

PATENT COOPERATION TREATY

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**WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY**
(PCT Rule 43*bis*.1)

To:

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FOR FURTHER ACTION
See paragraph 2 below

International application No.
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International Patent Classification (IPC) or both national classification and IPC
INV. H01Q1/24 H01Q1/27 H01Q1/44 H01Q13/16

Applicant
APPLE INC.

1. This opinion contains indications relating to the following items:

- Box No. I Basis of the opinion
- Box No. II Priority
- Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- Box No. IV Lack of unity of invention
- Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- Box No. VI Certain documents cited
- Box No. VII Certain defects in the international application
- Box No. VIII Certain observations on the international application


2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will usually be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA:



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see form
PCT/ISA/210

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Box No. I Basis of the opinion

1. With regard to the **language**, this opinion has been established on the basis of:
 - the international application in the language in which it was filed.
 - a translation of the international application into , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1 (b)).
2. This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43bis.1(a))
3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
 - a. forming part of the international application as filed:
 - in the form of an Annex C/ST.25 text file.
 - on paper or in the form of an image file.
 - b. furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
 - c. furnished subsequent to the international filing date for the purposes of international search only:
 - in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
 - on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
4. In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
5. Additional comments:

Box No. V Reasoned statement under Rule 43bis.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes: Claims	<u>3-5, 7, 15-18, 20</u>
	No: Claims	<u>1, 2, 6, 8-14, 19</u>
Inventive step (IS)	Yes: Claims	<u>3, 4, 17, 20</u>
	No: Claims	<u>1, 2, 5-16, 18, 19</u>
Industrial applicability (IA)	Yes: Claims	<u>1-20</u>
	No: Claims	

2. Citations and explanations

see separate sheet

Box No. VII Certain defects in the international application

The following defects in the form or contents of the international application have been noted:

see separate sheet

Box No. VIII Certain observations on the international application

The following observations on the clarity of the claims, description, and drawings or on the question whether the claims are fully supported by the description, are made:

see separate sheet

Re Item V

Reasoned statement with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1 Reference is made to the following documents:

- D1 US 2017/077603 A1 (KROGERUS JOONAS [FI]) 16 March 2017 (2017-03-16)
- D2 US 8 269 675 B2 (KOUGH DOUGLAS B [US]; SPRINGER GREGORY A [US]; CHIANG BING [US]; AYALA VAZQUEZ ENRIQUE [US]; XU HAO [US]; APPLE INC [US]) 18 September 2012 (2012-09-18)
- D3 US 2014/240176 A1 (TOLBERT WILLIAM HAYWOOD [US] ET AL) 28 August 2014 (2014-08-28)
- D4 US 2016/309007 A1 (IRCI ERDING [US] ET AL) 20 October 2016 (2016-10-20)
- D5 CN 104 638 361 A (SHANGHAI AMPHENOL AIRWAVE COMM ELECTRONICS CO LTD) 20 May 2015 (2015-05-20)
- D6 US 2015/351292 A1 (CHANG ALVIN T [US] ET AL) 3 December 2015 (2015-12-03)
- D7 US 2015/280771 A1 (MOW MATTHEW A [US] ET AL) 1 October 2015 (2015-10-01)

2 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 1, 6, 8-12, 19 is not new in the sense of Article 33(2) PCT.

2.1 **Regarding independent claim 1:**

2.1.1 D1 discloses an electronic device, comprising:

- a housing having metal housing walls (**figure 8 and paragraph [0043]: "The device body 103 in FIG. 8 may comprise a conductive ring around the circumference/ border of a device 100"**);
- a display cover layer (**implicit feature for a device as disclosed in D1, see paragraph [0019] of D1**);
- a display module that is overlapped by the display cover layer and that includes conductive display structures (**derived from paragraph [0044]: "a non-conductive gap may be formed between conductive ring and display or a structure supporting the display"**);
- an antenna feed for a slot antenna having a first feed terminal coupled to the conductive display structures and a second feed terminal coupled to the metal housing walls (**figure 8 elements 113, 113', 114, 114'; derived from paragraph [0044]: "This gap may be segmented into slots by grounding components 115,116,115', 116'" and "any of grounding components 115,116,115' or 116' may be configured at a distance from the open ends of slots 108,109,108', 109' respectively so as to form suitable resonance lengths for corresponding antenna feeds"**); and
- a conductive interconnect structure coupled to the metal housing walls, wherein the metal housing walls, the conductive display structures, and the conductive interconnect structure define a perimeter of a slot element for the slot antenna (**derived from paragraph [0043]: "gap may be segmented into slots by grounding components 115,116,115', 116'"**).

As a consequence, the subject-matter of claim 1 is not novel within the meaning of Article 33(2) PCT with respect to D1.

- 2.1.2 D2 (**figures 14-15; paragraph [0064]: "antenna 26 may be formed from a gap or space between conductive housing 12 and conductive internal frame 15 of electronic device 10 [...] Housing 12 may be formed from metal or another conductive material. Internal frame 15 may be, for**

example, a frame that is used to form a structural support for display 14 [...] Conductive materials 82 may help electrically connect housing 12 to internal frame 15 so that gap 84 forms a closed slot"), D3 (figures 3, 4A, 4B and paragraphs [0016]-[0017], [0021]-[0025]), D4 (figure 3 and paragraphs [0029], [0054], [0057]) and D5 (figures 1-3 and paragraphs [0035]-[0041], [0044]-[0045]) also disclose the features of claim 1. As a consequence, the subject-matter of claim 1 is not novel within the meaning of Article 33(2) PCT with respect to D2, D3, D4 and D5.

2.2 **Regarding independent claim 13**, notwithstanding the lack of clarity of claim 13 (see point VIII,), D5 discloses An electronic device, comprising:

- a conductive housing (**figures 1 and 2 element 1 and paragraph [0035] "1-metal frame"**);
- a display mounted (**figure 1 element 2 and figure 2 elements 21-22; paragraph [0035]: "2-display [...] 21-transparent dielectric layer, 22-metal shield of display"**) to the conductive housing;
- a printed circuit configured to convey data to the display (**figure 2 element 3 and paragraph [0035]: "3-PCB board"; figure 2 element 8 is the connection member; paragraph [0041]**); and
- a conductive structure that shorts a conductive trace on the printed circuit to the conductive housing (**figure 3 and paragraph [0045]: "the grounding portion [...] can be used to ensure short-circuit contact between the metal frame and the PCB board"**), wherein the display, the conductive housing, and the conductive structure form edges of a slot element of a slot antenna (**derived from the fact that the arrangement is the same as claimed and as in the description: the conductive structure shorts the conductive housing to the printed circuit, said printed circuit is connected to a conductive structure of the display through a connecting component**).

As a consequence, the subject-matter of claim 13 is not novel within the meaning of Article 33(2) PCT with respect to D5.

2.3 **Regarding independent claim 19**, D1 (paragraph [0019]) discloses that "The present embodiments are suitable for application in a variety of different types of devices, for example, in tablets, phablets, computers, cameras, game consoles, small laptop computers, **smart watches**...". Hence, D1 discloses A wristwatch , comprising:

- a conductive housing having first, second, third, and fourth sidewalls (**figure 8 and paragraph [0043]**);
- a display having a display module (**derived from paragraph [0044]**) and a display cover layer (**implicit feature**), wherein at least a portion of the display module is configured to emit light through the display cover layer (**implicit feature**);
- a conductive structure (**figure 8 elements 112', 113', 114' extend between the display and the bottom wall**) that extends between the display module and the fourth sidewall; and
- a slot antenna, wherein the slot antenna comprises a slot element having a first segment (**figure 8 elements 113, 114, 112 extend between the display and the top wall**) extending between the first sidewall and the display module, a second segment (**figure 8 element 115 extends between the display and the left wall**) extending between the second sidewall and the display module, and a third segment (**figure 8 element 116 extends between the display and the right wall**) extending between the third sidewall and the display module.

As a consequence, the subject-matter of claim 19 is not novel within the meaning of Article 33(2) PCT with respect to D1.

2.4 D1 further discloses the features of the following dependent claims:

- 8 (figure 8 element 113, 113', 114, 114');

- 9 (derived from paragraph [0044]: " a non-conductive gap may be formed between conductive ring and display or a structure supporting the display (not illustrated in FIG. 8). This gap may be segmented into slots by grounding components 115,116,115', 116'");
- 10 (derived from paragraph [0043]: "Grounding components 115,116,115', 116' electrically ground the conductive ring to a PWB 105. The grounding components may be, for example, wiring connects, conductive adhesive, soldered connects...");
- 11 (paragraph [0043]: "The grounding components may be, for example, wiring connects, **conductive adhesive**...");
- 12 (figure 8 elements 110, 110', 111, 111').

As a consequence, the subject-matter of claims 8-12 is not novel within the meaning of Article 33(2) PCT with respect to D1.

2.5 D2 further discloses the features of the following dependent claims:

- 6 (paragraph [0064]: "Internal frame 15 may be, for example, a frame that is used to form a structural support for display 14 ");
- 8 (figures 14, 15 elements 60, 62; paragraph [0064]: "Antenna 26 may be fed by positive feed terminal 60 and negative feed terminal 62 that are positioned on either side of gap 84");
- 9 (derived from paragraph [0064]: "Conductive materials 82 may help electrically connect housing 12 to internal frame 15");

As a consequence, the subject-matter of claims 6, 8-9 is not novel within the meaning of Article 33(2) PCT with respect to D2.

2.6 D5 further discloses the features of the following dependent claims:

- 2 (paragraph [0045]: "the grounding portion is set as a spring pin, and the tension of the spring can be used to ensure short-circuit contact between the metal frame and the PCB board");
- 14 (figure 3 element 9)

As a consequence, the subject-matter of claims 2, 14 is not novel within the meaning of Article 33(2) PCT with respect to D5.

- 3 The present application does not meet the criteria of Article 33(1) PCT, because the subject-matter of claims 5, 7, 15, 16 does not involve an inventive step in the sense of Article 33(3) PCT.
- 3.1 Regarding claims 5 and 16, it is known from the prior art (e.g. D5) to form a slot antenna between conductive structures of the display and the conductive display.
D6 (figure 3 elements 40 and 126; column 1 lines 47-51; column 1 line 25-column 6 line 25) discloses that a near-field communication antenna formed of metal traces may be mounted under a display layer.
In view of the combination of D1-D5 and D6, it would be obvious that the NFC antenna of D6 provide a conductive structure which allows to form a slot antenna between the display and the conductive housing.
As a consequence, the subject-matter of claims 5 and 16 does not involve an inventive step (Article 33(3) PCT).
- 3.2 Regarding claim 7, D1-D5 disclose a slot antenna provided between conductive structures of the display and the conductive housing. Adapting a slot to operate on two frequencies is an obvious possibility known to the skilled person (see for example figure 23 of D7).
As a consequence, the subject-matter of claim 7 does not involve an inventive step (Article 33(3) PCT).
- 3.3 Regarding claim 15, in view of the device to which the disclosure of D5 relates (smart watch), it would be obvious to have a display that comprises pixel circuitry that is configured to receive data from the printed circuit and to emit light corresponding to the data.
As a consequence, the subject-matter of claim 15 does not involve an inventive step (Article 33(3) PCT).
- 3.4 Regarding claim 18, D5 discloses a housing and a display of round shapes and, as such, D5 does not disclose a plurality of sides for the display module. However, in view of D1, it would be an obvious alternative to select a square shape for the display and the housing side walls as well as a slot that extends

between at least three sides.

As a consequence, the subject-matter of claim 18 does not involve an inventive step (Article 33(3) PCT).

- 4 Regarding claims 3 and 17, none of the available art discloses a conductive interconnect structure comprising a plurality of branches (as in figure 12 and paragraph [0090] of the description).
Hence, the subject-matter of claims 3 and 17 are novel within the sense of Article 33(2) PCT.
Paragraph [0090] of the description mentions: "conductive interconnect structure 174 may include a first branch 226-1, a second branch 226-2, and a third branch 226-3. **While the use of different branches may reduce the amount of space required to form interconnect structure 174 in device 10, in another suitable arrangement, each of the branches may be formed as a part of a single continuous (e.g., planar) conductor**". It is not apparent how the use of different branches may reduce the amount of space required to form interconnect structure. However, provided the above-mentioned technical effect (reduction of the space required to form the interconnect structure) is recognized, the subject-matter would involve an inventive step within the sense of Article 33(3) PCT.
- 5 Claim 4 is dependent on claim 3 and, as such, also meets the requirements of Article 33(1) PCT.

Re Item VII

Certain defects in the international application

- 6 The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).
- 7 Contrary to the requirements of Rule 5.1(a)(ii) PCT, the relevant background art disclosed in D1-D5 is not mentioned in the description, nor are these documents identified therein.

Re Item VIII

Certain observations on the international application

- 8 The application does not meet the requirements of Article 6 PCT, because claims 2, 13 and 20 are not clear.
- 8.1 Independent claim 13 defines a display. Claim 13 further defines that said display forms edges of a slot element of a slot antenna. In view of the description, it is apparent that, in order to form part of the edges of the slot, the display requires conductive structures (conductive display structures). However, claim 13 fails to define that the display includes conductive structures.
Hence, claim 13 lacks essential features (Article 6 PCT).
- 8.2 Claim 13 defines that "a conductive structure that shorts a conductive trace on the printed circuit to the conductive housing". Claim 13 further defines that "the display, the conductive housing, and the conductive structure form edges of a slot element of a slot antenna".
The claim attempts to define the subject-matter in terms of the result to be achieved ("**the display, the conductive housing, and the conductive structure form edges of a slot element of a slot antenna**"), which merely amounts to a statement of the underlying problem, without providing the technical features necessary for achieving this result.
Hence, claim 13 fails to meet the requirements of Article 6 PCT.
The same objection applies to claim 2.
Hence, claim 2 also fails to meet the requirements of Article 6 PCT.
Indeed, it is not apparent how the display can form part of a slot antenna element as defined in claim 13. According to the description, the interconnect structure may be in direct contact with the display conductive structure (paragraph [0071] or capacitively coupled [0074] to the display conductive structure. Paragraph [0075] mentions a third alternative wherein "conductive interconnect structures 174 may be located far enough away from display module 140 so that interconnect structures 174 are not capacitively coupled to the conductive material in display module 140. In this scenario, because interconnect structure 174 is held at a ground potential (e.g., because interconnect structure 174 shorts ground structures in display flexes 156 to grounded housing wall 1 2W), interconnect structure 174 may electrically define edges of slot 104 despite not actually being in contact with or capacitively coupled to conductive display structures 110 in module 140".

As a consequence, not even the description provides means for forming the edges of the slot antenna between the conductive trace on the printed circuit and the display.

- 8.3 Claim 20 defines "The electronic device defined in claim 19, wherein **the second segment of the slot element extends between an end of the first segment and an end of the second segment** and the conductive structure defines portions of the first and third segments of the slot element." Such a definition does not meet the requirements of Article 6 PCT as it is not consistent with the subject-matter of claim 20.

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