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Datasheet for the decision of 20 November 2017

Case Number: T 1732/12 - 3.4.01

Application Number: 06821574.8

Publication Number: 1958290

IPC: H01Q9/04, H01Q21/06

Language of the proceedings: EN

Title of invention:
PATCH ANTENNA ELEMENT AND APPLICATION THEREOF IN A PHASED ARRAY ANTENNA

Applicant:
Elta Systems Ltd.

Headword:

Relevant legal provisions:
EPC Art. 54, 56

Keyword:
Novelty - (yes)
Inventive step - (yes)

Decisions cited:

Catchword:

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Case Number: T 1732/12 - 3.4.01

D E C I S I O N
of Technical Board of Appeal 3.4.01
of 20 November 2017

Appellant: (Applicant)	Elta Systems Ltd. 100 Sderot Itzhak Hanasie P.O.B. 330 77102 Ashdod (IL)
Representative:	Vossius & Partner Patentanwälte Rechtsanwälte mbB Siebertstrasse 3 81675 München (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 14 March 2012 refusing European patent application No. 06821574.8 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Assi
Members:	P. Fontenay
	D. Rogers

Summary of Facts and Submissions

I. The examining division refused European patent application No. 06 821 574.

In the "*Reasons*" for the decision under appeal, the examining division held that the subject-matter of claims 1 to 20 of the main request then on file was not new in the sense of Art. 54(1),(2) EPC. Particular reference was made in this respect to document:

(D3) J-C. Cheng et al., "*Theoretical Modeling of Cavity-Backed Patch Antennas Using a Hybrid Technique*", IEEE Transactions on Antennas and Propagation, Vol. 43, No. 9, 1 September 1995, pages 1003-1013.

Moreover, the method of claims 21 to 26 was considered to lack an inventive step in the sense of Art. 56 EPC.

An appellant's auxiliary request was not admitted into the examination procedure under R. 137(3) EPC.

II. The appellant (applicant) filed an appeal against the decision.

With the grounds of appeal, the appellant requested interlocutory revision by the Examining Division under Art. 109 EPC with regard to a new set of claims according to a main request. In case the decision under appeal was not rectified, the appellant requested that the decision be set aside and a patent be granted with claims enclosed with the grounds of appeal according to said main request or auxiliary requests 1 to 4.

III. The decision under appeal was not rectified. The case was referred to the Board.

IV. In a phone conversation on 14 September 2017, the attention of the appellant was drawn to a contradiction between claim 1 and a dependent claim of the main request. A similar discrepancy existed between two passages in the description.

V. In a letter dated 20 October 2017, an amended set of claims 1 to 19 according to a new main request was filed. An amended page 19 of the description was also filed.

Whereas claim 1 of the main request underlying the impugned decision concerned a patch antenna element as such, claim 1 of the new main request relates to a phased array antenna comprising a plurality of patch antenna elements.

VI. Claim 1 of the main request reads:

"*1. A phased array antenna (90) comprising a plurality of patch antenna elements (20) spaced apart at a predetermined distance from each other comprised between λ/2 and λ, λ being an operative wavelength of the phased array antenna; and a beam steering system (91) configured for steering an energy beam produced by said phased array antenna (90), the patch antenna element comprising:*

a conductive ground plane (21) having a cavity (22) recessed therein and defining a cavity aperture (221),

a radiating patch (23) backed by the cavity (22) and arranged in the cavity aperture, wherein the radiating patch (23) and the cavity aperture (221) have

similar symmetrical shapes, the radiating patch (23) being centered in the cavity aperture (221) and

a feed arrangement (24) coupled to the radiating patch (23) at a feed point (25) located within the patch (23) at a predetermined distance (S) from a center of the patch and operable to provide radio frequency energy thereto;

characterized in that the patch antenna element (20) is configured such that:

(i) a dimension of the radiating patch (23) along an E-plane defined as a plane perpendicular to the radiating patch (23) and passing through a center (O) of the patch (23) and the feed point (25), is less than the dimension of the cavity aperture (221) along the E-plane by a first predetermined value V1;

(ii) a dimension of the radiating patch (23) along an H-plane defined as a plane perpendicular to the E-plane and passing through the feeding point (25), is less than the dimension of the cavity aperture (221) along the H-plane by a second predetermined value V2;

the first and second predetermined values V1, V2 being selected to provide a predetermined asymmetrical radiation pattern of the patch antenna element enabling that the grating lobes of the phased array antenna are substantially suppressed."

Claims 2 to 17 of the main request depend on claim 1.

Independent claim 18 of the main request reads:

"*18. A method for configuring a symmetrical patch antenna element with a predetermined asymmetrical radiation pattern enabling that grating lobes of a phased array antenna comprising a plurality of said*

symmetrical patch antenna elements (20) spaced apart at a predetermined distance from each other comprised between λ/2 and λ, λ being an operative wavelength of the phased array antenna, are substantially suppressed, the method comprising :

providing a conductive ground plane (21) having a cavity (22) recessed therein and defining a cavity aperture (221),

providing a radiating patch (23) backed by the cavity (22) and arranged in the cavity aperture, wherein the radiating patch (23) and the cavity aperture (221) have similar symmetrical shapes, the radiating patch (23) being centered in the cavity aperture (221) and

providing a feed arrangement (24) coupled to the radiating patch (23) at a feed point (25) located within the patch (23) at a predetermined distance (S) from a center of the patch and operable to provide radio frequency energy thereto;

setting a dimension of the radiating patch (23) along an E-plane defined as a plane perpendicular to the radiating patch (23) and passing through a center (O) of the patch (23) and the feed point (25), less than the dimension of the cavity aperture (221) along the E-plane by a first predetermined value V1;

setting a dimension of the radiating patch (23) along an H-plane defined as a plane perpendicular to the E-plane and passing through the feeding point (25), less than the dimension of the cavity aperture (221) along the H-plane by a second predetermined value V2."

Claim 19 of the main request refers to a "*method of suppressing grating lobes generated in a radiating pattern of a phased array antenna*", the method comprising *inter alia* a step of obtaining a "*symmetrical patch antenna element with a predetermined*

asymmetrical radiation pattern according to the method of claim 18".

The claims of auxiliary requests 1 to 4 are not relevant for the present decision and are therefore not reproduced herewith.

Reasons for the Decision

1. The appeal is admissible.

2. *Main request - Art. 84 EPC*

There are no objections under Art. 84 EPC.

3. *Main request - Art. 123/2) EPC*

3.1 Claim 1 of the main request results primarily from a combination of original claim 22 relating to a phased array antenna comprising a plurality of patch antenna elements and the definition of original claim 1 regarding the configuration of such patch antenna elements.

Present claim 1 further includes the indication that the plurality of patch antenna elements are spaced apart at a predetermined distance from each other comprised between $\lambda/2$ and λ, λ being an operative wavelength of the phased array antenna, as recited on page 5, lines 14, 15, of the description as published.

The features of claim 1 regarding the shape of the radiating patch and the cavity element, their relative positioning and their dimensions derive from original claims 2 to 4 and the passage of the description from page 13, line 29 to page 14, line 15.

3.2 The method according to independent claim 18 results from original claim 25 relative to the method of suppressing grating lobes and the passage of the description on page 5, line 16 to page 6, line 12 and page 8, lines 3 to 10 of the published application. It is observed, in this respect, that the method of suppressing grating lobes indeed entails the elaboration of the patch antenna elements which will allow such suppression when appropriately combined in an array. Since the effect to be achieved by the array in which the element shall be incorporated is indeed reproduced as the intended purpose of the claimed configuring method, the conditions of Art. 123(2) are met.

3.3 Claim 19 finds its basis in original claim 25 and the various passages and claims of the published application considered to provide a sufficient support for current claim 1.

3.4 The dependent claims do not give cause for any concern.

3.5 Therefore, the requirements of Art. 123(2) EPC are met.

4. *Main request - Art. 54(1),(2) EPC*

4.1 The disclosure of document D3 was regarded by the examining division as being novelty destroying for the subject-matter of claim 1 of the main request underlying the impugned decision. In particular, the examining division held that the radiation pattern disclosed in D3 was asymmetric, as required by claim 1.

Document D3, however, does not provide any details as to the radiation patterns which could be obtained from

a plurality of patch elements combined in an antenna array configuration. There is accordingly no teaching that a plurality of patch elements combined in an antenna array and spaced apart at a predetermined distance from each other comprised between λ/2 and λ, λ defining the operating wavelength of the antenna, would contribute to suppressing grating lobes of the antenna array.

The thus identified distinguishing feature derives from the structural features of the patch antenna elements constituting the claimed phased array antenna and, more specifically, from the fact that the first and second predetermined values, V1 and V2, have been selected so as to provide a predetermined asymmetrical radiation pattern.

In the context of the present application, the notions of symmetry or asymmetry are to be understood with regard to the drift of the beam squint angle (the angle corresponding to the midpoint of the 3 dB beam width) with regard to the bore-sight axis. This interpretation is the only one which appears to be consistent with the fact that the rate of asymmetry of the element pattern is expressed in the description in degrees (cf. page 11, lines 5,6). It also reflects the meaning associated to this notion in the prior art relied upon by the applicant in the original application (cf. page 4) by reference to document D0 (US-A-5 006 857).

Moreover, although not explicitly reproduced in the wording of the independent claims, this interpretation of the notion of symmetry appears to be the only one making sense in the context of the current application. The alternative approach consisting in associating this notion with the fact that the radiation pattern of an

antenna element would be perfectly symmetrical with regard to the bore-sight axis should thus be excluded in that it would not be consistent with the intended purpose of the claimed invention to suppress the grating lobes.

4.2 None of the other available documents discloses a phased array antenna according to claim 1. The same applies *mutatis mutandis* to the method claims 18 and 19.

4.3 The subject-matter of claims 1, 18 and 19 is thus new in the sense of Art. 54(1),(2) EPC.

5. *Main request - Art. 56 EPC*

5.1 Document D3 discloses a theoretical simulation model of a cavity-backed patch antenna element. The model discussed in D3 is analysed with known Finite Element Methods (FEM) and confirms the asymmetry of the electromagnetic field within the cavity of such antenna.

D3 is however silent as to the possibility which might result from the association within a phased array antenna of such patch elements. There is no hint that such a combination of elements could possibly lead to the suppression of grating lobes. There is, in particular, no mention that the dimensions of the radiating patch relative to the dimensions of the cavity would contribute to the manufacturing of an array antenna deprived of grating lobes when a certain condition regarding the distance separating the various patch elements within the array with regard to the operating frequency is met.

For these reasons, D3 does not appear to define an adequate item of prior art when deciding on the inventive merits of the claimed inventions.

5.2 Document D0, acknowledged by the applicant in the application, discloses a microstrip antenna structure made of a plurality of individual antenna elements in the form of asymmetrical triangular patches, each antenna element consisting of a ground plate separated from a radiating antenna element by a dielectric layer (cf. column 1, lines 7-12; column 4, lines 29-42). The radiation pattern of an individual antenna element is not symmetrical and includes a maximum at approximately 10 degrees forward of bore-sight (cf. Figure 7; column 4, lines 43-51).

Document D0 relates to a phased array antenna and shares with the claimed invention the basic concept of using individual radiation elements with asymmetrical radiation patterns. It is therefore considered to reflect the closest prior art.

The claimed array antenna differs from this known antenna structure by the configuration of the individual patch elements it incorporates. More concretely, the claimed array antenna differs from the antenna of D0, for the essential, in that:
- the radiating patch is arranged in a cavity of the ground plane;
- the radiation patch and the cavity aperture have similar symmetrical shapes, the patch being centered in the cavity;
- the dimensions of the radiating patch relative to the cavity aperture are such as to provide a predetermined asymmetrical radiation pattern of the individual

element enabling suppression of the grating lobes of the phased array antenna; and
- the individual antenna elements are separated from each other by a distance between λ/2 and λ, λ being the operating frequency.

The claimed phased array antenna may be easily and efficiently manufactured. It thus avoids a complex and lengthy manufacturing process.

None of the documents available discloses or hints at the claimed structure and geometry. For this reason, it would not be obvious for the skilled person to arrive at the claimed subject-matter.

5.3 Therefore, the claimed phased antenna array of claim 1 is considered to be inventive in the sense of Art. 56 EPC. The same conclusion applies *mutatis mutandis* to method claims 18 and 19.

6. Consequently, the main request is allowable.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent with claims 1 to 19 filed with letter of 20 October 2017 as a new main request and a description to be adapted thereto.

The Registrar: The Chairman:

L. Stridde G. Assi

Decision electronically authenticated