UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF TEXAS
WACO DIVISION

MIMO RESEARCH, LLC, ***Plaintiff,*** v. **STMICROELECTRONICS, INC. AND STMICROELECTRONICS N.V.,** ***Defendants.***	**Civil Action No. 6:22-cv-668** **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.: 7,200,166 (the "'166 patent") and 7,305,057 (the "'057 patent") (collectively, the "patents-in-suit"). Defendants STMicroelectronics, Inc. and STMicroelectronics N.V. (collectively, "STMicroelectronics" 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]
- Sony Group Corporation[4]
- Nokia Corporation[5]
- Qualcomm, Inc.[6]
- Siemens AG[7]
- Fujitsu Limited[8]

3. STMicroelectronics has cited the MIMO Research patents in ten patents and patent applications including: U.S. Patent Nos. 7,656,932; 7,660,341; 7,660,342; 7,817,763; 8,817,935; and U.S. Patent Application Nos. 2006/0256845; 2006/0262833; 2007/0098056; 2008/0037667; and 2010/0289628.

4. On information and belief, STMicroelectronics, Inc. is a Delaware corporation with offices located at 8501 North Mo-Pac Expressway, Suite 420, Austin Texas. STMicroelectronics, Inc. is registered to do business in the State of Texas and may be served with process through its registered agent, CT Corp System, 1999 Bryan Street, Suite 900, Dallas, Texas 75201-3136. On

[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. 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.

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

[6] *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.

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

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

information and belief, STMicroelectronics, Inc. conducts business operations within the Western District of Texas through its facilities in Austin, Texas.

5. On information and belief, STMicroelectronics N.V. is a foreign corporation with headquarters located at 39 Chemin du Champ des Filles Plan-Les-Quates, Geneva 1118BH Switzerland. STMicroelectronics N.V. does business in Texas, directly or through its wholly-owned subsidiaries.

6. STMicroelectronics conducts business operations within the Western District of Texas where it sells, develops, and/or markets its products including facilities in Austin, Texas.

JURISDICTION AND VENUE

7. 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).

8. This Court has personal jurisdiction over STMicroelectronics in this action because STMicroelectronics has committed acts within the Western District of Texas giving rise to this action and has established minimum contacts with this forum such that the exercise of jurisdiction over STMicroelectronics would not offend traditional notions of fair play and substantial justice. Defendant STMicroelectronics, 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, STMicroelectronics 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.

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

State of Texas, has transacted business in the Western District of Texas and has committed acts of direct and indirect infringement in the Western District of Texas.

10. STMicroelectronics has a regular and established place of business in this District and has committed acts of infringement in this District. STMicroelectronics has a permanent office located at 8501 North Mo-Pac Expressway, Suite 420, Austin, Texas, which is located within this District. STMicroelectronics employs full-time personnel such as sales personnel and engineers in this District, including in Austin, Texas. STMicroelectronics has also committed acts of infringement in this District by commercializing, marketing, selling, distributing, testing, and servicing certain Accused Products.

11. This Court has personal jurisdiction over STMicroelectronics. STMicroelectronics has conducted and does conduct business within the State of Texas. STMicroelectronics, 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 Western 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 Western District of Texas. STMicroelectronics, 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 Western 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 Western District

of Texas. STMicroelectronics has committed acts of patent infringement within the Western District of Texas. STMicroelectronics interacts with customers in Texas, including through visits to customer sites in Texas. Through these interactions and visits, STMicroelectronics directly infringes the patents-in-suit. STMicroelectronics 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.

12. STMicroelectronics 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 STMicroelectronics.

THE ASSERTED PATENTS

U.S. PATENT NO. 7,200,166

13. U.S. Patent No. 7,200,166 ("the '166 patent") entitled, *Dual-Mode Transceiver For Indoor And Outdoor Ultra Wideband Communications,* was filed on July 10, 2003. The '166 patent is subject to a 35 U.S.C. § 154(b) term extension of 768 days. MIMO Research, LLC is the owner by assignment of the '166 patent. A true and correct copy of the '166 patent is attached hereto as Exhibit A.

14. The '166 patent claims specific systems for a dual-mode digital lowpass shaping finite impulse response (FIR) filter.

15. The '166 patent is directed to enabling a communication device to operate in a dual mode where each mode has different emission masks and/or frequency bands.

16. The ‘166 patent is directed to allowing a single communication device to operate in a dual mode by employing a dual-mode architecture through digital transmission-shaping filters and receiver filters for two modes of operations.

17. The ‘166 patent teaches use of a digital lowpass-shaping FIR transmission filter to enable a dual-mode system. Further, the ‘166 patent teaches a FIR transmission filter wherein the filter is a filter whose impulse response is of a finite duration as the filter settles to zero after a period of time.

18. The ‘166 patent teaches improvements to communication devices where operating in two or more modes is required where the modes include different masks of emissions limitations.

19. The ‘166 patent is directed to addressing the continuing need for a communication transceiver employing a dual-mode architecture of digital transmission-shaping filters and receiver filters for operating in two modes.

20. The ‘166 patent has been cited by 15 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 ‘166 patent as relevant prior art:

- Samsung Electronics Co., Ltd.
- Qualcomm, Inc.
- Tata Sons Ltd.
- Interuniversity Microelectronics Centre
- Shandong Academy of Science Institute of Automation

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

21. 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.

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

23. 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.

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

25. 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.

26. 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)

COUNT I
INFRINGEMENT OF U.S. PATENT NO. 7,200,166

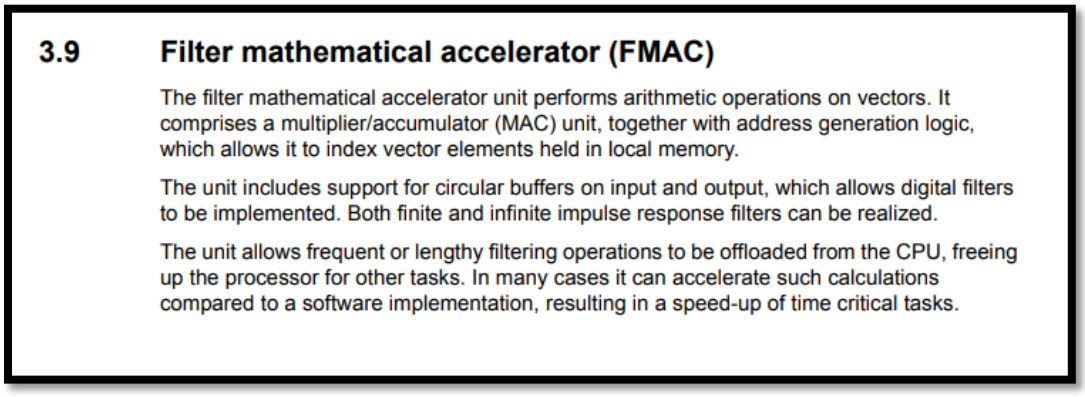
27. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

28. STMicroelectronics designs, makes, uses, sells, and/or offers for sale in the United States products comprising a dual-mode system containing a transmission filter.

29. STMicroelectronics designs, makes, sells, offers to sell, imports, and/or uses STMicroelectronics STM32 G4 microcontrollers, including at least the STM32G4x1 Series microcontrollers, STM32G4x3 Series microcontrollers, and STM32G4x4 Series microcontrollers (collectively, the "STMicroelectronics '166 Products(s)").

30. One or more STMicroelectronics subsidiaries and/or affiliates use the STMicroelectronics '166 Products in regular business operations.

31. The STMicroelectronics '166 Products comprise a dual-mode implementation system of a digital lowpass-shaping FIR transmission filter. Specifically, the STMicroelectronics '166 Products comprise a FIR filter engine that enables a digital lowpass-shaping FIR transmission filter.



3.9 Filter mathematical accelerator (FMAC)

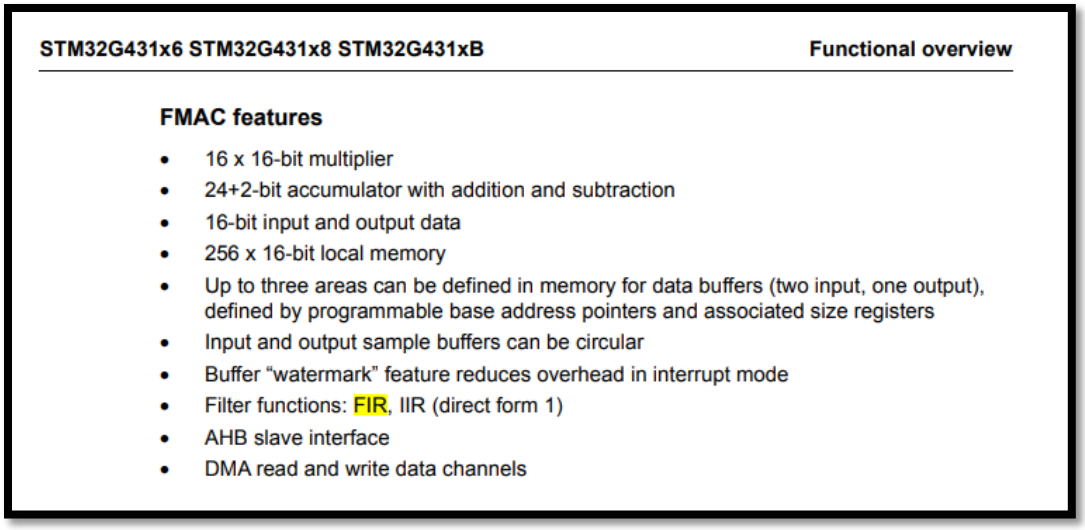
The filter mathematical accelerator unit performs arithmetic operations on vectors. It comprises a multiplier/accumulator (MAC) unit, together with address generation logic, which allows it to index vector elements held in local memory.

The unit includes support for circular buffers on input and output, which allows digital filters to be implemented. Both finite and infinite impulse response filters can be realized.

The unit allows frequent or lengthy filtering operations to be offloaded from the CPU, freeing up the processor for other tasks. In many cases it can accelerate such calculations compared to a software implementation, resulting in a speed-up of time critical tasks.

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 20 (October 2021).

32. The STMicroelectronics '166 Products contain a digital lowpass shaping FIR filter that enables the removal of the high frequency to get the low frequency from a mixed signal. The following excerpt from STMicroelectronics documentation shows an example of an implementation of the digital lowpass FIR filter.



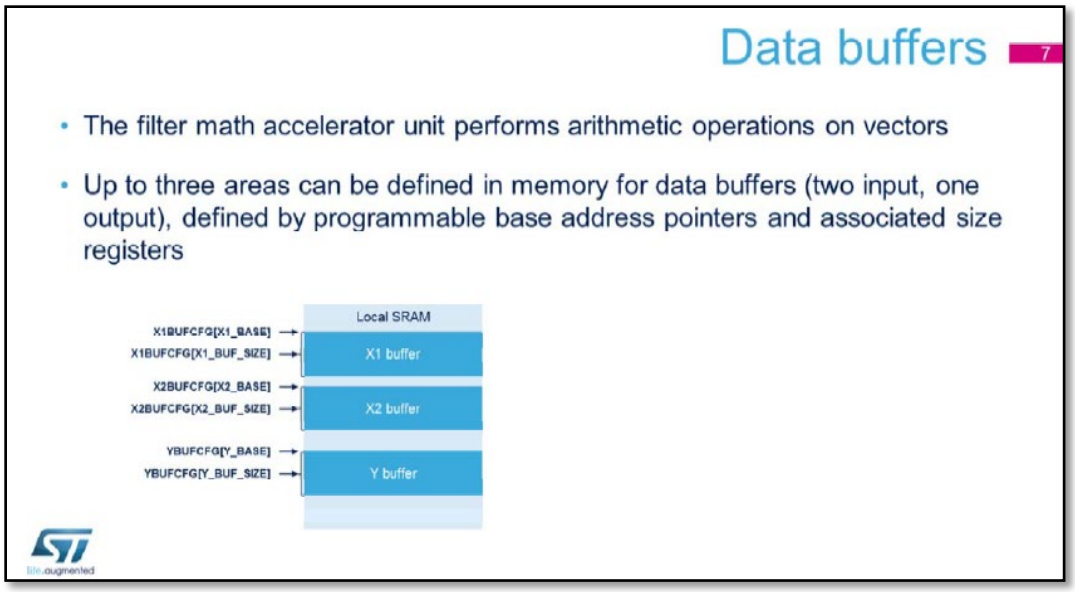
STM32G431x6 STM32G431x8 STM32G431xB Functional overview

FMAC features

- 16 x 16-bit multiplier
- 24+2-bit accumulator with addition and subtraction
- 16-bit input and output data
- 256 x 16-bit local memory
- Up to three areas can be defined in memory for data buffers (two input, one output), defined by programmable base address pointers and associated size registers
- Input and output sample buffers can be circular
- Buffer "watermark" feature reduces overhead in interrupt mode
- Filter functions: FIR, IIR (direct form 1)
- AHB slave interface
- DMA read and write data channels

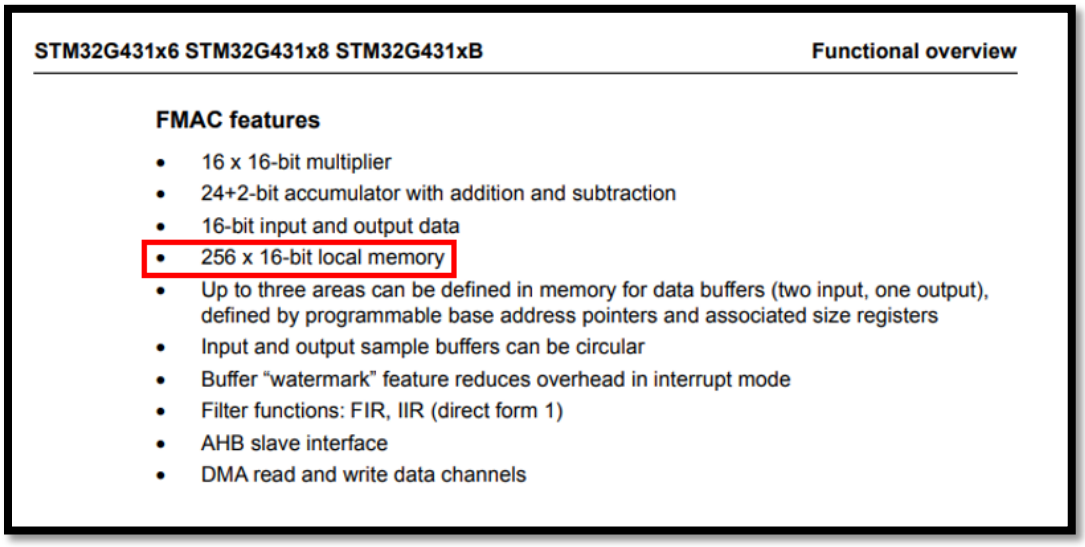
STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 21 (October 2021).

33. The STMicroelectronics '166 Products enable up to three areas to be defined in memory for data buffers. These data buffers are defined by programmable base address pointers and associated size registers. The base addresses can be chosen anywhere in internal memory of the STMicroelectronics '166 Products.



STM32G4 – Filter Math Accelerator Presentation Revision 1.0, STMICROELECTRONICS PRESENTATION at 8 (2019).

34. The STMicroelectronics '166 Products include a set of memory banks. Specifically, the memory banks in the STMicroelectronics '166 Products can be used to store the FIR filter coefficients.



STM32G431x6 STM32G431x8 STM32G431xB Functional overview

FMAC features

- 16 x 16-bit multiplier
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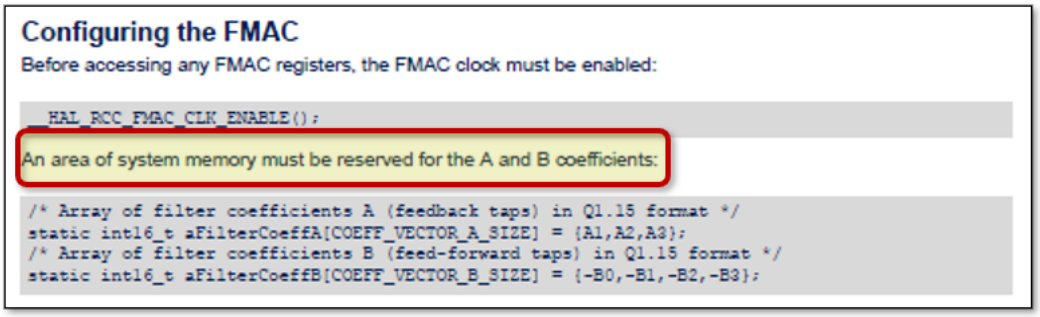
- AHB slave interface
- DMA read and write data channels

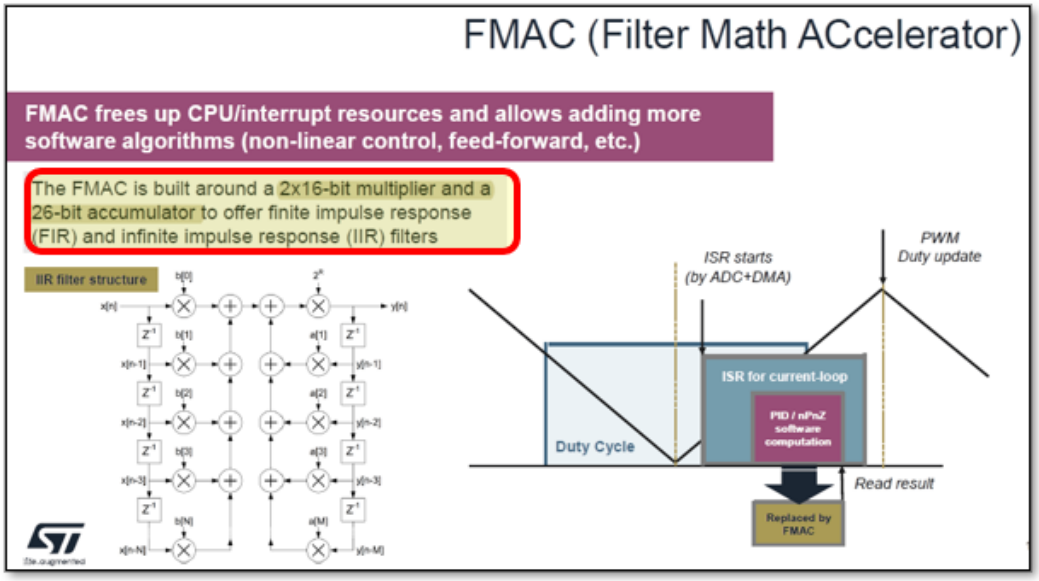
STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 21 (October 2021) (emphasis added).

35. The STMicroelectronics '166 Products enable the storing in memory of two sets of coefficients. The below excerpt from STMicroelectronics documentation describes storing the two sets of coefficients in two arrays in memory.



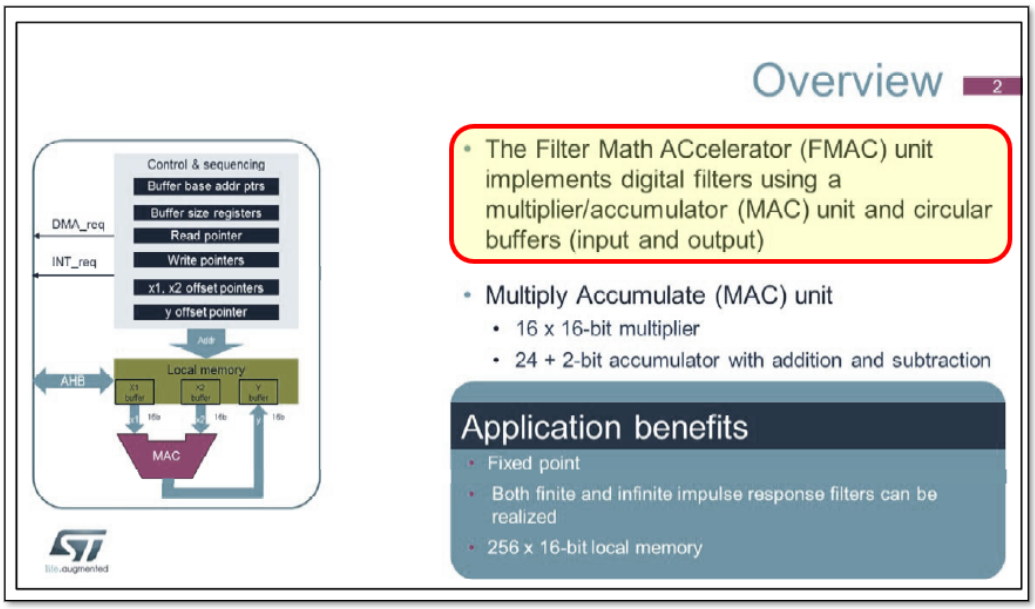
Application Note 5305 - Digital filter implementation with the FMAC using STM32CubeG4 MCU Package, STMICROELECTRONICS DOCUMENTATION at 21 (May 2019).

36. The STMicroelectronics '166 Products include a set of multiply and accumulate (MAC) units. Specifically, the STMicroelectronics '166 Products contain multiply and accumulate units that enable the multiplying of a coefficient by a corresponding delayed data sample and accumulating the result.



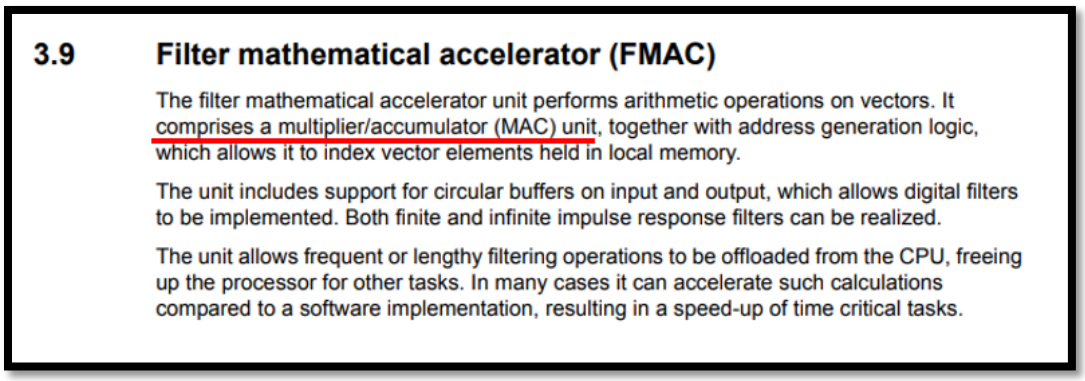
Design Consideration of Digital Solutions for Totem Pole PFC Using STM32G4, STMICROELECTRONICS PRESENTATION at 17 (2021) (emphasis added).

37. The STMicroelectronics '166 Products contain a FMAC unit that is built around a fixed-point multiplier and accumulator (MAC). The MAC receives operations from an internal 256x16 bit RAM and writes the result back to memory. This process is identified in the following excerpt from STMicroelectronics documentation.



STM32G4 – Filter Math Accelerator Presentation Revision 1.0, STMICROELECTRONICS PRESENTATION at 8 (2019) (emphasis added).

38. The STMicroelectronics '166 Products contain a set of multiply and accumulate (MAC) units in the form of a "filter mathematical accelerator" that performs arithmetic operations and comprises a multiplier/accumulator unit.



3.9 Filter mathematical accelerator (FMAC)

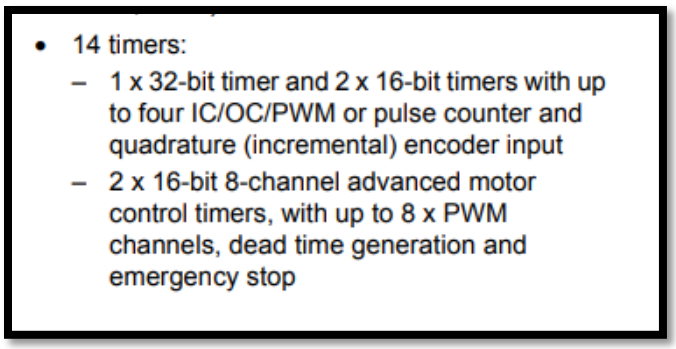
The filter mathematical accelerator unit performs arithmetic operations on vectors. It comprises a multiplier/accumulator (MAC) unit, together with address generation logic, which allows it to index vector elements held in local memory.

The unit includes support for circular buffers on input and output, which allows digital filters to be implemented. Both finite and infinite impulse response filters can be realized.

The unit allows frequent or lengthy filtering operations to be offloaded from the CPU, freeing up the processor for other tasks. In many cases it can accelerate such calculations compared to a software implementation, resulting in a speed-up of time critical tasks.

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 21 (October 2021) (emphasis added).

39. The STMicroelectronics '166 Products include a set of counter units. Specifically, the STMicroelectronics '166 Products comprise multiple counter units including a pulse counter, motor control timers, 16-bit timers, and 32-bit timers.



- 14 timers:
  - 1 x 32-bit timer and 2 x 16-bit timers with up to four IC/OC/PWM or pulse counter and quadrature (incremental) encoder input
  - 2 x 16-bit 8-channel advanced motor control timers, with up to 8 x PWM channels, dead time generation and emergency stop

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 21 (October 2021).

40. The STMicroelectronics '166 Products include a high-resolution (HR) timer. The HRTimer is configured to generate a differential PWM signal at 200 kHz. One counter is configured as Timer A, running at 32 x 170 MHz = 5440 MHz.

```
HRTIM_HandleTypeDef hhrtim1;
```

The HRTimer is configured to generate a differential PWM signal at 200 kHz. One counter is configured, Timer A, running at 32 x 170 MHz = 5440 MHz.

```
HRTIM_TimeBaseCfgTypeDef pTimeBaseCfg;
pTimeBaseCfg.Period = 27200; /* 200kHz (32 * 170 / 0.2 = 27200) */
pTimeBaseCfg.RepetitionCounter = 0x00;
pTimeBaseCfg.PrescalerRatio = HRTIM_PRESCALERRATIO_MUL32;
pTimeBaseCfg.Mode = HRTIM_MODE_CONTINUOUS;
if (HAL_HRTIM_TimeBaseConfig(&hhrtim1, HRTIM_TIMERINDEX_TIMER_C,
&pTimeBaseCfg) != HAL_OK)
    _Error_Handler();
```

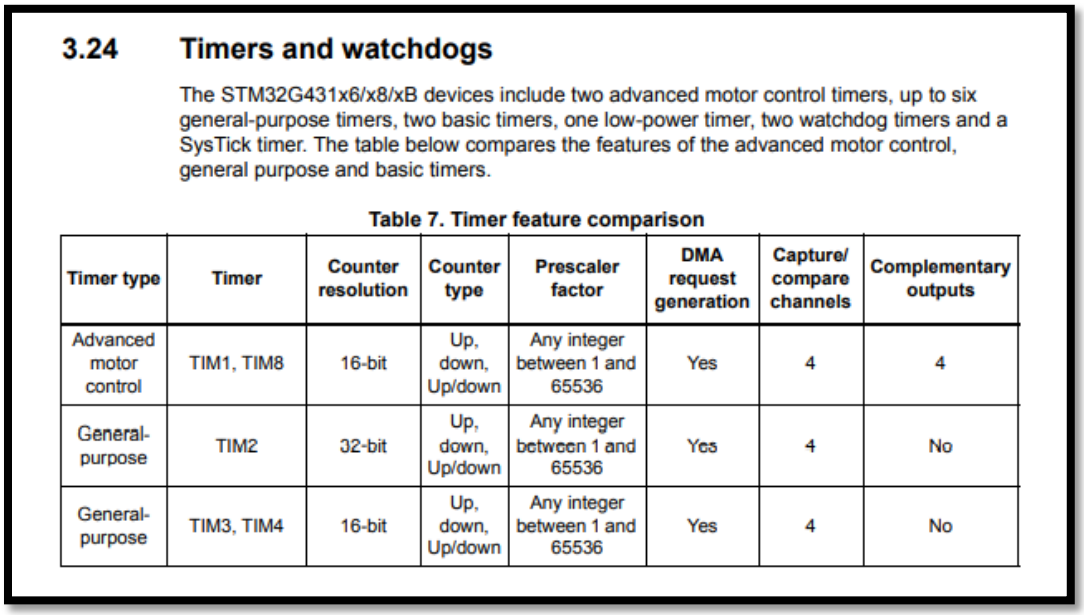
We need to enable three compare units, used respectively to:

1. Apply the duty cycle
   The duty cycle can be intialised to 0 - it is updated every PWM period with the output of the controller.

```
HRTIM_CompareCfgTypeDef pCompareCfg;
pCompareCfg.CompareValue = 0; /* Will be updated */
pCompareCfg.AutoDelayedMode = HRTIM_AUTODELAYEDMODE_REGULAR;
if (HAL_HRTIM_WaveformCompareConfig(&hhrtim1,
HRTIM_TIMERINDEX_TIMER_C, HRTIM_COMPAREUNIT_1, &pCompareCfg) != HAL_OK)
    _Error_Handler();
```

Application Note 5305 - Digital filter implementation with the FMAC using STM32CubeG4 MCU Package, STMICROELECTRONICS DOCUMENTATION at 24 (May 2019) (emphasis added).

41. The STMicroelectronics '166 Products comprise counter units including advanced motor control timers, general purpose timers, basic timers, low-power timers, watchdog timers, and a SysTick timer and shown in the following documentation from STMicroelectronics.



3.24 Timers and watchdogs

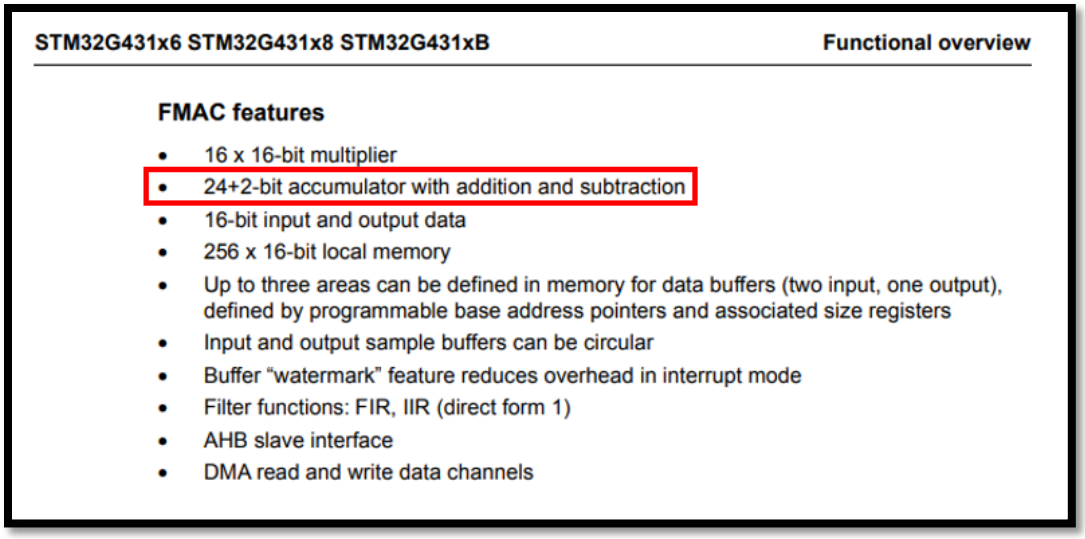
The STM32G431x6/x8/xB devices include two advanced motor control timers, up to six general-purpose timers, two basic timers, one low-power timer, two watchdog timers and a SysTick timer. The table below compares the features of the advanced motor control, general purpose and basic timers.

Table 7. Timer feature comparison

Timer type	Timer	Counter resolution	Counter type	Prescaler factor	DMA request generation	Capture/ compare channels	Complementary outputs
Advanced motor control	TIM1, TIM8	16-bit	Up, down, Up/down	Any integer between 1 and 65536	Yes	4	4
General-purpose	TIM2	32-bit	Up, down, Up/down	Any integer between 1 and 65536	Yes	4	No
General-purpose	TIM3, TIM4	16-bit	Up, down, Up/down	Any integer between 1 and 65536	Yes	4	No

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 32 (October 2021).

42. One or more of the STMicroelectronics '166 Products comprise a pre-addition unit. STMicroelectronics describes this as an accumulator with addition and subtraction.



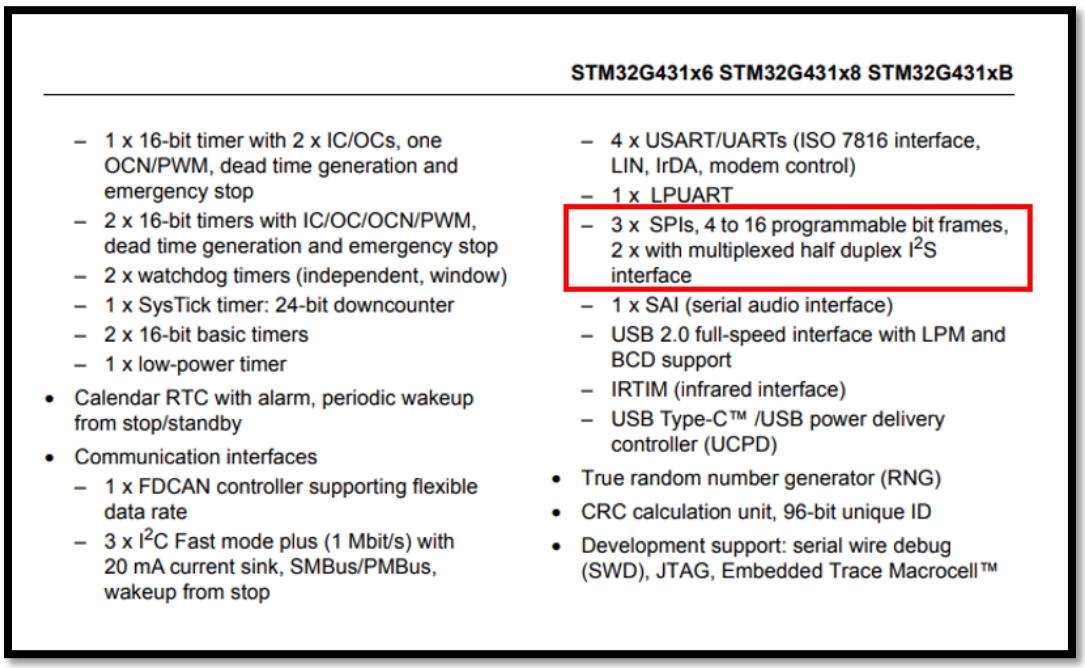
STM32G431x6 STM32G431x8 STM32G431xB Functional overview

FMAC features

- 16 x 16-bit multiplier
- 24+2-bit accumulator with addition and subtraction
- 16-bit input and output data
- 256 x 16-bit local memory
- Up to three areas can be defined in memory for data buffers (two input, one output), defined by programmable base address pointers and associated size registers
- Input and output sample buffers can be circular
- Buffer "watermark" feature reduces overhead in interrupt mode
- Filter functions: FIR, IIR (direct form 1)
- AHB slave interface
- DMA read and write data channels

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 21 (October 2021) (emphasis added).

43. One or more of the STMicroelectronics '166 Products include a multiplexer (MUX) unit.



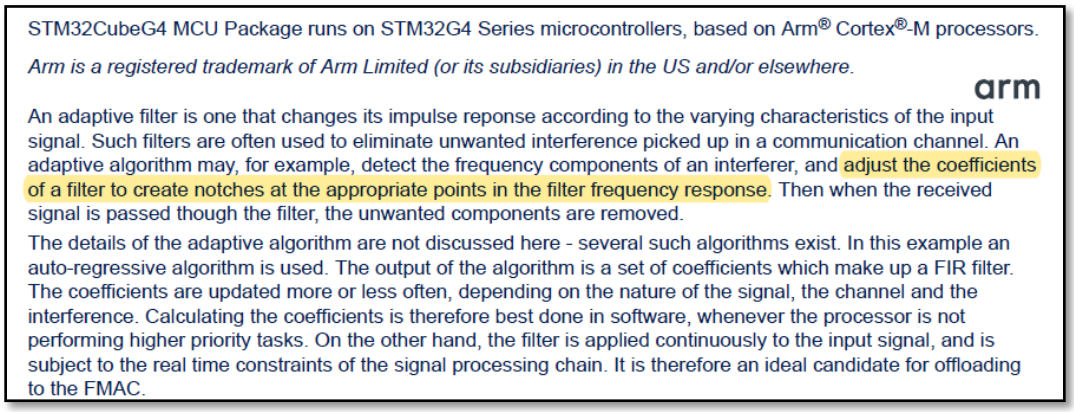
STM32G431x6 STM32G431x8 STM32G431xB

- 1 x 16-bit timer with 2 x IC/OCs, one OCN/PWM, dead time generation and emergency stop
- 2 x 16-bit timers with IC/OC/OCN/PWM, dead time generation and emergency stop
- 2 x watchdog timers (independent, window)
- 1 x SysTick timer: 24-bit downcounter
- 2 x 16-bit basic timers
- 1 x low-power timer

- Calendar RTC with alarm, periodic wakeup from stop/standby
- Communication interfaces
  - 1 x FDCAN controller supporting flexible data rate
  - 3 x I^2C Fast mode plus (1 Mbit/s) with 20 mA current sink, SMBus/PMBus, wakeup from stop
  - 4 x USART/UARTs (ISO 7816 interface, LIN, IrDA, modem control)
  - 1 x LPUART
  - 3 x SPIs, 4 to 16 programmable bit frames, 2 x with multiplexed half duplex I^2S interface
  - 1 x SAI (serial audio interface)
  - USB 2.0 full-speed interface with LPM and BCD support
  - IRTIM (infrared interface)
  - USB Type-C™ /USB power delivery controller (UCPD)
- True random number generator (RNG)
- CRC calculation unit, 96-bit unique ID
- Development support: serial wire debug (SWD), JTAG, Embedded Trace Macrocell™

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 2 (October 2021) (emphasis added).

44. The STMicroelectronics '166 Products contain functionality for an adaptive FIR filter where the signal frequency is detected and the coefficients that are applied are adjusted.



STM32CubeG4 MCU Package runs on STM32G4 Series microcontrollers, based on Arm® Cortex®-M processors.

Arm is a registered trademark of Arm Limited (or its subsidiaries) in the US and/or elsewhere.

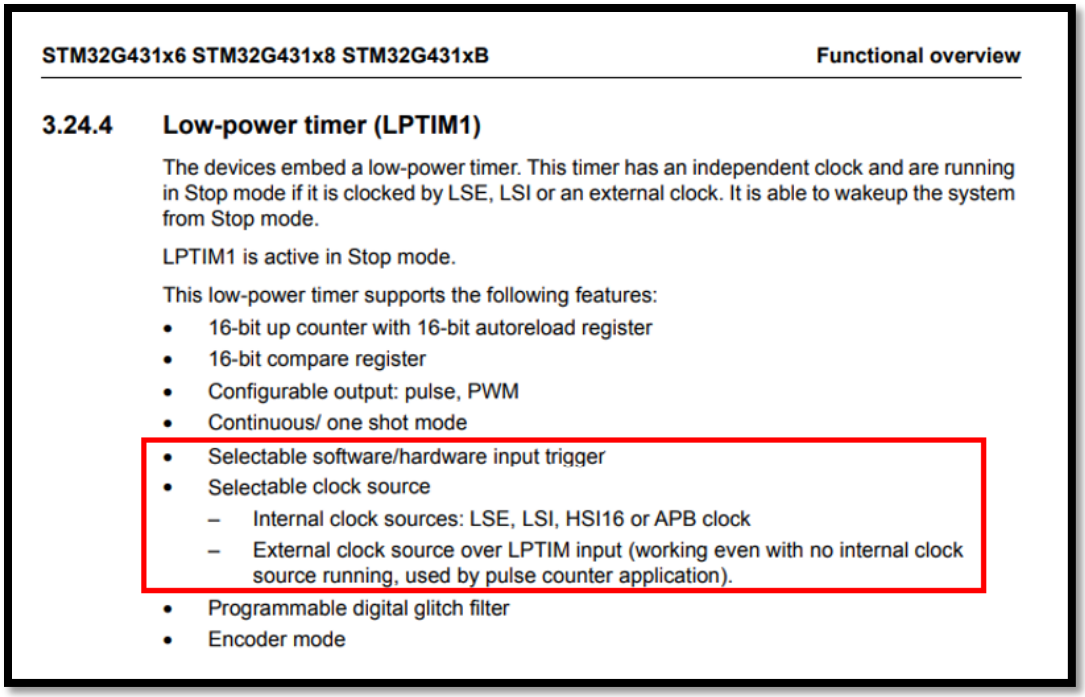
arm

An adaptive filter is one that changes its impulse reponse according to the varying characteristics of the input signal. Such filters are often used to eliminate unwanted interference picked up in a communication channel. An adaptive algorithm may, for example, detect the frequency components of an interferer, and adjust the coefficients of a filter to create notches at the appropriate points in the filter frequency response. Then when the received signal is passed though the filter, the unwanted components are removed.

The details of the adaptive algorithm are not discussed here - several such algorithms exist. In this example an auto-regressive algorithm is used. The output of the algorithm is a set of coefficients which make up a FIR filter. The coefficients are updated more or less often, depending on the nature of the signal, the channel and the interference. Calculating the coefficients is therefore best done in software, whenever the processor is not performing higher priority tasks. On the other hand, the filter is applied continuously to the input signal, and is subject to the real time constraints of the signal processing chain. It is therefore an ideal candidate for offloading to the FMAC.

Application Note 5305 - Digital filter implementation with the FMAC using STM32CubeG4 MCU Package, STMICROELECTRONICS DOCUMENTATION at 2 (May 2019) (emphasis added).

45. One or more of the STMicroelectronics '166 Products comprise a selectable unit.



STM32G431x6 STM32G431x8 STM32G431xB **Functional overview**

3.24.4 Low-power timer (LPTIM1)

The devices embed a low-power timer. This timer has an independent clock and are running in Stop mode if it is clocked by LSE, LSI or an external clock. It is able to wakeup the system from Stop mode.

LPTIM1 is active in Stop mode.

This low-power timer supports the following features:

- 16-bit up counter with 16-bit autoreload register
- 16-bit compare register
- Configurable output: pulse, PWM
- Continuous/ one shot mode
- Selectable software/hardware input trigger
- Selectable clock source
  - Internal clock sources: LSE, LSI, HSI16 or APB clock
  - External clock source over LPTIM input (working even with no internal clock source running, used by pulse counter application).
- Programmable digital glitch filter
- Encoder mode

STM32G431X6 STM32G431X8 STM32G431XB DATA SHEET - DS12589 REV. 6 AT 32 (October 2021) (emphasis added).

46. STMicroelectronics has directly infringed and continues to directly infringe the '166 patent by, among other things, making, using, offering for sale, and/or selling technology comprising a dual-mode system containing a transmission filter, including but not limited to the STMicroelectronics '166 Products.

47. The STMicroelectronics '166 Products are available to businesses and individuals throughout the United States.

48. The STMicroelectronics '166 Products are provided to businesses and individuals located in the Western District of Texas.

49. By making, using, testing, offering for sale, and/or selling products and services comprising a dual-mode system containing a transmission filter, including but not limited to the STMicroelectronics '166 Products, STMicroelectronics has injured Plaintiff and is liable to Plaintiff for directly infringing one or more claims of the '166 patent, including at least claim 11 pursuant to 35 U.S.C. § 271(a).

50. To the extent applicable, the requirements of 35 U.S.C. § 287(a) have been met with respect to the '166 patent.

51. As a result of STMicroelectronics's infringement of the '166 patent, Plaintiff has suffered monetary damages, and seek recovery in an amount adequate to compensate for STMicroelectronics's infringement, but in no event less than a reasonable royalty for the use made of the invention by STMicroelectronics together with interest and costs as fixed by the Court.

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

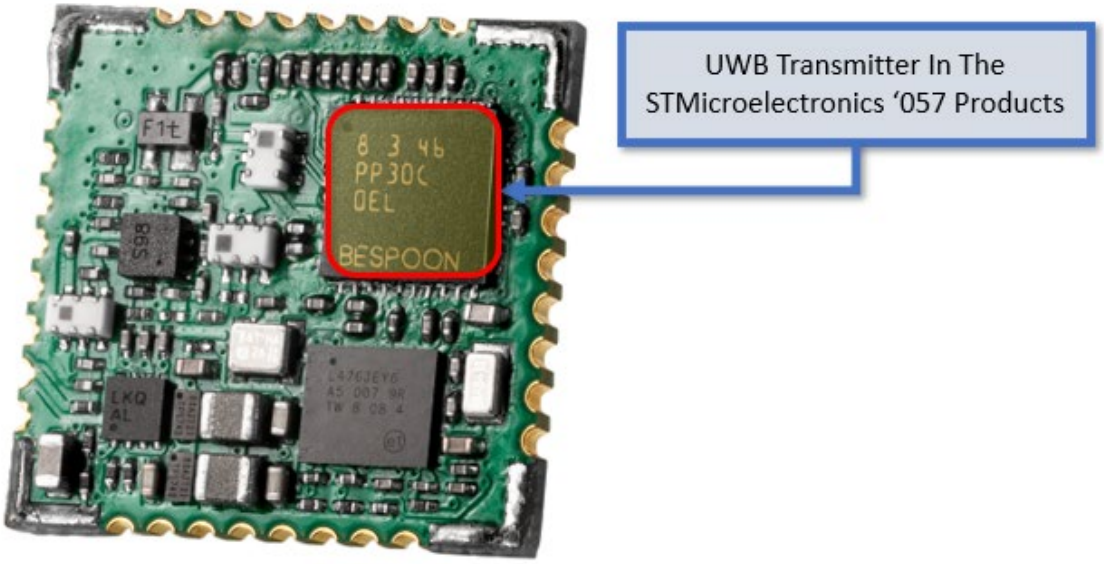
52. Plaintiff references and incorporates by reference the preceding paragraphs of this Complaint as if fully set forth herein.

53. STMicroelectronics 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.

54. STMicroelectronics designs, makes, sells, offers to sell, imports, and/or uses the B-UWB-MEK1 Ultra-wideband Module Evaluation Kit and B-UWB-MOD1 Ultra-wideband (UWB) Module (collectively, the "STMicroelectronics '057 Products(s)").

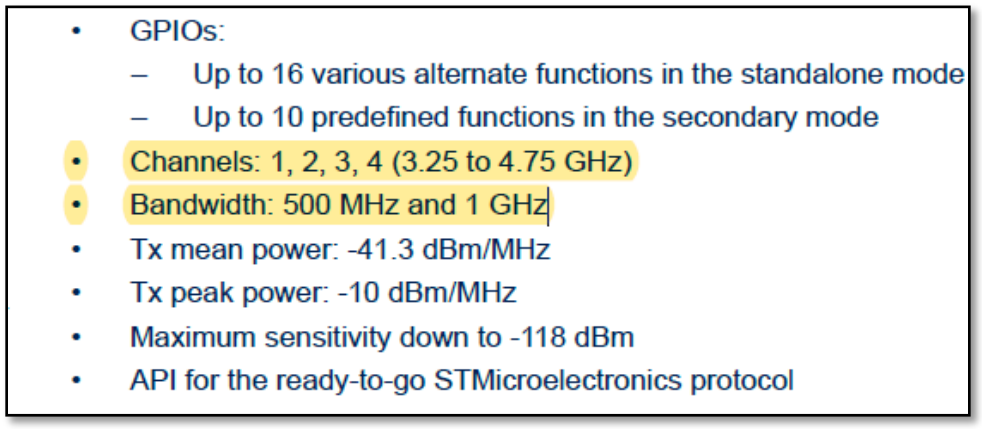
55. One or more STMicroelectronics subsidiaries and/or affiliates use the STMicroelectronics '057 Products in regular business operations.

56. One or more of the STMicroelectronics '057 Products comprise a UWB transmitter.



B-UWB-MOD1 Data Brief DB4404 Rev. 1, STMICROELECTRONICS DOCUMENTATION at 1 (March 2001) (annotation added).

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



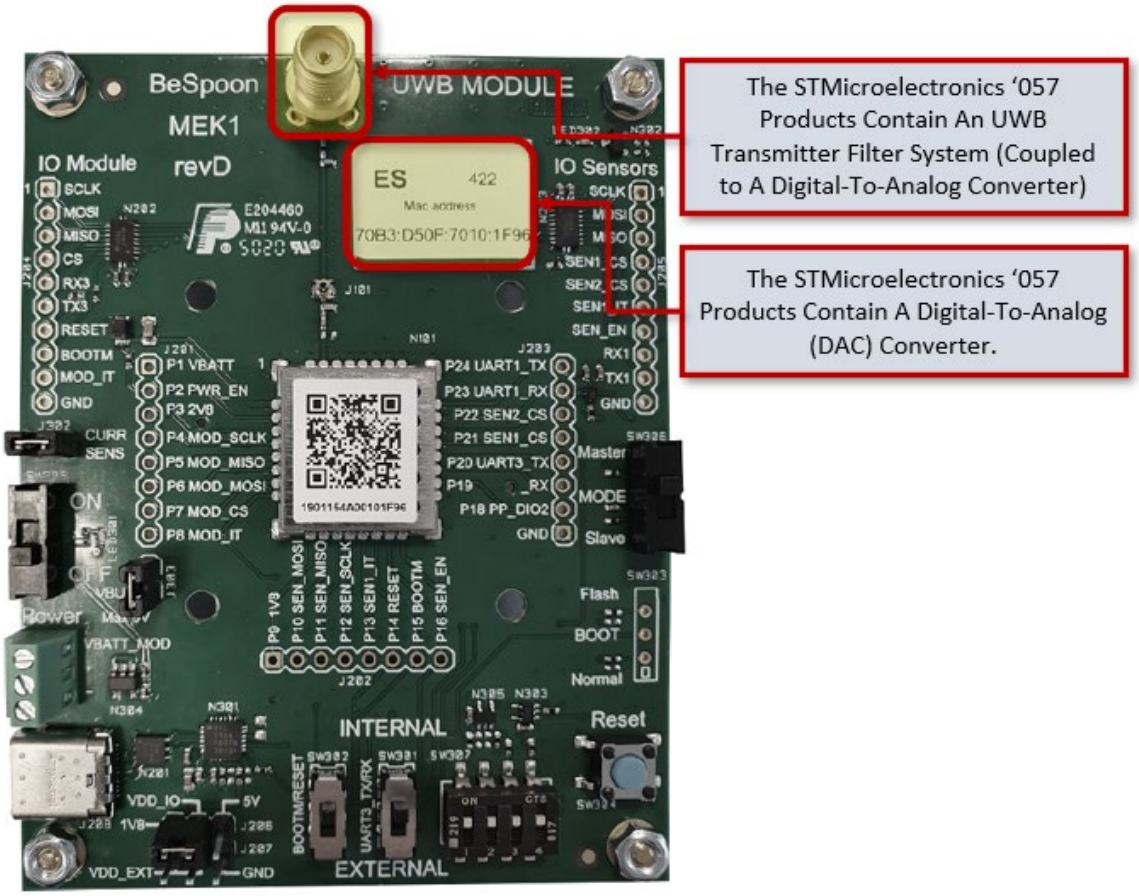
- GPIOs:
  - Up to 16 various alternate functions in the standalone mode
  - Up to 10 predefined functions in the secondary mode
- Channels: 1, 2, 3, 4 (3.25 to 4.75 GHz)
- Bandwidth: 500 MHz and 1 GHz
- Tx mean power: -41.3 dBm/MHz
- Tx peak power: -10 dBm/MHz
- Maximum sensitivity down to -118 dBm
- API for the ready-to-go STMicroelectronics protocol

B-UWB-MOD1 Data Brief DB4404 Rev. 1, STMICROELECTRONICS DOCUMENTATION at 1 (March 2001) (annotation added).

58. The STMicroelectronics '057 Products are available to businesses and individuals throughout the United States.

59. The STMicroelectronics '057 Products are provided to businesses and individuals located in the Western District of Texas.

60. The STMicroelectronics '057 Products comprise a surface mounted UWB module that enable highly precise location identification down to 10 cm. The PHY controller in the STMicroelectonics '057 Products is optimized for ranging. *See Application Note 5630 - UWB Networks Topology Rev. 1*, STMICROELECTRONICS DOCUMENTATION at 1 (April 20, 2021).



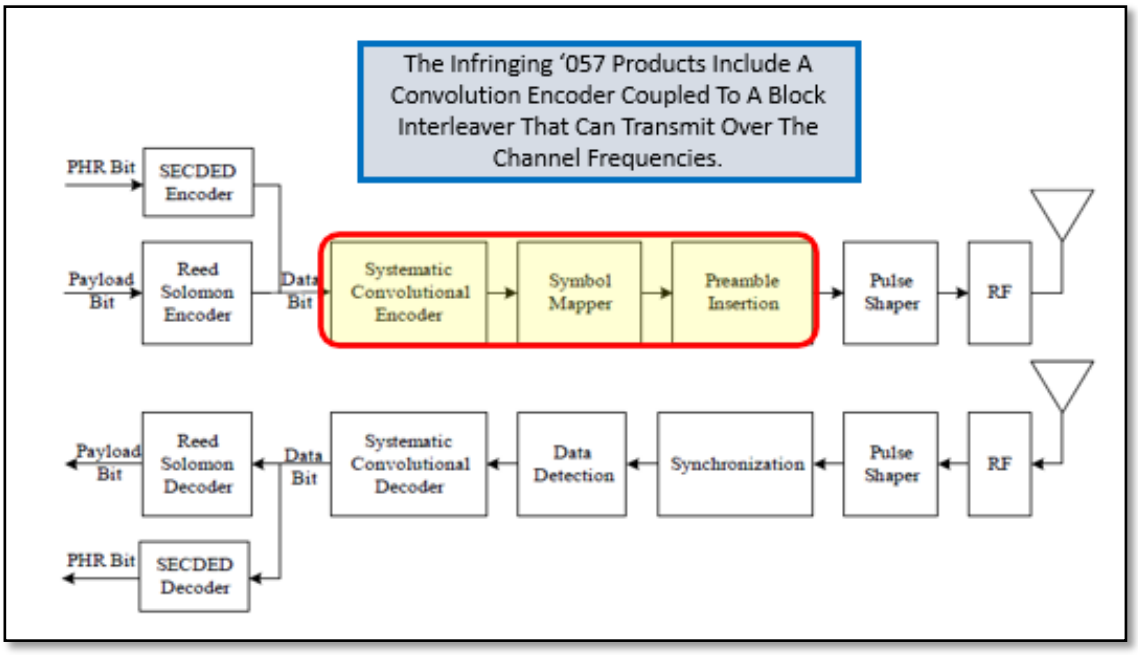
B-UWB-MEK1 Quick Start Guide UM2798 Rev. 1, STMICROELECTRONICS DOCUMENTATION at 2 (March 17, 2021) (annotation added).

61. One or more of the STMicroelectronics '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).

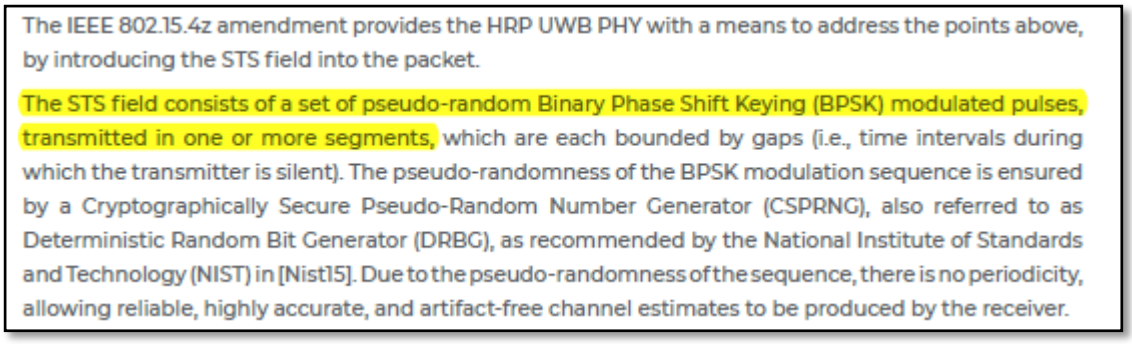
62. One or more of the STMicroelectronics '057 Products utilize a combination of BPM and BPSK to transmit and receive UWB signals over multiple channels. The combined BPM-BPSK is used to modulate symbols with each symbol composed of an active burst of UWB pulses. The following figure shows the sequence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



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

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

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

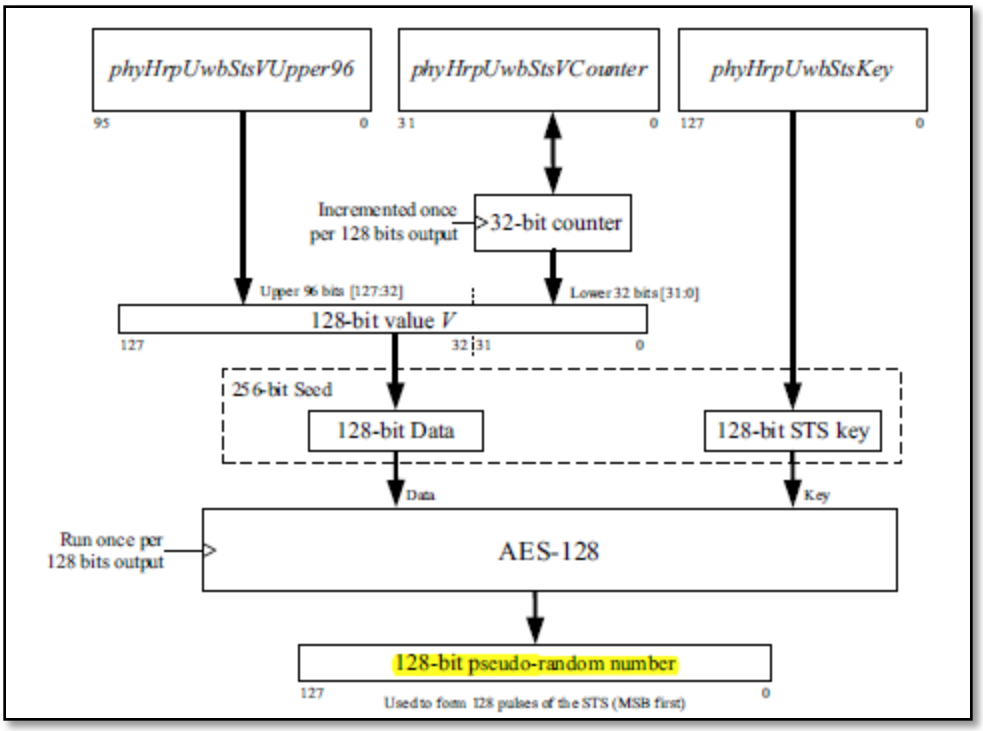


The IEEE 802.15.4z amendment provides the HRP UWB PHY with a means to address the points above, by introducing the STS field into the packet.

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).

65. One or more of the STMicroelectronics '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.

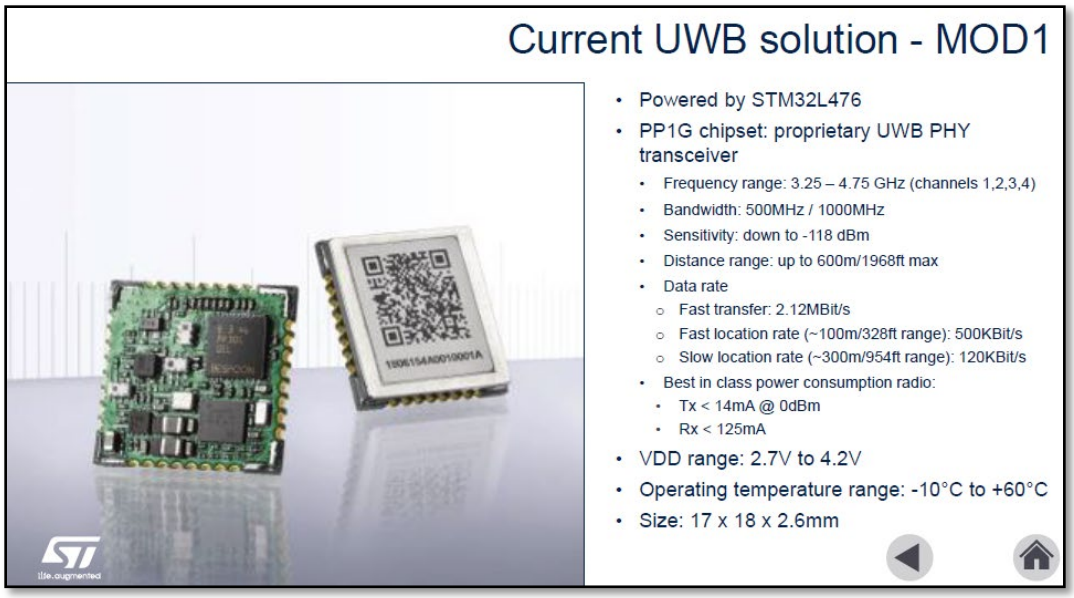


IEEE STANDARD FOR LOW-RATE WIRELESS NETWORKS - AMENDMENT 1: ENHANCED ULTRA WIDEBAND (UWB) PHYSICAL LAYERS (PHYS) AND ASSOCIATED RANGING TECHNIQUES 802.15.4z-2020 § 15.2.9.1 (2020) (emphasis added).

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

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

68. One or more of the STMicroelectronics '057 Products include a digital UWB transmitter filter system coupled to a digital-to-analog converter. Specifically, STMicroelectronics documentation describes the STMicroelectronics '057 Products as containing a PP1G chipset that is a UWB PHY transceiver that enables digital signals to be filtered and converted to an analog signal.



Asset Tracking Sensor To Cloud Applications, STMICROELECTRONICS PRESENTATION at 4 (2022).

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

70. One or more of the STMicroelectronics '057 Products include a DAC that is connected to a modulator that transmits and receives UWB signals that have a center frequency of 3494.4 MHz, 3993.6 MHz, 4492.8 MHz, and 3993.6 MHz. Each UWB channel has a bandwidth of 500 MHz. The following specification from BeSpoon which forms the basis for the STMicroelectronics UWB transceiver in the STMicroelectronics '057 Products shows the frequency range that is enabled.

Symbol	Parameter	Comments	Min.	Typ.	Max.	Unit
CH1	Channel 1			3494.4		MHz
BW1	Freq. bandwidth of channel 1	@ -10dB		500		MHz
CH2	Channel 2			3993.6		MHz
BW2	Freq. bandwidth of channel 2	@ -10dB		500		MHz
CH3	Channel 3	Filtering required on antenna side at 4.8GHz		4492.8		MHz
BW3	Freq. bandwidth of channel 3	@ -10dB		500		MHz
CH4	Channel 4			3993.6		MHz
BW4	Freq. bandwidth of channel 4	@ -10dB		1000		MHz

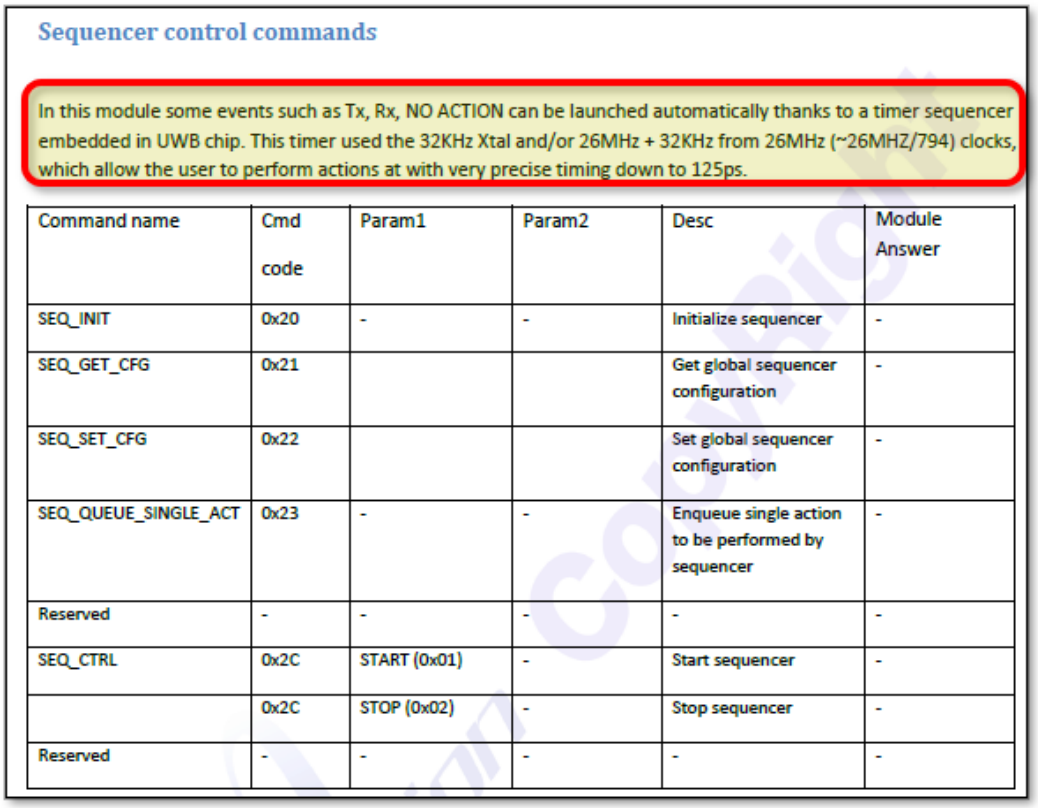
Brief Specification of IR-UWB Module UM100 Rev. 2.1, BESPOON DOCUMENTATION at 14 (September 2014).

71. One or more of the STMicroelectronics '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).

72. The STMicroelectronics '057 Products enable the use of a clock control including through the use of a timer sequencer embedded in the UWB chip. The timer sequencer is described in the following excerpt from BeSpoon documentation which forms the basis of the STMicroelectronics '057 Products.



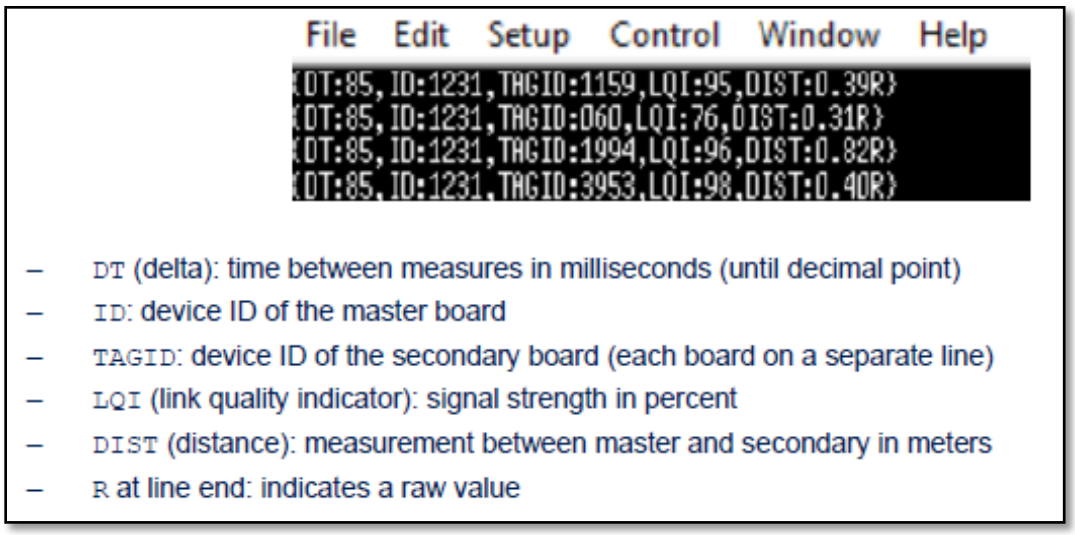
Sequencer control commands

In this module some events such as Tx, Rx, NO ACTION can be launched automatically thanks to a timer sequencer embedded in UWB chip. This timer used the 32KHz Xtal and/or 26MHz + 32KHz from 26MHz (~26MHZ/794) clocks, which allow the user to perform actions at with very precise timing down to 125ps.

Command name	Cmd code	Param1	Param2	Desc	Module Answer
SEQ_INIT	0x20	-	-	Initialize sequencer	-
SEQ_GET_CFG	0x21			Get global sequencer configuration	-
SEQ_SET_CFG	0x22			Set global sequencer configuration	-
SEQ_QUEUE_SINGLE_ACT	0x23	-	-	Enqueue single action to be performed by sequencer	-
Reserved	-	-	-	-	-
SEQ_CTRL	0x2C	START (0x01)	-	Start sequencer	-
	0x2C	STOP (0x02)	-	Stop sequencer	-
Reserved	-	-	-	-	-

Brief Specification of IR-UWB Module UM100 Rev. 2.1, BESPOON DOCUMENTATION at 14 (September 2014) (emphasis added).

73. The STMicroelectronics '057 Products enable the tracking of the time between measurements that are received by the UWB transceiver and a measurement between the transceiver and the UWB node.



UWB-MEK1 Quick Start Guide UM2798 Rev. 1, STMICROELECTRONICS DOCUMENTATION at 9 (March 17, 2021).

74. STMicroelectronics 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 STMicroelectronics '057 Products.

75. 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 STMicroelectronics '057 Products, STMicroelectronics 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).

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

77. As a result of STMicroelectronics's infringement of the '057 patent, Plaintiff has suffered monetary damages, and seek recovery in an amount adequate to compensate for

STMicroelectronics's infringement, but in no event less than a reasonable royalty for the use made of the invention by STMicroelectronics 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 STMicroelectronics has infringed, either literally and/or under the doctrine of equivalents, the '166 and '057 patents;

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

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

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 24, 2022

Respectfully submitted,

/s/ Daniel P. Hipskind

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