UNITED STATES DISTRICT COURT
EASTERN DISTRICT OF TEXAS
TEXARKANA DIVISION

MIMO RESEARCH, LLC, ***Plaintiff,*** v. **QORVO, INC.,** ***Defendant.***	**Civil Action No. 5:22-cv-75** **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.: 7,002,470 (the "'470 patent"); 7,305,057 (the "'057 patent"); and 7,433,166 (the "'382 patent") (collectively, the "patents-in-suit"). Defendant Qorvo, Inc. ("Qorvo" or "Defendant") infringes 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 Qorvo, Inc. ("Qorvo") is a Delaware corporation with an established place of business within this District at 500 W. Renner Road, Richardson, Texas 75080. Defendant is authorized to do business in Texas. Defendant may be served by serving its registered agent, Corporation Service Company, 251 Little Falls Drive, Wilmington, Delaware 19808.

4. Qorvo conducts business operations within the Eastern District of Texas where it sells, develops, and/or markets its products including facilities at 500 W. Renner Road, Richardson, Texas 75080.

[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.

JURISDICTION AND VENUE

5. 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).

6. This Court has personal jurisdiction over Qorvo in this action because Qorvo 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 Qorvo would not offend traditional notions of fair play and substantial justice. Defendant Qorvo, 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, Qorvo is registered to do business 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.

7. Venue is proper in this district under 28 U.S.C. §§ 1391(b)-(d) and 1400(b). Defendant Qorvo is registered to do business in the State of Texas, has offices in the State 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.

8. Qorvo has a regular and established place of business in this District and has committed acts of infringement in this District. Qorvo has a permanent office location at 500 W. Renner Road, Richardson, Texas 75080 which is located within this District. Qorvo employs full-time personnel such as sales personnel and engineers in this District, including in Richardson, Texas. Qorvo has also committed acts of infringement in this District by commercializing, marketing, selling, distributing, testing, and servicing certain Accused Products.

9. This Court has personal jurisdiction over Qorvo. Qorvo has conducted and does conduct business within the State of Texas. Qorvo, 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. Qorvo, 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. Qorvo has committed acts of patent infringement within the Eastern District of Texas. Qorvo interacts with customers in Texas, including through visits to customer sites in Texas. Through these interactions and visits, Qorvo directly infringes the patents-in-suit. Qorvo 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.

10. Qorvo 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 Qorvo.

THE ASSERTED PATENTS

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

11. 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 A.

12. 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.

13. 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.

14. 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.

15. 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

16. 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 B.

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

18. 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.

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

20. 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.

21. 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

22. 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 C.

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

24. 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.

25. 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.

26. 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.

27. 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.

28. 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.

29. 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. 7,002,470

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

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

32. Qorvo designs, makes, sells, offers to sell, imports, and/or uses the following products: Ultra-Wideband Transceiver Modules (including models: DWM1000, DWM1001C, DWM1004C, DWM3000, and DWM3001C), Ultra-Wideband Transceivers (including models:

DW1000, DW3110, DW3120, DW3210, and DW3220), and Ultra-Wideband Development Boards & Kits (including models: DWM1001-DEV, DWM3000EVB, DWM3001CDK, and MDEK1001) (collectively, the "Qorvo '470 Products(s)").

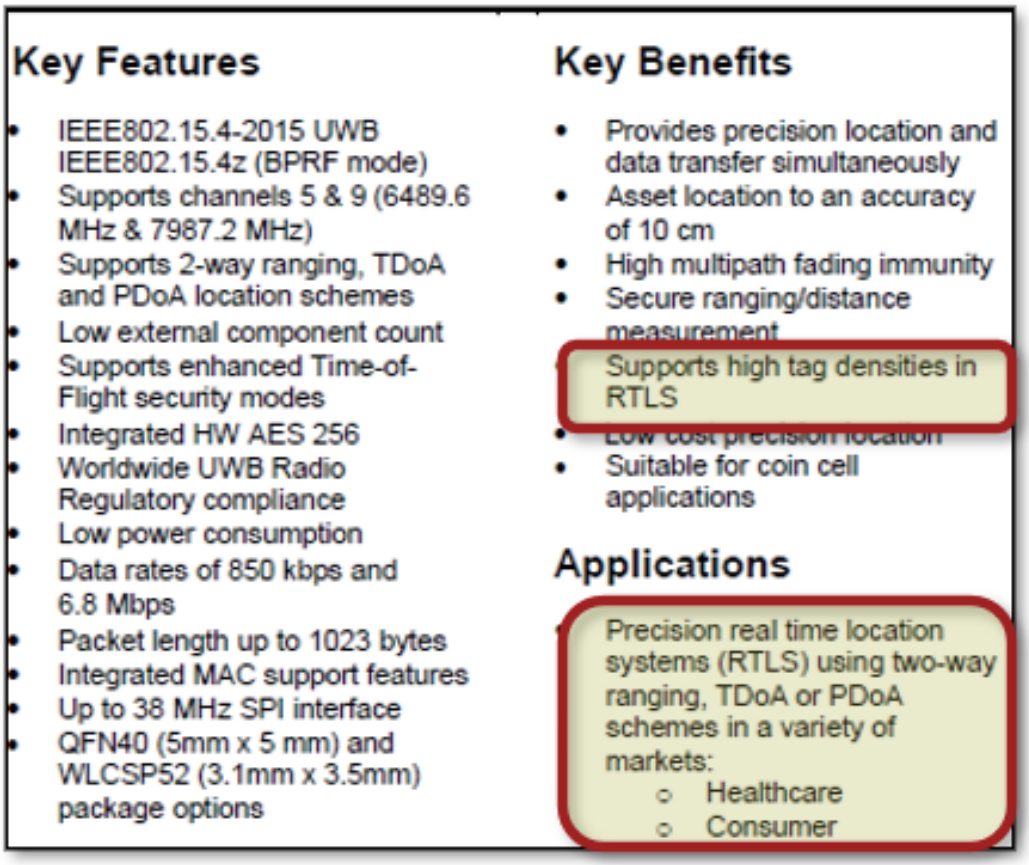
33. One or more Qorvo subsidiaries and/or affiliates use the Qorvo '470 Products in regular business operations.

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

> The *Cluster Join Request* message contains information about the joining anchor (hardware version, firmware version, firmware checksum, and other node capabilities) and the requested seat number. The joined anchors send a response to the request using the extended part of the *Beacon* message. They embed a *Cluster Join Confirmation* message at the end of the *Beacon* messages. They repeat this for 3 cycles (superframes) since the last reception of the *Cluster Join Request* message. During this exchange the anchors in the network and the joining anchor are "locked" and no new anchors will be able to join. If any new anchor sends a join request it will be ignored, this means only one anchor can join at a time. The first *Cluster Join Request* message will contain seat number 0xFF which means, the joining anchor is probing if the networked anchors already have it on their lists.

DWM1001 SYSTEM OVERVIEW AND PERFORMANCE VERSION 2.0 at 17 (2018) (emphasis added).

35. One or more of the Qorvo '470 Products include programmable instructions that cause the processor-based system to start a clustering approach for wireless UWB-based space-time sensor nodes.



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

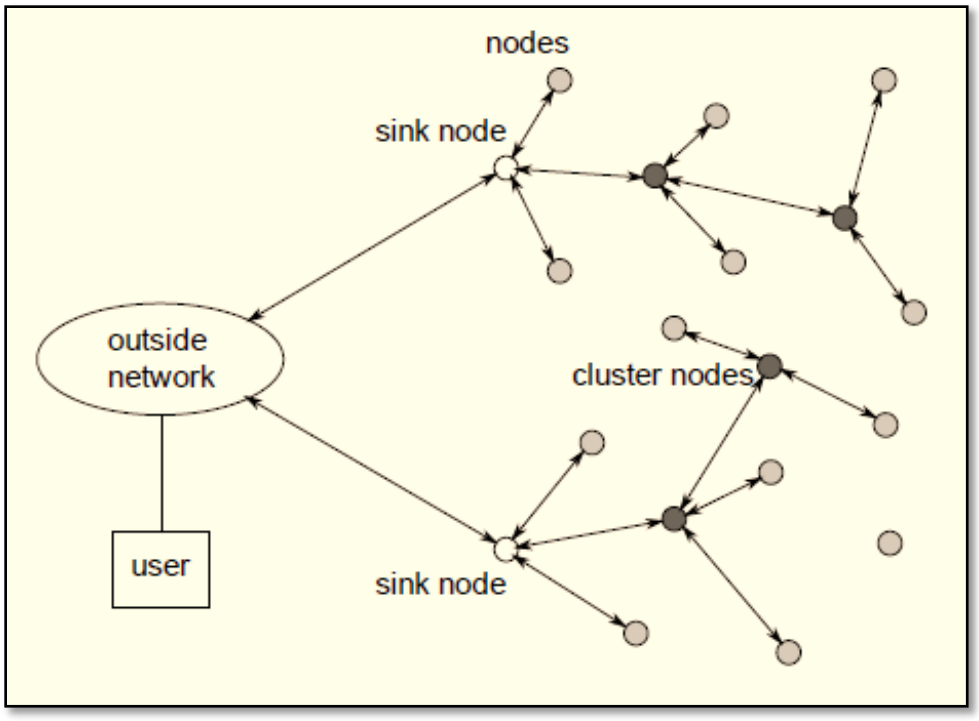
Applications

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).

36. One or more of the Qorvo '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 Qorvo '470 Products enable some nodes to be assigned to function of 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.



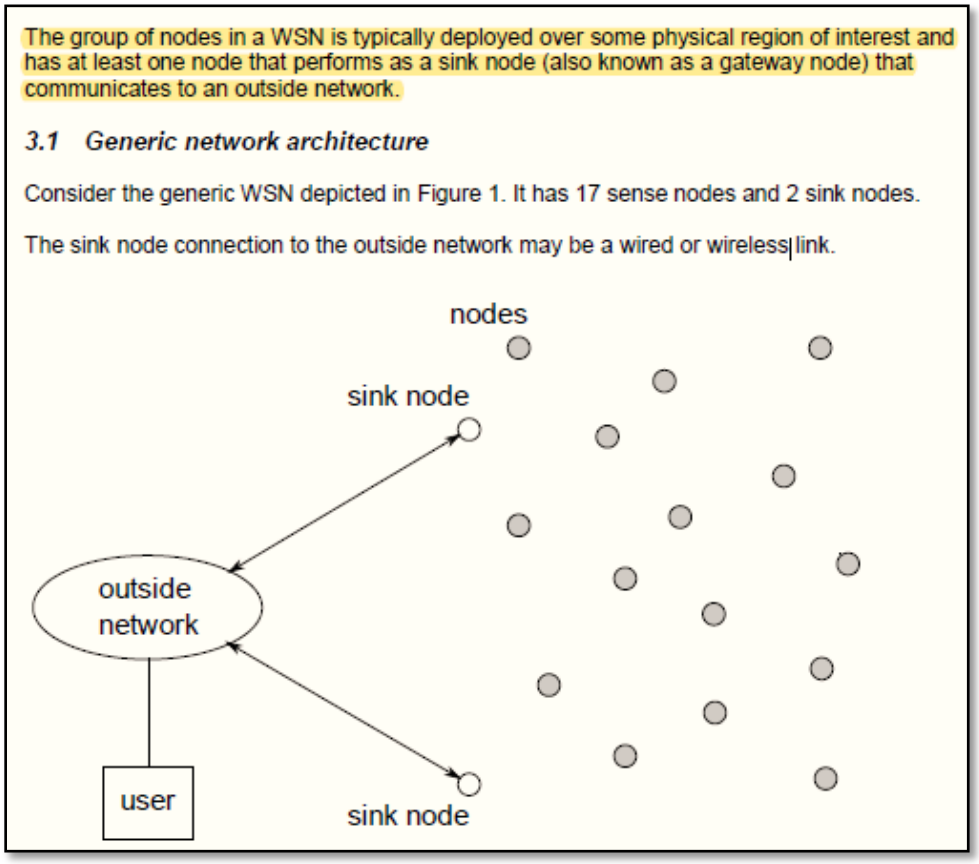
APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 9 (2014).

37. The Qorvo '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 Qorvo '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 (2014) (emphasis added).

38. One or more of the Qorvo '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).

39. Qorvo 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 Qorvo '470 Products.

40. The Qorvo '470 Products are available to businesses and individuals throughout the United States.

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

42. 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 Qorvo '470 Products, Qorvo 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).

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

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

45. Qorvo intended to induce patent infringement by third-party customers and users of the Qorvo '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. Qorvo specifically intended and was aware that the normal and customary use of the accused products would infringe the '470 patent. Qorvo 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, Qorvo provides the Qorvo '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 Qorvo further provides documentation and training materials that cause customers and end users of the Qorvo '470 Products to utilize the products in a manner that directly infringe one or more claims of the '470 patent.[10] By providing

[10] *See e.g.,* APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 7 (2014); DECAWAVE DECARANGERTLS ARM SOURCE CODE GUIDE – UNDERSTANDING AND USING THE DECARANGERTLS V. 2.3 (2014); DW3000 DATASHEET VERSION 1.1 (March 24, 2021); DWM1001 SYSTEM OVERVIEW AND PERFORMANCE VERSION 2.0 (2018); APS006 PART 3 APPLICATION NOTE DW1000 METRICS FOR ESTIMATION OF NON LINE OF

instruction and training to customers and end-users on how to use the Qorvo '470 Products in a manner that directly infringes one or more claims of the '470 patent, including at least claim 19, Qorvo specifically intended to induce infringement of the '470 patent. Qorvo engaged in such inducement to promote the sales of the Qorvo '470 Products, e.g., through Qorvo user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '470 patent. Accordingly, Qorvo 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 '470 patent, knowing that such use constitutes infringement of the '470 patent.

46. 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. Qorvo is utilizing the technology claimed in the '470 patent without paying a reasonable royalty. Qorvo 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.

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

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

SIGHT OPERATING CONDITIONS VERSION 1.1 (2016); and DWM1001 FIRMWARE APPLICATION PROGRAMMING INTERFACE (API) GUIDE VERSION 2.2 (2019).

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

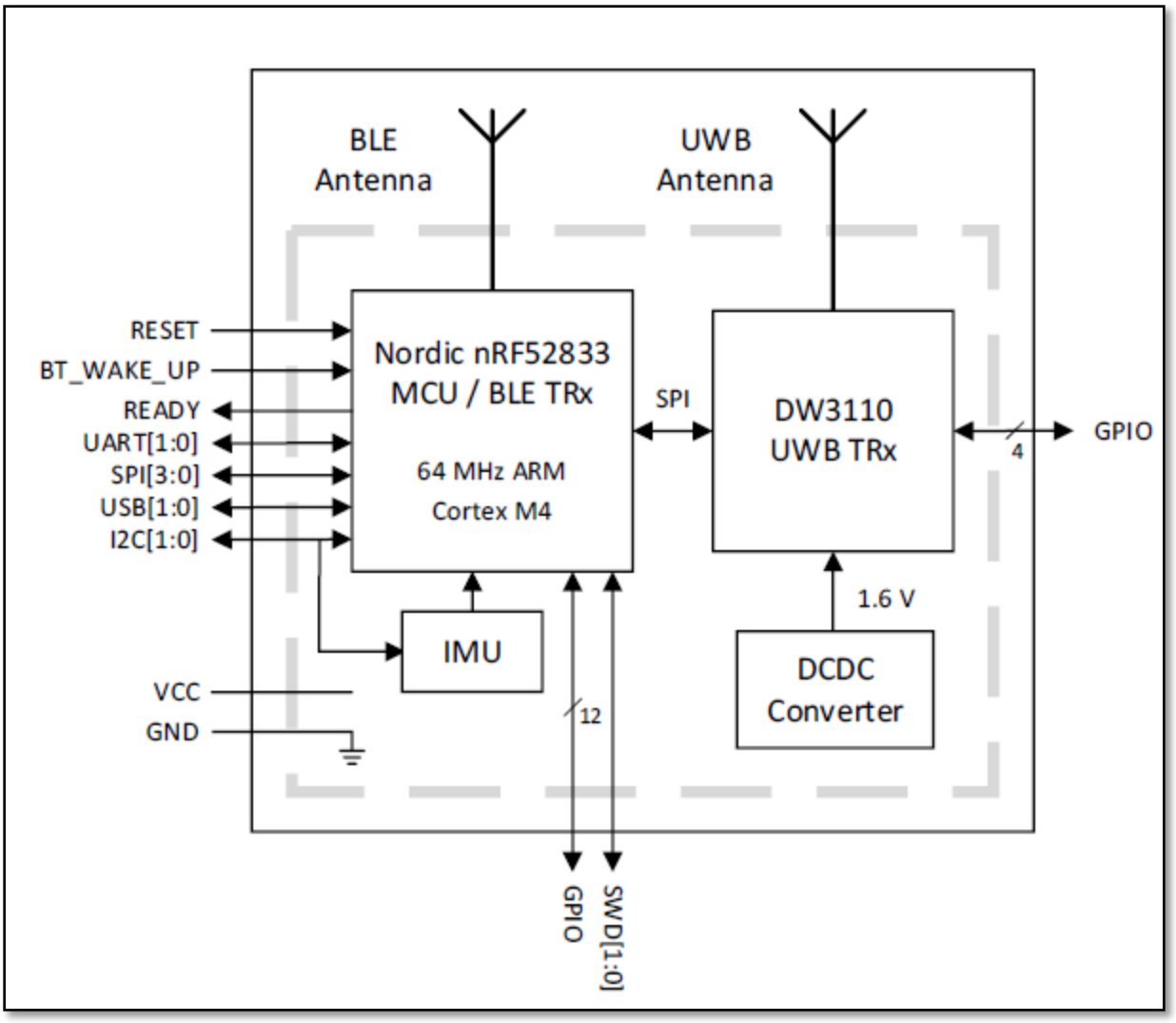
49. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

50. Qorvo 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.

51. Qorvo designs, makes, sells, offers to sell, imports, and/or uses the following products: Ultra-Wideband Transceiver Modules (including models: DWM1000, DWM1001C, DWM1004C, DWM3000, and DWM3001C), Ultra-Wideband Transceivers (including models: DW1000, DW3110, DW3120, DW3210, and DW3220), and Ultra-Wideband Development Boards & Kits (including models: DWM1001-DEV, DWM3000EVB, DWM3001CDK, and MDEK1001) (collectively, the "Qorvo '057 Products(s)").

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

53. One or more of the Qorvo '057 Products comprise a UWB transmitter.



QORVO DWM3001C TRANSCEIVER MODULE DATASHEET REV. B at 1 (May 2022).

54. One or more of the Qorvo '057 Products comprise a multichannel filter-based handheld UWB transmitter. Specifically, the Qorvo '057 Products utilize multiple channels for precise UWB localization.

Table 8: DW1000 Transmitter AC Characteristics

Parameter	Min.	Typ.	Max.	Units	Condition/Note
Frequency range	3244		6999	MHz	
Channel Bandwidths		500 900		MHz	Channel 1, 2, 3 and 5 Channel 4 and 7
Output power spectral density (programmable)		-39	-35	dBm/MHz	See Section 5.5
Load impedance		100		Ω	Differential
Power level range		37		dB	
Coarse Power level step		3		dB	
Fine Power level step		0.5		dB	
Output power variation with temperature		0.05		dB/°C	
Output power variation with voltage		2.73 3.34		dB/V	Channel 2 Channel 5

DECAWAVE1000 DATASHEET VERSION 2.12 at 12 (2016) (emphasis added).

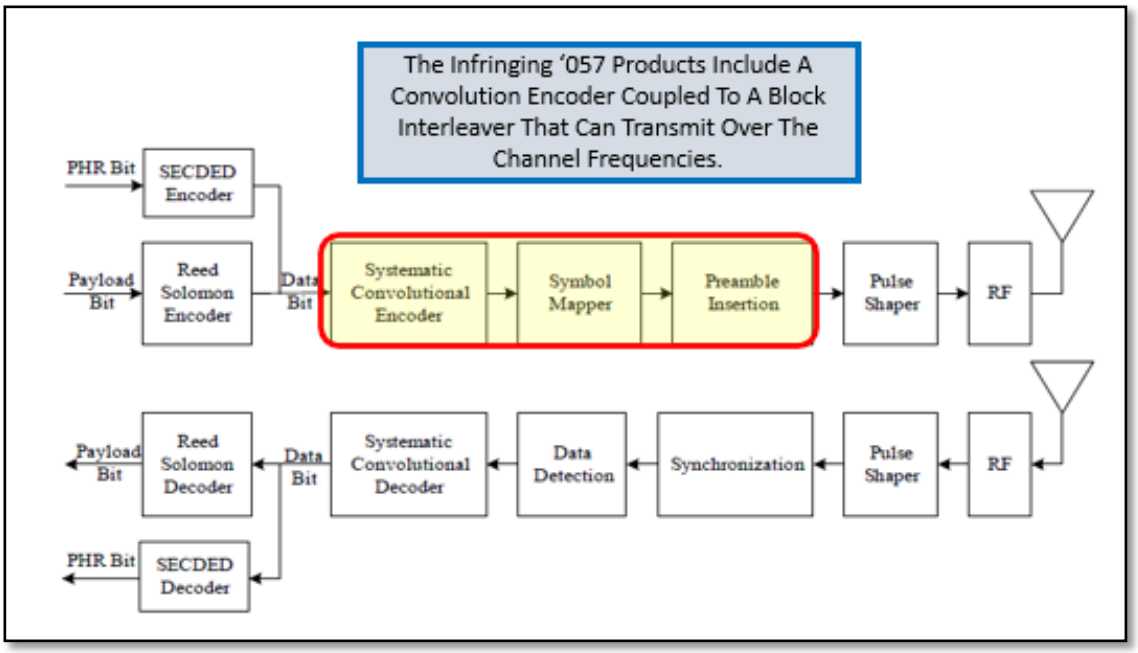
55. One or more of the Qorvo '057 Products include a convolution encoder coupled to a block interleaver. Specifically, the forward error correction (FEC) "used by the HRP UWB PHY is a concatenated code consisting of an outer Reed-Solomon systematic block code and an inner half-rate systematic convolutional 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).

56. One or more of the Qorvo '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

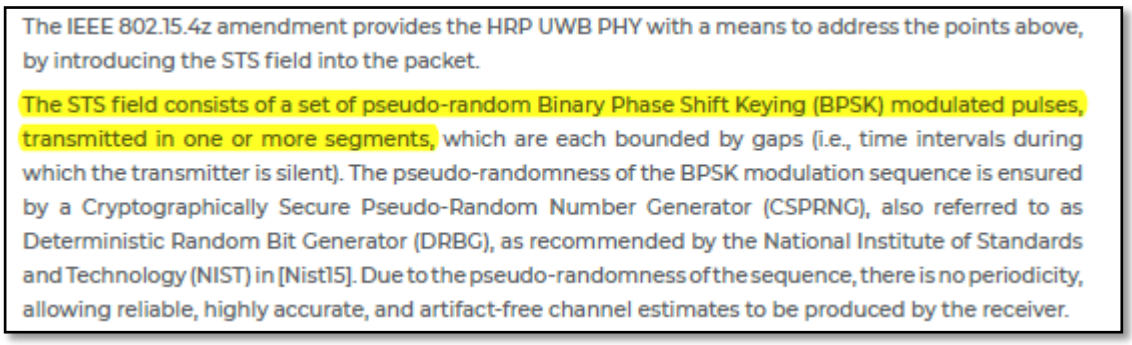
figure shows the sequence of processing steps used to create and modulate an HRP UWB PPDU by the Qorvo '057 Products.



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

57. One or more of the Qorvo '057 Products include a multichannel-based multicarrier modulator coupled to a power amplifier.

58. One or more of the Qorvo '057 Products include a block interleaver coupled to a multichannel pseudorandom (PN) sequence mapping. Specifically, the Qorvo '057 Products utilize a Cryptographically Secure Pseudo-Random Number Generator (CSPRNP), also referred to as a Deterministic Random Bit Generator (DRBG).

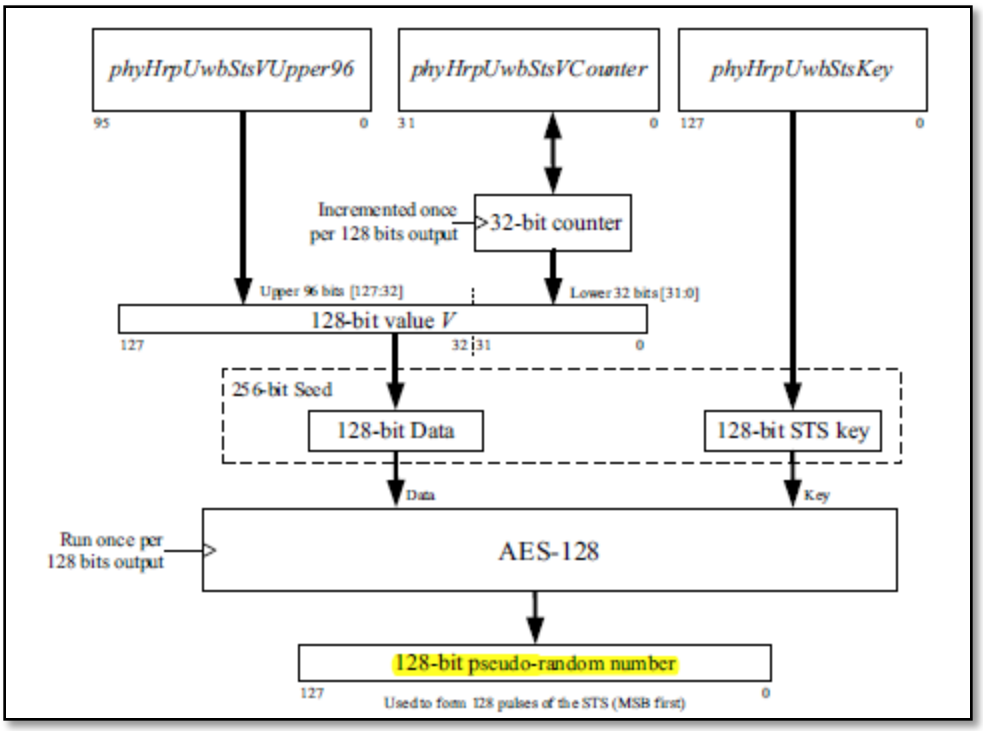


The IEEE 802.15.4z amendment provides the HRP UWB PHY with a means to address the points above, by introducing the STS field into the packet.

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).

59. One or more of the Qorvo '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.

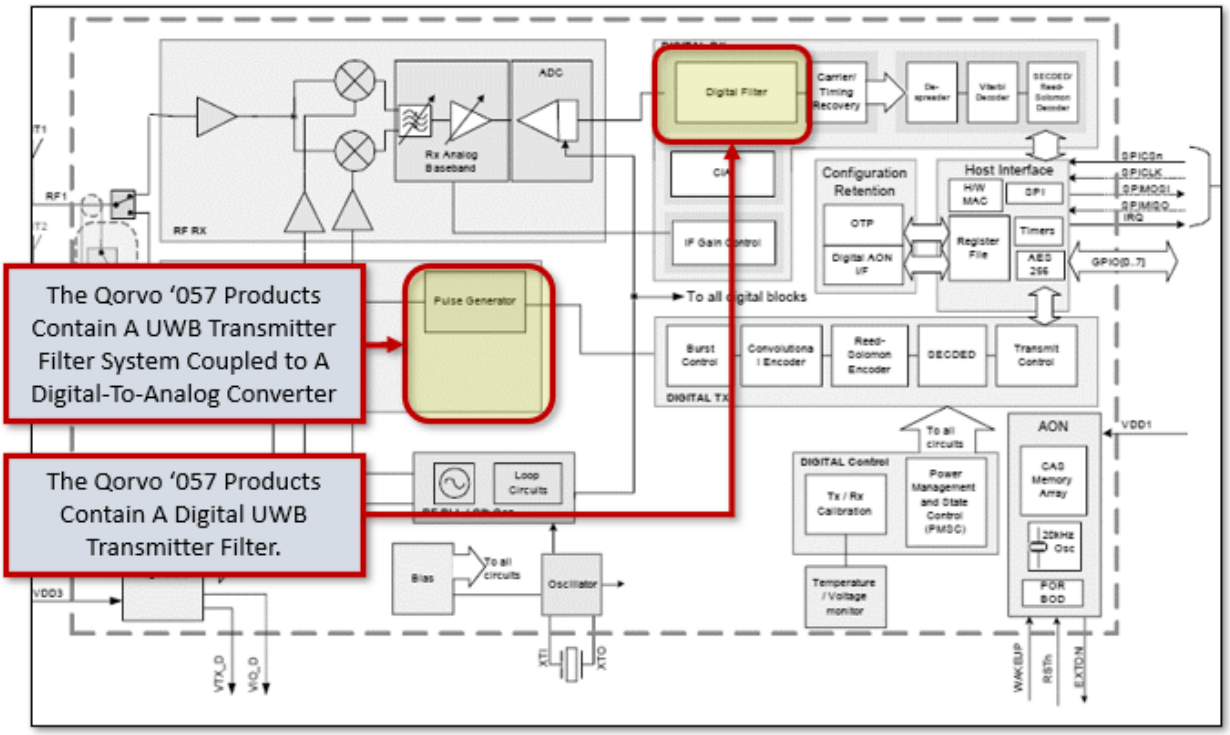


IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS - AMENDMENT 1: ENHANCED ULTRA WIDEBAND (UWB) PHYSICAL LAYERS (PHYS) AND ASSOCIATED RANGING TECHNIQUES 802.15.4z-2020 § 15.2.9.1 (2020) (emphasis added).

60. One or more of the Qorvo '057 Products include a pseudorandom sequence look-up table coupled to a multichannel pseudorandom sequence mapping component.

61. One or more of the Qorvo '057 Products include a multichannel control coupled to the multichannel pseudorandom sequence mapping and coupled to the multichannel-based multicarrier modulator.

62. The Qorvo '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 Qorvo '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).

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

64. One or more of the Qorvo '057 Products include a DAC that is connected to a modulator that transmits and receives UWB signals between 3244 MHz and 6999 MHz. Each UWB channel has a bandwidth of between 500 MHz and 900 MHz.

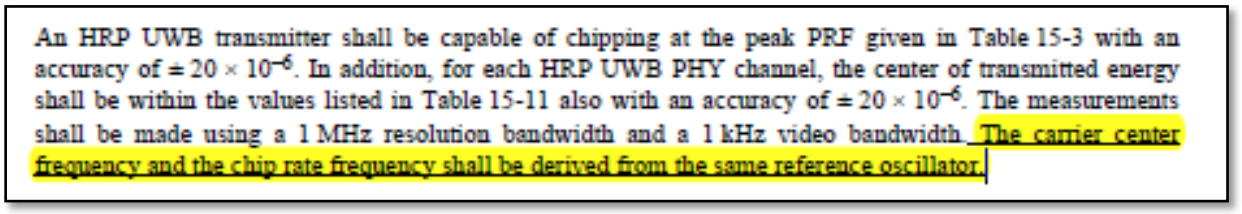
The DW1000 supports the following six IEEE802.15.4-2011 [1] UWB channels: -

Table 11: UWB IEEE802.15.4-2011 UWB channels supported by the DW1000

UWB Channel Number	Centre Frequency (MHz)	Band (MHz)	Bandwidth (MHz)
1	3494.4	3244.8 – 3744	499.2
2	3993.6	3774 – 4243.2	499.2
3	4492.8	4243.2 – 4742.4	499.2
4	3993.6	3328 – 4659.2	1331.2*
5	6489.6	6240 – 6739.2	499.2
7	6489.6	5980.3 – 6998.9	1081.6*

DECAWAVE1000 DATASHEET Version 2.12 at 17 (2016).

65. One or more of the Qorvo '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).

66. Qorvo 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 Qorvo '057 Products.

67. The Qorvo '057 Products are available to businesses and individuals throughout the United States.

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

69. 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 Qorvo '057 Products, Qorvo 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).

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

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

72. Qorvo intended to induce patent infringement by third-party customers and users of the Qorvo '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. Qorvo specifically intended and was aware that the normal and customary use of the accused products would infringe the '057 patent. Qorvo 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, Qorvo provides the Qorvo '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 Qorvo further provides documentation and training materials that cause customers and end users of the Qorvo '057 Products to utilize the products in a manner that directly infringe one or more claims of the '057 patent.[11] By providing instruction and training to customers and end-users on how to use the Qorvo '057 Products in a manner that directly infringes one or more claims of the '057 patent, including at least claim 1, Qorvo specifically intended to induce infringement of the '057 patent. Qorvo engaged in such inducement to promote the sales of the Qorvo '057 Products, e.g., through Qorvo user manuals,

[11] *See e.g.,* QORVO DWM3001C TRANSCEIVER MODULE DATASHEET REV. B (May 2022); DECAWAVE1000 DATASHEET VERSION 2.12 (2016); APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 7 (2014); DECAWAVE DECARANGERTLS ARM SOURCE CODE GUIDE – UNDERSTANDING AND USING THE DECARANGERTLS V. 2.3 (2014); DW3000 DATASHEET VERSION 1.1 (March 24, 2021); DWM1001 SYSTEM OVERVIEW AND PERFORMANCE VERSION 2.0 (2018); APS006 PART 3 APPLICATION NOTE DW1000 METRICS FOR ESTIMATION OF NON LINE OF SIGHT OPERATING CONDITIONS VERSION 1.1 (2016); and DWM1001 FIRMWARE APPLICATION PROGRAMMING INTERFACE (API) GUIDE VERSION 2.2 (2019).

product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '057 patent. Accordingly, Qorvo 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.

73. 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. Qorvo is utilizing the technology claimed in the '057 patent without paying a reasonable royalty. Qorvo 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.

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

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

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

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

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

78. Qorvo designs, makes, sells, offers to sell, imports, and/or uses the following products: Ultra-Wideband Transceiver Modules (including models: DWM1000, DWM1001C, DWM1004C, DWM3000, and DWM3001C), Ultra-Wideband Transceivers (including models: DW1000, DW3110, DW3120, DW3210, and DW3220), and Ultra-Wideband Development Boards & Kits (including models: DWM1001-DEV, DWM3000EVB, DWM3001CDK, and MDEK1001) (collectively, the "Qorvo '382 Products(s)").

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

80. One or more of the Qorvo '382 Products comprise a spread spectrum based multichannel modulation UWB communication transceiver. Specifically, the Qorvo '382 Products utilize multichannel modulator in supporting UWB channels with a center frequency of 3494.4 MHz, 3993.6 MHz, 4492.8 MHz, and 6489.6 MHz. Each UWB channel has a bandwidth of between 499.2 MHz and 900 MHz.

The DW1000 supports the following six IEEE802.15.4-2011 [1] UWB channels: -

Table 11: UWB IEEE802.15.4-2011 UWB channels supported by the DW1000

UWB Channel Number	Centre Frequency (MHz)	Band (MHz)	Bandwidth (MHz)
1	3494.4	3244.8 – 3744	499.2
2	3993.6	3774 – 4243.2	499.2
3	4492.8	4243.2 – 4742.4	499.2
4	3993.6	3328 – 4659.2	1331.2*
5	6489.6	6240 – 6739.2	499.2
7	6489.6	5980.3 – 6998.9	1081.6*

DECAWAVE1000 DATASHEET VERSION 2.12 at 17 (2016).

81. The Qorvo '382 Products comprise a spread spectrum physical layer (PHY). Specifically, the Qorvo '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).

82. The Qorvo '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).

83. The Qorvo '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).

84. One or more of the Qorvo '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).

85. One or more of the Qorvo '382 Products comprise a multichannel pseudorandom noise sequence mapping coupled to a digital lowpass finite impulse response shaping filter. Specifically, the Qorvo '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.

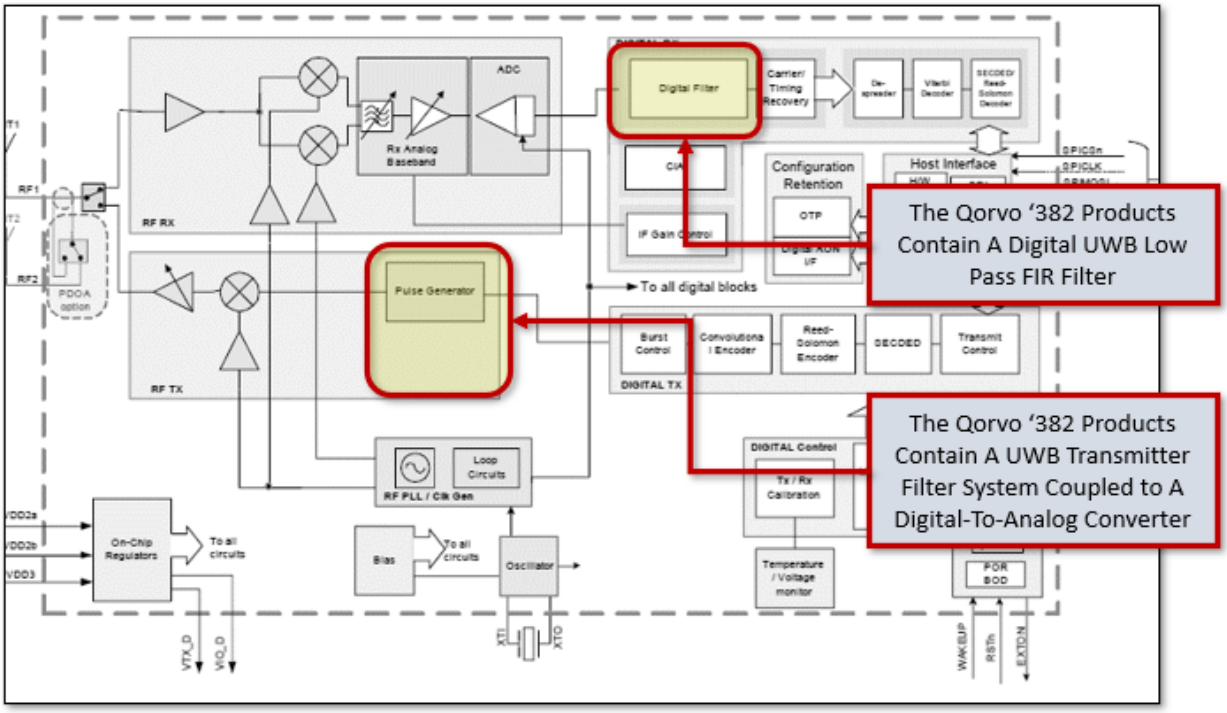
Frank Leong and Hans-Juergen Pirch (HID), *Introduction to Impulse Radio UWB Seamless Access Systems*, FIRA WHITE PAPER at 3 (2020) (emphasis added)

86. Further, the Qorvo '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).

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



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

88. One or more of the Qorvo '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).

89. Qorvo 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 Qorvo '382 Products.

90. The Qorvo '382 Products are available to businesses and individuals throughout the United States.

91. The Qorvo '382 Products are provided to businesses and individuals located in the Eastern District of Texas.

92. 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 Qorvo '382 Products, Qorvo 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).

93. Qorvo also indirectly infringes the '382 patent by actively inducing infringement under 35 U.S.C. § 271(b).

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

95. Qorvo intended to induce patent infringement by third-party customers and users of the Qorvo '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. Qorvo specifically intended and was aware that the normal and customary use of the accused products would infringe the '382 patent. Qorvo 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, Qorvo provides the Qorvo '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 Qorvo further provides documentation and training materials that cause customers and end users of the Qorvo '382 Products to utilize the

products in a manner that directly infringe one or more claims of the '382 patent.[12] By providing instruction and training to customers and end-users on how to use the Qorvo '382 Products in a manner that directly infringes one or more claims of the '382 patent, including at least claim 1, Qorvo specifically intended to induce infringement of the '382 patent. Qorvo engaged in such inducement to promote the sales of the Qorvo '382 Products, e.g., through Qorvo user manuals, product support, marketing materials, and training materials to actively induce the users of the accused products to infringe the '382 patent. Accordingly, Qorvo 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.

96. 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. Qorvo is utilizing the technology claimed in the '382 patent without paying a reasonable royalty. Qorvo is infringing the '382 patent in a manner best described as willful, wanton, malicious, in bad faith, deliberate, consciously wrongful, flagrant, or characteristic of a pirate.

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

[12] *See e.g.,* QORVO DWM3001C TRANSCEIVER MODULE DATASHEET REV. B (May 2022); DECAWAVE1000 DATASHEET VERSION 2.12 (2016); APS010 APPLICATION NOTE – WIRELESS SENSOR NETWORKS AND THE DW1000 VERSION 0.1 at 7 (2014); DECAWAVE DECARANGERTLS ARM SOURCE CODE GUIDE – UNDERSTANDING AND USING THE DECARANGERTLS V. 2.3 (2014); DW3000 DATASHEET VERSION 1.1 (March 24, 2021); DWM1001 SYSTEM OVERVIEW AND PERFORMANCE VERSION 2.0 (2018); APS006 PART 3 APPLICATION NOTE DW1000 METRICS FOR ESTIMATION OF NON LINE OF SIGHT OPERATING CONDITIONS VERSION 1.1 (2016); and DWM1001 FIRMWARE APPLICATION PROGRAMMING INTERFACE (API) GUIDE VERSION 2.2 (2019).

98. As a result of Qorvo's infringement of the '382 patent, Plaintiff has suffered monetary damages, and seeks recovery in an amount adequate to compensate for Qorvo's infringement, but in no event less than a reasonable royalty for the use made of the invention by Qorvo 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 Qorvo has infringed, either literally and/or under the doctrine of equivalents, the '470, '057, and '382 patents;

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

C. A judgment and order finding that Qorvo'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 Qorvo.

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 21, 2022

Respectfully submitted,

/s/ Daniel P. Hipskind

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