



US011631940B2

(12) **United States Patent**
Takahashi et al.

(10) **Patent No.:** **US 11,631,940 B2**
(45) **Date of Patent:** **Apr. 18, 2023**

- (54) **WAVEGUIDE SLOT ANTENNA**
- (71) Applicant: **NGK SPARK PLUG CO., LTD.**,
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- (72) Inventors: **Hiroyuki Takahashi**, Nagoya (JP);
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- (73) Assignee: **NGK SPARK PLUG CO., LTD.**,
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- (*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 279 days.

(58) **Field of Classification Search**
CPC H01Q 13/10; H01Q 21/005; H01Q
21/0043
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS
5,055,852 A * 10/1991 Dusseux H01Q 9/0414
343/846
9,099,789 B1 * 8/2015 Modro H01Q 1/48
(Continued)

FOREIGN PATENT DOCUMENTS
JP 2005-051330 A 2/2005
JP 2005-051331 A 2/2005
(Continued)

- (21) Appl. No.: **17/055,001**
- (22) PCT Filed: **Nov. 1, 2019**
- (86) PCT No.: **PCT/JP2019/043126**
§ 371 (c)(1),
(2) Date: **Nov. 12, 2020**
- (87) PCT Pub. No.: **WO2020/110610**
PCT Pub. Date: **Jun. 4, 2020**

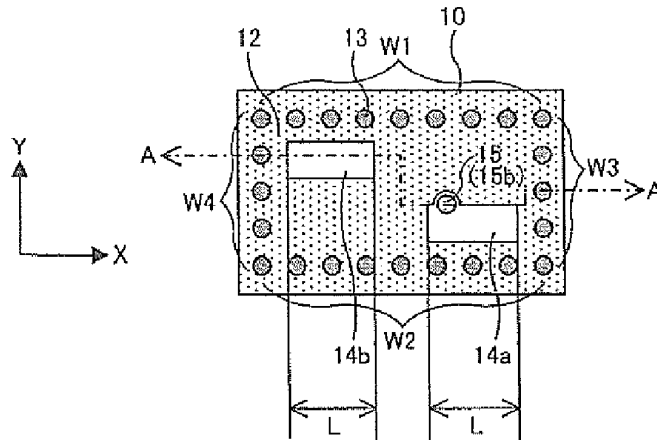
OTHER PUBLICATIONS
Han et al.; Low-Cost Wideband and High-Gain Slotted Cavity
Antenna Using High-Order Modes for Millimeter-Wave Applica-
tion; IEEE Transactions on Antennas and Propagation, vol. 63, No.
11, Nov. 2015 (Year: 2015)*
(Continued)

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(74) *Attorney, Agent, or Firm* — Stites & Harbison,
PLLC; Jeffrey A. Haeberlin

- (65) **Prior Publication Data**
US 2021/0265736 A1 Aug. 26, 2021
- (30) **Foreign Application Priority Data**
Nov. 26, 2018 (JP) JP2018-220670

(57) **ABSTRACT**
A waveguide slot antenna is configured by a waveguide,
formed by a dielectric substrate, a first conductive layer
formed at a lower surface of the dielectric substrate, a
second conductive layer formed at an upper surface of the
dielectric substrate and provided with one or a plurality of
slots, and a pair of side wall parts electrically connecting the
first and second conductive layers and extending in a first
direction, being provided with a power feeding part. The one
or a plurality of slots include a first slot having a predeter-
mined slot length along the first direction. The waveguide
slot antenna has a structure in which, on a plan view from
a second direction, the power feeding part overlaps the first
(Continued)

- (51) **Int. Cl.**
H01Q 13/10 (2006.01)
H01Q 13/22 (2006.01)
H01Q 21/00 (2006.01)
- (52) **U.S. Cl.**
CPC **H01Q 13/10** (2013.01); **H01Q 13/22**
(2013.01); **H01Q 21/0043** (2013.01)





US011631943B2

(12) **United States Patent**
Hsu et al.

(10) **Patent No.:** **US 11,631,943 B2**
(45) **Date of Patent:** **Apr. 18, 2023**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE USING SAME**

USPC 343/702
See application file for complete search history.

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(56) **References Cited**

U.S. PATENT DOCUMENTS

(72) Inventors: **Cho-Kang Hsu**, New Taipei (TW);
Min-Hui Ho, New Taipei (TW)

8,259,015 B2 * 9/2012 Wu H01Q 5/40 343/702
2013/0088397 A1 * 4/2013 Mo H01Q 1/44 343/702

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

FOREIGN PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 37 days.

CN 105514604 A 4/2016
CN 110380197 A 10/2019
TW 201929320 A 7/2019
TW 201947814 A 12/2019

(21) Appl. No.: **17/523,073**

* cited by examiner

(22) Filed: **Nov. 10, 2021**

Primary Examiner — Andrea Lindgren Baltzell
(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(65) **Prior Publication Data**

US 2022/0166150 A1 May 26, 2022

(57) **ABSTRACT**

(30) **Foreign Application Priority Data**

Nov. 25, 2020 (CN) 202011338097.9

An antenna structure applied in a wireless communication device includes a frame, a first feed portion, a second feed portion, and a ground portion. The frame defines at least a first gap and a second gap. The first gap and the second gap collectively divide the frame into a first radiation portion and a second radiation portion. The first feed portion is electrically connected to the first radiation portion and a first signal feed point for feeding currents and signals to the first radiation portion. The second feed portion is electrically connected to the second radiation portion and a second signal feed point for feeding currents and signals to the second radiation portion. When the first radiation portion and the second radiation portion supply currents, respectively, the first radiation portion and the second radiation portion generate radiation signals in at least one same frequency band.

(51) **Int. Cl.**

H01Q 21/28 (2006.01)
H01Q 1/24 (2006.01)
H01Q 3/24 (2006.01)
H01Q 5/371 (2015.01)

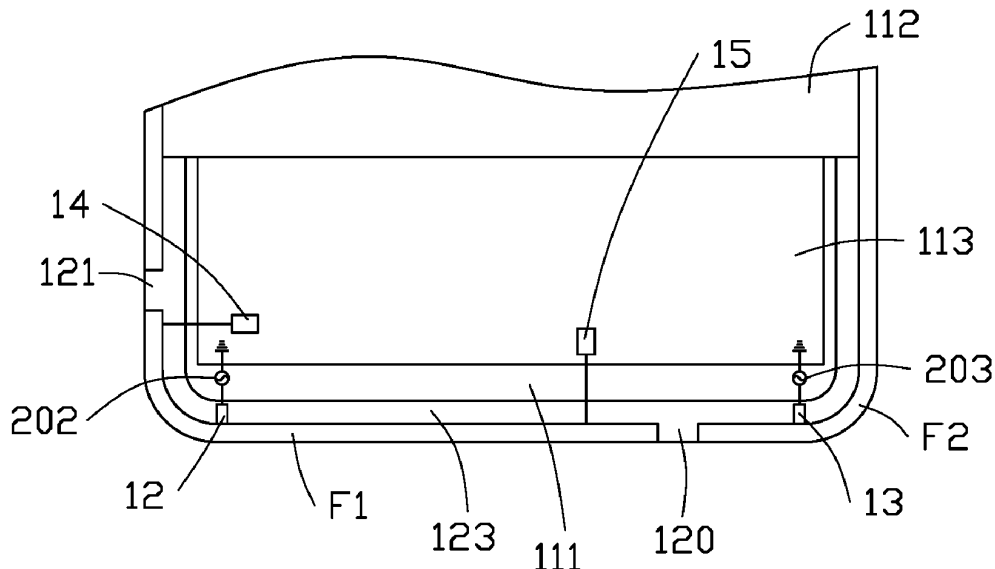
(52) **U.S. Cl.**

CPC **H01Q 21/28** (2013.01); **H01Q 1/241** (2013.01); **H01Q 3/24** (2013.01); **H01Q 5/371** (2015.01)

(58) **Field of Classification Search**

CPC H01Q 21/28; H01Q 5/37; H01Q 1/24; H01Q 3/24

17 Claims, 13 Drawing Sheets





US011637361B2

(12) **United States Patent**
Chen et al.

(10) **Patent No.:** **US 11,637,361 B2**
(45) **Date of Patent:** **Apr. 25, 2023**

(54) **ANTENNA STRUCTURE AND WIRELESS COMMUNICATION DEVICE**

(71) Applicant: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(72) Inventors: **Yung-Chin Chen**, New Taipei (TW);
Kun-Lin Sung, New Taipei (TW);
Yi-Chieh Lee, New Taipei (TW)

(73) Assignee: **Chiun Mai Communication Systems, Inc.**, New Taipei (TW)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 318 days.

(21) Appl. No.: **17/106,347**

(22) Filed: **Nov. 30, 2020**

(65) **Prior Publication Data**

US 2021/0218130 A1 Jul. 15, 2021

(30) **Foreign Application Priority Data**

Jan. 14, 2020 (CN) 202010037127.6

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 13/10 (2006.01)
H01Q 5/378 (2015.01)
H01Q 1/48 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 1/243** (2013.01); **H01Q 1/48** (2013.01); **H01Q 5/378** (2015.01); **H01Q 13/10** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/48; H01Q 5/378; H01Q 13/10

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2015/0372372 A1*	12/2015	Lee	.....	H01Q 1/243
				343/702
2018/0026335 A1*	1/2018	Lee	.....	H01Q 1/242
				343/702
2018/0026354 A1*	1/2018	Lin	.....	H01Q 5/335
				343/702
2019/0181552 A1*	6/2019	Lee	.....	H01Q 3/247
2021/0126349 A1*	4/2021	Zhou	.....	H01Q 1/243

FOREIGN PATENT DOCUMENTS

CN	205543232 U	8/2016
CN	107645042 A	1/2018
CN	110661082 A	1/2020

* cited by examiner

Primary Examiner — Andrea Lindgren Baltzell

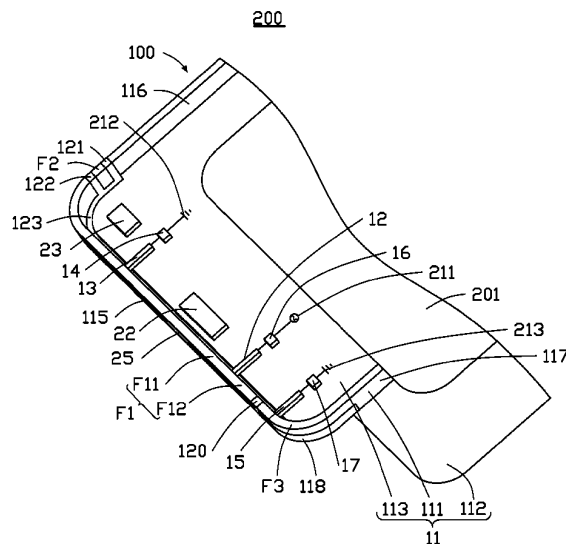
Assistant Examiner — Amal Patel

(74) *Attorney, Agent, or Firm* — ScienBiziP, P.C.

(57) **ABSTRACT**

An antenna structure includes a metal frame, a feeding portion, and a first ground portion. The metal frame is provided with a slot, a first gap, a second gap, and a third gap. The first gap, the second gap, and the third gap are coupled to the slot, and the slot, the first gap, the second gap, and the third gap divide the metal frame into a radiating portion and a first coupling portion. A portion of the metal frame between the first gap and the third gap form the radiating portion, and a portion of the metal frame between the second gap and the third gap form the first coupling portion. The feeding portion is electrically coupled to the radiating portion to feed an electric signal to the radiating portion. The first ground portion is electrically coupled to the radiating portion to provide ground to the radiating portion.

12 Claims, 7 Drawing Sheets





US011637375B2

(12) **United States Patent**
Zhao et al.

(10) **Patent No.:** **US 11,637,375 B2**
(45) **Date of Patent:** **Apr. 25, 2023**

(54) **ANTENNA STRUCTURE AND ELECTRONIC DEVICE**

(71) Applicant: **BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.**, Beijing (CN)

(72) Inventors: **Yarui Zhao**, Beijing (CN); **Mingming Zhou**, Beijing (CN); **Yuchuan Su**, Beijing (CN)

(73) Assignee: **BEIJING XIAOMI MOBILE SOFTWARE CO., LTD.**, Beijing (CN)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **17/204,043**

(22) Filed: **Mar. 17, 2021**

(65) **Prior Publication Data**
US 2022/0037790 A1 Feb. 3, 2022

(30) **Foreign Application Priority Data**
Jul. 29, 2020 (CN) 202010746041.0

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 9/0414** (2013.01); **H01Q 1/2291** (2013.01); **H01Q 9/0464** (2013.01)

(58) **Field of Classification Search**
CPC .. H01Q 9/0414; H01Q 1/2291; H01Q 9/0464; H01Q 5/25; H01Q 5/371; H01Q 5/40; H01Q 9/04; H01Q 1/243; H01Q 1/36; H01Q 1/48

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

2012/0313834 A1* 12/2012 Eom H01Q 7/00 343/700 MS
2019/0214707 A1* 7/2019 Kim H01Q 1/243
2021/0066787 A1* 3/2021 Wang H01Q 9/0464
2022/0102838 A1* 3/2022 Bolz H01Q 9/285

FOREIGN PATENT DOCUMENTS

CN 101662069 A 3/2010

OTHER PUBLICATIONS

European Patent Application No. 21165890.1 extended Search and Opinion dated Sep. 1, 2021, 8 pages.

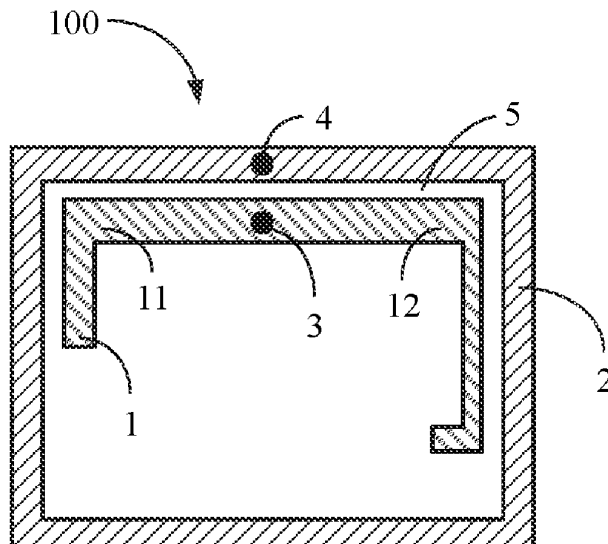
* cited by examiner

Primary Examiner — Hai V Tran
Assistant Examiner — Michael M Bouizza
(74) *Attorney, Agent, or Firm* — Cozen O'Connor

(57) **ABSTRACT**

An antenna structure includes: a branching radiator, including a plurality of first radiation modes; a ring-shaped radiator surrounding the branching radiator, and including a plurality of second radiation modes; a feeding point and a grounding point, one of which is connected to the ring-shaped radiator, and the other is connected to the branching radiator; an antenna gap, which is provided between the branching radiator and the ring-shaped radiator. The ring-shaped radiator and the branching radiator are coupled through the antenna gap to form coupled radiation modes. A coupling among the first radiation modes, the second radiation modes and the coupled radiation modes broaden a radiation bandwidth of the antenna structure. The antenna structure may be incorporated in an electronic device.

16 Claims, 3 Drawing Sheets





US011641059B2

(12) **United States Patent**
Huang et al.

(10) **Patent No.:** **US 11,641,059 B2**
(45) **Date of Patent:** ***May 2, 2023**

(54) **WIRELESS COMMUNICATION
STRUCTURE, DISPLAY PANEL AND
WIRELESS COMMUNICATION DEVICE**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **Yungu (Gu'an) Technology Co., Ltd.**,
Hebei (CN)

2007/0024399 A1 * 2/2007 Martin Antolin H01Q 7/00
333/205
2011/0095848 A1 * 4/2011 Dounaevski H03H 7/0115
333/181

(72) Inventors: **Huan-Chu Huang**, Taoyuan (CN);
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(Continued)

FOREIGN PATENT DOCUMENTS

(73) Assignee: **Yungu (Gu'an) Technology Co., Ltd.**,
Hebei (CN)

CN 201898208 U 7/2011
CN 106450725 A 2/2017

(Continued)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

OTHER PUBLICATIONS

This patent is subject to a terminal dis-
claimer.

The Notice of Allowance dated Sep. 1, 2022, in corresponding
Korean Application No. 10-2022-0101574, 4 pages (with English
translation).

(Continued)

(21) Appl. No.: **17/889,976**

(22) Filed: **Aug. 17, 2022**

Primary Examiner — Hai V Tran

Assistant Examiner — Michael M Bouizza

(65) **Prior Publication Data**

US 2022/0407228 A1 Dec. 22, 2022

(74) *Attorney, Agent, or Firm* — Maier & Maier, PLLC

(51) **Int. Cl.**
H01Q 5/50 (2015.01)
H01Q 7/00 (2006.01)

(57) **ABSTRACT**

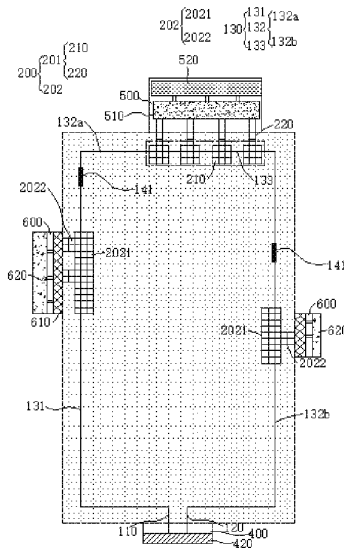
(52) **U.S. Cl.**
CPC **H01Q 7/00** (2013.01); **H01Q 5/50**
(2015.01)

A wireless communication structure, a display panel and a
wireless communication device, the wireless communica-
tion structure includes: a loop structure including a first
connection end, a second connection end and a coil body, at
least a part of the coil body being connected between the first
connection end and the second connection end; an antenna
connected to the coil body. The antenna is connected to the
coil body of the loop structure, so that not only the loop
structure and the antenna can be arranged in a limited space,
but also a desired optical performance of the display screen
can be ensured.

(58) **Field of Classification Search**
CPC H01Q 7/00; H01Q 5/50; H01Q 7/005;
H01Q 1/44; H01Q 1/2291; H01Q 1/36;
H01Q 1/243; H01Q 1/273; H01Q 1/38;
H01Q 1/50; H01Q 21/00; H01Q 7/06;
G06F 3/0416; G06F 3/046; H04B 1/40

See application file for complete search history.

15 Claims, 37 Drawing Sheets





US011641065B2

(12) **United States Patent**
So et al.

(10) **Patent No.:** **US 11,641,065 B2**
(45) **Date of Patent:** **May 2, 2023**

(54) **ANTENNA DEVICE**

(71) Applicants: **SAMSUNG ELECTRO-MECHANICS CO., LTD.**, Suwon-si (KR); **Research & Business Foundation SUNGKYUNKWAN UNIVERSITY**, Suwon-si (KR)

(72) Inventors: **Won Wook So**, Suwon-si (KR); **Jeongki Ryoo**, Suwon-si (KR); **Woncheol Lee**, Suwon-si (KR); **Youngsik Hur**, Suwon-si (KR); **Keum Cheol Hwang**, Suwon-si (KR); **Nam Heung Kim**, Suwon-si (KR); **Yong-Serk Kim**, Suwon-si (KR)

(73) Assignees: **Samsung Electro-Mechanics Co., Ltd.**, Suwon-si (KR); **Research & Business Foundation SUNGKYUNKWAN UNIVERSITY**, Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 17 days.

(21) Appl. No.: **17/361,789**

(22) Filed: **Jun. 29, 2021**

(65) **Prior Publication Data**
US 2022/0166149 A1 May 26, 2022

(30) **Foreign Application Priority Data**
Nov. 23, 2020 (KR) 10-2020-0158133

(51) **Int. Cl.**
H01Q 21/06 (2006.01)
H01Q 5/307 (2015.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 5/307** (2015.01); **H01Q 9/0414** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 21/065; H01Q 5/307; H01Q 9/0414
See application file for complete search history.

(56) **References Cited**
U.S. PATENT DOCUMENTS

2011/0001682 A1 1/2011 Rao
2019/0020110 A1 1/2019 Paulotto et al.
(Continued)

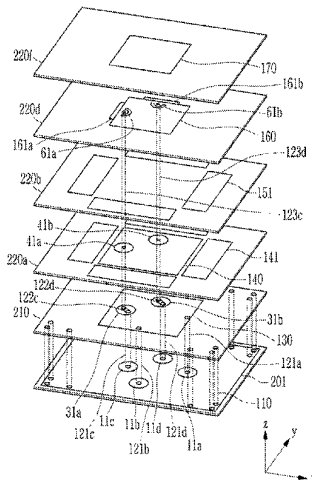
FOREIGN PATENT DOCUMENTS
KR 10-2019-0123195 A 10/2019

OTHER PUBLICATIONS
M. Stanley, et al. "A Dual-Band Dual-Polarized Stacked Patch Antenna for 28 GHz and 39 GHz 5G Millimetre-Wave Communication," 2019 13th European Conference on Antennas and Propagation (EuCAP), pp. 1-4, 2019 (4 pages in English).
(Continued)

Primary Examiner — Dieu Hien T Duong
(74) *Attorney, Agent, or Firm* — NSIP Law

(57) **ABSTRACT**
An antenna device is provided. The antenna device includes a first antenna patch configured to transmit and receive an RF signal in a first frequency bandwidth and disposed of a first dielectric layer; a second antenna patch disposed on a second dielectric layer and coupled to the first antenna patch; a third antenna patch disposed on a third dielectric layer and coupled to the second antenna patch; and a fourth antenna patch configured to transmit and receive an RF signal in the second frequency bandwidth, wherein the second antenna patch includes a plurality of first sub-antenna patches that do not overlap the first antenna patch, and the third antenna patch includes a plurality of second sub-antenna patches that overlap the first sub-antenna patches.

20 Claims, 23 Drawing Sheets





US011646501B2

(12) **United States Patent**
Wu et al.

(10) **Patent No.:** **US 11,646,501 B2**
(45) **Date of Patent:** **May 9, 2023**

(54) **ELECTRONIC DEVICES HAVING ANTENNAS WITH HYBRID SUBSTRATES**

(56) **References Cited**

(71) Applicant: **Apple Inc.**, Cupertino, CA (US)
(72) Inventors: **Jiangfeng Wu**, San Jose, CA (US);
Siwen Yong, Mountain View, CA (US);
Simon G. Begashaw, Santa Clara, CA (US);
Yi Jiang, Cupertino, CA (US);
Lijun Zhang, Los Gatos, CA (US)

U.S. PATENT DOCUMENTS

9,692,102 B2 6/2017 Herbsommer et al.
10,109,604 B2 10/2018 Topak et al.
10,333,047 B2 6/2019 Gilbert et al.
10,361,487 B2 7/2019 Rashidian et al.
10,594,028 B2 3/2020 Yong et al.
(Continued)

(73) Assignee: **Apple Inc.**, Cupertino, CA (US)
(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

OTHER PUBLICATIONS

J. J. Wang et al., Circuit Model of Microstrip Patch Antenna on Ceramic Land Grid Array Package for Antenna-Chip Codesign of Highly Integrated RF Transceivers, IEEE Transactions on Antennas and Propagation, Dec. 2005, pp. 3877-3883, vol. 53, No. 12.

(21) Appl. No.: **17/338,481**

(Continued)

(22) Filed: **Jun. 3, 2021**

Primary Examiner — Thai Pham

(65) **Prior Publication Data**

(74) *Attorney, Agent, or Firm* — Treyz Law Group, P.C.; Michael H. Lyons

US 2022/0393365 A1 Dec. 8, 2022

(51) **Int. Cl.**
H01Q 1/22 (2006.01)
H01Q 1/38 (2006.01)
H01Q 3/26 (2006.01)
H01Q 19/00 (2006.01)
H01Q 21/06 (2006.01)
H01Q 1/24 (2006.01)

(57) **ABSTRACT**

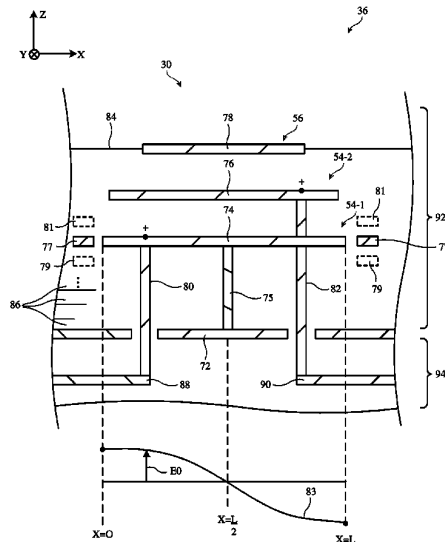
An electronic device may have an antenna embedded in a substrate. The substrate may have first layers, second layers on the first layers, and third layers on the second layers. The antenna may include a first patch on the first layers that radiates in a first band, a second patch on the second antenna layers that radiates in a second band, and a parasitic patch on the third layers. A short path may couple ground to a location on the first patch that allows the first patch to form a ground extension in the second band for the second patch without affecting performance of the first patch in the first band. The first layers may have a higher dielectric permittivity than the second and third layers to minimize the thickness of the substrate without requiring a separate dielectric loading layer over the substrate.

(52) **U.S. Cl.**
CPC **H01Q 19/005** (2013.01); **H01Q 1/38** (2013.01); **H01Q 21/065** (2013.01); **H01Q 1/243** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/22; H01Q 1/2283; H01Q 1/24; H01Q 1/243; H01Q 1/38; H01Q 1/32; H01Q 1/32617; H01Q 5/385; H01Q 9/04; H01Q 9/0414; H01Q 19/005; H01Q 21/065

See application file for complete search history.

20 Claims, 9 Drawing Sheets





US011646503B2

(12) **United States Patent**
Lim et al.

(10) **Patent No.:** **US 11,646,503 B2**

(45) **Date of Patent:** **May 9, 2023**

(54) **ANTENNA APPARATUS**

21/08; H01Q 21/28; H01Q 21/0006;
H01Q 9/0435; H01Q 9/045; H01Q
9/0414; H01Q 9/0407

(71) Applicant: **Samsung Electro-Mechanics Co., Ltd.**,
Suwon-si (KR)

See application file for complete search history.

(72) Inventors: **Dae Ki Lim**, Suwon-si (KR); **Nam Ki Kim**,
Suwon-si (KR); **Myeong Woo Han**, Suwon-si (KR); **Jeong Ki Ryoo**,
Suwon-si (KR); **Ju Hyoung Park**, Suwon-si (KR); **Won Cheol Lee**,
Suwon-si (KR)

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,008,763 A	*	12/1999	Nystrom	.....	H01Q 21/08 343/700 MS
7,518,513 B2		4/2009	Liu		
8,803,757 B2		8/2014	Shen et al.		
10,193,231 B2		1/2019	Wallace et al.		
2001/0020920 A1		9/2001	Shigihara		

(Continued)

(73) Assignee: **Samsung Electro-Mechanics Co., Ltd.**,
Suwon-si (KR)

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 191 days.

FOREIGN PATENT DOCUMENTS

JP	2000-510305 A	8/2000
JP	2010-503357 A	1/2010

(Continued)

(21) Appl. No.: **16/661,084**

(22) Filed: **Oct. 23, 2019**

(65) **Prior Publication Data**

US 2020/0395679 A1 Dec. 17, 2020

OTHER PUBLICATIONS

The American Radio Relay League, Gerald Hall (Year: 1988).*

(Continued)

(30) **Foreign Application Priority Data**

Jun. 12, 2019 (KR) 10-2019-0069536

Primary Examiner — Awat M Salih

(74) Attorney, Agent, or Firm — NSIP Law

(51) **Int. Cl.**
H01Q 1/24 (2006.01)
H01Q 21/06 (2006.01)
H01Q 21/00 (2006.01)

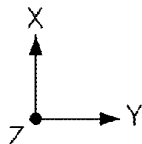
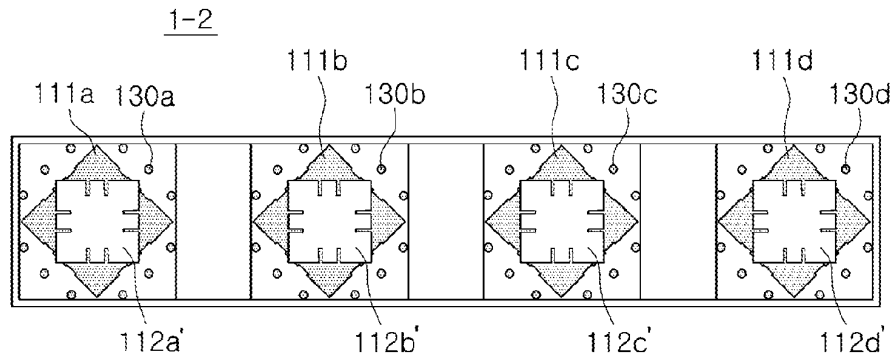
(57) **ABSTRACT**

An antenna apparatus may include: first patch antenna patterns arrayed in an N×1 structure, the first patch antenna patterns each having a polygonal shape having an oblique side with respect to an array direction of the N×1 structure; feed vias electrically connected to the first patch antenna patterns; and guide vias arrayed along the oblique side, wherein N is a natural number greater than or equal to 2.

(52) **U.S. Cl.**
CPC **H01Q 21/065** (2013.01); **H01Q 1/243**
(2013.01); **H01Q 21/0025** (2013.01)

(58) **Field of Classification Search**
CPC H01Q 1/243; H01Q 1/2283; H01Q 1/523;
H01Q 1/38; H01Q 1/48; H01Q 1/50;
H01Q 21/0025; H01Q 21/065; H01Q

16 Claims, 11 Drawing Sheets





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(12) **United States Patent**
Odes

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(54) **EXTREMELY LOW PROFILE ULTRA WIDE BAND ANTENNA**

6,950,068	B2 *	9/2005	Bordi	H01Q 9/0442
					343/702
2003/0038749	A1 *	2/2003	Chen	.....	H01Q 1/243
					343/702
2009/0027294	A1 *	1/2009	Bourry	.....	H01Q 9/0421
					343/848
2014/0285382	A1 *	9/2014	Dobric	.....	H01Q 9/0414
					343/700 MS
2017/0047660	A1 *	2/2017	Manry, Jr.	H01Q 9/0457
2018/0358697	A1 *	12/2018	Zhou	H01Q 9/0421

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 26 days.

FOREIGN PATENT DOCUMENTS

CN	101102009	A *	1/2008	
JP	6151251	B2 *	6/2017 H01Q 21/26

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H01Q 1/36 (2006.01)
H01Q 1/48 (2006.01)
H01Q 9/04 (2006.01)

(52) **U.S. Cl.**
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(58) **Field of Classification Search**
 CPC H01Q 1/36; H01Q 1/48; H01Q 9/0421; H01Q 5/25; H01Q 9/0414; H01Q 9/0407
 See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,926,150	A *	7/1999	McLean	.....	G01R 29/0821
					343/846
6,483,463	B2 *	11/2002	Kadambi	.....	H01Q 21/24
					343/702

OTHER PUBLICATIONS

U.S. Appl. No. 17/409,543, filed Aug. 23, 2021, Odes.
U.S. Appl. No. 17/409,627, filed Aug. 23, 2021, Odes.
U.S. Appl. No. 17/409,646, filed Aug. 23, 2021, Odes.

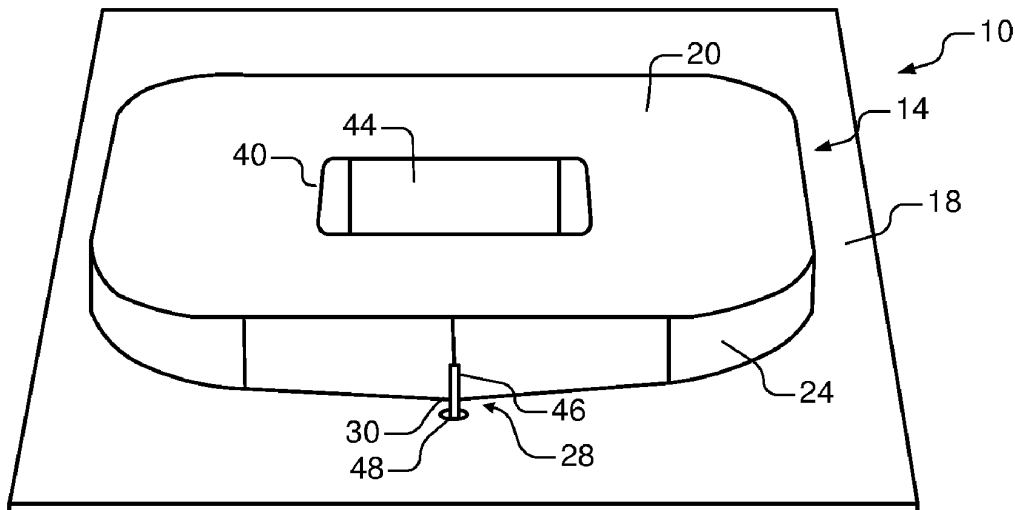
* cited by examiner

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Assistant Examiner — Anh N Ho

(57) **ABSTRACT**

An ultra wide band antenna includes a ground plane and an antenna body. The antenna body includes a planar portion arranged above and parallel to the ground plane. A tapered side portion extends perpendicular to the planar portion in a direction towards the ground plane, wraps at least 50% around an outer edge of the planar portion and tapers in height from a feed side of the antenna body in a direction towards a back side of the antenna body. A cylinder is connected to a bottom surface of the planar portion and to the ground plane. A connecting portion connects the back side at the outer edge of the planar portion to the ground plane.

10 Claims, 5 Drawing Sheets





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Chang**

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(54) **DUAL ANTENNA WITH A SHARED
RADIATOR**

1/52; H01Q 9/00; H01Q 9/04; H01Q
9/30; H01Q 9/42; H04B 1/00; H04B
1/38; H04B 1/3827; H04B 1/3833; H04B
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USPC 324/600, 649, 658, 686
See application file for complete search history.

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(56) **References Cited**

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U.S. PATENT DOCUMENTS

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

6,049,314 A * 4/2000 Munson H01Q 9/0471
343/846
2015/0234019 A1 * 8/2015 Biber G01R 33/3415
324/322

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FOREIGN PATENT DOCUMENTS

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CN 106299604 A * 1/2017 H01Q 1/242
CN 110911842 B * 5/2021 H01Q 1/2258
CN 114122716 A * 3/2022 H01Q 1/36

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* cited by examiner

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G01D 5/24 (2006.01)

(57) **ABSTRACT**

(52) **U.S. Cl.**

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(2013.01)

A dual antenna with a shared radiator includes a radiator unit, a first feed-in unit, a second feed-in unit, a sensing module and a ground unit. The first feed-in unit and the second feed-in unit are respectively coupled with the radiator unit. The sensing module is connected to a substantial center of the radiator unit and used for sensing a distance between the radiator unit and an external object through the radiator unit. The ground unit is connected to the sensing module. The first feed-in unit is used to send or receive a first radio frequency signal together with the radiator unit, and the second feed-in unit is used to send or receive a second radio frequency signal together with the radiator unit.

(58) **Field of Classification Search**

CPC .. G01D 5/00; G01D 5/12; G01D 5/14; G01D
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5/307; H01Q 5/314; H01Q 1/00; H01Q
1/12; H01Q 1/22; H01Q 1/24; H01Q
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10 Claims, 7 Drawing Sheets

