UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
TEXARKANA DIVISION

MIMO RESEARCH, LLC, ***Plaintiff,*** v. **MURATA ELECTRONICS NORTH AMERICA, INC. AND MURATA MANUFACTURING CO., LTD.** ***Defendants.***	**Civil Action No. 5:22-cv-74** **JURY TRIAL DEMANDED**

COMPLAINT FOR PATENT INFRINGEMENT

MIMO Research, LLC ("MIMO Research" or "Plaintiff") brings this action and makes the following allegations of patent infringement relating to U.S. Patent Nos.: 7,091,854 (the "'854 patent"); 7,002,470 (the "'470 patent"); 7,305,057 (the "'057 patent"); and 7,433,382 (the "'382 patent") (collectively, the "patents-in-suit"). Defendants Murata Electronics North America, Inc. and Murata Manufacturing Co., Ltd. (collectively, "Murata" or "Defendant") infringe the patents-in-suit in violation of the patent laws of the United States of America, 35 U.S.C. § 1 *et seq*.

THE PARTIES

1. Plaintiff MIMO Research, LLC ("Plaintiff" or "MIMO Research") is a New York limited liability company established in 2017. MIMO Research owns a portfolio of patents that cover Multiple Input Multiple Output ("MIMO") wireless communication, powerline networking, and ultra-wideband ("UWB") technology. MIMO Research is the owner of all rights, title, and interest in and to the patents-in-suit.

2. Highlighting the importance of the patents-in-suit is the fact that the MIMO Research's patent portfolio has been cited by over 800 U.S. and international patents and patent

applications assigned to a wide variety of the largest companies operating in the wireless integrated circuit field. MIMO Research's patents have been cited by companies such as:

- Apple Inc.[1]
- Samsung Electronics Co., Ltd. [2]
- Broadcom Inc.[3]
- STMicroelectronics N.V. [4]
- Sony Group Corporation[5]
- Nokia Corporation[6]
- Qualcomm, Inc.[7]
- Siemens AG[8]
- Fujitsu Limited[9]

3. Defendant Murata Electronics North America, Inc. ("MENA"), is a Texas corporation with its principal place of business at 2200 Lake Park Drive, Smyrna, Georgia 30080. Upon information and belief, MENA may be served with process at CSC-Lawyers, Inc., 211 E. 7th Street Suite 620 Austin, TX 78701.

[1] *See, e.g.*, U.S. Patent Nos. 7,548,577; 8,279,913; 8,705,641; 8,743,852; 8,958,760; 9,490,864; and 9,614,578.

[2] *See, e.g.*, U.S. Patent Nos. 8,478,271; 7,929,995; 7,305,250; 7,392,012; 7,969,859; 9,002,304; and 9,306,616.

[3] *See, e.g.*, U.S. Patent Nos. 7,885,323; 8,520,715; 7,680,083; 7,725,096; 7,795,973; 7,808,985; 7,860,146; 7,873,324; 7,877,078; 7,899,436; 7,956,689; 8,160,127; 8,213,895; 8,406,239; 8,437,387; 8,509,707; 8,750,362; 8,750,392; 8,885,814; 9,042,436; 9,065,465; 9,313,828; and 9,936,439.

[4] *See, e.g.*, U.S. Patent Nos. 7,660,342; 7,656,932; 7,660,341; 7,817,763; and 8,817,935.

[5] *See, e.g.*, U.S. Patent Nos. 9,265,004; 7,542,728; 7,545,787; 7,567,820; 7,688,784; 7,822,436; 7,881,252; 8,045,447; 8,121,144; 8,160,001; 8,259,823; 8,462,746; 9,036,569; 9,237,572; 9,258,833; 8,660,196; and 9,276,649.

[6] *See, e.g.*, U.S. Patent Nos. 7,499,674; 7,643,811; 7,697,893; 7,782,894; and 9,913,248.

[7] *See, e.g.*, U.S. Patent Nos. 8,767,812; 9,300,491; 7,916,081; 8,009,775; 8,054,223; 8,401,503; 8,452,294; 8,467,331; 8,472,551; 8,743,903; 8,745,137; 8,745,695; 8,774,334; and 8,824,477.

[8] *See, e.g.*, U.S. Patent Nos. 7,378,980; 7,382,271; 7,408,839; 8,155,664; and 10,051465.

[9] *See, e.g.*, U.S. Patent Nos. 7,702,022; 7,995,680; 8,761,275; and 8,938,017.

4. MENA conducts business operations within the Eastern District of Texas where it sells, develops, and/or markets its products in facilities in Texas, including facilities at 4100 Midway Road, Suite 2050, Carrollton, Texas 75007.

5. Murata Manufacturing Co., Ltd. ("Murata Ltd.") is a Japanese Corporation with its principal place of business at 10-1, Higashikotari 1-chome, Nagaokakyo-shi, Kyoto 617-8555, Japan.

JURISDICTION AND VENUE

6. This action arises under the patent laws of the United States, Title 35 of the United States Code. Accordingly, this Court has exclusive subject matter jurisdiction over this action under 28 U.S.C. §§ 1331 and 1338(a).

7. This Court has personal jurisdiction over Murata in this action because Murata has committed acts within the Eastern District of Texas giving rise to this action and has established minimum contacts with this forum such that the exercise of jurisdiction over Murata would not offend traditional notions of fair play and substantial justice. Defendant Murata, directly and/or through subsidiaries or intermediaries (including distributors, retailers, and others), has committed and continues to commit acts of infringement in this District by, among other things, offering to sell and selling products and/or services that infringe the patents-in-suit. Moreover, Murata is incorporated in the State of Texas, has offices and facilities in the State of Texas, and actively directs its activities to customers located in the State of Texas.

8. Venue is proper in this district under 28 U.S.C. §§ 1391(b)-(d) and 1400(b). Defendant Murata is registered to do business in the State of Texas, is incorporated in Texas, has offices in the Eastern District of Texas, has transacted business in the Eastern District of Texas and has committed acts of direct and indirect infringement in the Eastern District of Texas.

9. Murata has a regular and established place of business in this District and has committed acts of infringement in this District. Murata has a permanent office location at 4100 Midway Road, Suite 2050, Carrollton, Texas 75007. Further, Murata has maintained a significant presence in Texas for over 40 years and has continued to expand its presence in the Eastern District of Texas.

Entrepreneurship is Thriving in Big D

Dallas's stature as a corporate headquarters magnet went up several more notches recently when, in fairly quick succession, Fujitsu America Inc. and GTE Corp. announced major expansions to the area. The U.S. subsidiary of Tokyo-based high-tech giant Fujitsu Ltd. revealed plans to build an $80 million telecommunications manufacturing and research complex in suburban Richardson that is expected eventually to employ nearly 5,000 persons. It will be an expansion of an existing Richardson operation. GTE will move the headquarters of its telephone division (4,000 jobs) from Stamford, Conn., to the suburb of Irving. These announcements came just months after J.C. Penney Co. (3,700 jobs) relocated its headquarters from New York City. (Penney will build a permanent home office complex in suburban Plano.)

Says Kerney Laday, vice president and region general manager for Xerox Corp., "Things tend to run in cycles. It's simply Dallas's turn for an up cycle." Exclaims another Dallas

Dallas is home to Murata, Texas Instruments, Electronic Data Systems and other high-tech industry leaders.

Entrepreneurship is Thriving in Big D, FORTUNE MAGAZINE VOL. 119, No. 3 at 400 (January 30, 1989) ("Dallas is home to Murata, Texas Instruments . . .").

10. In 2006, Murata acquired Plano, Texas based SyChip Inc.[10] In 2012, Murata acquired Dallas, Texas based RF Monolithics, Inc.[11] In 2016, Murata further expanded its presence in the Eastern District of Texas when it opened a 28,000 square foot facility in Carrollton, Texas.

> Murata's Texas operation will be a strategic hub that supports our long-term plan for continued growth. It will house the RF Product Department, Murata Energy Solutions Americas, Murata North America's Strategic Marketing and Texas Sales teams, the Wireless Business Development team, and other future associates. Needless to say, this opening is very exciting as it underscores the tremendous

[10] *Murata Acquires SyChip for $140M,* EDN Magazine (April 17, 2006).
[11] Peter Clarke, *Murata buys RF Monolithics for $22 million,* EETimes (April 16, 2012).

> growth opportunities we see on many, many levels," said David Kirk, President and CEO, Murata Americas.

Mike Albanese, *Carrollton Company Announces Expansion,* CARROLLTON LEADER (February 12, 2016).

11. In March 2022, Murata purchased Resonant, Inc. a designer of 5G components based in Texas. Currently, Murata employs full-time personnel such as sales personnel and engineers in this District, including in Carrollton, Texas. Murata has also committed acts of infringement in this District by commercializing, marketing, selling, distributing, testing, and servicing certain Accused Products.

12. This Court has personal jurisdiction over Murata. Murata has conducted and does conduct business within the State of Texas. Murata, directly or through subsidiaries or intermediaries (including distributors, retailers, and others), ships, distributes, makes, uses, offers for sale, sells, imports, and/or advertises (including by providing an interactive web page) its products and/or services in the United States and the Eastern District of Texas and/or contributes to and actively induces its customers to ship, distribute, make, use, offer for sale, sell, import, and/or advertise (including the provision of an interactive web page) infringing products and/or services in the United States and the Eastern District of Texas. Murata, directly and through subsidiaries or intermediaries (including distributors, retailers, and others), has purposefully and voluntarily placed one or more of its infringing products and/or services, as described below, into the stream of commerce with the expectation that those products will be purchased and used by customers and/or consumers in the Eastern District of Texas. These infringing products and/or services have been and continue to be made, used, sold, offered for sale, purchased, and/or imported by customers and/or consumers in the Eastern District of Texas. Murata has committed acts of patent infringement within the Eastern District of Texas. Murata interacts with customers in Texas, including through visits to customer sites in Texas. Through these interactions and visits,

Murata directly infringes the patents-in-suit. Murata also interacts with customers who sell the Accused Products into Texas, knowing that these customers will sell the Accused Products into Texas, either directly or through intermediaries.

13. Murata has minimum contacts with this District such that the maintenance of this action within this District would not offend traditional notions of fair play and substantial justice. Thus, the Court therefore has both general and specific personal jurisdiction over Murata.

THE ASSERTED PATENTS

U.S. PATENT NO. 7,091,854

14. U.S. Patent No. 7,091,854 (the "'854 patent") entitled, *Multiple-Input Multiple-Output Wireless Sensor Networks Communications,* was filed on April 9, 2004. The '854 patent is subject to a 35 U.S.C. § 154(b) term extension of 187 days. MIMO Research, LLC is the owner by assignment of the '854 patent. A true and correct copy of the '854 patent is attached hereto as Exhibit A.

15. The '854 patent claims specific systems for wireless multiple-input multiple-output communication devices.

16. The '854 patent teaches the use of a MIMO sensor transmitter that improves array gain, diversity, and reduces channel interference and inter-symbol interference.

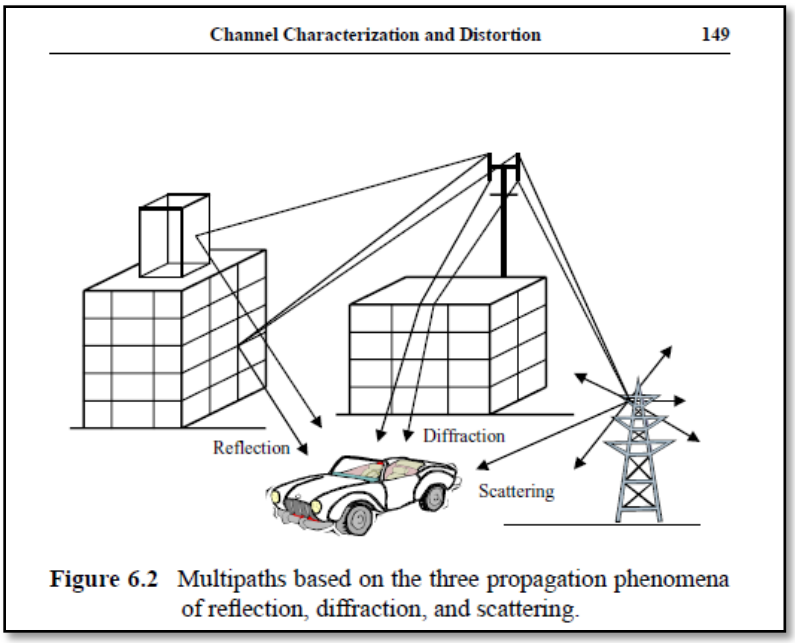
17. The '854 patent teaches the use of a sensor array unit coupled to an analog-to-digital converter which is coupled to a signal processing and data computing unit. The signal processing and data computing unit are coupled to a MIMO transceiver containing multiple antennas. This system improves average signal power, mitigates fading, and reduces channel interference and intersymbol interference. The reduction in channel and intersymbol interference allows the

systems claimed in the '854 patent to significantly improve the capacity, coverage, and quality of wireless communication.

18. The inventions taught in the '854 patent boost the data rate not only on uplink channels but also on downlink channels, which allows for better communication and control between wireless devices.

19. The '854 patent teaches the use of a MIMO transceiver to overcome multipath propagation. Multipath propagation arises from scattering, reflection, refraction or diffraction of the radiated energy off objects in the environment. Thus, received signals are much weaker than transmitted signals due to mean propagation loss. In addition to a mean path loss, the received signals exhibit fluctuations in a signal level that is referred to fading.

20. The '854 patent is directed to overcoming problems attendant to multipath propagation which occurs through the reflection, diffraction, and scattering of a wireless signal. "The multipath propagation arises from scattering, reflection, refraction or diffraction of the radiated energy off objects in the environment." '854 patent, col. 2:43-45. The inventor of the '854 patent illustrated the problem of multipath propagation in a subsequent textbook on signal processing.



George J. Maio, SIGNAL PROCESSING IN DIGITAL COMMUNICATIONS at 149 (2006).

21. The '854 patent teaches the use of a MIMO transceiver which turns multipath propagation into a benefit. By combining the use of the transmitter antennas at one end and receiver antennas, the systems taught in the '854 patent enhance wireless transmission over the MIMO channel.

22. The inventor of '854 patent described the problem of multipath propagation in a 2006 textbook on signal processing:

> Wireless channels experience multipath propagation due to reflection, diffraction, and/or scattering of radiated energy off of objects located in the environment. Signals at the receiver are much feebler than transmitted signals because of propagation path loss. In addition, received signals may display fading over traveling distance from the transmitter. The fading includes large-scale fading and small-scale fading.

George J. Maio, SIGNAL PROCESSING IN DIGITAL COMMUNICATIONS at 184-85 (2006).

23. The '854 patent has been cited by 61 United States and international patents and patent applications as relevant prior art. Specifically, patents issued to the following companies and research institutions have cited the '854 patent as relevant prior art:

- Qualcomm, Inc.

- NEC Corporation
- Samsung Electronics Co., Ltd.
- Allied Telesis Holdings K.k.
- University Of Virginia
- Texas Instruments Incorporated
- Honeywell International Inc.
- Shanghai Jiaotong University
- Zebra Technologies Corp.
- The Boeing Company
- Chinese Academy of Sciences
- Itron, Inc.
- HBX Control Systems, Inc.

U.S. PATENT NO. 7,002,470

24. U.S. Patent No. 7,002,470 (the "'470 patent") entitled, *Wireless UWB-Based Space-Time Sensor Networks Communications*, was filed on May 3, 2004. The '470 patent is subject to a 35 U.S.C. § 154(b) term extension of 142 days. MIMO Research, LLC is the owner by assignment of the '470 patent. A true and correct copy of the '470 patent is attached hereto as Exhibit B.

25. The '470 patent discloses novel systems for clustering wireless UWB sensor nodes. Further the '470 invention addresses the need for a network of sensors where some of the sensors are not in a line-of site.

26. The '470 patent teaches technological solutions to the issue of multipath propagation which arises from UWB sensors not being guaranteed a line-of-sight transmission path to the receiver.

27. The '470 patent discloses architectural schemes for UWB sensor nodes to communicate where the selection of UWB sensor notes is enabled through classifying the UWB nodes into cluster groups.

28. The ‘470 patent has been cited by 72 patents and patent applications as relevant prior art. Specifically, patents issued to the following companies have cited the ‘470 patent as relevant prior art:

- Siemens AG
- STMicroelectronics N.V.
- Raytheon Technologies Corporation
- Broadcom Ltd.
- Qualcomm, Inc.
- Telefonaktiebolaget LM Ericsson
- Nokia Corporation
- NXP B.V.
- Koninklijke Philips Electronics, N.V.
- Honeywell International Inc.
- Microsoft Corporation
- Samsung Electronics Co., Ltd.
- Electronics And Telecommunications Research Institute
- General Dynamics Corporation

U.S. PATENT NO. 7,305,057

29. U.S. Patent No. 7,305,057 entitled, *Multichannel Filter-Based Handheld Ultra Wideband Communications*, was filed on July 7, 2003. The ‘057 patent is subject to a 35 U.S.C. § 154(b) term extension of 922 days. MIMO Research, LLC is the owner by assignment of the ’057 patent. A true and correct copy of the ‘057 patent is attached hereto as Exhibit C.

30. The ‘057 patent discloses novel systems for multichannel filter based UWB transceivers that avoid interference with WLAN 802.11a devices.

31. The inventions disclosed in the ‘057 patent teach systems that permit a UWB device to operate using spectrum occupied by existing radio services without causing interference, thereby permitting scarce spectrum resources to be used more efficiently.

32. The ‘057 patent improves the operation of wireless networks by disclosing technologies that enable new products incorporating UWB technology.

33. The ‘057 patent discloses the use of a multichannel filter for a UWB transceiver. The multichannel filter allows the UWB transceiver to operate in the frequency band from 3.1 GHz to 10.6 GHz, with a conservative out of band emission mask to address interference with other devices.

34. The ‘057 patent has been cited by 16 patents and patent applications as relevant prior art. Specifically, patents issued to the following companies and research institutions have cited the ‘057 patent as relevant prior art:

- University Of Minnesota
- Sorbonne Université
- Qualcomm, Inc.
- Nokia Corporation
- Huawei Technologies Co., Ltd.
- Industrial Technology Research Institute
- Graz University of Technology (Austria)

U.S. PATENT NO. 7,433,382

35. U.S. Patent No. 7,433,382 entitled, *Spread Spectrum Based Multichannel Modulation for Ultra Wideband Communications*, was filed on July 7, 2003. The ‘382 patent is subject to a 35 U.S.C. § 154(b) term extension of 704 days. MIMO Research, LLC is the owner by assignment of the ’382 patent. A true and correct copy of the ‘382 patent is attached hereto as Exhibit D.

36. The ‘382 patent discloses novel systems UWB devices that enable the transmission of data while avoiding interference with WLAN 802.11a devices.

37. The inventions disclosed in the ‘382 patent are directed to solving the problem of interference between UWB devices and other devices, such as WLAN 802.11a devices. Interference between UWB and 802.11a transmission was a problem at the time the inventions disclosed in the ‘382 patent were invented because the WLAN 802.11a devices operated in the

frequency ranges 5.15 GHz to 5.35 GHz and 5.725 GHz to 5.825 GHz which overlapped with UWB signals that could operate in the frequency band of 3.1 GHz to 10.6 GHz.

38. The inventions disclosed in the '382 patent teach technologies that permit the transmission of data using UWB without interfering with the transmission of data using non-UWB signals that overlap with the UWB frequency band.

39. To address the issue of interference between devices operating in the UWB frequency band and non-UWB signals sent in an overlapping frequency band, the '382 patent teaches the use of multichannel pseudorandom noise mapping comprising N-I delay units coupled to N down sampling units followed by N Exclusive OR (XOR) units in parallel.

40. The '382 patent discloses systems that improve the operation of wireless networks by disclosing technologies that reduce interference with WLAN signals using a multichannel pseudorandom noise look-up table coupled to a multichannel sequence mapping component.

41. The '382 patent discloses the use of a digital finite impulse response shaping filter that attenuates signals with frequencies higher then specific thresholds. By using the disclosed filter, the systems taught in the '382 patent reduce interference with non-UWB signal.

42. The '382 patent has been cited by 10 patents and patent applications as relevant prior art. Specifically, patents issued to the following companies and research institutions have cited the '382 patent as relevant prior art:

- STMicroelectronics N.V.
- Industrial Technology Research Institute
- Huawei Technologies Co., Ltd.
- East China Normal University
- Beifang Tongyong Electronics Group Co., Ltd.
- Universite De Provence

COUNT I
INFRINGEMENT OF U.S. PATENT NO. 7,091,854

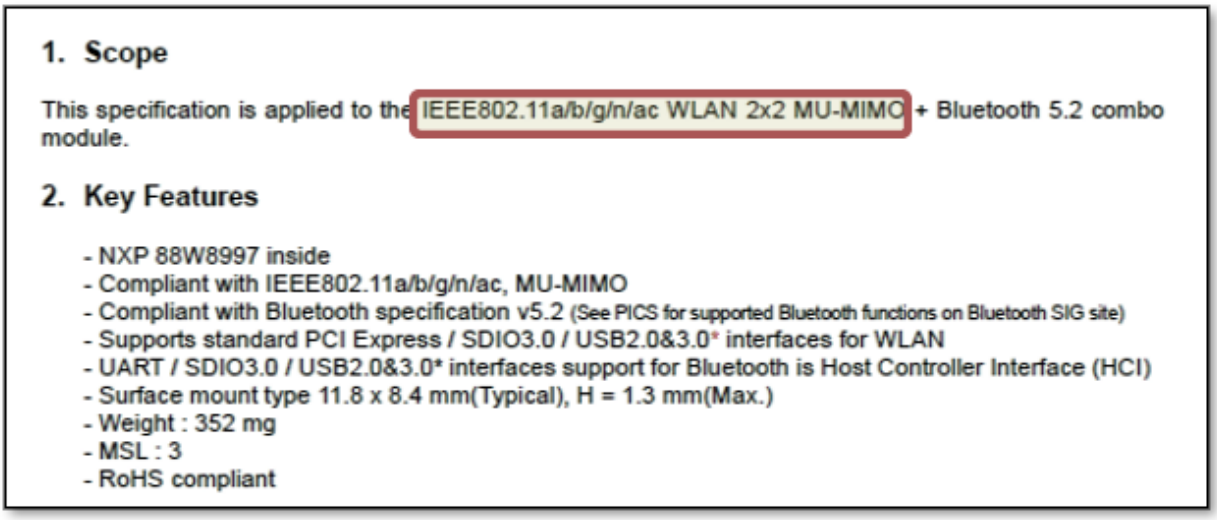
43. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

44. Murata designs, makes, uses, sells, and/or offers for sale in the United States products comprising a MIMO wireless sensor and transceiver system.

45. Murata designs, makes, sells, offers to sell, imports, and/or uses the following products: Murata Wi-Fi Modules LBEE5XV1XA, LBEE5XV1YM, LBEE5U91CQ, LBEE5XV1VA, LBEH5UL1CX, and LBEE5ZZ1XL (collectively, the "Murata '854 Products(s)").

46. One or more Murata subsidiaries and/or affiliates use the Murata '854 Products in regular business operations.

47. One or more of the Murata '854 Products include technology for a wireless multiple-input multiple-output sensor node and transceiver system.



1. Scope

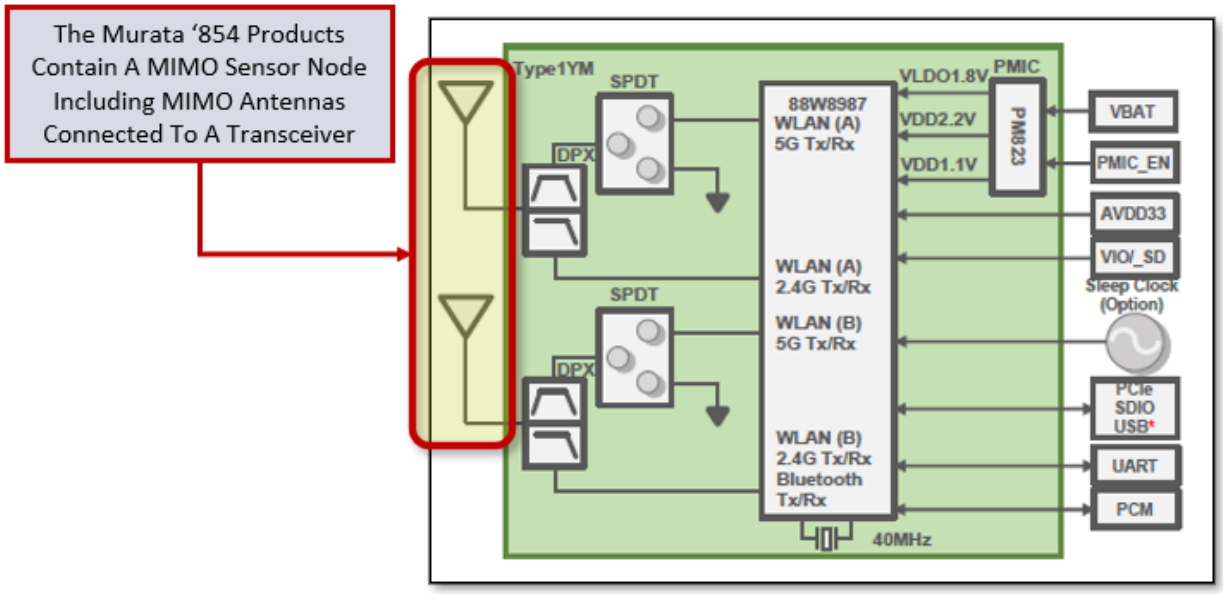
This specification is applied to the IEEE802.11a/b/g/n/ac WLAN 2x2 MU-MIMO + Bluetooth 5.2 combo module.

2. Key Features

- NXP 88W8997 inside
- Compliant with IEEE802.11a/b/g/n/ac, MU-MIMO
- Compliant with Bluetooth specification v5.2 (See PICS for supported Bluetooth functions on Bluetooth SIG site)
- Supports standard PCI Express / SDIO3.0 / USB2.0&3.0* interfaces for WLAN
- UART / SDIO3.0 / USB2.0&3.0* interfaces support for Bluetooth is Host Controller Interface (HCI)
- Surface mount type 11.8 x 8.4 mm(Typical), H = 1.3 mm(Max.)
- Weight : 352 mg
- MSL : 3
- RoHS compliant

W-LAN+Bluetooth Combo Module Data Sheet - P/NLBEE5XV1YM, MURATA DOCUMENTATION at 5 (December 14, 2021) (emphasis added).

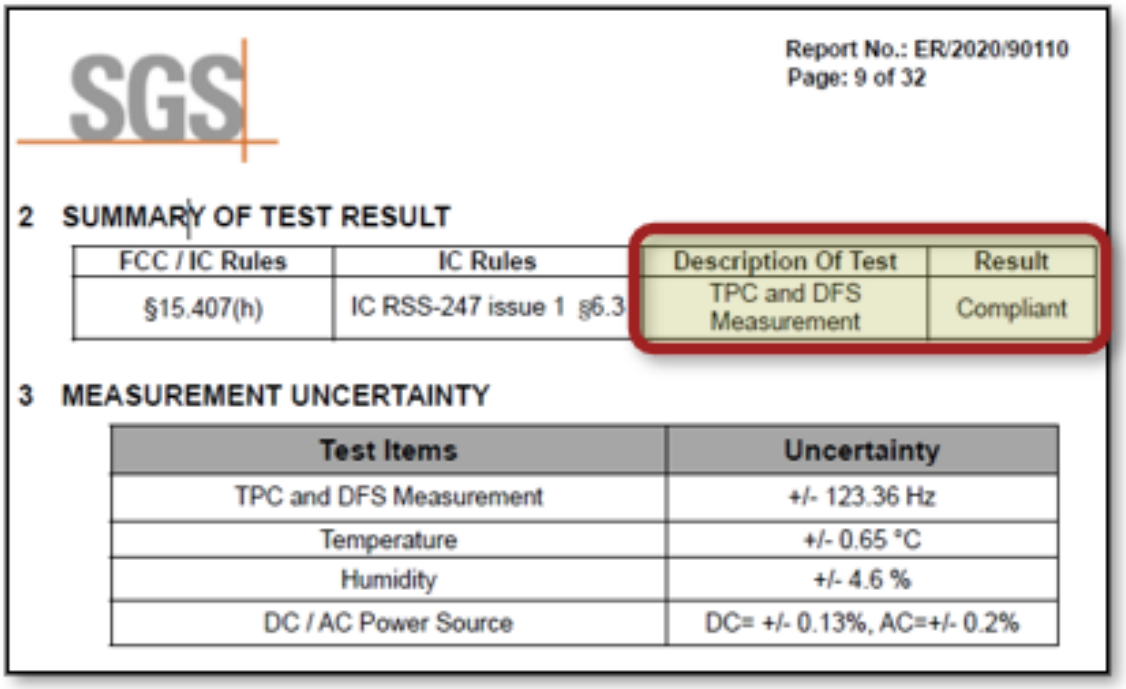
48. One or more of the Murata '854 Products include a sensor array unit coupled to an analog-to-digital converter unit. Specifically, the Murata '854 Products include a sensor array unit that receives data in the form of Wi-Fi and BT signals



W-LAN+Bluetooth Combo Module Data Sheet - P/NLBEE5XV1YM, MURATA DOCUMENTATION at 5 (December 14, 2021) (annotation added).

49. The Murata '854 Products enable dynamic frequency selection ("DFS") for detecting radar pulses when operating in the 5 GHz band.

50. One or more of the Murata '854 Products include a signal processing and data computing unit that is coupled to a multiple-input multiple-output space-time transceiver that is connected to two or more antennas.



SGS

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2 SUMMARY OF TEST RESULT

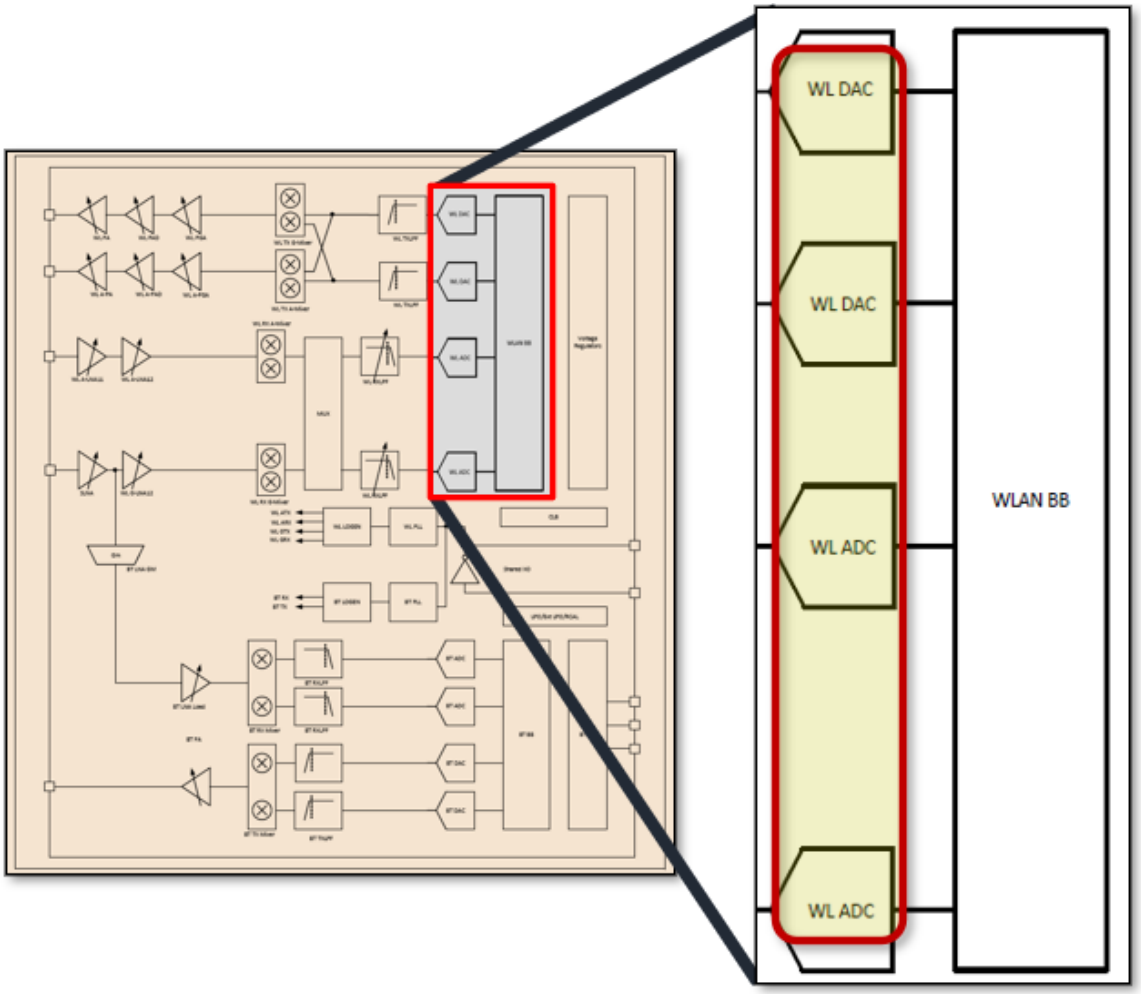
FCC / IC Rules	IC Rules	Description Of Test	Result
§15.407(h)	IC RSS-247 issue 1 §6.3	TPC and DFS Measurement	Compliant

3 MEASUREMENT UNCERTAINTY

Test Items	Uncertainty
TPC and DFS Measurement	+/- 123.36 Hz
Temperature	+/- 0.65 °C
Humidity	+/- 4.6 %
DC / AC Power Source	DC= +/- 0.13%, AC=+/- 0.2%

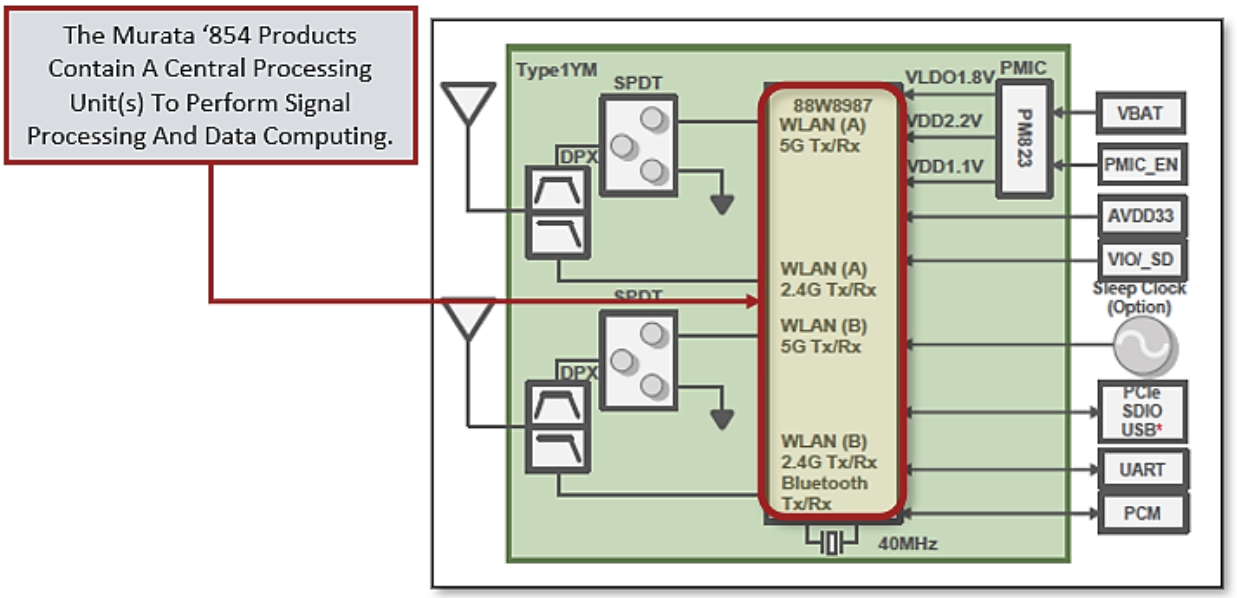
FEDERAL COMMUNICATIONS COMMISSION REPORT NO. ER/2020/90110 – DFS TEST REPORT AT 9 (January 7, 2021) (emphasis added).

51. One or more of the Murata '854 Products comprise technology for an analog-to-digital converter unit coupled to a signal processing and data computing unit. For example, the Murata '854 Products contain integrated circuits that perform signal processing and data computing. These integrated circuits are connected to the transmission systems of the Murata '854 Products that comprise technology to convert signals from analog to digital signals. For example, the LBEE5XV1VA product contains a CYW88359 chipset that converts analog signals to digital signals as shown in the below excerpt from the CYW88359 datasheet.



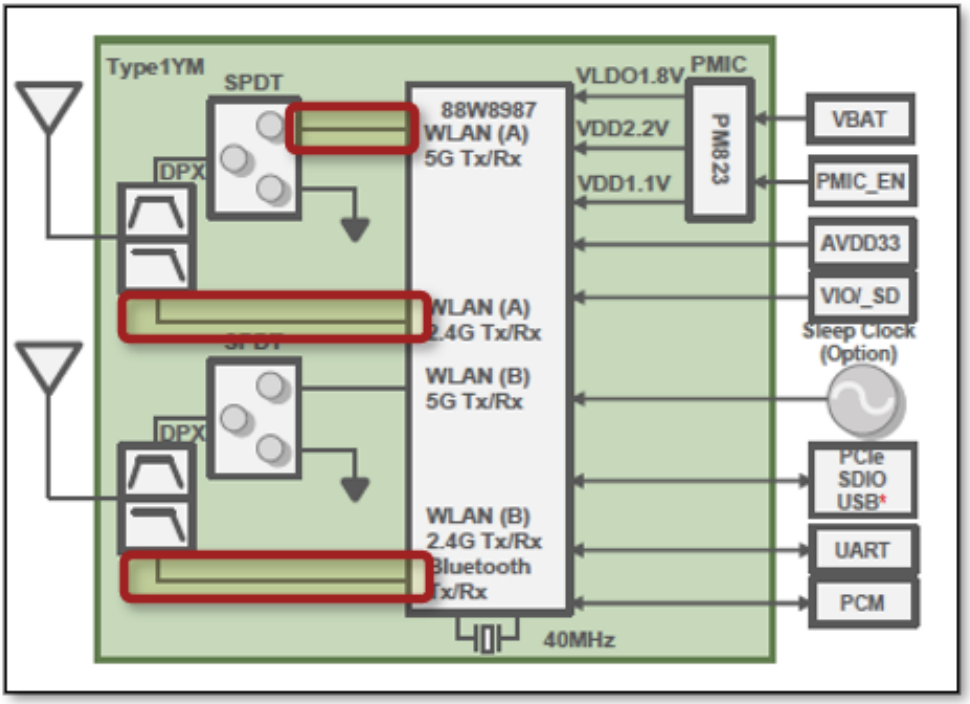
CYW88335 - SINGLE-CHIP 5G WI-FI IEEE 802.11AC MAC/BASEBAND/RADIO WITH INTEGRATED BLUETOOTH 4.1 FOR AUTOMOTIVE APPLICATIONS at 51 (May 8, 2017) (annotation added).

52. The Murata '854 Products contain an analog-to-digital (ADC) converter unit coupled to a signal processing and data computing unit. Specifically, the Murata '854 Products contain central processing unit(s) to perform signal processing and data computing.



W-LAN+Bluetooth Combo Module Data Sheet - P/NLBEE5XV1YM, MURATA DOCUMENTATION at 5 (December 14, 2021) (annotation added).

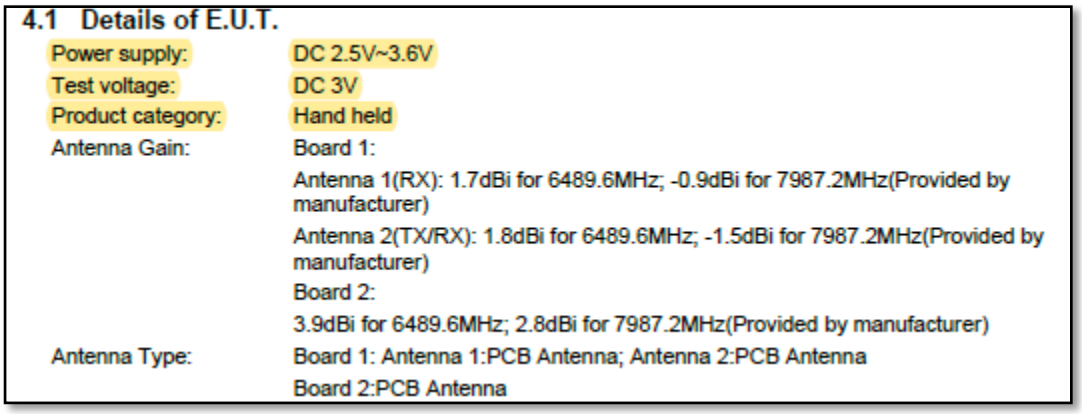
53. One or more of the Murata '854 Products include a signal processing and data computing unit that is coupled to a multiple-input multiple-output space-time transceiver that is connected to two or more antennas. The below diagram shows one example of the infringing functionality wherein Wi-Fi antennas are coupled to the signal processing and data computing unit.



W-LAN+Bluetooth Combo Module Data Sheet - P/NLBEE5XV1YM, MURATA DOCUMENTATION at 5 (December 14, 2021) (annotation added).

54. The Murata '854 Products include memory that is coupled to the analog-to-digital converter unit, the signal processing and data computing unit, and the multiple-input multiple-output space-time transceiver.

55. One or more of the Murata '854 Products include a power generator coupled to a power unit. Specifically, Murata documentation for the infringing products shows a power regulator connected to the power unit (supply voltages).



4.1 Details of E.U.T.

Power supply:	DC 2.5V~3.6V
Test voltage:	DC 3V
Product category:	Hand held
Antenna Gain:	Board 1:
	Antenna 1(RX): 1.7dBi for 6489.6MHz; -0.9dBi for 7987.2MHz(Provided by manufacturer)
	Antenna 2(TX/RX): 1.8dBi for 6489.6MHz; -1.5dBi for 7987.2MHz(Provided by manufacturer)
	Board 2:
	3.9dBi for 6489.6MHz; 2.8dBi for 7987.2MHz(Provided by manufacturer)
Antenna Type:	Board 1: Antenna 1:PCB Antenna; Antenna 2:PCB Antenna
	Board 2:PCB Antenna

FEDERAL COMMUNICATION COMMISSION REPORT NO. KSCR211000018402FOR FCC ID NO. VPYLB2AB at 5 (March 4, 2022) (emphasis added).

56. One or more of the Murata '854 Products include a power unit that is connected to the sensor array unit, the analog-to-digital converter unit, the signal processing and data computing unit, and the multiple-input multiple-output space-time transceiver.

57. The Murata '854 Products are available to businesses and individuals throughout the United States.

58. The Murata '854 Products are provided to businesses and individuals located in the Eastern District of Texas.

59. Murata has directly infringed and continues to directly infringe the '854 patent by, among other things, making, using, offering for sale, and/or selling technology for MIMO wireless sensor networks, including but not limited to the Murata '854 Products.

60. By making, using, testing, offering for sale, and/or selling products and services that comprise a MIMO wireless sensor, including but not limited to the Murata '854 Products, Murata has injured Plaintiff and is liable to Plaintiff for directly infringing one or more claims of the '854 patent, including at least claim 15 pursuant to 35 U.S.C. § 271(a).

61. Murata also indirectly infringes the '854 patent by actively inducing infringement under 35 U.S.C. § 271(b).

62. Murata has had knowledge of the '854 patent since at least service of this Complaint or shortly thereafter, and Murata knew of the '854 patent and knew of its infringement, including by way of this lawsuit.

63. Murata intended to induce patent infringement by third-party customers and users of the Murata '854 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. Murata specifically intended and was aware that the normal and customary use of the accused products would infringe the '854 patent. Murata performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '854 patent and with the knowledge that the induced acts would constitute infringement. For example, Murata provides the Murata '854 Products that have the capability of operating in a manner that infringe one or more of the claims of the '854 patent, including at least claim 15, and Murata further provides documentation and training materials that cause customers and end users of the Murata '854 Products to utilize the products in a manner that directly infringe one or more claims of the '854 patent.[12] By providing instruction and training to customers and end-users on how to use the Murata '854 Products in a manner that directly infringes one or more claims of the '854 patent, including at least claim 15, Murata specifically intended to induce infringement of the '854 patent. Murata engaged in such inducement to promote the sales of the Murata '854 Products, e.g., through Murata

[12] *See e.g., W-LAN+Bluetooth Combo Module Data Sheet - P/NLBEE5XV1YM*, MURATA DOCUMENTATION (December 14, 2021); *W-LAN + Bluetooth Module Data Sheet Qualcomm Chipset for 802.11a/b/g/n/ac + Bluetooth 4.2 Tentative P/N : LBEE5U91CQ-TEMP*, MURATA DATASHEET (May 14, 2018); *Murata Wireless Connectivity Can You Afford Not To?*, MURATA SPEAKS MONTHLY WEBINAR SERIES #09 (May 27, 2021); *Murata wireless solutions for i.MX applications Products,* MURATA PRODUCT BRIEFS (December 2020); *W-LAN+Bluetooth Combo Module Data Sheet - NXP 88W9098 Chipset for 802.11a/b/g/n/ac/ax 2x2 MIMO + Bluetooth 5.2 Design Name: Type1XL Module P/N : LBEE5ZZ1XL-774 Sample P/N : LBEE5ZZ1XL-SMP,* MURATA DATASHEET (February 1, 2022); and *Murata Wi-Fi/BT (CYW) Solution for i.MX FreeRTOS Quick Start Guide 2.0*, MURATA DOCUMENTATION (November 17, 2020).

user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '854 patent. Accordingly, Murata has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '854 patent, knowing that such use constitutes infringement of the '854 patent.

64. The '854 patent is well-known within the industry as demonstrated by multiple citations to the '854 patent in published patents and patent applications assigned to technology companies and academic institutions. Murata is utilizing the technology claimed in the '854 patent without paying a reasonable royalty. Murata is infringing the '854 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

65. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '854 patent.

66. As a result of Murata's infringement of the '854 patent, Plaintiff has suffered monetary damages, and seeks recovery in an amount adequate to compensate for Murata's infringement, but in no event less than a reasonable royalty for the use made of the invention by Murata together with interest and costs as fixed by the Court.

COUNT II
INFRINGEMENT OF U.S. PATENT NO. 7,002,470

67. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

68. Murata designs, makes, uses, sells, and/or offers for sale in the United States products for clustering wireless UWB-based space-time sensor nodes.

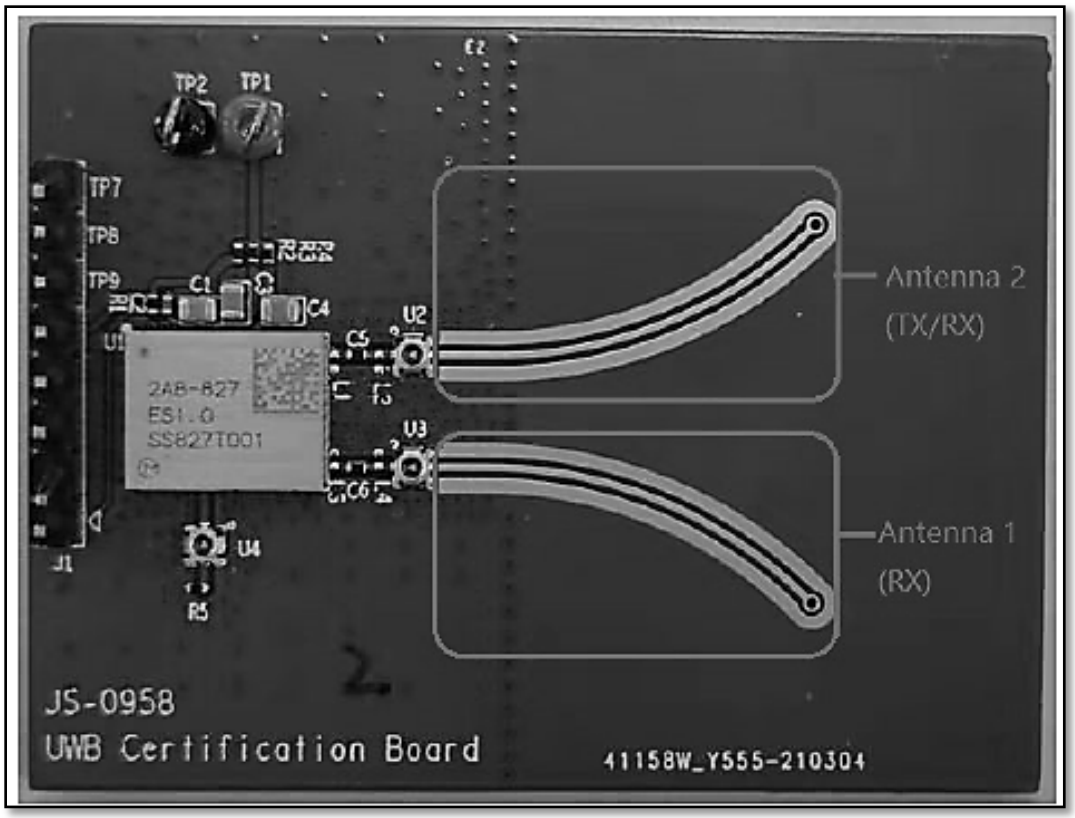
69. Murata designs, makes, sells, offers to sell, imports, and/or uses the following products: Murata Type 2AB UWB Modules, including the Murata LBUA5QJ2AB-EVB Evaluation Kit (collectively, the "Murata '470 Products(s)").

70. One or more Murata subsidiaries and/or affiliates use the Murata '470 Products in regular business operations.

71. One or more of the Murata '470 Products comprise a medium for storing programmable instructions that cause a processor-based system to cluster UWB-based nodes.

72. The LBUA5QJ2AB-EVB and Murata Type 2AB modules contain a Qorvo DW3110/3120 chipset, hostless module Integrated Nordic IC / nRF52840 for waking up UWB and updating firmware, a PCB antenna, and an integrated 3-Axis sensor for conserving battery. The LBUA5QJ2AB-EVB evaluation board contains 2 PCB antennas. *See Murata UWB Modules – Type 2AB*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-us/products/connectivitymodule/ultra-wide-band/qorvo

73. The following image shows the two antennas on the LBUA5QJ2AB-EVB device identified as Antenna 2 (TX/RX) and Antenna 1 (RX).



EXTERNAL IMAGE OF THE LBUA5QJ2AB-EVB DEVICE (showing antennas 1 & 2 for UWB signals).

74. The Murata '470 Product supports the transmission of UWB signals over Channel 5 and Channel 9 as shown in the following excerpt from the User Manual for the Murata '470 Products.

UWB+BLE Module User Manual

muRata
INNOVATOR IN ELECTRONICS

Part Number: LBUA5QJ2AB

LBUA5QJ2AB has been FCC/ISED certified as Single Modular Approval with the following IDs.

FCC ID: VPYLB2AB IC: 772C-LB2AB

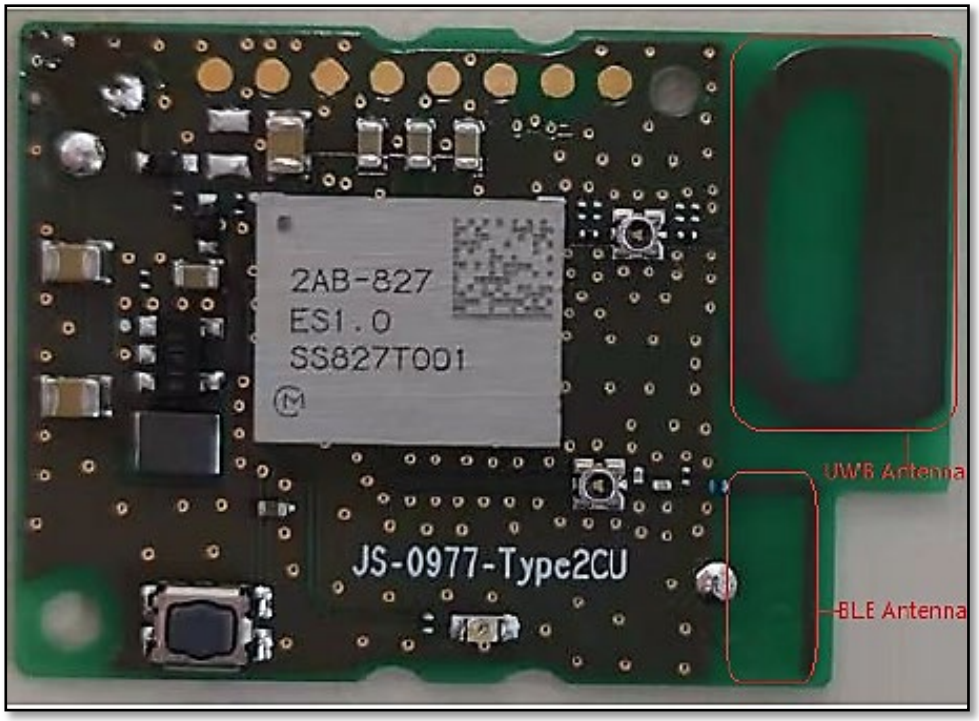
The module is limited to OEM installation ONLY. The OEM integrator is responsible for ensuring that the end-user has no manual instruction to remove or install module.
Therefore, the final host product must be submitted to Murata for confirmation that the installation for the module into the host is in compliance with regulations of FCC and IC Canada. Specially, if an antenna other than the model documented in the Filing is used, a Class 2 Permissive Change must be filed with the FCC.
Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

This module has been approved by FCC to operate with the antenna types with the maximum permissible gain indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device. The following antennas have been certified in combination with the module. Refer to next pages for the antenna application guidance.

(a) TWR/TDoA antenna for UWB with peak gains of 3.9dBi (channel 5) and 2.8dBi (channel 9);
(b) AoA/PDoA antenna for UWB with peak gains of 1.8dBi (channel 5) and -1.5dBi (channel 9);
(c) PCB antenna for BLE with a peak gain of -4.7dBi;

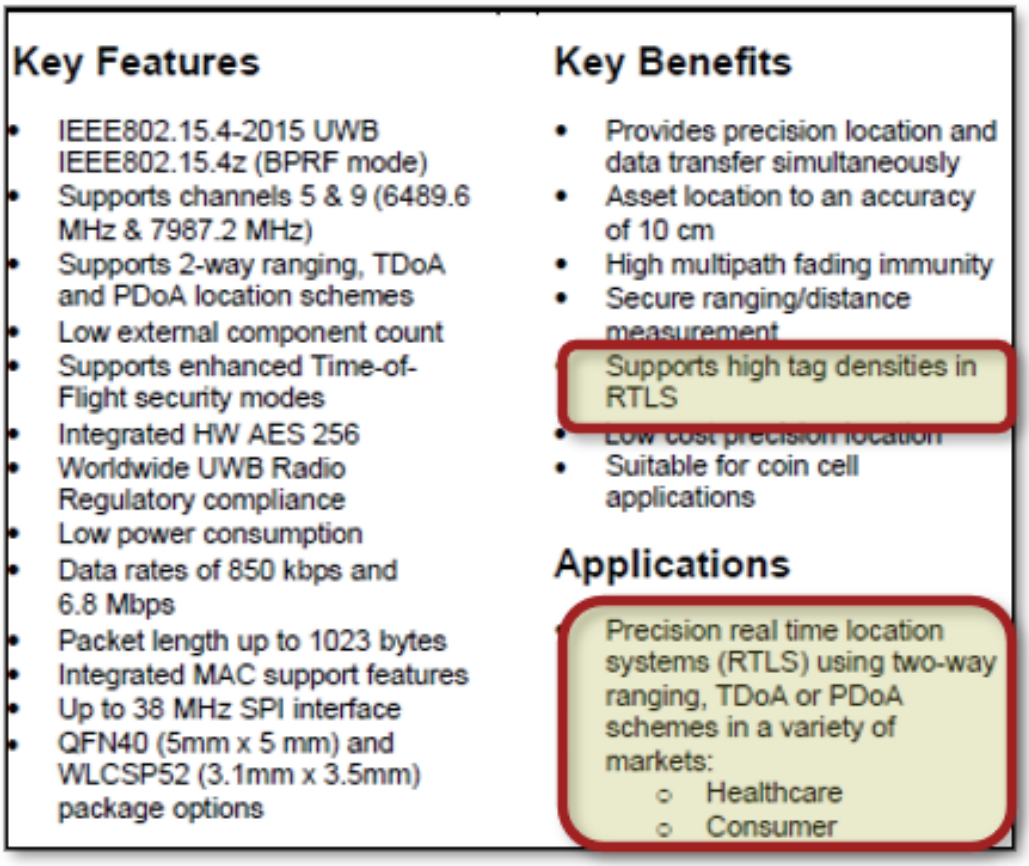
Murata UWB+BLE Module User Manual - Part Number LBUA5QJ2AB, MURATA DOCUMENTATION at 1 (March 2022) (emphasis added).

75. The following image shows the UWB Antenna and BLE Antennas on the Murata Type 2AB modules that contain the DW3110/DW3120 chipset.



EXTERNAL IMAGE OF THE MURATA TYPE 2AB MODULE (showing the UWB and BLE antennas).

76. One or more of the Murata '470 Products include programmable instructions that cause the processor-based system to start a clustering approach for wireless UWB-based space-time sensor nodes. Specifically, the Murata '470 Products contain a DW3110/DW3120 UWB chipset that enables clustering of UWB-based space-time sensor nodes using RTLS.



Key Features

- IEEE802.15.4-2015 UWB IEEE802.15.4z (BPRF mode)
- Supports channels 5 & 9 (6489.6 MHz & 7987.2 MHz)
- Supports 2-way ranging, TDoA and PDoA location schemes
- Low external component count
- Supports enhanced Time-of-Flight security modes
- Integrated HW AES 256
- Worldwide UWB Radio Regulatory compliance
- Low power consumption
- Data rates of 850 kbps and 6.8 Mbps
- Packet length up to 1023 bytes
- Integrated MAC support features
- Up to 38 MHz SPI interface
- QFN40 (5mm x 5 mm) and WLCSP52 (3.1mm x 3.5mm) package options

Key Benefits

- Provides precision location and data transfer simultaneously
- Asset location to an accuracy of 10 cm
- High multipath fading immunity
- Secure ranging/distance measurement
- Supports high tag densities in RTLS
- Low cost precision location
- Suitable for coin cell applications

Applications

Precision real time location systems (RTLS) using two-way ranging, TDoA or PDoA schemes in a variety of markets:

- Healthcare
- Consumer

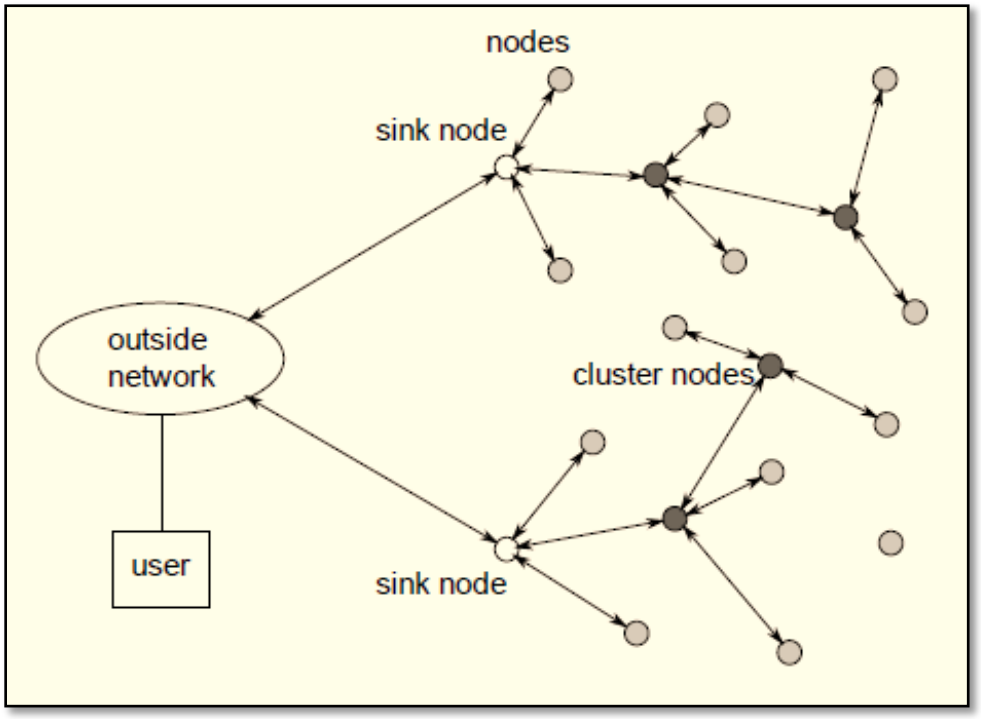
DW3000 DATASHEET VERSION 1.1 at 1 (March 24, 2021) (emphasis added).

77. The Murata '470 Products enable sensor nodes to be grouped together by the gateway/anchor node. This can be enabled through the DecaRange RTLS ARM Source Code which is enabled in the Murata '470 Products.

Octet #'s	Value	Description
1	0x70	Function code: This octet 0x70 identifies this as the Response message
2, 3	-	Sleep correction: This two octet parameter is a correction factor that adjusts the Tag's sleep duration so that the Tag's ranging activity can be assigned and aligned into a slot that does not interfere with other tags in the system. Anchor #0, the gateway anchor, will control/set this field. All other anchors set this field to 0.
12 to 15	-	32-bit TOF from the previous exchange, corresponding to the range number as given in the next octet
16	-	Range number: This is a range sequence number, corresponding to the reported TOF.

DECAWAVE DECARANGERTLS ARM SOURCE CODE GUIDE – UNDERSTANDING AND USING THE DECARANGERTLS V. 2.3 at 20 (20145) (emphasis added).

78. The Murata '470 Products include programmable instructions for selecting sensor node forward stations as a cluster central head. Within the network architecture shown in the following figure, the Murata '470 Products enable some nodes to be assigned to function as a cluster node. Cluster nodes provide the ability to aggregate data from other nodes, disseminate data to other nodes, and act as sensor node forward stations and pass data to a sink node which as a cluster central head.



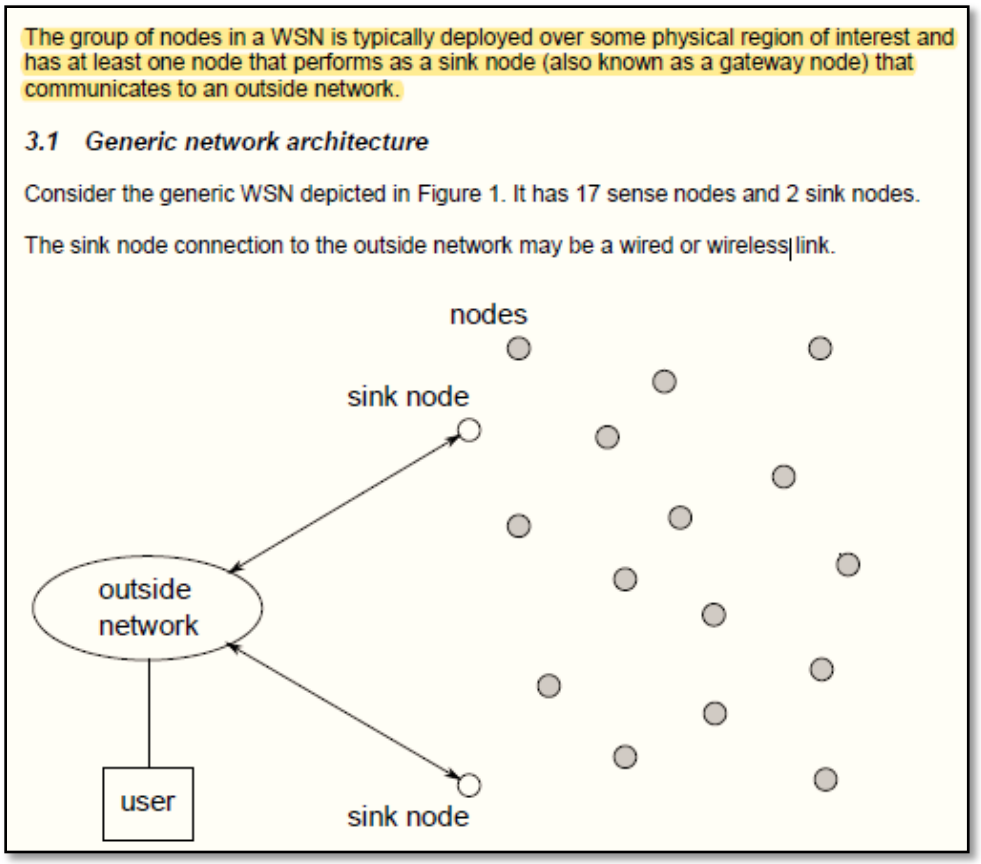
APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 9 (2014).

79. The Murata '470 Products are available to businesses and individuals throughout the United States.

80. The Murata '470 Products are provided to businesses and individuals located in the Eastern District of Texas.

81. Murata has directly infringed and continues to directly infringe the '470 patent by, among other things, making, using, offering for sale, and/or selling technology for clustering wireless UWB-based space-time sensor nodes, including but not limited to the Murata '470 Products.

82. The Murata '470 Products include programmable instructions for classifying wireless UWB-based space-time sensor nodes into cluster groups.



APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 7 (2014) (emphasis added).

83. By making, using, testing, offering for sale, and/or selling products and services for clustering wireless UWB-based space-time sensor nodes, including but not limited to the Murata '470 Products, Murata has injured Plaintiff and is liable to Plaintiff for directly infringing one or more claims of the '470 patent, including at least claim 19 pursuant to 35 U.S.C. § 271(a).

84. Murata also indirectly infringes the '470 patent by actively inducing infringement under 35 U.S.C. § 271(b).

85. Murata has had knowledge of the '470 patent since at least service of this Complaint or shortly thereafter, and Murata knew of the '470 patent and knew of its infringement, including by way of this lawsuit.

86. Murata intended to induce patent infringement by third-party customers and users of the Murata '470 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. Murata specifically intended and was aware that the normal and customary use of the accused products would infringe the '470 patent. Murata performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the '470 patent and with the knowledge that the induced acts would constitute infringement. For example, Murata provides the Murata '470 Products that have the capability of operating in a manner that infringe one or more of the claims of the '470 patent, including at least claim 19, and Murata further provides documentation and training materials that cause customers and end users of the Murata '470 Products to utilize the products in a manner that directly infringe one or more claims of the '470 patent.[13] By providing instruction and training to customers and end-users on how to use the Murata '470 Products in a manner that directly infringes one or more claims of the '470 patent, including at least claim 19, Murata specifically intended to induce infringement of the '470 patent. Murata engaged in such inducement to promote the sales of the Murata '470 Products, e.g., through Murata user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '470 patent. Accordingly, Murata has induced and continues to induce users of the accused products to use the accused products in their ordinary and

[13] *See e.g., Murata UWB+BLE Module User Manual - Part Number LBUA5QJ2AB,* MURATA DOCUMENTATION (March 2022); *Murata Wireless Connectivity Can You Afford Not To?*, MURATA SPEAKS MONTHLY WEBINAR SERIES #09 (May 27, 2021); *Murata x Infineon Joint Webinar* - Murata Speaks – Questions & Answers, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2021/aug'21_infineon/qna-for-lp_without-attendees-questions.ashx; and *Accelerate and simplify your IoT product development with Murata and AWS,* MURATA WEBINAR Presentation (December 10, 2020), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2020/aws-webinar/murata-aws-webinar-presentation_final2.ashx.

customary way to infringe the '470 patent, knowing that such use constitutes infringement of the '470 patent.

87. The '470 patent is well-known within the industry as demonstrated by multiple citations to the '470 patent in published patents and patent applications assigned to technology companies and academic institutions. Murata is utilizing the technology claimed in the '470 patent without paying a reasonable royalty. Murata is infringing the '470 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

88. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '470 patent.

89. As a result of Murata's infringement of the '470 patent, Plaintiff has suffered monetary damages, and seeks recovery in an amount adequate to compensate for Murata's infringement, but in no event less than a reasonable royalty for the use made of the invention by Murata together with interest and costs as fixed by the Court.

COUNT III
INFRINGEMENT OF U.S. PATENT NO. 7,305,057

90. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

91. Murata designs, makes, uses, sells, and/or offers for sale in the United States products comprising a multichannel filter-based handheld ultra-Wideband (UWB) communication transmitter.

92. Murata designs, makes, sells, offers to sell, imports, and/or uses Murata UWB Modules and evaluation kits including: UWB Module Type 2DK, UWB Module Type 2BP, UWB

Module Type 2AB, LBUA5QJ2AB-EVB Evaluation Kit, LBUA0VG2BP-EVB Evaluation Kit, and LBUA2ZZ2DK-EVK Evaluation Kit (collectively, the "Murata '057 Products(s)").

93. The LBUA2ZZ2DK-EVK and Murata Type 2DK modules contain an NXP Trimension SR040 UWB Chipset, and NXP QN9090 Bluetooth LE + MCU chipset, on board antenna, and peripheral components. *See* Murata UWB Modules – Type 2DK, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2dk

94. The LBUA0VG2BP-EVB and Murata Type 2BK modules contain an NXP Trimension SR150 UWB chipset, clock, filters, and peripheral components. Further, for the evaluation board a NXP QN9090 (BLE chip) a USB-UART conversion IC are included. *See Murata UWB Modules Type 2BP*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2bp.

95. The LBUA5QJ2AB-EVB and Murata Type 2AB modules contain a Qorvo DW3110/3120 chipset, Hostless module Integrated Nordic IC / nRF52840 for waking up UWB and updating firmware, a PCB antenna, and an integrated 3-Axis sensor for conserving battery. The LBUA5QJ2AB-EVB evaluation board contains 2 PCB antennas. *See Murata UWB Modules – Type 2AB*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-us/products/connectivitymodule/ultra-wide-band/qorvo

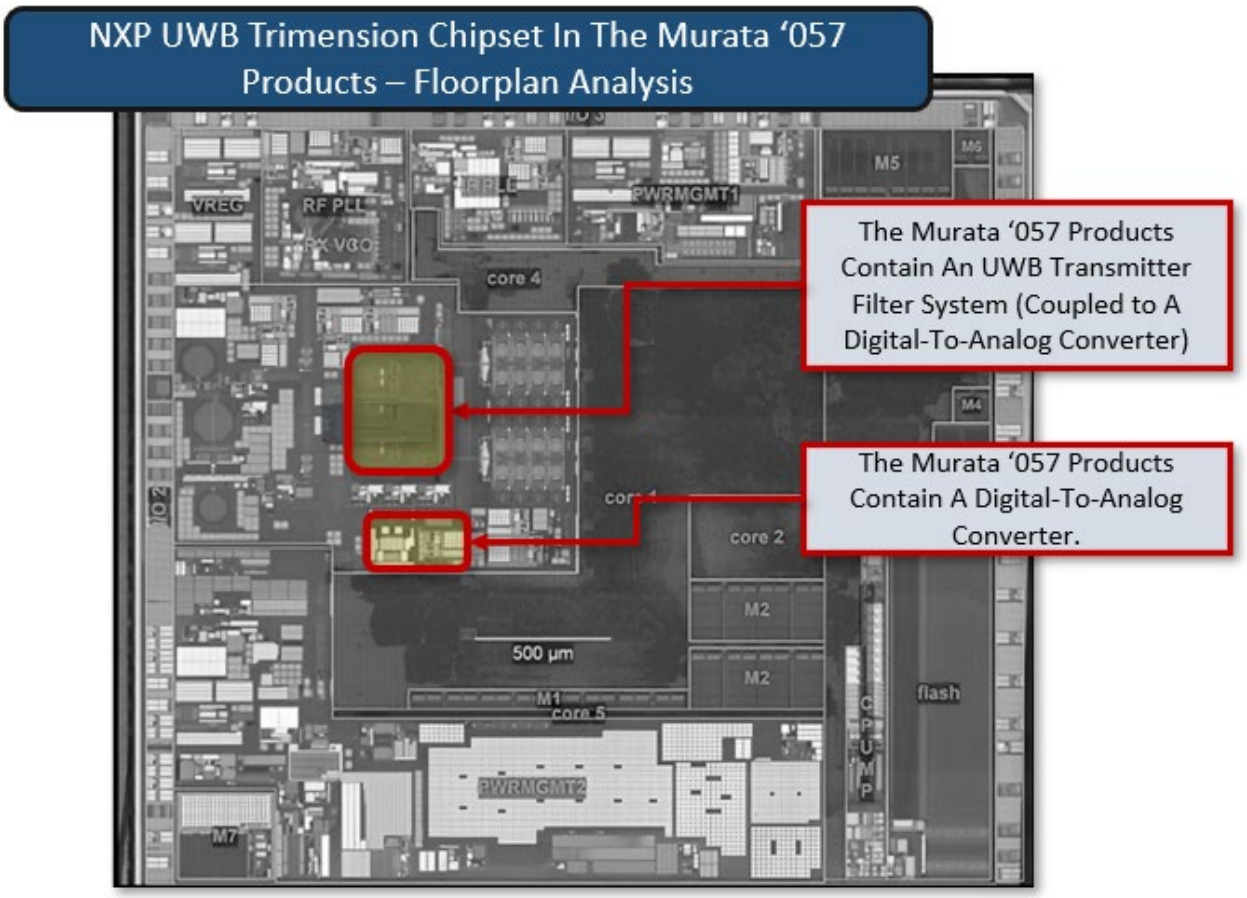
96. The Murata '057 Products comprise a UWB transmitter. For example, the LBUA5QJ2AB-EVB and Murata Type 2AB modules contain a DW3110/3120 chipset for UWB signal transmission and receipt.

UWB	
Power supply:	DC 2.5V~3.6V
Test voltage: Product category:	DC 3V hand held
Antenna Gain:	Board 1: Antenna 1(RX): 1.7dBi for 6489.6MHz; -0.9dBi for 7987.2MHz(Provided by manufacturer) Antenna 2(TX/RX): 1.8dBi for 6489.6MHz; -1.5dBi for 7987.2MHz(Provided by manufacturer) Board 2: 3.9dBi for 6489.6MHz; 2.8dBi for 7987.2MHz(Provided by manufacturer)
Antenna Type:	Board 1: Antenna 1:PCB Antenna; Antenna 2:PCB Antenna Board 2:PCB Antenna
Modulation Type:	BPM+BPSK
Number of Channels:	2
Frequency range:	6489.6MHz to 7987.2MHz
Serial Number:	Board 1: 09411594 Board 2: 09425885

FEDERAL COMMUNICATION COMMISSION REPORT NO. KSCR211000018403 FOR FCC ID NO. VPYLB2AB at 4 (December 25, 2021) (emphasis added).

97. One or more Murata subsidiaries and/or affiliates use the Murata '057 Products in regular business operations.

98. The Murata '057 Products include the LBUA2ZZ2DK-EVK, LBUA0VG2BP-EVK, Murata Type 2DK modules, and Murata Type 2BK modules contain an NXP Trimension UWB chipset for receiving and sending UWB signals. The following annotated image shows the NXP Trimension SR040 UWB chipset die and contain annotations showing the location of the digital-to-analog (DAC) converter which is coupled to a digital UWB transmitter filter system.



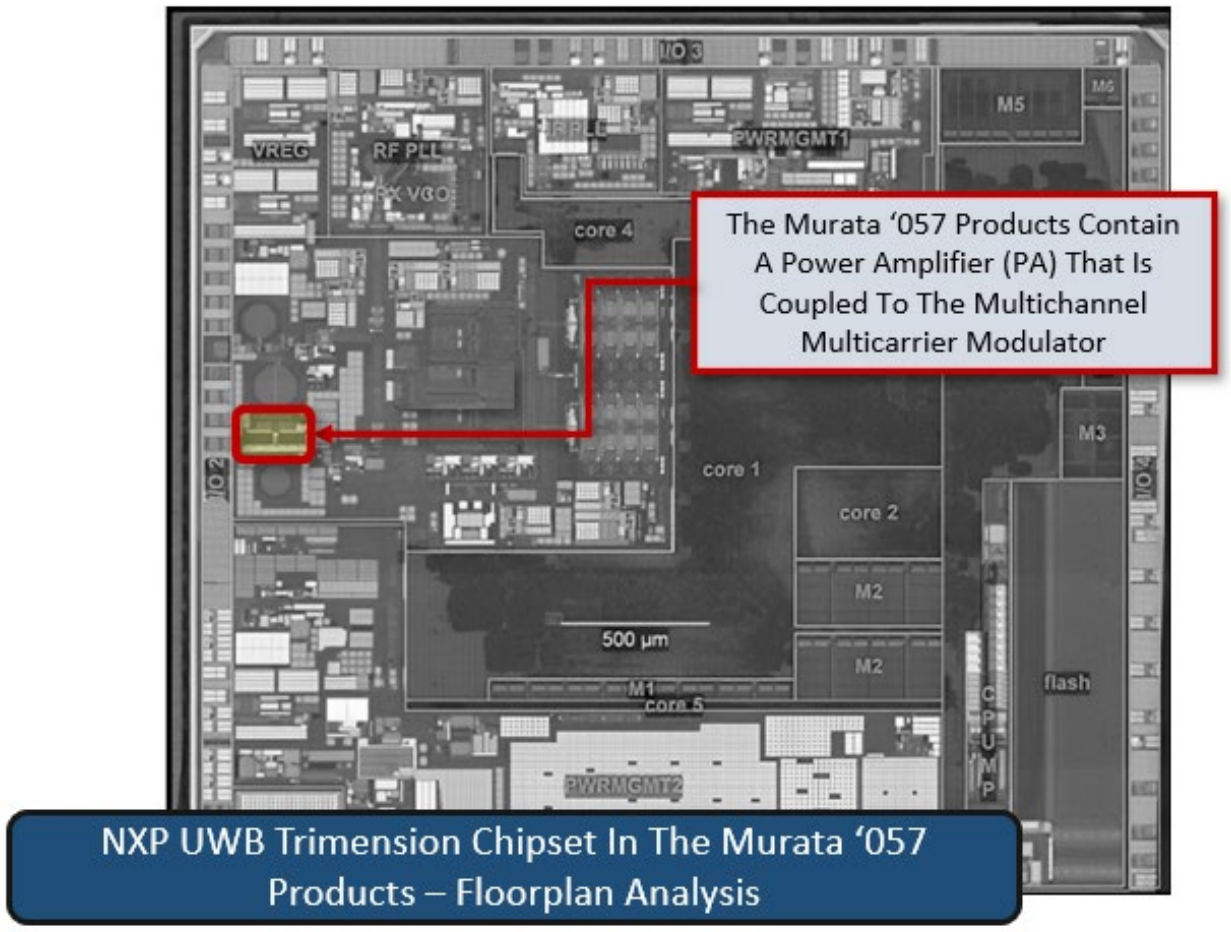
NXP TRIMENSION SR040 UWB TRANSCEIVER IC DIE FLOOR PLAN ANALYSIS (2022) (annotations added).

99. The Murata '057 Products comprise a multichannel filter based handheld UWB transmitter. Specifically, the Murata '057 Products utilize multiple channels for precise UWB localization. The following submission to the Federal Communications Commission from Murata shows one or more of the Murata '057 Products transmit over Channel 5 and Channel 9 BPM+BPSK modulated UWB signal data.

Product category:	Hand held
Antenna Gain:	Board 1:
	Antenna 1(RX): 1.7dBi for 6489.6MHz; -0.9dBi for 7987.2MHz(Provided by manufacturer)
	Antenna 2(TX/RX): 1.8dBi for 6489.6MHz; -1.5dBi for 7987.2MHz(Provided by manufacturer)
	Board 2:
	3.9dBi for 6489.6MHz; 2.8dBi for 7987.2MHz(Provided by manufacturer)
Antenna Type:	Board 1: Antenna 1:PCB Antenna; Antenna 2:PCB Antenna
	Board 2:PCB Antenna
Modulation Type:	BPM+BPSK
Number of Channels:	2
Frequency range:	6489.6MHz to 7987.2MHz
Serial Number:	Board 1: 09411594
	Board 2: 09425885

FEDERAL COMMUNICATION COMMISSION REPORT NO. KSCR211000018402FOR FCC ID NO. VPYLB2AB at 5 (March 4, 2022) (emphasis added).

100. The Murata '057 Products include a multichannel-based multicarrier modulator coupled to a power amplifier. Specifically, the Murata '057 Products include a power amplifier (PA) that amplifies the UWB signal after it is encoded by the multichannel-based multicarrier modulator. The UWB signal that is transmitted by the Murata '057 Products is generated by applying digitally encoded transmit data to the analog pulse generator. The UWB signal is up-converted to a carrier generated the UWB transmitter and centered on one of the permitted IEEE 802.15.4-2015 UWB channel. The modulated RF waveform is amplified before transmission from the antenna by the connected power amplifier.



NXP TRIMENSION SR040 UWB TRANSCEIVER IC DIE FLOOR PLAN ANALYSIS (2022) (annotations added).

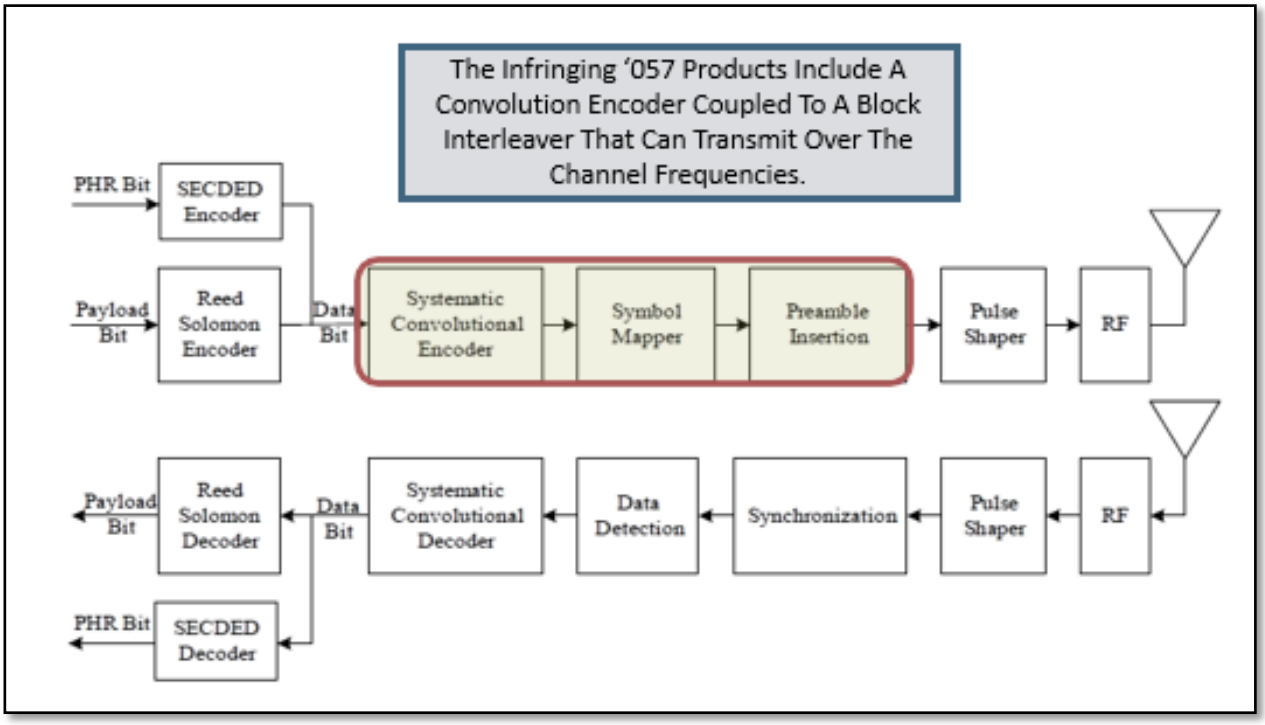
101. The Murata '057 Products include a multichannel control coupled to the multichannel pseudorandom sequence mapping and coupled to the multichannel-based multicarrier modulator.

102. One or more of the Murata '057 Products include a convolution encoder coupled to a block interleaver. Specifically, the forward error correction (FEC) "used by the HRP UWB PHY is a concatenated code consisting of an outer Reed-Solomon systematic block code and an inner half-rate systematic convolutional code." IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS 802.15.4-2020 § 15.3.3.1 (2020).

> Data bits, as used in the PHY Header (PHR) and the PHY Service Data Unit (PSDU), are encoded using either a SECDED (PHR) or Reed-Solomon (PSDU) code, followed by convolutional encoding, after which the coded bits are mapped via Burst Position Modulation (BPM) and BPSK onto sets of multiple pulses called "bursts". The pulses within a burst are transmitted back-to-back, meaning without gaps on the 499.2 MHz chip grid. The (BPSK) polarities of the pulses, as well as the (BPM) burst timings, are scrambled using a linear feedback shift register (LFSR), in order to whiten the spectrum, so as not to cause spectral peaks which would degrade the allowable transmitted integrated band power. Scrambling also increases orthogonality between different transmitted signals, which may provide benefits in (co-channel) interference scenarios.

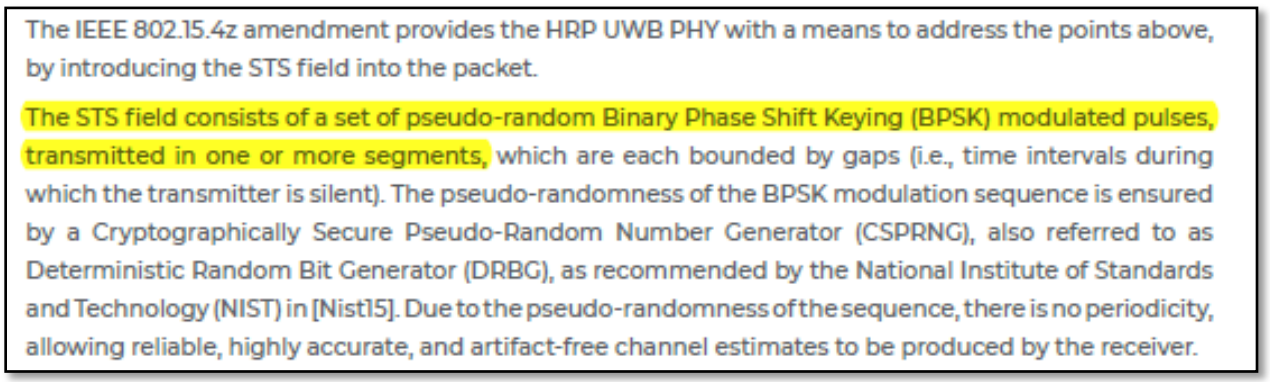
Frank Leong and Hans-Juergen Pirch, *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 9 (2020) (emphasis added).

103. One or more of the Murata '057 Products utilize a combination of BPM and BPSK to transmit and receive UWB signals over multiple channels. The combined BPM-BPSK is used to modulate symbols with each symbol composed of an active burst of UWB pulses. The following figure shows the sequence of processing steps used to create and modulate an HRP UWB PPDU by the Murata '057 Products.



IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS 802.15.4-2020 § 15.1 (2020) (annotation added).

104. The Murata '057 Products include a block interleaver coupled to a multichannel pseudorandom (PN) sequence mapping. Specifically, the Murata '057 Products utilize a Cryptographically Secure Pseudo-Random Number Generator (CSPRNP), also referred to as a Deterministic Random Bit Generator (DRBG).



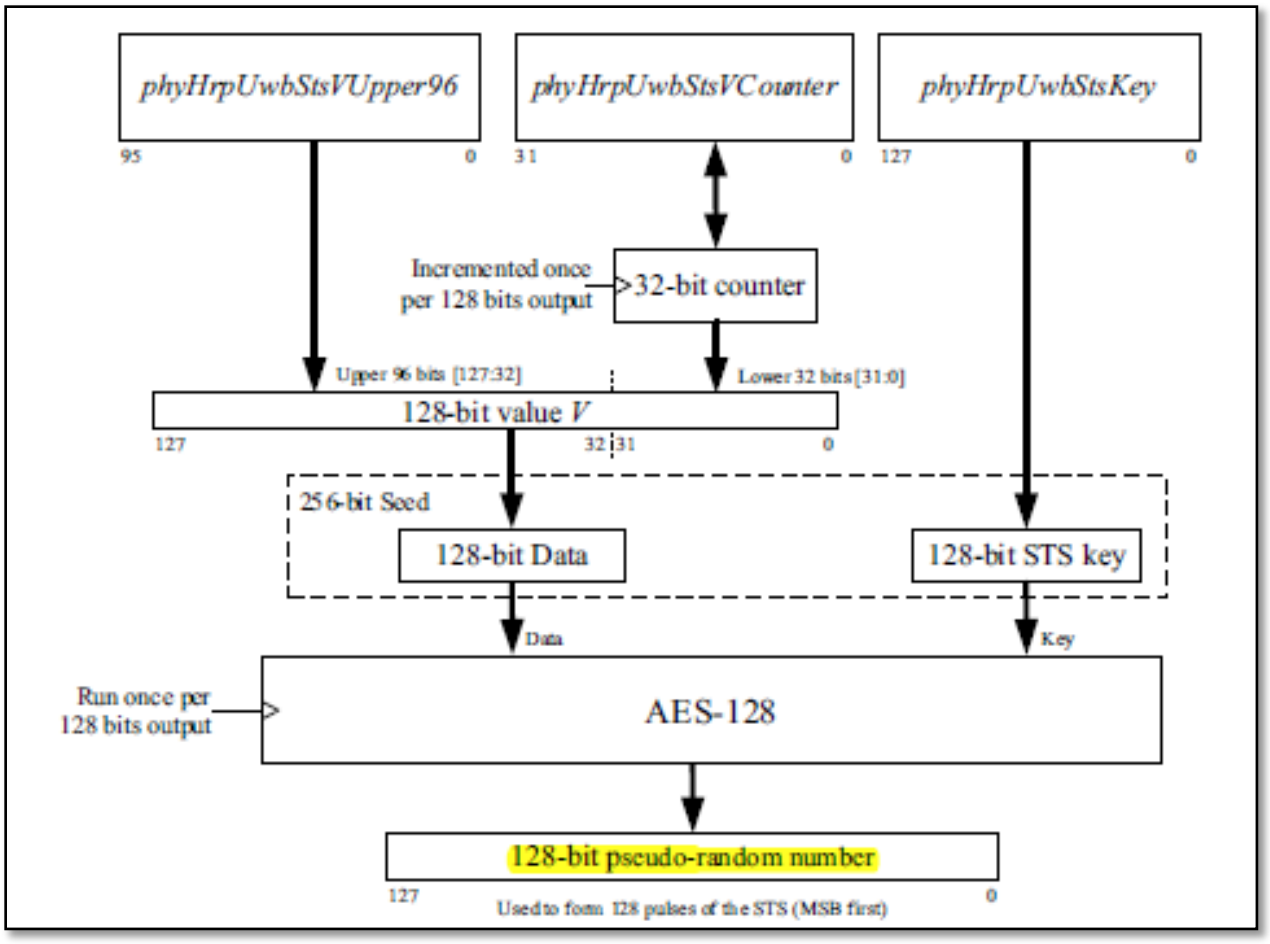
The IEEE 802.15.4z amendment provides the HRP UWB PHY with a means to address the points above, by introducing the STS field into the packet.

The STS field consists of a set of pseudo-random Binary Phase Shift Keying (BPSK) modulated pulses, transmitted in one or more segments, which are each bounded by gaps (i.e., time intervals during which the transmitter is silent). The pseudo-randomness of the BPSK modulation sequence is ensured by a Cryptographically Secure Pseudo-Random Number Generator (CSPRNG), also referred to as Deterministic Random Bit Generator (DRBG), as recommended by the National Institute of Standards and Technology (NIST) in [Nist15]. Due to the pseudo-randomness of the sequence, there is no periodicity, allowing reliable, highly accurate, and artifact-free channel estimates to be produced by the receiver.

Frank Leong and Hans-Juergen Pirch, *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 8 (2020) (emphasis added).

105. The Murata '057 Products include a pseudorandom sequence look-up table coupled to a multichannel pseudorandom sequence mapping component.

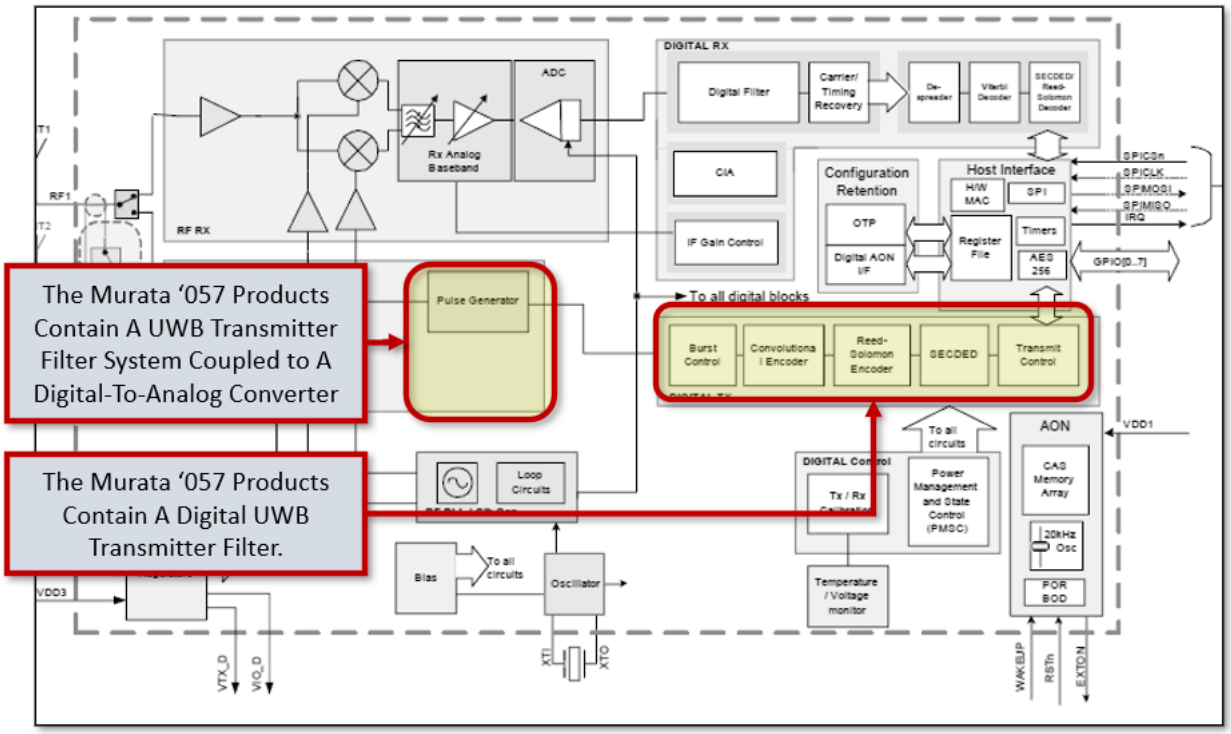
106. The Murata '057 Products comprise a multichannel PN sequence mapping coupled to a digital UWB transmitter filter system. Each iteration of the CSPRNG/DRBG produces a 128-bit pseudo-random number. This transmits the most significant bit first, where each bit of value zero produces a positive polarity pulse and each bit of value one produces a negative polarity pulse. These pulses are spread and transmitted. The creation of the PM sequence mapping is shown in the below diagram.



IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS - AMENDMENT 1: ENHANCED ULTRA WIDEBAND (UWB) PHYSICAL LAYERS (PHYS) AND ASSOCIATED RANGING TECHNIQUES 802.15.4z-2020 § 15.2.9.1 (2020) (emphasis added).

107. One or more of the Murata '057 Products comprise a digital-to-analog converter (DAC) connected to a multichannel-based multicarrier modulator.

108. The Murata '057 Products include a digital UWB transmitter filter system coupled to a digital-to-analog converter. The UWB chipset in one or more of the Murata '057 products consists of an analog front end containing a receiver and a transmitter and a digital back end that interfaces to an off-chip host processor. A TX/RX switch is used to connect the receiver or transmitter to the antenna port.



DW3000 UWB TRANSCEIVER DATASHEET REV. B at 5 (2021) (annotation added).

109. One or more of the Murata '057 Products include a DAC that is connected to a modulator that transmits and receives UWB signals that have a center frequency of 6489.6 MHz, and 7987.2 MHz. Each UWB channel has a bandwidth of between 504.7 MHz and 506.5 MHz.

110. The Murata '057 Products comprise a clock control coupled to the digital UWB transmitter filter system, the digital-to-analog converter, and the multichannel-based multicarrier modulator.

> An HRP UWB transmitter shall be capable of chipping at the peak PRF given in Table 15-3 with an accuracy of $\pm 20 \times 10^{-6}$. In addition, for each HRP UWB PHY channel, the center of transmitted energy shall be within the values listed in Table 15-11 also with an accuracy of $\pm 20 \times 10^{-6}$. The measurements shall be made using a 1 MHz resolution bandwidth and a 1 kHz video bandwidth. The carrier center frequency and the chip rate frequency shall be derived from the same reference oscillator.

IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS - AMENDMENT 1: ENHANCED ULTRA WIDEBAND (UWB) PHYSICAL LAYERS (PHYS) AND ASSOCIATED RANGING TECHNIQUES 802.15.4Z-2020 § 15.4.6 (2020) (emphasis added).

111. Murata has directly infringed and continues to directly infringe the '057 patent by, among other things, making, using, offering for sale, and/or selling technology comprising a multichannel filter-based handheld ultra-wideband (UWB) communication transmitter, including but not limited to the Murata '057 Products.

112. The Murata '057 Products are available to businesses and individuals throughout the United States.

113. The Murata '057 Products are provided to businesses and individuals located in the Eastern District of Texas.

114. By making, using, testing, offering for sale, and/or selling products and services comprising a multichannel filter-based handheld ultra-wideband (UWB) communication transmitter, including but not limited to the Murata '057 Products, Murata has injured Plaintiff and is liable to Plaintiff for directly infringing one or more claims of the '057 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

115. Murata also indirectly infringes the '057 patent by actively inducing infringement under 35 U.S.C. § 271(b).

116. Murata has had knowledge of the '057 patent since at least service of this Complaint or shortly thereafter, and Murata knew of the '057 patent and knew of its infringement, including by way of this lawsuit.

117. Murata intended to induce patent infringement by third-party customers and users of the Murata '057 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. Murata specifically intended and was aware that the normal and customary use of the accused products would infringe the '057 patent. Murata performed the acts that constitute induced infringement,

and would induce actual infringement, with knowledge of the '057 patent and with the knowledge that the induced acts would constitute infringement. For example, Murata provides the Murata '057 Products that have the capability of operating in a manner that infringe one or more of the claims of the '057 patent, including at least claim 1, and Murata further provides documentation and training materials that cause customers and end users of the Murata '057 Products to utilize the products in a manner that directly infringe one or more claims of the '057 patent.[14] By providing instruction and training to customers and end-users on how to use the Murata '057 Products in a manner that directly infringes one or more claims of the '057 patent, including at least claim 1, Murata specifically intended to induce infringement of the '057 patent. Murata engaged in such inducement to promote the sales of the Murata '057 Products, e.g., through Murata user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '057 patent. Accordingly, Murata has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '057 patent, knowing that such use constitutes infringement of the '057 patent.

[14] *See e.g., Murata UWB Modules – Type 2DK,* MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2dk; *Murata UWB Modules Type 2BP*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2bp; *Murata UWB Modules – Type 2AB*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-us/products/connectivitymodule/ultra-wide-band/qorvo; *Murata UWB+BLE Module User Manual - Part Number LBUA5QJ2AB,* MURATA DOCUMENTATION (March 2022); *Murata Wireless Connectivity Can You Afford Not To?*, MURATA SPEAKS MONTHLY WEBINAR SERIES #09 (May 27, 2021); *Murata x Infineon Joint Webinar* - Murata Speaks – Questions & Answers, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2021/aug'21_infineon/qna-for-lp_without-attendees-questions.ashx; and *Accelerate and simplify your IoT product development with Murata and AWS,* MURATA WEBINAR Presentation (December 10, 2020), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2020/aws-webinar/murata-aws-webinar-presentation_final2.ashx.

118. The '057 patent is well-known within the industry as demonstrated by multiple citations to the '057 patent in published patents and patent applications assigned to technology companies and academic institutions. Murata is utilizing the technology claimed in the '057 patent without paying a reasonable royalty. Murata is infringing the '057 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

119. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '057 patent.

120. As a result of Murata's infringement of the '057 patent, Plaintiff has suffered monetary damages, and seek recovery in an amount adequate to compensate for Murata's infringement, but in no event less than a reasonable royalty for the use made of the invention by Murata together with interest and costs as fixed by the Court.

COUNT IV
INFRINGEMENT OF U.S. PATENT NO. 7,433,382

121. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

122. Murata designs, makes, uses, sells, and/or offers for sale in the United States products comprising a multichannel modulation Ultra-Wideband (UWB) communication transceiver.

123. Murata designs, makes, sells, offers to sell, imports, and/or uses UWB Modules and evaluation kits including: UWB Module Type 2DK, UWB Module Type 2BP, UWB Module Type 2AB, LBUA5QJ2AB-EVB Evaluation Kit, LBUA0VG2BP-EVB Evaluation Kit, and LBUA2ZZ2DK-EVK Evaluation Kit (collectively, the "Murata '382 Products(s)").

124. One or more Murata subsidiaries and/or affiliates use the Murata '382 Products in regular business operations.

125. The LBUA2ZZ2DK-EVK and Murata Type 2DK modules contain an NXP Trimension SR040 UWB Chipset, and NXP QN9090 Bluetooth LE + MCU chipset, on board antenna, and peripheral components. *See* Murata UWB Modules – Type 2DK, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2dk

126. The LBUA0VG2BP-EVB and Murata Type 2BK modules contain an NXP Trimension SR150 UWB chipset, clock, filters, and peripheral components. Further, for the evaluation board a NXP QN9090 (BLE chip) a USB-UART conversion IC are included. *See Murata UWB Modules Type 2BP*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2bp.

127. The LBUA5QJ2AB-EVB and Murata Type 2AB modules contain a Qorvo DW3110/3120 chipset, Hostless module Integrated Nordic IC / nRF52840 for waking up UWB and updating firmware, a PCB antenna, and an integrated 3-Axis sensor for saving battery. The LBUA5QJ2AB-EVB evaluation board contains 2 PCB antennas. *See Murata UWB Modules – Type 2AB*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-us/products/connectivitymodule/ultra-wide-band/qorvo

128. One or more of the Murata '382 Products comprise a spread spectrum based multichannel modulation UWB communication transceiver. Specifically, the Murata '382 Products utilize multichannel modulator in supporting UWB channels with a center frequency of 6489.6 MHz, and 7987.2 MHz. Each UWB channel has a bandwidth of between 504.7 MHz and 506.5 MHz.

Product category:	Hand held
Antenna Gain:	Board 1:
	Antenna 1(RX): 1.7dBi for 6489.6MHz; -0.9dBi for 7987.2MHz(Provided by manufacturer)
	Antenna 2(TX/RX): 1.8dBi for 6489.6MHz; -1.5dBi for 7987.2MHz(Provided by manufacturer)
	Board 2:
	3.9dBi for 6489.6MHz; 2.8dBi for 7987.2MHz(Provided by manufacturer)
Antenna Type:	Board 1: Antenna 1:PCB Antenna; Antenna 2:PCB Antenna
	Board 2:PCB Antenna
Modulation Type:	BPM+BPSK
Number of Channels:	2
Frequency range:	6489.6MHz to 7987.2MHz
Serial Number:	Board 1: 09411594
	Board 2: 09425885

FEDERAL COMMUNICATION COMMISSION REPORT NO. KSCR211000018402FOR FCC ID NO. VPYLB2AB at 5 (March 4, 2022) (emphasis added).

129. The Murata '382 Products comprise a spread spectrum physical layer (PHY). Specifically, the Murata '382 Products enable what is "essentially a spread-spectrum PHY. Preamble symbols are repeated by the transmitter such that energy can be accumulated in the receiver and data symbols are spread across multiple pulses." Frank Leong and Hans-Juergen Pirch, *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 9 (2020).

130. The Murata '382 Products contain a spread-spectrum PHY wherein the encoded block is spread and modulated using BPM-BPSK modulation such that the transmit waveform during the *k*th symbol interval may be expressed as follows:

$$x^{(k)}(t) = [1-2g_1^{(k)}] \sum_{n=1}^{N_{cpb}} [1-2s_{n+kN_{cpb}}] \times p(t-g_0^{(k)}T_{BPM}-h^{(k)}T_{burst}-nT_c)$$

IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS 802.15.4-2020 § 15.3.1 (2020).

131. The Murata '382 Products use the spreading sequence to improve the interference rejection capabilities of the UWB PHY.

> Data bits, as used in the PHY Header (PHR) and the PHY Service Data Unit (PSDU), are encoded using either a SECDED (PHR) or Reed-Solomon (PSDU) code, followed by convolutional encoding, after which the coded bits are mapped via Burst Position Modulation (BPM) and BPSK onto sets of multiple pulses called "bursts". The pulses within a burst are transmitted back-to-back, meaning without gaps on the 499.2 MHz chip grid. The (BPSK) polarities of the pulses, as well as the (BPM) burst timings, are scrambled using a linear feedback shift register (LFSR), in order to whiten the spectrum, so as not to cause spectral peaks which would degrade the allowable transmitted integrated band power. Scrambling also increases orthogonality between different transmitted signals, which may provide benefits in (co-channel) interference scenarios.

Frank Leong and Hans-Juergen Pirch, *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 8 (2020).

132. One or more of the Murata '382 Products contain a pseudorandom noise sequence look-up table coupled to a multichannel pseudorandom noise sequence mapping.

> [T]he BPSK modulated STS sequence is used for enabling secure ranging in HRP mode of IEEE 802.15.4. In absence of multi-path and receiver noise, HRP with STS can be used to implement a secure ranging system. In such a scenario the receiver might be able to decode most of the individual pulses of the STS sequence and can require high correlation of the received and template STS. Since an adversary is unable to predict the pseudo-randomly generated sequence it will not be able to generate a high enough correlation peak that satisfies the checks applied at the receiver.

M. Singh, *et al.*, *Security Analysis of IEEE 802.15.4z/HRP UWB Time-of-Flight Distance Measurement,* PROCEEDINGS OF THE 14TH ACM CONFERENCE ON SECURITY AND PRIVACY IN WIRELESS AND MOBILE NETWORKS at 4 (June 28, 2021).

133. One or more of the Murata '382 Products comprise a multichannel pseudorandom noise sequence mapping coupled to a digital lowpass finite impulse response shaping filter. Specifically, the Murata '382 Products use a pulse shaper to ensure compliance to the specified transmit mask and avoid distortion of other channels.

> In order to match the UWB signal to the 500 MHz bandwidth of [Ieee15], the pulse shape needs to be chosen carefully to ensure compliance to the [Ieee15] specified transmit spectrum mask and avoid distortion of adjacent channels. Additionally, stringent regulatory transmit limits must be respected. Figure 2 shows the [Ieee15] Root Raised Cosine (RRC) HRP UWB reference pulse with a center frequency that corresponds to channel 9, as well as an upconverted 8th order Butterworth low pass pulse with a -3 dB bandwidth of 500 MHz and a center frequency that corresponds to channel 5. Both of these pulses would meet the requirements specified in [Ieee15] to be used for IR-UWB radios.

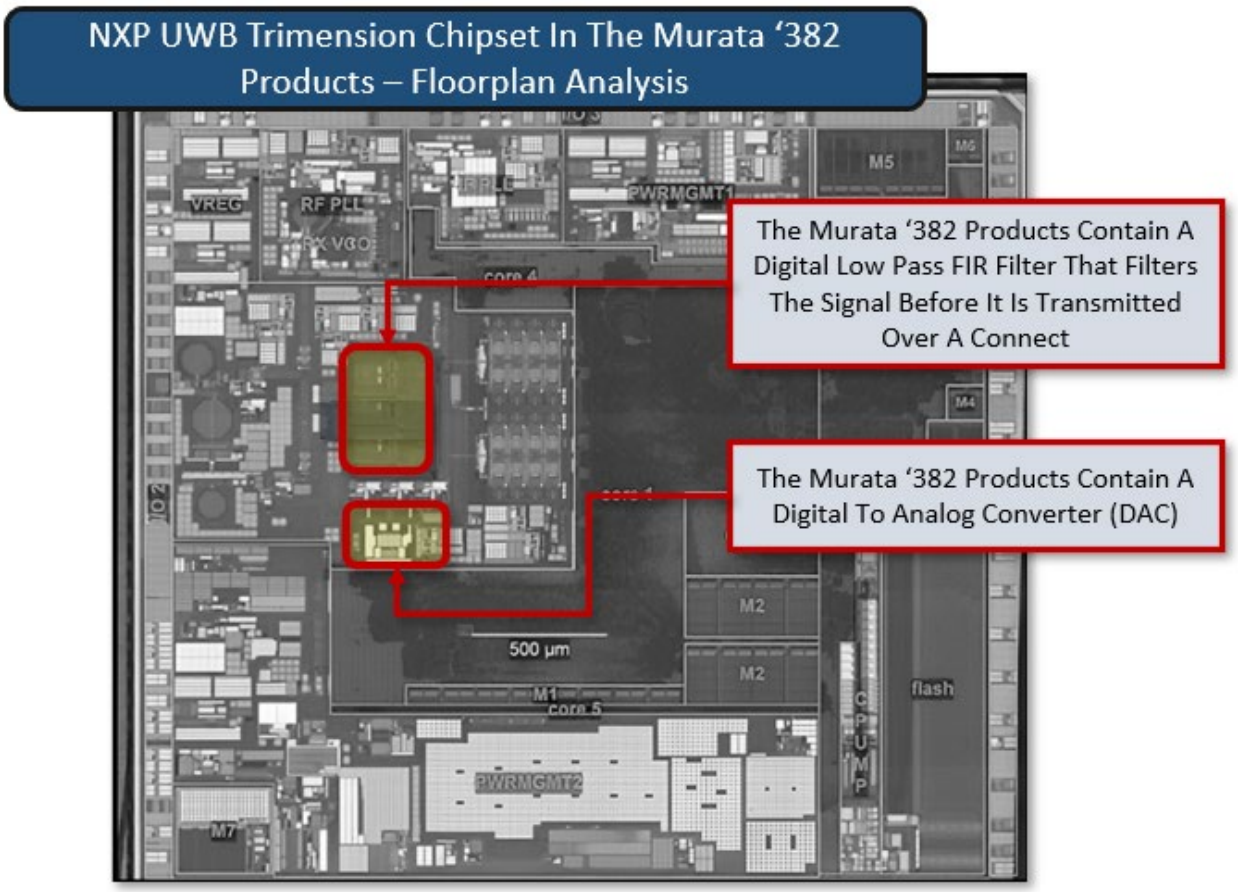
Frank Leong and Hans-Juergen Pirch, *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 3 (2020) (emphasis added)

134. The Murata '382 Products use the multichannel PN sequence mapping to ensure compliance with the IEEE 802.15.4z standard.

> In other words, some systematic redundancy is added into the data in order to recover the correct data at the receiver in the presence of errors. Then, the coded data is mapped onto specific symbols for modulation purposes. As an example, the coded data can be mapped onto binary phase shift keying (BPSK) symbols, which take values from the set $\{-1,+1\}$.

Sinan Gezici and H. Vincent Poor, *Position Estimation via Ultra-Wideband Signals,* PROCEEDINGS OF THE IEEE 97.2 at 25 (2009).

135. One or more of the Murata '382 Products comprise a digital lowpass finite impulse response shaping filter coupled to a digital-to-analog converter.



NXP TRIMENSION SR040 UWB TRANSCEIVER IC DIE FLOOR PLAN ANALYSIS (2022) (annotations added).

136. One or more of the Murata '382 Products contain a multichannel pseudorandom noise sequence mapping wherein two or more I delay units are coupled to two or more down sampling units followed by two or more Exclusive OR (XOR) units in parallel and said two or more XOR units are connected to a pseudorandom noise sequence look-up table.

Table 15-1 and Table 15-2 show how the PHR field, $H_0 - H_{18}$, PHY Payload field, $D_0 - D_{N-1}$, and Tail field, $T_0 - T_1$, are mapped onto the symbols. In these tables, the polarity bit column operation is an XOR. The tables also show when the transition from the header bit rate to the data bit rate takes place. Note that the delay line of the convolutional code is initialized to zero. For this reason, the position bit of Symbol 0 shall always be zero..

Table 15-1—Mapping of PHR field bits, PHY Payload field bits, and Tail field bits onto symbols with Viterbi rate 0.5

Symbol #	Input data	Position bit	Polarity bit	
0	H_0	0	H_0	21 symbols of PHY header at 850 kb/s or 110 kb/s
1	H_1	H_0	H_1	
2	H_2	H_1	$H_0 \oplus H_2$	
3	H_3	H_2	$H_1 \oplus H_3$	
...	...	...	...	
16	H_{16}	H_{15}	$H_{14} \oplus H_{16}$	
17	H_{17}	H_{16}	$H_{15} \oplus H_{17}$	
18	H_{18}	H_{17}	$H_{16} \oplus H_{18}$	
19	D_0	H_{18}	$H_{17} \oplus D_0$	
20	D_1	D_0	$H_{18} \oplus D_1$	
21	D_2	D_1	$D_0 \oplus D_2$	N symbols of data at data rate, e.g., 6.8 Mb/s
...	...	...	...	
N+17	D_{N-2}	D_{N-3}	$D_{N-4} \oplus D_{N-2}$	
N+18	D_{N-1}	D_{N-2}	$D_{N-3} \oplus D_{N-1}$	
N+19	T_0	D_{N-1}	$D_{N-2} \oplus T_0$	
N+20	T_1	T_0	$D_{N-1} \oplus T_1$	

IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS 802.15.4-2020 § 15.2.2 (2020) (emphasis added).

137. Murata has directly infringed and continues to directly infringe the '382 patent by, among other things, making, using, offering for sale, and/or selling technology for a multichannel modulation Ultra-Wideband (UWB) communication transceiver, including but not limited to the Murata '382 Products.

138. The Murata '382 Products are available to businesses and individuals throughout the United States.

139. The Murata ‘382 Products are provided to businesses and individuals located in the Eastern District of Texas.

140. By making, using, testing, offering for sale, and/or selling products and services for a multichannel modulation Ultra-Wideband (UWB) communication transceiver, including but not limited to the Murata ‘382 Products, Murata has injured Plaintiff and is liable to Plaintiff for directly infringing one or more claims of the ‘382 patent, including at least claim 1 pursuant to 35 U.S.C. § 271(a).

141. Murata also indirectly infringes the ‘382 patent by actively inducing infringement under 35 U.S.C. § 271(b).

142. Murata has had knowledge of the ‘382 patent since at least service of this Complaint or shortly thereafter, and Murata knew of the ‘382 patent and knew of its infringement, including by way of this lawsuit.

143. Murata intended to induce patent infringement by third-party customers and users of the Murata ‘382 Products and had knowledge that the inducing acts would cause infringement or was willfully blind to the possibility that its inducing acts would cause infringement. Murata specifically intended and was aware that the normal and customary use of the accused products would infringe the ‘382 patent. Murata performed the acts that constitute induced infringement, and would induce actual infringement, with knowledge of the ‘382 patent and with the knowledge that the induced acts would constitute infringement. For example, Murata provides the Murata ‘382 Products that have the capability of operating in a manner that infringe one or more of the claims of the ‘382 patent, including at least claim 1, and Murata further provides documentation and training materials that cause customers and end users of the Murata ‘382 Products to utilize

the products in a manner that directly infringe one or more claims of the '382 patent.[15] By providing instruction and training to customers and end-users on how to use the Murata '382 Products in a manner that directly infringes one or more claims of the '382 patent, including at least claim 1, Murata specifically intended to induce infringement of the '382 patent. Murata engaged in such inducement to promote the sales of the Murata '382 Products, e.g., through Murata user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '382 patent. Accordingly, Murata has induced and continues to induce users of the accused products to use the accused products in their ordinary and customary way to infringe the '382 patent, knowing that such use constitutes infringement of the '382 patent.

144. The '382 patent is well-known within the industry as demonstrated by multiple citations to the '382 patent in published patents and patent applications assigned to technology companies and academic institutions. Murata is utilizing the technology claimed in the '382 patent without paying a reasonable royalty. Murata is infringing the '382 patent in a manner best

[15] *See e.g., Murata UWB Modules – Type 2DK,* MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2dk; *Murata UWB Modules Type 2BP*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-sg/products/connectivitymodule/ultra-wide-band/nxp/type2bp; *Murata UWB Modules – Type 2AB*, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/en-us/products/connectivitymodule/ultra-wide-band/qorvo; *Murata UWB+BLE Module User Manual - Part Number LBUA5QJ2AB,* MURATA DOCUMENTATION (March 2022); *Murata Wireless Connectivity Can You Afford Not To?*, MURATA SPEAKS MONTHLY WEBINAR SERIES #09 (May 27, 2021); *Murata x Infineon Joint Webinar* - Murata Speaks – Questions & Answers, MURATA WEBSITE (last visited June 2022), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2021/aug'21_infineon/qna-for-lp_without-attendees-questions.ashx; and *Accelerate and simplify your IoT product development with Murata and AWS,* MURATA WEBINAR Presentation (December 10, 2020), *available at*: https://www.murata.com/-/media/webrenewal/campaign/events/asean/2020/aws-webinar/murata-aws-webinar-presentation_final2.ashx.

described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

145. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '382 patent.

146. As a result of Murata's infringement of the '382 patent, Plaintiff has suffered monetary damages, and seeks recovery in an amount adequate to compensate for Murata's infringement, but in no event less than a reasonable royalty for the use made of the invention by Murata together with interest and costs as fixed by the Court.

PRAYER FOR RELIEF

WHEREFORE, Plaintiff MIMO Research, LLC respectfully requests that this Court enter:

A. A judgment in favor of Plaintiff that Murata has infringed, either literally and/or under the doctrine of equivalents, the '854, '470, '057, and '382 patents;

B. An award of damages resulting from Murata's acts of infringement in accordance with 35 U.S.C. § 284;

C. A judgment and order finding that Murata's infringement was willful, wanton, malicious, bad-faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate within the meaning of 35 U.S.C. § 284 and awarding to Plaintiff enhanced damages.

D. A judgment and order finding that this is an exceptional case within the meaning of 35 U.S.C. § 285 and awarding to Plaintiff reasonable attorneys' fees against Murata.

E. Any and all other relief to which Plaintiff may show themselves to be entitled.

JURY TRIAL DEMANDED

Pursuant to Rule 38 of the Federal Rules of Civil Procedure, Plaintiff MIMO Research, LLC requests a trial by jury of any issues so triable by right.

Dated: June 15, 2022

Respectfully submitted,

/s/ Daniel P. Hipskind

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