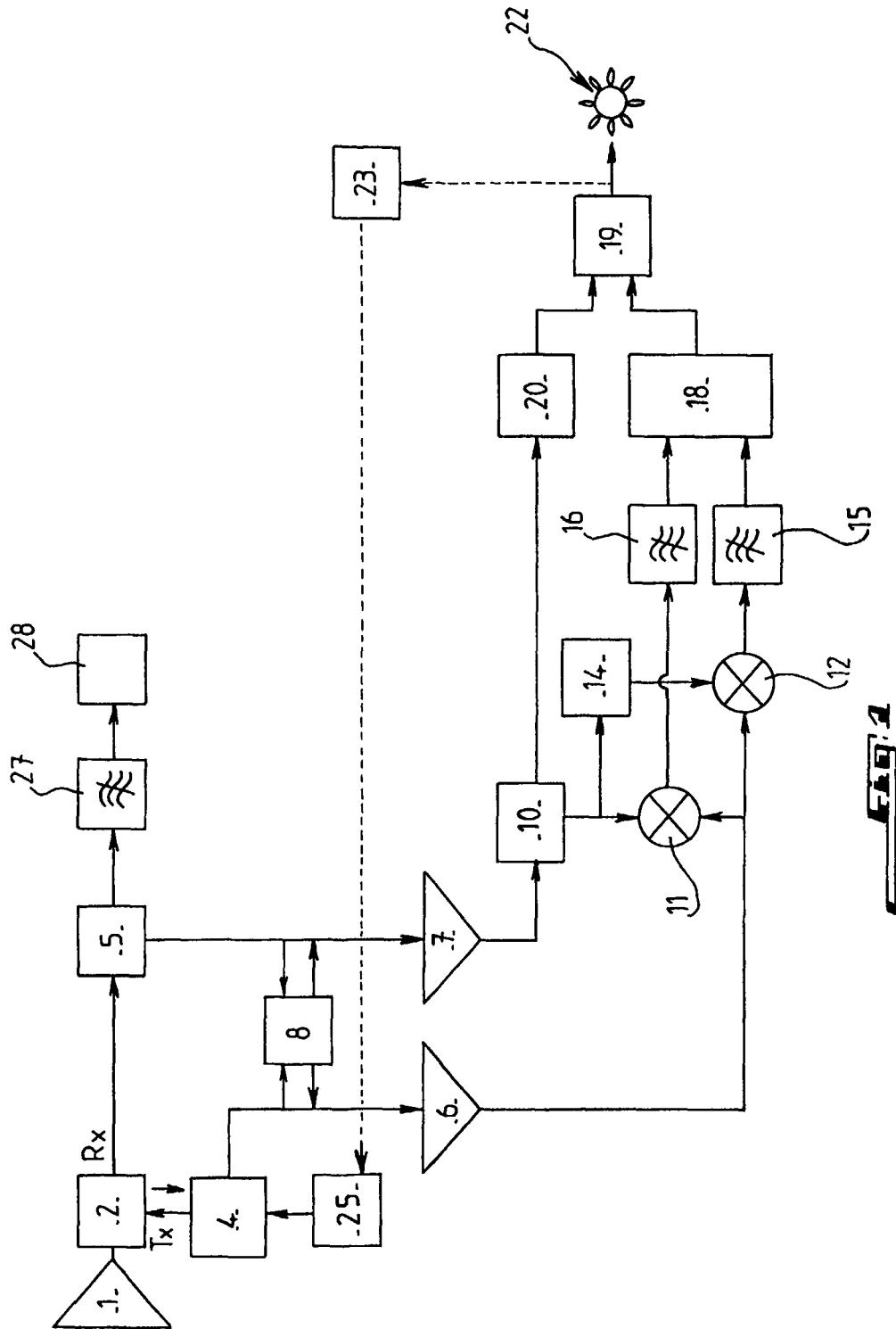
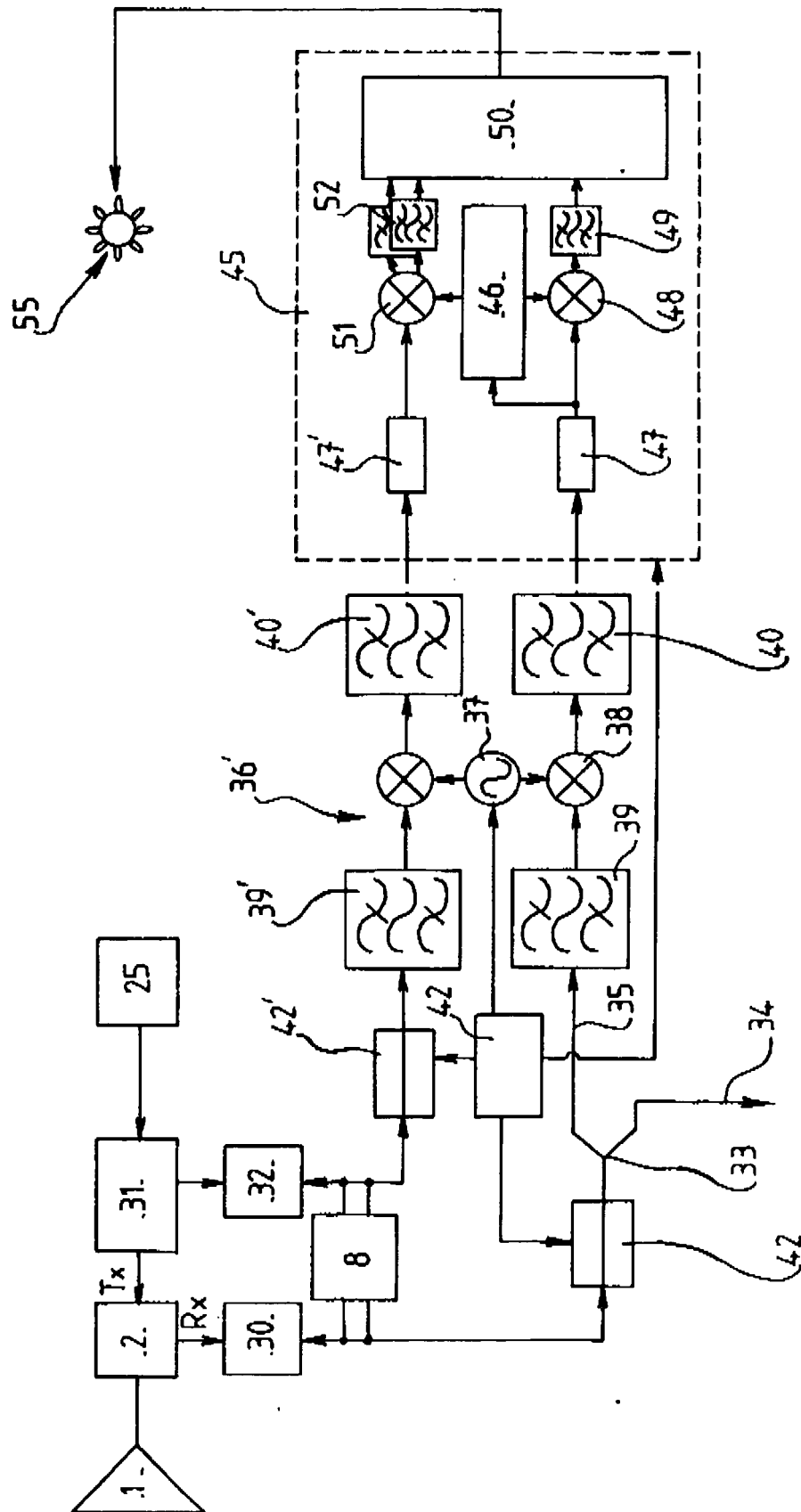


FIG. 1



REFERENCES CITED IN THE DESCRIPTION

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