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(54) Microwave polariser

Mikrowellen-Polarisator

Polariseur à micro-ondes

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Description

[0001] This invention relates to a microwave polariser and particularly to a microwave polariser for coupling energy between a waveguide and a transmission line or vice versa.

[0002] Coupling of energy between a waveguide and a transmission line leading to an amplifier is usually achieved by the use of one or more wire probes inserted into the waveguide cavity through the wall of the waveguide, so that the probes are lying transverse to its axis. In the case of a waveguide accommodating circular polarisation two such probes are required to be mutually orthogonal within the cavity. Those probes can be spaced from one another a prescribed distance, normally one wavelength, in the direction of the axis or can be arranged in a common plane orthogonal to the waveguide axis. These polarisers for circular polarisation are often used for receiving of television signals by satellites where often different polarisations for different channels are employed. This means that at the receiver channels with the same frequency but different circular polarisations can be selected. Therefore, one frequency of transmission can be used for a number of different channels. This means in a microwave polariser, for example known from EP-A-0350324, one circular polarisation will appear only at the output of probe 1 wherein the other polarisation will appear only at the output of probe 2. In practice, however, due to the coupling between the probes, a small amount of the received signal at one probe will also appear at the output of the other probe. In other words, the cross polarisation performance of the known polarisers is poor and a matching circuit is needed between the probes and the low noise amplifier, wherein the probes normally are adjusted to an impedance of 50 ohms.

GB-A-2235340 discloses a microwave polariser with a waveguide and two transmission lines that are connected at one end to a low noise amplifier and at the other end to a probe, wherein the two probes are arranged orthogonally in a plane orthogonal to the axis of the waveguide and penetrate into said waveguide.

[0003] International Journal of Electronics, vol.47, no. 5, London GB, Pages 525-527, H.P. Joglekar et al., shows that the resistive part of the impedance of a probe penetrating into a waveguide is a function of the signal frequency, the penetration depth and the distance between the probe and a short circuit termination.

IEEE, MTT-S International Microwave Symposium Digest, Orlando, May 16-20, 1995, vol.3, 16 May 1995, Kirby L (ED), pages 1403-1406, W. Grabherr et al., 'Active Low Noise Transition from Rectangular Waveguide to Microstrip Line', discloses an active low noise transition from a rectangular waveguide to a microstrip line using for example a HEMT transistor.

[0004] It is an object of the invention to provide a microwave polariser for coupling energy between a waveguide and a transmission line, wherein the cross polarisation is improved and matching circuits become unnecessary.

[0005] This object is solved by the features of the independent claim.

[0006] Further preferred embodiments of the invention are given in the dependent claims.

[0007] To improve the cross polarisation of the microwave polariser the length of the probes x, penetrating into the waveguide, are reduced to reduce the coupling between the probes. This also has the effect of reducing their input impedance. Normally the signal collected by the probes is amplified using a low noise HEMT amplifier. To optimise the performance of this amplifier it is necessary to terminate its input with a certain impedance level. Fortunately for HEMT amplifiers the resistive part of the impedance is less than 50 ohms, typically 20 ohms. This can be achieved by shortening the length of the probes, penetrating into the waveguide. This has the further advantage, that normally no matching network is necessary between the probes and the input of the amplifier to optimize the noise performance of the amplifier, which was the case in the previous state of the art.

[0008] The microwave polariser according to the invention for coupling energy between a waveguide and a transmission line connected to an amplifier, especially a low noise amplifier, comprises two orthogonal probes arranged in a plane orthogonal to the axis of the waveguide and penetrating a length x into the waveguide, wherein the penetration depth x of the probes is set to a value corresponding to an impedance value smaller than 50 ohms, in particular to an impedance value corresponding to 20 ohms.

[0009] Further the two mutually orthogonal probes are mounted on a common microwave substrate and are etched on the surface of said microwave substrate

[0010] Further the microwave receiving/sending arrangement of this invention uses a polariser according to the invention and this microwave polariser is sandwiched between a circular waveguide and a circular lambda/4 short circuit cavity. The microwave travelling in the waveguide is supplied by the feed of the antenna. The probe signals picked up by the polariser are then amplified by a HEMT amplifier.

[0011] To further improve the performance of the amplifier and to achieve the necessary resistive part of the impedance at the input of the amplifier, the length of the short circuit cavity can be adjusted properly.

[0012] An embodiment of the microwave polariser according to the invention will now be described by way of example with reference to the accompanying drawing, in which:

Fig. 1a shows a cross section of the polariser according to the invention, and

Fig. 1b shows a an elevational cross section of a polariser mounted between a waveguide and a short circuit cavity.

[0013] Fig. 1a shows an end view of the microwave polariser according to the invention. Two probes 1 and 2 are provided mutually orthogonal to each other on a microwave substrate 5. The probes 1 and 2 are connected via, for example, microwave stripes 3, 4 to an amplifier (not shown). The probes 1, 2 penetrate a depth x into the space provided by a waveguide 6. The two end points of the probes E-E are spaced by a distance, wherein the cross polarisation (i.e. cross talk) increases when the distance between the two tips of the probes decreases. The penetration depth x according to the invention is chosen so that the input impedance of the respective strobe is smaller than 50 ohms, preferably 20 ohms.

[0014] Fig. 1b shows a sectional plane view of the receiving/sending arrangment, with a polariser comprising probes 1, 2 and a substrate 5, which is sandwiched between a waveguide 6 and a short circuit cavity 7. This short circuit cavity 7 is preferably approximately a quarter of a wavelength long. In particularly the length of the short circuit cavity is optimized according to the input impedance of the probes 1, 2. The amplifier used is preferably of HEMT type. For example, in the usual case of the TE_{11} mode propagating in the waveguide, where it can be assumed that the signal arriving from the satellite via the feed is polarised such that its electric field is perpendicular to probe 1, ideally the signal will appear only at the output of probe 2. In practice, however, if in conventional systems the depth of penetration of the probes 1, 2 is set to provide a 50 ohms output impedance, the distance of the two points E is so close, that due to the coupling between the probes a small amount of the signal will also appear at the output of probe 1. This coupling degrades the cross polarisation of the system. In order to improve the cross polarisation of this system, the penetration depth x is shortened so that the distance between the end points E of the two probes is increased, which reduces the coupling between the probes. This also has the effect of reducing the input impedance of the probes 1, 2. Normally, the signal collected by the probes 1, 2 is amplified using a low noise HEMT amplifier (not shown). To optimise the performance of this amplifier it is necessary to terminate its input with a certain impedance level. For HEMT amplifiers the resistive part of the impedance is less than 50 ohms, typically 20 ohms. This input impedance can be achieved by shortening the penetration depth x of the probes. For this reason a matching network between the probes and the input of the amplifier to optimise the noise performance of the amplifier is not necessary. This has the advantage that the network loss is omitted and the noise of the receiver is decreased. Further to improve the performance of the amplifier the length of the short circuit cavity should be properly adjusted. The probes are not restricted to probes etched on a microwave substrate, but any type of probe system in a circular waveguide is possible.

Claims

1. Microwave polariser for coupling energy between a waveguide (6) and two transmission lines (3, 4), each transmission line being connected at one end without matching circuit to a low noise amplifier and at the other end to a probe, wherein the two probes (1, 2) are arranged orthogonally in a plane orthogonal to the axis of said waveguide and penetrate a length x into said waveguide, **characterised in that** said low noise amplifiers are HEMT amplifiers having a resistive part of the input impedance less than 50 ohms, and that - by increasing the distance between the probe ends (E) - said penetration depth x of each of said probes (1, 2) is set to a value such that the coupling between said probes is reduced and the resulting probe input impedance matches that of said HEMT amplifiers.

2. Microwave polariser according to claim 1, wherein said penetration depth x of each of said probes (1, 2) is set to a value such that the resulting probe impedance corresponds to 20 ohms.

3. Microwave polariser according to claim 1 or 2, wherein said probes (1, 2) are mounted on a common microwave substrate (5).

4. Microwave polariser according to claim 3, wherein said probes (1, 2) are etched on the surface of said microwave substrate (5).

5. Microwave receiving/sending arrangement using a polariser according to one of the claims 1 to 4, wherein the microwave polariser is sandwiched between a circular waveguide (6) and a circular λ/4 short circuit cavity (7).

6. Arrangement according to claim 5, wherein the waveguide (6) is supplied by the feed of an antenna.

Patentansprüche

1. Mikrowellen-Polarisator zum Koppeln von Energie zwischen einem Wellenleiter (6) und zwei Übertragungsleitungen (3, 4), von denen jede mit ihrem einen Ende ohne Anpassungsschaltung mit einem rauscharmen Verstärker und mit ihrem anderen Ende mit einer Sonde verbunden ist, wobei die beiden Sonden (1, 2) orthogonal in einer Ebene orthogonal zu der Achse des Wellenleiters angeordnet sind und mit einer Länge x in den Wellenleiter eindringen, **dadurch gekennzeichnet, dass** die rauscharmen Verstärker HEMT-Verstärker sind, die einen Widerstandsteil der Eingangs-Impedanz von weniger als 50 Ohm haben, und dass - durch Erhöhen des Abstandes zwischen den Sondenenden (E) -

die Eindringtiefe x der beiden Sonden (1, 2) auf einen solchen Wert festgelegt wird, dass die Kopplung zwischen den Sonden vermindert wird und die resultierende Sonden-Eingangs-Impedanz an die des HEMT-Verstärkers angepasst ist.

2. Mikrowellen-Polarisator nach Anspruch 1, bei dem die Eindringtiefe x der beiden Sonden (1, 2) auf einen solchen Wert festgelegt wird, dass die resultierende Sonden-Impedanz 20 Ohm entspricht.

3. Mikrowellen-Polarisator nach Anspruch 1 oder 2, bei dem die Sonden (1, 2) auf einem gemeinsamen Mikrowellen-Substrat (5) angebracht sind.

4. Mikrowellen-Palarisator nach Anspruch 3, bei dem die Sonden (1, 2) auf die Oberfläche des Mikrowellen-Substrats (5) geätzt sind.

5. Mikrowellen-Empfangs/Sende-Anordnung unter Verwendung eines Polarisators nach einem der Ansprüche 1 bis 4, bei der der Mikrowellen-Polarisator sandwichartig zwischen einem kreisförmigen Wellenleiter (6) und einem kreisförmigen Lambda/4-Kurzschluss-Hohlraum (7) angeordnet ist.

6. Anordnung nach Anspruch 5, bei der der Wellenleiter (6) durch die Speisung einer Antenne versorgt wird.

Revendications

1. Polariseur hyperfréquence pour transférer de l'énergie entre un guide d'ondes (6) et deux lignes de transmission (3, 4), chacune des lignes de transmission étant connectée à une extrémité sans circuit d'adaptation à un amplificateur à faible bruit et à l'autre extrémité à une sonde, dans lequel les deux sondes (1, 2) sont perpendiculaires et se trouvent dans un plan perpendiculaire à l'axe dudit guide d'ondes et pénètrent d'une longueur x dans ledit guide d'ondes, **caractérisé en ce que** lesdits amplificateurs à faible bruit sont des amplificateurs HEMT dans lesquels la partie résistive de l'impédance d'entrée est inférieure à 50 ohms et **en ce que** - en augmentant la distance entre les extrémités des sondes (E) - ladite profondeur de pénétration x de chacune desdites sondes (1 , 2) est fixée à une valeur telle que le couplage entre lesdites sondes est réduit et l'impédance d'entrée des sondes qui en résulte s'adapte à celle desdits amplificateurs HEMT.

2. Polariseur hyperfréquence selon la revendication 1, dans lequel ladite profondeur de pénétration x de chacune desdites sondes (1, 2) est fixée à une valeur telle que l'impédance de la sonde qui en résulte correspond à 20 ohms.

3. Polariseur hyperfréquence selon la revendication 1 ou 2, dans lequel lesdites sondes (1, 2) sont montées sur un substrat hyperfréquence commun (5).

4. Polariseur hyperfréquence selon la revendication 3, dans lequel lesdites sondes (1, 2) sont photogravées sur la surface dudit substrat hyperfréquence (5).

5. Structure hyperfréquence de réception/émission utilisant un polariseur selon l'une des revendications 1 à 4, dans laquelle le polariseur est intercalé entre un guide d'ondes circulaire (6) et une cavité en court-circuit cylindrique (7) de longueur $\lambda/4$.

6. Structure selon la revendication 5, dans laquelle le guide d'ondes (6) est alimenté par l'excitation d'une antenne.

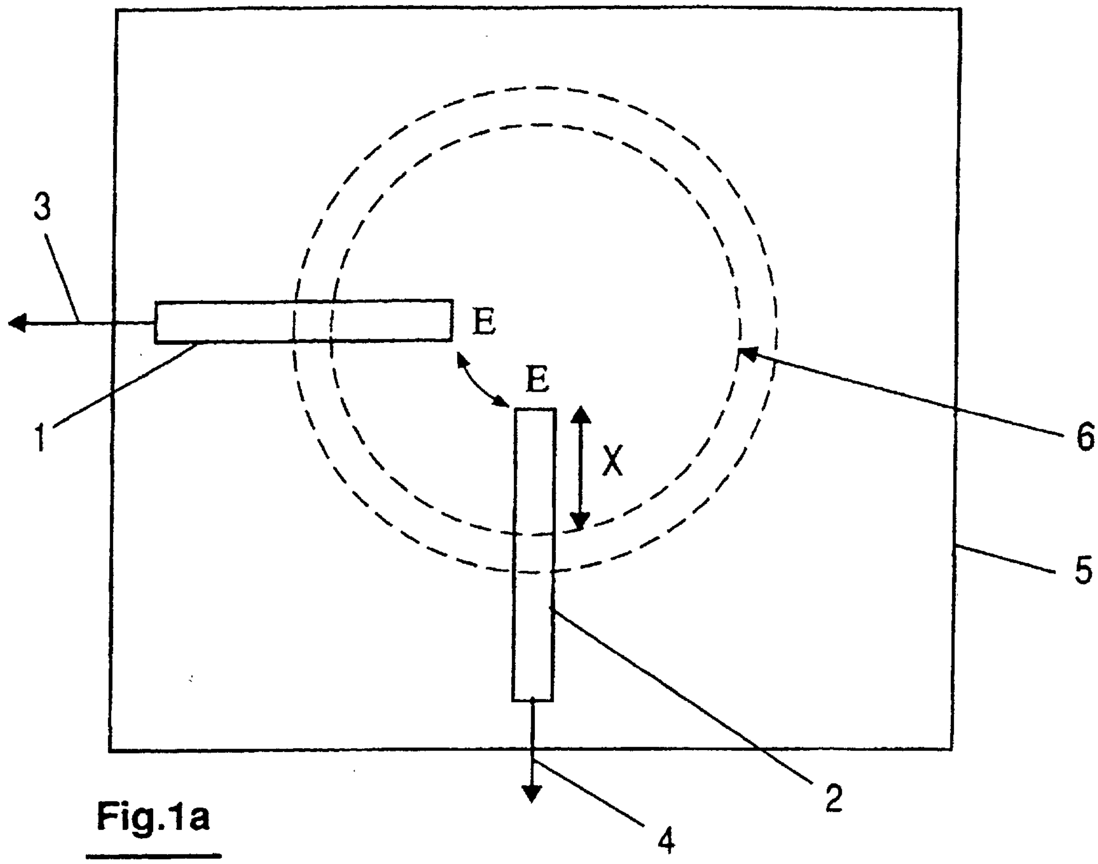

Fig.1a

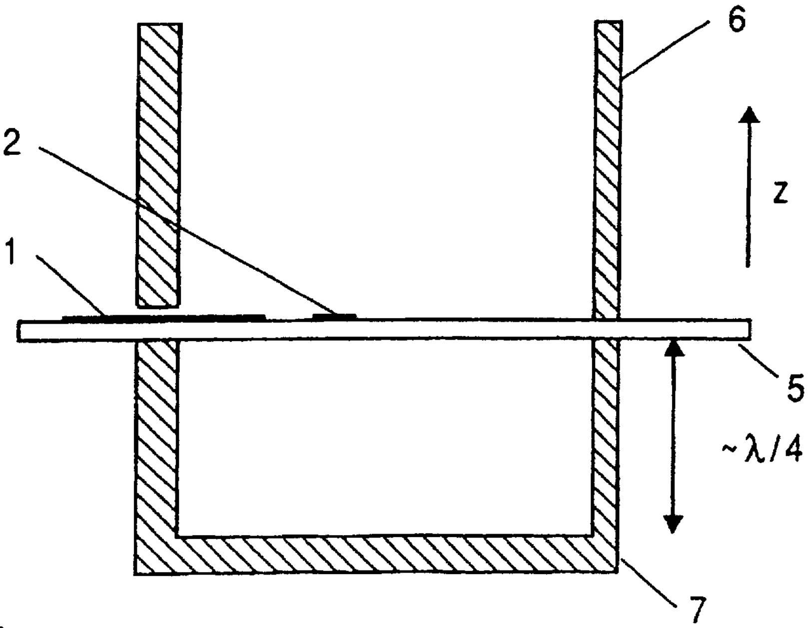

Fig.1b