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First Named Inventor	Dashen Fan
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Art Unit	Not yet assigned
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Attorney Docket Number	K41090.P8C2

SIGNATURE of Applicant or Patent Practitioner

Signature	/MARK S. PELOQUIN/	Date (Optional)	APRIL 30, 2019
Name	MARK S. PELOQUIN	Registration Number	50,787
Title (if Applicant is a juristic entity)			
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Attorney Docket Number K41090.P8C2

Luxottica et al. v. Solos
IPR2026-00512
Petitioners Ex. 1002

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Address 800 FIFTH AVE, SUITE 4100

City SEATTLE State WA Zip 98104

Country US

Telephone (206) 447-1336

Email

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ABSTRACT

Systems and methods are described to time delay a signal output from an analog-to-digital converter (ADC). The ADC includes a digital sensor responsive to an analog field quantity. The digital sensor is configured to output an oversampled digital output signal at a sampling clock frequency. A time delay element is configured to receive as an input, the oversampled digital output signal and to output a time delayed oversampled digital output signal. A filter is configured to receive as an input the delayed oversampled digital output signal. The filter low pass filters and decimates to a lower sample rate the delayed oversampled digital output signal. An output includes a low pass filtered decimated delayed digital output signal, where the lower sample rate is less than the sampling clock frequency.

What is claimed is:

1. A method to create a beamformed digital signal, comprising:
outputting a first oversampled digital signal output from an analog-to-digital converter (ADC), wherein the first oversampled digital signal is responsive to an analog field and the first oversampled digital signal is created at a sampling clock frequency;
delaying the first oversampled digital signal by a time delay wherein the time delay is equal to an integer number of sampling clock cycles to produce a time delayed first oversampled digital signal; and
combining the time delayed first oversampled digital signal with a second oversampled digital signal to obtain the beamformed digital signal, wherein the second oversampled digital signal is responsive to the analog field.
2. The method of claim 1, wherein the combining is performed in an oversampled signal domain.
3. The method of claim 1, wherein the combining is performed in at an intermediate sampling rate.
4. The method of claim 1, wherein the combining is performed in a baseband signal domain.

5. The method of claim 1, wherein the first oversampled digital signal and the second oversampled digital signal are obtained from different sensors.
6. The method of claim 1, wherein the first oversampled digital signal and the second oversampled digital signal are obtained from the same sensor.
7. The method of claim 1, further comprising:
applying a low pass filter with decimation to the time delayed first oversampled digital signal to output a baseband digital signal that is delayed by the time delay.
8. The method of claim 7, wherein the time delay is equal to a fraction of a baseband sampling period.
9. The method of claim 7, wherein the time delay is greater than a baseband sampling period.
10. The method of claim 7, wherein the first oversampled digital signal is digitized to create samples which are more than one bit deep.
11. A system to create a beamformed digital signal, comprising:

a first digital sensor responsive to an analog field, the first digital sensor is configured to output a first oversampled digital output signal at a sampling clock frequency;

a second digital sensor responsive to the analog field, the second digital sensor is configured to output a second oversampled digital output signal at the sampling clock frequency;

a time delay element, the time delay element is configured to receive as an input, the first oversampled digital output signal and to output a time delayed oversampled digital output signal, wherein the time delayed oversampled digital output signal and the second oversampled digital output signal are separated by a time delay that is imparted by the time delay element; and

an arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and the second oversampled digital output signal, the arithmetic unit is configured to produce the beamformed digital signal from the time delayed oversampled digital output signal and the second oversampled digital output signal.

12. The apparatus of claim 11, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal.

13. The apparatus of claim 12, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a summation function.

14. The apparatus of claim 12, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a subtraction function.

15. The apparatus of claim 11, further comprising:

a sigma-delta modulator, the first digital sensor utilizes the sigma-delta modulator and the first digital sensor is configured to produce a pulse density modulated (PDM) output signal at the sampling clock frequency responsive to the analog field.

16. A system to create a beamformed digital signal, comprising:

a digital sensor responsive to an analog field, the digital sensor is configured to output an oversampled digital output signal at a sampling clock frequency;

a time delay element, the time delay element is configured to receive as an input, the oversampled digital output signal and to output a time delayed oversampled digital output signal, wherein the time delayed oversampled digital output signal and the second oversampled digital output signal are separated by a time delay and the time delay is imparted by the time delay element; and

an arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and a second oversampled digital output signal, wherein the second oversampled digital output signal is responsive to the analog field, the arithmetic unit is configured to produce the beamformed digital signal from the time delayed oversampled digital output signal and the second oversampled digital output signal.

17. The apparatus of claim 16, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal.

18. The apparatus of claim 17, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a summation function.

19. The apparatus of claim 17, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a subtraction function.

20. The apparatus of claim 16, further comprising:

a sigma-delta modulator, the digital sensor utilizes the sigma-delta modulator and the digital sensor is configured to produce a pulse density

modulated (PDM) output signal at the sampling clock frequency responsive to the analog field.

UNITED STATES PATENT APPLICATION
FOR
**BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY
OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS**

Inventors:

Dashen Fan and Joseph Kwon

PREPARED BY:

MARK S. PELOQUIN
PELOQUIN, PLLC
800 FIFTH AVENUE, SUITE 4100
SEATTLE, WA 98104-3100

206-447-1336 TELEPHONE
206-770-6562 FACSIMILE

RELATED APPLICATIONS

[0001] This patent application is a continuation of United States Patent Application Serial Number 15/947,845, titled "TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS," filed on April 08, 2018, which is a continuation of United States Patent Application Serial Number 15/225,745, titled "TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS," filed on August 01, 2016, now U.S. Patent 9,941,895. United States Patent Application Serial Number 15/225,745 and United States Patent Application Number 15/947,845 are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

1. FIELD OF INVENTION

[0002] The invention relates generally to sampled systems more specifically to time delay in digitally oversampled sensor systems, apparatuses, and methods.

2. ART BACKGROUND

[0003] Field quantities which exist in the natural world are generally analog signals which have continuously varying amplitude as a function of time. Examples of these field quantities are sound pressure, vibration, light, etc. Measurement of a field

quantity is accomplished with an analog sensor or a digital sensor. Digital electronics work with digital signals. Interfacing analog signals with digital electronics presents a technical problem for which a technical solution using a technical means is needed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0004] The invention may best be understood by referring to the following description and accompanying drawings that are used to illustrate embodiments of the invention. The invention is illustrated by way of example in the embodiments and is not limited in the figures of the accompanying drawings, in which like references indicate similar elements.

[0005] **Figure 1** illustrates a digital sensor system.

[0006] **Figure 2A** illustrates time delaying an oversampled signal within an analog-to-digital converter (ADC) system, according to embodiments of the invention.

[0007] **Figure 2B** illustrates two signals from **Figure 2A**, according to embodiments of the invention.

[0008] **Figure 2C** illustrates an oversampling system utilizing sigma-delta modulation and pulse density modulation (PDM), according to embodiments of the invention.

[0009] **Figure 3** illustrates applications of the system from **Figure 2C**, according to embodiments of the invention.

[0010] **Figure 4** illustrates a pulse density modulation (PDM) receiver architecture, according to embodiments of the invention.

[0011] **Figure 5** illustrates placing a time delay between stages of a pulse density modulation (PDM) receiver, according to embodiments of the invention.

[0012] **Figure 6** illustrates placing a time delay between different stages of a pulse density modulation (PDM) receiver, according to embodiments of the invention.

[0013] **Figure 7** illustrates placing a time delay in yet another location within a pulse density modulation (PDM) receiver, according to embodiments of the invention.

[0014] **Figure 8** illustrates programmable time delay in an analog-to-digital converter (ADC) system, according to embodiments of the invention.

[0015] **Figure 9A** illustrates time delays for multiple sensors, according to embodiments of the invention.

[0016] **Figure 9B** illustrates multiple time delays applied to an output from a single sensor, according to embodiments of the invention.

[0017] **Figure 10** illustrates beamforming, according to embodiments of the invention.

[0018] **Figure 11A and 11B** illustrate increased resolution provided by a fractional delay, according to embodiments of the invention.

[0019] **Figure 12** illustrates a process to impart a time delay to an oversampled system, according to embodiments of the invention.

[0020] **Figure 13** illustrates a process to use a time delay imparted to an oversampled system in a beamforming process, according to embodiments of the invention.

[0021] **Figure 14** illustrates a data processing system in which embodiments of the invention may be used.

[0022] **Figure 15A-15B** illustrates integrated circuit dies in which embodiments of the invention may be implemented.

DETAILED DESCRIPTION

[0023] In the following detailed description of embodiments of the invention, reference is made to the accompanying drawings in which like references indicate similar elements, and in which is shown by way of illustration, specific embodiments in which the invention may be practiced. These embodiments are described in sufficient detail to enable those of skill in the art to practice the invention. In other instances, well-known circuits, structures, and techniques have not been shown in detail in order not to obscure the understanding of this description. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the invention is defined only by the appended claims.

[0024] Systems and methods are described for applying a time delay to an oversampled digital signal. In various embodiments the time delay is applied in various locations within the oversampled domain of the digital signal during signal processing in an analog-to-digital converter (ADC).

[0025] **Figure 1** illustrates, generally at 100, a digital sensor system. With reference to **Figure 1**, an analog field quantity 102 is sensed by a digital sensor system 104. As represented in **Figure 1** at 104, the digital sensor system includes a digital sensor which is typically configured to oversample the analog signal 102. Within the digital sensor system 104 the oversampled signal is input to a receiver which decimates and low pass filters the oversampled signal in order to output a signal at a baseband sampling rate at 106 which is the digital representation of the analog field quantity 102. A time delay can be imparted to the digital baseband signal at 108. The time delay 108

can be of various lengths and is sometimes expressed in two parts, i.e., an integer part and a fractional part. A first part 114 can be referred to as an integer delay where "integer" refers to an integer number of baseband sampling rate cycles. A second part 110 can be referred to as a fractional delay where "fraction" refers to a fraction of the baseband sampling rate period. A time delayed digital version of the digital signal 106 is output at 116. The time delayed digital signal 116 can be used in various subsequent processes such as beamforming, etc.

[0026] **Figure 2A** illustrates, generally at 200, time delaying an oversampled signal within an analog-to-digital converter (ADC) system, according to embodiments of the invention. With reference to **Figure 2A**, a time delay is inserted in the oversampled domain of the ADC. In various embodiments, the time delay is inserted between a digitally oversampled sensor output signal and a receiver used to process the oversampled digital output signal. In operation, an analog field quantity 202 is incident upon a digital sensor 212. The digital sensor 212 converts the incident analog field to an oversampled digital output signal at 214 which preserves phase information of the signal within the bit stream of the signal 214. In various embodiments, the oversampled signal 214 is provided as a pulse density modulated (PDM) signal. In other embodiments, other digitizing methodologies can be employed to digitize the oversampled signal. The oversampling which occurs in the oversampled sensor 212 occurs at a sampling clock frequency. The sampling clock signal is often provided externally by the data processing system or a dedicated digital signal processing system (DSP) clock which is divided down to the desired sampling clock frequency used to sample the digital sensor 212. In

other embodiments, the sampling clock can be provided locally even on the same integrated circuit with a digital sensor.

[0027] The oversampled digital signal 214 is input into a delay element 216 and is output at 218 after a time delay " Δt " is imparted to the oversampled digital signal. The time delay Δt imparted to the oversampled digital signal 214 at delay element 216 is represented by an integer number of sampling clock cycles. When it is desirable to impart a "fractional delay" at delay element 216, then the maximum number of sampling clock cycles that would be imparted at 216 is equal to the ratio of sampling clock frequency divided by the baseband sampling rate, indicated herein by the variable " R ." R is discussed more completely below in conjunction with the figures that follow. Note that in other embodiments, systems are configured without the constraint R of equation (3). In such cases, the delay imposed by the delay element 216 exceeds the upper limit R of equation (3).

[0028] In various embodiments, the delay element 216 is implemented as a buffer, which can be programmable. In other embodiments, the delay element is implemented with a delay line; the delay line can be a programmable delay line. In yet other embodiments, the delay element is implemented with a circuit constructed to provide a delay and the delay can be programmable. A programmable delay element 216 will allow the magnitude of the delay Δt to be adjusted as desired. In the context of beamforming, a programmable delay(s) will allow a beam formed with two or more sensors to be steered to different directions. Beamforming will be discussed more completely below in conjunction with the figures that follow.

[0029] The output signal from the delay element 216 is a delayed oversampled digital signal 218 which is input into a receiver module 220. The receiver module 220 performs the functions of low pass filtering and decimation. Low pass filtering removes the high frequency noise resulting from the oversampling process and decimation reduces the sampling frequency to a baseband sampling rate. A baseband digital signal is output at 222 from the receiver module 220. The baseband signal 222 is a digital signal having a bandwidth as prescribed by an application of interest and, depending on the digitization methodology, an increased dynamic range relative to the oversampled digital signal 214 output from the digital sensor 212.

[0030] As an illustration of a sinusoidal representation of an analog field quantity 204 is illustrated as a function of time 206 and amplitude 208. A marker 210 indicates a peak t_1 in the field quantity 204. After the time delay " Δt " is imparted to the oversampled digital signal and the post processing described above in the receiver 220 is performed, for illustration herein, when the signal at 222 is converted back to an analog signal it would appear as illustrated at 224 where the time delayed amplitude 224 is time delayed by Δt resulting in the peak amplitude of the signal 224 delayed to $t_1 + \Delta t$ as illustrated at 219. Thus, a time delay is imparted to the oversampled digital signal in the system described above in **Figure 2A**. Imparting the time delay is accomplished by insertion of the delay element 216 which can be accomplished, in various embodiments, by inserting, in one embodiment, a buffer as shown between the oversampled digital sensor output 214 and the input to the receiver module 220. In alternative embodiments, described in the figures that follow, a time delay element will be inserted between stages

of a receiver module. Thus, embodiments of the invention are not limited to introduction of the time delay element on the input to the receiver module 220.

[0031] In various embodiments, the oversampling performed in the digital sensor 212 is accomplished with a sigma-delta modulator in an analog-to-digital conversion (ADC) process which outputs at 214 a one-bit deep pulse density modulated (PDM) oversampled digital signal representing the digitization of the analog signal 256 (**Figure 2B**). Note that for illustration purposes only, without limiting embodiments of the invention, the illustration of the oversampled digital signal 214 is presented at 252 as a pulse density modulated (PDM) signal in the time domain and again in **Figure 2B** in enlarged view. At 252 the oversampled digital signal is illustrated with marker 254 indicating a peak of the analog signal 256.

[0032] Following application of the time delay Δt , imparted by delay element 216, the time delayed oversampled digital signal 218 is illustrated at 262 with the oversampled digital signal illustrated with marker 254 indicating the peak of the analog signal 256 which has been delayed in time by Δt , the peak is now indicated at 264.

[0033] The illustrative example presented with 252, 262, **Figure 2A**, and **Figure 2B** illustrates oversampling where one wavelength of an analog signal has been sampled one hundred (100) times. No limitation is implied thereby and this example is provided merely for illustration. **Figure 2B** illustrates, generally at 250, two signals from **Figure 2A**, according to embodiments of the invention.

[0034] Referring back to **Figure 2A**, as described above the sampling clock frequency is represented by a variable f_{sf} ; the baseband sampling frequency is given by the variable f_{bb} . Equation (1) is the requirement for the oversampling condition where

$f_{sf} > f_{bb}$. The ratio of the sampling clock frequency to the baseband sampling frequency is given by equation (2) as $R = f_{sf} / f_{bb}$. In analog-to-digital conversion methodologies that are one-bit deep, R will represent the number of subintervals that a baseband sampling period can be divided into for the purpose of applying a "fractional" time delay to the oversampled digital signal 214. Pulse density modulation (PDM) is such a digital conversion methodology that is one-bit deep where the sign is carried by the bit value where a "1" corresponds to a pulse of plus polarity (+A) and a "0" corresponds with a pulse of negative polarity (-A). Equation (3) indicates that a fractional delay can be selected based on a number of sampling clock cycles N from the range $1 \leq N \leq R$, and the time delay which is applied by delay element 216 is given by equation (4) as: $\Delta t = N *$

T_{sf} . Where T_{sf} is the period of the sampling clock. Where as described above,

"fractional delay" refers to a fraction of a baseband sampling rate cycle.

[0035] Note that when other analog-to-digital digitization methodologies are used in the digital sensor 212 the resulting digital bit stream can be other than one-bit deep. In such cases, the oversampled digital signal at 212 can still be delayed with delay element 216, where the delay will be a multiple of a "sample" regardless of how many bits are used to encode the "sample" at the digital sensor 212. The minimum time delay increment will depend on the bit depth of the analog-to-digital digitization methodology used in the digital sensor 212. Thus, equation (4) is modified to equation (5) as follows:

$\Delta t = N * (M * T_{sf})$. Where T_{sf} is the period of the sampling clock, M is the bit depth of the digitization methodology and the product $N * M$, given by equation (6), which is: $1 \leq N * M \leq R$ with N being an integer subject to the constraint of equation (6) for a fractional

delay. Note that in other embodiments, systems are configured without the constraint R of equation (6). In such cases, the delay imposed by the delay element 216 exceeds the upper limit R in equation (6). Thus, a time delay imposed by the system on the oversampled digital signal can be a fraction of a baseband sampling period or greater than the baseband sampling period.

[0036] For example, in one non-limiting embodiment, given merely for illustration, a 2-bit amplitude modulated digitization methodology utilizes 2 bits to establish 4 amplitude states for a digital representation of an analog signal. In this example, $M=2$, which means that a magnitude of the time delay which can be applied to the oversampled digital signal will be an integer number (a multiple) of two successive sampling clock cycles, e.g., 2, 4, 6, 8, etc., thus the oversampled digital signal is delayed 2 bits at a time in this example of $M=2$. Introducing a delay of one sampling clock cycle or three sampling clock cycles at 216 when the analog-to-digital encoding methodology is 2 bits deep would introduce noise into the system because 2 successive bits are required to represent the expected value of the analog signal, i.e., a sample.

[0037] A variety of different digital sensors can be used at 212. For example, some non-limiting examples of sensors used to detect field quantities are sensors used to detect pressure fluctuations such as acoustic pressure fluctuations in air or water. Frequency ranges can range from the low end of the audio spectrum to the ultrasonic range. Sensors can also be used to detect field quantities such as vibration or electromagnetic energy. The following description and the associated figures are set in the context of a digital microphone however, the description is applicable to sensors other than digital microphones and is generally applicable to oversampled sensors used

during analog-to-digital conversion (ADC) where a time delay is introduced in the oversampled digital domain.

[0038] **Figure 2C** illustrates, generally at 270, an oversampling system utilizing sigma-delta modulation and pulse density modulation (PDM), according to embodiments of the invention. With reference to **Figure 2C**, a digital microphone is indicated at 272. Digital microphone 272 responds to an acoustic field 273. The digital microphone 272 can take the form of an electret capsule microphone or it can be made using microelectromechanical systems (MEMS) technology as a component on an integrated circuit. In some embodiments, MEMS digital microphones are made as a structure on an integrated circuit which uses a membrane that forms a capacitor with a base plate. Sound waves cause a vibration of the membrane which causes variations in capacitance which are sensed, amplified, and processed in the integrated circuit.

[0039] The MEMS digital microphones can be configured with a sigma-delta modulator which produces an oversampled digital output of the analog signal sensed by the microphone. A digital MEMS microphone configured with a sigma-delta modulator is supplied with power and a sampling clock signal. In various embodiments, the digital microphone outputs a pulse density modulated (PDM) oversampled signal. A clock signal can be provided as an external clock signal from a digital data processing system or the sampling clock signal can be provided locally as part of the integrated circuit package that houses the digital microphone. Digital microphones using MEMS technology and sigma-delta modulators for analog-to-digital conversion can be designed to operate at a variety of sampling clock frequencies. Common sampling clock

frequencies are in the range of 1 MHz to 5MHz. The sampling clock frequencies listed here are given merely for illustration and do not limit embodiments of the invention.

[0040] Some baseband audio signal applications have established frequency ranges and these ranges together with a desired dynamic range for the audio signal place requirements on the sampling clock frequency used to with the digital microphone 272. For example, telephony, compact disk (CD) format, etc. all have requirements for the baseband audio signal that can be accommodated through embodiments of the invention as described herein. Some non-limiting examples are, for example, pulse code modulated (PCM) audio which can be provided at various dynamic ranges and sample rates, which could be provided at 16 bits per sample at 48 kHz in one or more embodiments. Another non-limiting example is 16 bit CD quality stereo PCM at 44.1 kHz. Telephony can be accommodated at different specifications. A non-limiting example is PCM audio at 12 bits per sample at 8 kHz. The foregoing examples of baseband audio formats are provided merely for example and do not limit embodiments of the invention.

[0041] The oversampled digital output 274 is input to a delay element 276 as described previously. The delay element 276 applies a time delay to the oversampled digital signal and outputs a time delayed oversampled digital signal at 278.

[0042] The oversampled digital signal 278 is input into a PDM receiver module 280. In various embodiments, the PDM receiver module 280 converts an input signal to pulse code modulation (PCM) format and can be alternatively referred to as a PDM to PCM conversion module 280 without limitation to embodiments of the invention. The PDM receiver module 280 decimates and low pass filters the time delayed oversampled digital signal 278 and outputs a time delayed PCM baseband digital signal at 282. Those

of ordinary skill in the art will recognize that PCM format is a digital data format in use with digital signals such as digital audio signals. PDM receiver modules such as 280, as well as other receiver modules described in the other figures in this description of embodiments, can be implemented with conversion to a format other than PCM format and the description given herein with conversion to PCM format does not impose any limitation on embodiments of the invention.

[0043] As described above, the time delay element 276 can apply a fractional time delay to the oversampled digital signal 274. In some embodiments, the system design is such that a total time delay applied to the baseband signal 286 is made up from the fractional delay contribution at 276 and an integer delay contribution at 284. In other embodiments, the entire delay is applied by the delay element 276.

[0044] Accomplishing a fractional delay at the baseband stage in a digital microphone system is computationally intensive and has been eliminated by embodiments of the invention described herein by introducing the fractional delay in the oversampled signal domain. Equations (1), (2), and (3) from **Figure 2A** apply to the digital microphone system of **Figure 2C**. Here the digital microphone 272 is driven by a sampling clock frequency f_{SF} the baseband sampling frequency is given by f_{bb} , therefore from equation (1) $f_{SF} > f_{bb}$. The ratio of the sampling clock frequency to the baseband sampling frequency is given by equation (2) as $R = f_{SF} / f_{bb}$. Equation (3) indicates that a fractional delay can be selected based on a number of sampling clock cycles N from the range $1 \leq N \leq R$, and the time delay which is applied by delay element 276 is given by equation (4) as: $\Delta t = N * T_{SF}$. Where T_{SF} is the period of the sampling clock. In various

embodiments, the PDM receiver module 280 is constructed with a sequence of stages as explained below in conjunction with the figures that follow.

[0045] **Figure 3** illustrates, generally at 300, applications of the system from **Figure 2C**, according to embodiments of the invention. With reference to **Figure 3**, a non-limiting example of a digital microphone system is provided with a four stage PDM receiver module. An analog field quantity e.g., an acoustic field 302 is sensed by a digital microphone 304. The digital microphone 304 employs a one-bit sigma-delta modulation to perform analog-to-digital conversion (ADC). In one non-limiting embodiment, the digital microphone 304 is driven with a 2.048 MHz sampling clock frequency to output an oversampled digital output signal at 306. In the example of **Figure 3**, the baseband sampling frequency is chosen to be 16 kHz. From equation 2 (**Figure 2A**), $R = 2,048,000/16,000 = 128$. Thus, the period of the baseband sampling frequency can be divided by 128 by selecting a time delay Δt which is related to a number of sampling clock cycles N from the range $1 \leq N \leq 128$. In this example, the time delay which is applied by delay element 308 is given by equation (4) from **Figure 2B** as: $\Delta t = N * T_{SF}$ where T_{SF} is the period of the 2.048 MHz sampling clock frequency, which equals 4.8828×10^{-7} seconds. Equation (4) from **Figure 2B** then provides as a fractional delay: $\Delta t = N * 4.8828 \times 10^{-7}$.

[0046] In one or more embodiments, the time delay element 308 is implemented with a buffer one-bit deep and 128 bits wide. At 8 bits per byte the buffer needed for time delay element 308 in the present example is of size 16 bytes. 16 bytes is a very small buffer which makes the system and process needed to impart a fractional time delay to an oversampled digital signal much less resource intensive than that of existing

systems which impart a fractional time delay to the baseband signal through application of filtering and or post processing in the baseband domain. The time delay element 308 can be configured to be controllable, such that the time delay imparted to the oversampled digital signal can be set using a control line 310. A controller can be configured with one or more digital microphones according to embodiments of the invention to provide a steerable array of microphones for beamforming applications. Utilizing a controller with multiple microphones is described more fully below in conjunction with the figures that follow.

[0047] Illustrated in **Figure 3**, is a PDM receiver module 314 which has, in one embodiment, an architecture based on four main stages, also shown in **Figure 3** in enlarged view at 332. The time delay element 308 applies a delay to the oversampled digital signal outputting a time delayed oversampled digital signal at 312. The oversampled digital signal 312 is input in the PDM receiver module 314 and enters a first stage 316. For the purpose of this example, the first stage of the PDM receiver module 314 is a cascaded-integrator-comb (CIC) filter structure. The integrator keeps a running sum of values adding each new sample, the comb filter subtracts off the oldest sample. The CIC filter is a cascade of integrator comb stages. The final component is a decimator which reduces the sampling rate by a multiple of 2. In the example of **Figure 3**, the CIC filter provides 8:1 decimation which reduces the sampling clock frequency of 2.048MHz to 256 kHz at 318 following the CIC 316 stage. The CIC stage 316 low pass filters the input digital signal 312 thereby providing an increase to the dynamic range of the output digital signal at 318.

[0048] In the example of **Figure 3**, the second stage of PDM receiver module 314 is a half-band filter 320. Half-band filter 320 decimates by a factor of 2:1 thereby reducing the sampling rate of the input signal 318 from 256 kHz to 128 kHz at the output 322. Half-band filter 320 provides further low pass filtering and a further increase in dynamic range of the signal at 322.

[0049] Similarly, in the example of **Figure 3**, the third stage of PDM receiver module 314 is a half-band filter 324. Half-band filter 324 decimates by a factor of 2:1 thereby reducing the sampling rate of the input signal 322 from 128 kHz to 64 kHz at the output 326. Half-band filter 324 provides further low pass filtering and a further increase in dynamic range of the signal at 326

[0050] In the example of **Figure 3**, the fourth stage of PDM receiver module 314 is a low pass filter 328 which decimates by a factor of 4:1 thereby reducing the input digital signal at 326 from a sample rate of 64 kHz to a baseband sample rate of 16 kHz at 330. A finite impulse response (FIR) filter structure or an infinite impulse response (IIR) filter structure can be used in the stages of the PDM receiver module 314 described above, such as, for example in low pass filter 328, etc. Thus, the PDM receiver module receives as an input a time delayed oversampled digital signal at 312 with sampling rate of 2.048 MHz and outputs a baseband signal, which in some embodiments is an acoustic signal, at a baseband sampling rate of 16 kHz at 330. Note that in order to eliminate aliasing, the useful frequency range of the baseband signal will be reduced by a factor of 1/2 from the baseband sampling rate in order to satisfy the Nyquist sampling criteria which requires the maximum useful frequency $F_{\text{NYQUIST}} \leq f_{\text{bb}} / 2$, where f_{bb} is the baseband sample rate.

[0051] Figure 4 illustrates, generally at 400, a pulse density modulation (PDM) receiver architecture, according to embodiments of the invention. With respect to Figure 4, alternative locations for the time delay element 308 from Figure 3 are illustrated. An initial position for the time delay element 416 corresponds with the position of the time delay element 308 in Figure 3. In this initial position, as described above the time delay element 416 delays the oversampled digital signal and outputs a time delayed digital signal at 312.

[0052] The time delay element can be located throughout the oversampled domain of the PDM module 314. In Figure 4, a first alternative location of the delay element is indicated at 418 between the first stage 402 and the second stage 406 at location 418. In this alternative location, in one embodiment, the time delay element 416 is removed and 312 represents the digital oversampled signal, the time delay is applied internal to 314. When the delay element is located at 418 the number of fractional delay elements is obtained by dividing the sampling rate which exists at 404, which is the output of 402 and the input to time delay element at 418, by the baseband sampling rate at 330. For the non-limiting example of Figure 3, $R = 256 \text{ kHz}/16 \text{ kHz} = 16$. Thus, the fractional delay which can be imparted by the time delay element when located at position 418 is calculated by equation (4) from Figure 2B as: $\Delta t = N * T_{SF}$ where is the period of the 256 kHz sampling rate period equals 3.90625×10^{-6} seconds. Equation (4) from Figure 2B then provides: $\Delta t = N * 3.90625 \times 10^{-6}$ seconds.

[0053] In Figure 4, a second alternative location of the delay element is indicated at 420 between the second stage 406 and the third stage 410 at location 420. In this alternative location, in one embodiment, the time delay element 416 is removed and 312

represents the digital oversampled signal, the time delay is applied internal to 314. When the time delay element is located at 420 the number of fractional delay elements is obtained by dividing the sampling rate which exists at 408, which is the output of 406 and the input to time delay element at 420, by the baseband sampling rate at 330. For the non-limiting example of **Figure 3**, $R = 128 \text{ kHz}/16 \text{ kHz} = 8$. Thus, the fractional delay which can be imparted by the time delay element when located at position 420 is calculated by equation (4) from **Figure 2B** as: $\Delta t = N * T_{SF}$ where T_{SF} is the period of the 128 kHz sampling rate period which equals 7.8125×10^{-6} seconds. Equation (4) from **Figure 2B** then provides: $\Delta t = N * 7.8125 \times 10^{-6}$ seconds.

[0054] In **Figure 4**, a third alternative location of the delay element is indicated at 422 between the third stage 410 and the fourth stage 414 at location 422. In this alternative location, in one embodiment, the time delay element 416 is removed and 312 represents the digital oversampled signal, the time delay is applied internal to 314. When the delay element is located at 422 the number of fractional delay elements is obtained by dividing the sampling rate which exists at 412, which is the output of 410 and the input to time delay element at 422, by the baseband sampling rate at 330. For the example of **Figure 3**, $R = 64 \text{ kHz}/16 \text{ kHz} = 4$. Thus, the fractional delay which can be imparted by the time delay element when located at position 422 is calculated by equation (4) from **Figure 2B** as: $\Delta t = N * T_{SF}$ where T_{SF} is the period of the 64 kHz sampling rate period which equals 1.5625×10^{-5} seconds. Equation (4) from **Figure 2B** then provides: $\Delta t = N * 1.5625 \times 10^{-5}$ seconds. In other embodiments, a time delay element can be located in a plurality of locations, i.e., one or more of 416, 418, 420, and 422.

[0055] **Figure 5** illustrates, generally at 500, placing a time delay between stages of a pulse density modulation (PDM) receiver, according to embodiments of the invention. With respect to **Figure 5**, a PDM receiver module 580 is illustrated with an oversampled digital input signal at 578. The oversampled digital input signal 578 originates in various embodiments, for example, from a digital microphone such as 272 in **Figure 2C**. The PDM receiver module 280 is configured with a 1st stage 502, a second stage 510, a third stage 514, and up to an i^{th} stage 518. Each stage can provide one or both of decimation and low pass filtering. A time delay element 506 is located between the first stage 502 the second stage 510. In operation, an oversampled digital signal 578 originates from example a digital microphone or another type of digital sensor as described above.

[0056] The oversampled digital signal 578 is input into a first stage 502 of the PDM receiver module 580 where the signal is decimated and low pass filtered. An output of the first stage 502 is then input at 504 into the time delay element 506. An output of the time delay element 506 is input at 508 into the second stage 510. The second stage 510 performs further decimation and low pass filtering with an output 512 providing an input into the third stage 514. The third stage 514 performs further decimation and low pass filtering with an output 516 providing an input into the i^{th} stage 518. The i^{th} stage 518 provides the output 582 from the PDM receiver module 580 which can be configured to be at the baseband sampling rate. In various other embodiments, the time delay element 506 can be placed between other stages of the PDM receiver module 580.

[0057] **Figure 6** illustrates, generally at 600, placing a time delay between different stages of a pulse density modulation (PDM) receiver, according to embodiments of the invention. With respect to **Figure 6**, the PDM receiver module 580 from **Figure 5** illustrated with stages 502, 510, 514, up to 518. Here in **Figure 6**, a time delay element is inserted between the second stage 510 and the third stage 514. An output 604 from the second stage 510 is input to a time delay element 602. An output 606 from the time delay element 602 is a time delayed digital signal at an intermediate sampling rate.

[0058] **Figure 7** illustrates, generally at 700, placing a time delay in yet another location within a pulse density modulation (PDM) receiver, according to embodiments of the invention. With respect to **Figure 7**, the PDM receiver module 580 from **Figure 5** illustrated with stages 502, 510, 514, up to 518. In **Figure 7**, a time delay element is inserted between the $i-1$ stage 514 and the i^{th} stage 518. An output 704 from the $i-1$ stage 514 is time delayed at time delay element 702. An output 706 from the time delay element 702 is a time delayed digital signal at an intermediate sampling rate which is input into the i^{th} stage 518 for further processing before being output at 582 from the PDM receiver module 580. The output 582 is at a sampling frequency which is a reduced sample rate, which in some embodiments can be the baseband sample rate of the desired output signal from the system.

[0059] **Figure 8** illustrates, generally at 800, programmable time delay in an analog-to-digital converter (ADC) system, according to embodiments of the invention. With respect to **Figure 8**, an analog field quantity is represented by 802 incident on a digital sensor 804, which in various embodiments, is a digital microphone, vibration sensor, electromagnetic energy sensor, etc. For the discussion herein, digital sensor 804

is referred to as a digital microphone without limitation implied thereby. In response to the incident field 802 the digital microphone 804 outputs an oversampled digital signal at 806. The oversampled digital signal output 806 is input to a time delay element 808 which outputs a time delayed oversampled digital output at 810. The time delayed oversampled digital output 810 is input into a PDM receiver module 812. The PDM receiver module 812 can be configured with a single stage or a multi-stage architecture as described above. At 814 an output from PDM receiver module 812 can optionally be time delayed at 816 before being output at 822. In some embodiments, a controller 818 provides a control signal 820 to the time delay element 808. In some embodiments, when the time delay element 816 is configured with the system, the controller 818 or a separate controller provides a control signal at 822 to the time delay element 816.

[0060] In various embodiments, the time delay element such as 808 can be configured as a buffer or to include a buffer which has a number of values, where each value corresponds to a different number of clock cycles of the sampling clock used within the digital sensor 804. In various embodiments, the time delay element 808 can be configured to provide a fixed time delay to the input digital signal 806 or the time delay element 808 can be programmable. In operation, the controller 818 provides a control signal 820 which is used to specify a number of sampling clock cycles which will be used by the time delay element 808 to provide the time delay to the input signal 806.

[0061] Similarly, when present in the system, the time delay element such as 816 can be configured as a buffer or to include a buffer which has a number of values, where each value corresponds to a different number of cycles at the lower sample rate corresponding to the output of the PDM receiver module 812. In various embodiments,

the time delay element 816 can be configured to provide a fixed time delay to the input digital signal 814 or the time delay element 816 can be programmable. In operation, the controller 818 provides a control signal 822 which is used to specify a number of cycles at the lower sample rate which will be used by the time delay element 816 to provide the time delay to the input signal 814. Thus, the total time delay imparted by the system at the output 822 relative to the input 806 is the sum of the time delay imparted by the time delay element 808 and the time delay element 816.

[0062] **Figure 9A** illustrates, generally at 900, time delays for multiple sensors, according to embodiments of the invention. With respect to **Figure 9A**, an analog field quantity is represented by 902, which is incident on digital sensors 920, 940, up to a general number of **N** sensors indicated by 960, which in various embodiments is a digital microphone, vibration sensor, electromagnetic energy sensor, etc. For the discussion herein, digital sensors 920, 940, and 960 are referred to as digital microphones without limitation implied thereby. Each digital microphone has a signal transmission path indicated by 906, 908 and 910. A controller 904 is used to adjust time delay(s), which are used to delay each of the microphone signal paths.

[0063] In operation, a time delay Δt_1 is associated with the digital signal output at 912 for the digital microphone 920. Similarly, a time delay Δt_2 is associated with the digital signal output at 914 for the digital microphone 930. And a time delay Δt_n is associated with the digital signal output at 916 for the digital microphone 960. A controller 904 is used to supply one or more control signals to each signal path 906, 908, up to 910. As described above in the preceding figures, a control signal 922 supplied to a time delay element 924 is used to specify a time delay applied by the time delay element

924 to the oversampled digital signal received from the microphone 920. Optionally, the controller 904 can supply a control signal 928 to a time delay element 940 (if present in a given system configuration). Similarly, a control signal 942 supplied to a time delay element 944 is used to specify a time delay applied by the time delay element 944 to the oversampled digital signal received from the microphone 940. Optionally, the controller 904 can supply a control signal 948 to a time delay element 950 (if present in a given system configuration). Control signals are supplied as need to successive microphone signal paths, and finally within microphone signal path 910 a control signal 962 supplied to a time delay element 964 which is used to specify a time delay applied by the time delay element 964 to the oversampled digital signal received from the microphone 960. Optionally, the controller 904 can supply a control signal 968 to a time delay element 970 (if present in a given system configuration).

[0064] Note that the time delay element 924 can be located within the PDM receiver module 926, e.g., between stages of the PDM receiver module 926 as described in the figures above. Similarly, and without limitations, the time delay element 944 can be located within the PDM receiver module 946, e.g., between stages of the PDM receiver module 946 and the time delay element 964 can be located within the PDM receiver module 966, e.g., between stages of the PDM receiver module 966 as described in the figures above. The microphone signal paths 906, 908, up through 910 need not be configured in the same way. For example, one or more microphone signal paths can be configured with a time delay element inserted between a digital microphone and a PDM receiver module while another microphone signal path can be configured with a time delay element inserted internally to the PDM receiver module.

[0065] In various embodiments, the controller 904 is used to steer the array of microphones 920, 940, through 960 as needed in order to perform beamforming with the time delayed microphone signals 912, 914, through 916. As described in **Figure 9A**, a general number of ***n*** microphones has been described; however, beamforming can be performed with as few as two microphones as described below in conjunction with **Figure 10**.

[0066] **Figure 9B** illustrates, generally at 980, multiple time delays applied to an output from a single sensor, according to embodiments of the invention. With respect to **Figure 9B**, an analog field quantity is represented by 902, which is incident on a digital sensor 920, which in various embodiments is a digital microphone, vibration sensor, electromagnetic energy sensor, etc. For the discussion herein, the digital sensor 920 is referred to as digital microphone without limitation implied thereby. The digital microphone 920 outputs a signal 912 which is replicated (split) at 982 into ***n*** replicas, indicated by 984 through 986. Each replica of the microphone 920 signal 912 has a signal transmission path indicated by 906 through 910. A controller 904 is used to adjust time delay(s), which are used to delay each of the replicas 984 through 986 of the microphone signal paths.

[0067] In operation, the signal 912 is input into 982 in order to produce the ***n*** replicas 984 through 986. In various embodiments, 982 is an ***n***-way splitter. In other embodiments, replication at 982 is accomplished by other means. In some embodiments, replication is performed in software. A time delay Δt_1 is associated with the digital signal output at 984 for the digital microphone 920 at 924. Similarly, a time delay Δt_n is

associated with the digital signal output at 986 for the digital microphone 920 at 964. A controller 904 is used to supply one or more control signals to each signal path 906 up to 910. As described above in the preceding figures, a control signal 922 supplied to the time delay element 924 is used to specify a time delay applied by the time delay element 924 to the oversampled digital signal received from the microphone 920. Optionally, the controller 904 can supply a control signal 928 to a time delay element 930 (if present in a given system configuration). Control signals are supplied as need to successive microphone signal paths, and finally within microphone signal path 910 a control signal 962 supplied to the time delay element 964 which is used to specify a time delay applied by the time delay element 964 to the oversampled digital signal received from the microphone 920 at 986. Optionally, the controller 904 can supply a control signal 968 to a time delay element 970 (if present in a given system configuration).

[0068] Note that the time delay element 924 can be located within the PDM receiver module 926, e.g., between stages of the PDM receiver module 926 as described in the figures above. Similarly, and without limitations, the time delay element 964 can be located within the PDM receiver module 966, e.g., between stages of the PDM receiver module 966 as described in the figures above. The microphone signal paths 906 up through 910 need not be configured in the same way. For example, one or more microphone signal paths can be configured with a time delay element inserted between a digital microphone and a PDM receiver module while another microphone signal path can be configured with a time delay element inserted internally to the PDM receiver module.

[0069] In various embodiments, the controller 904 is used to steer the array of signals obtained from the single microphone 920 as needed in order to perform beamforming with the time delayed microphone signals 912 through 916. As described in **Figure 9B**, a general number of N time delayed signals from a single microphone has been described. However, beamforming, as described below in conjunction with **Figure 10**, can be performed with as few as two time delayed signals ($N = 2$) from a single microphone. Thus, in some embodiments, the N -way splitter is a splitter providing two outputs ($N = 2$) from a single input.

[0070] **Figure 10** illustrates, generally at 1000, beamforming, according to embodiments of the invention. With respect to **Figure 10**, an analog field quantity is represented by 1002, which is incident on digital sensors 1004 and 1006. In one or more embodiments, the digital sensors 1004 and 1006 are digital microphones; however no limitation is implied thereby. The digital microphone 1004 outputs an oversampled digital signal which is time delayed at a time delay element 1008. Optionally a gain is adjusted at 1010 which either increases or decreases an amplitude of the signal output at 1016. The second microphone 1006 outputs an oversampled digital signal which is time delayed at a time delay element 1012. Optionally a gain is adjusted at 1014 which either increases or decreases an amplitude of the signal output at 1018.

[0071] The signals 1016 and 1018 are input into an arithmetic block at 1020 and the beamformed output is provided at 1022. Depending on a given implementation of a system and the processing of the signals therein, the arithmetic block 1020 can perform a summation or a subtraction of the inputs 1016 and 1018 as needed for the given

beamforming operation. In **Figure 10**, beamforming is illustrated with two microphones however beamforming can be performed with a general number of microphones. The example of **Figure 10** is provided merely for illustration and does not limit embodiments of the invention.

[0072] **Figure 11A** and **11B** illustrate increased resolution provided by a fractional delay, according to embodiments of the invention. Referring to **Figure 11A** and **Figure 11B** together, as described above, a "fractional delay" is used in this description of embodiments to refer to a fraction of a baseband sampling rate cycle. In the context of beamforming, increased resolution in time corresponds to increased resolution in space, which is advantageous to the beamforming process.

[0073] Equation (7) provides the relationship between a signal with frequency f and period τ . As described above, a time delay can be introduced into an output of an analog-to-digital converter (ADC) process which has an integer time delay based on the baseband sampling rate of the system given by equation (8). Similarly, when the time delay is introduced at the sampling clock frequency in the oversampled domain, the time delay is given by equation (9).

[0074] Equations (8) and (9) are substituted into equation (2) **Figure 2A** to yield equation (10). Solving equation (10) for $\Delta t_{\text{fractional delay}}$ yields for equation (11):

$$\Delta t_{\text{fractional delay}} = \Delta t_{\text{integer delay}}/R.$$

[0075] The Nyquist sampling theorem states that the highest unaliased frequency " f_{NYQUIST} " which can be measured with sampling frequency f_s is defined to be: f_{NYQUIST}

$=f_s/2$, in this context the sampling frequency f_s which is relevant is the baseband sampling rate f_{bb} . Thus $f_{\text{NYQUIST}} = f_{bb}/2$.

[0076] The periods for three waveforms are illustrated in **Figure 11B**. 1102 is an illustration of a period corresponding with a sampling clock frequency which would be used to oversample a digital sensor according to embodiments of the invention. 1104 is an illustration of a period of a baseband sampling rate which corresponds to the sampling rate after decimation of the oversampled signal. The relationship between periods 1102 and 1104 is given by equation (10). 1104 also represents an integer time delay which can be applied to a baseband signal. 1106 represents a period of the waveform that corresponds with the Nyquist frequency for the system. The Nyquist wavelength 1106 is the shortest wavelength (and highest frequency) of the field quantity that can be processed without aliasing.

[0077] Fractional time delay qualitatively represented by 1102 can be applied to baseband signal 1106 and represents an improvement in spatial resolution over the spatial resolution which could be achieved from integer time delay represented by 1104.

[0078] Field quantities such as those indicated in the figures above represent wave propagation in a medium. In the case of acoustic wave propagation, the relevant medium is either air or water and the speed of sound in air is nominally 340 meters per second. The speed of sound will vary as the physical properties of a medium change, for example in the case of air and water the speed of sound will vary with temperature, pressure, and salinity (water). In the non-limiting examples presented herein a nominal value of 340 meters per second is used for illustration purposes and no limitation is implied thereby.

[0079] Fractional time delay permits the spatial resolution of a system used for beamforming to be increased with respect to the spatial resolution achievable with integer time delay. The spatial resolution is given by ΔX in terms of C and $\Delta t_{\text{fractional delay}}$, where $\Delta X = C * \Delta t_{\text{fractional delay}}$.

[0080] In other embodiments as described above, a time delay element can be inserted within a receiver module for a digital oversampled sensor such as for example a PDM receiver module. In such cases a period 1102 represents an intermediate sampling rate. The number of sampling clock cycles or intermediate sampling rate cycles that are used to produce a time delay in the oversampled domain that is incorporated into the decimated and low pass filtered signal can vary as described above.

[0081] In the oversampled systems described above, in various non-limiting embodiments, the variable R has been used to represent the ratio of the sampling clock frequency (at the digital microphone) to the sampling rate at baseband. In the non-limiting example of **Figure 3**, with f_{SF} equal to 2.048 MHz and f_{bb} equal to 16 kHz, then from equation 2 in **Figure 2A**, $R = f_{\text{SF}}/f_{\text{bb}} = 128$. From equation (10) in **Figure 11A** in this non-limiting example a minimum fraction that R represents with respect to the integer sampling rate is $1/128$. Other fractional time delay values are achieved by the techniques described herein, such as by time delaying for additional clock cycles at f_{SF} or additional intermediate sampling rate cycles or by changing the sampling clock frequency that is used to drive the ADC in the digital sensor.

[0082] **Figure 12** illustrates, generally at 1200, a process to impart a time delay to an oversampled system, according to embodiments of the invention. With reference to

Figure 12, a process begins at a block 1202. At a block 1204 a relationship is established between sampling clock cycles and the digital representation of the analog signal produced by the digitization methodology employed in an analog-to-digital converter (ADC) process. In some instances, this is a one-bit deep process such as with Pulse Density Modulation (PDM) described above. In other embodiments, the process is other than one-bit deep but is then multiple bits deep. At a block 1206 a number of clock cycles needed for a given time delay is computed taking into consideration the bit depth of the encoding methodology used in the ADC. At a block 1208 the oversampled digital signal is delayed by a number of clock cycles that represents the time delay calculated in the block 1206. The process stops at the block 1210.

[0083] **Figure 13** illustrates, generally at 1300, a process to use a time delay imparted to an oversampled system in a beamforming process, according to embodiments of the invention. With reference to **Figure 13**, a process starts with a block 1302. At a block 1304 a time delay is selected for a beamforming process. At a block 1306 the time delay from the block 1304 is applied to a digitally oversampled signal in the oversampled domain for the signal. The oversampled domain for the signal can be, as described in the figures above, between the digital sensor and a receiver module for the digital sensor or in other embodiments the time delay is inserted at a location within the receiver module. In yet other embodiments, the time delay is inserted at more than one location within the oversampled domain. At a block 1308 a beamforming process is performed with the time delayed digital signal that represents the field quantity of interest. The time delay applied in the beamforming process at the block 1308 can be a fractional time delay with respect to a baseband sampling rate or it can be a sum of the fractional time delay and an

integer time delay. In some embodiments, a magnitude of the time delay applied in the oversampled domain can exceed the duration of a sampling interval (or clock cycle) in the baseband domain. Thus, use of the terms "fractional delay" does not limit embodiments of the invention, but is used herein to describe the relative magnitude of the delays in some embodiments. Where the integer time delay is a number of baseband sampling rate cycles. The process ends at a block 1310.

[0084] **Figure 14** illustrates, generally at 1400, a data processing system in which embodiments of the invention may be used. The block diagram is a high-level conceptual representation and may be implemented in a variety of ways and by various architectures. With reference to **Figure 14**, bus system 1402 interconnects a Central Processing Unit (CPU) 1404, Read Only Memory (ROM) 1406, Random Access Memory (RAM) 1408, storage 1410, display 1420, audio 1422, keyboard 1424, pointer 1426, data acquisition unit (DAU) 1428, and communications 1430. The bus system 1402 may be for example, one or more of such buses as a system bus, Peripheral Component Interconnect (PCI), Advanced Graphics Port (AGP), Small Computer System Interface (SCSI), Institute of Electrical and Electronics Engineers (IEEE) standard number 1394 (FireWire), Universal Serial Bus (USB), or a dedicated bus designed for a custom application, etc. The CPU 1404 may be a single, multiple, or even a distributed computing resource or a digital signal processing (DSP) chip. Storage 1410 may be Compact Disc (CD), Digital Versatile Disk (DVD), hard disks (HD), optical disks, tape, flash, memory sticks, video recorders, etc. The signal processing system 1400 can be an acoustic signal processing system used to receive acoustic signals that are input from a single microphone or a plurality of microphones (e.g., a first microphone, a second

microphone, etc.). Note that depending upon the actual implementation of the acoustic signal processing system, the acoustic signal processing system may include some, all, more, or a rearrangement of components in the block diagram. In some embodiments, aspects of the system 1400 are performed in software. While in some embodiments, aspects of the system 1400 are performed in dedicated hardware such as a digital signal processing (DSP) chip 1440, or a system on a chip (SOC) which can also be represented at 1440, etc. as well as combinations of dedicated hardware and software as is known and appreciated by those of ordinary skill in the art.

[0085] Thus, in various embodiments, acoustic signal data is received at 1429 for processing by the acoustic signal processing system 1400. Such data can be transmitted at 1432 via communications interface 1430 for further processing in a remote location. Connection with a network, such as an intranet or the Internet is obtained via 1432, as is recognized by those of skill in the art, which enables the acoustic signal processing system 1400 to communicate with other data processing devices or systems in remote locations.

[0086] For example, embodiments of the invention can be implemented on a computer system 1400 configured as a desktop computer or work station, on for example a WINDOWS® compatible computer running operating systems such as WINDOWS® XP Home or WINDOWS® XP Professional, WINDOWS® 10 Home or WINDOWS® 10 Professional, Linux, Unix, etc. as well as computers from APPLE COMPUTER, Inc. running operating systems such as OS X, etc. Alternatively, or in conjunction with such an implementation, embodiments of the invention can be configured with devices such as speakers, earphones, video monitors, etc. configured for use with a Bluetooth

communication channel. In yet other implementations, embodiments of the invention are configured to be implemented by mobile devices such as a smart phone, a tablet computer, a wearable device, such as eye glasses, a near-to-eye (NTE) headset, or the like.

[0087] In various embodiments, the components of systems as well as the systems described in the previous figures are implemented in an integrated circuit device, which may include an integrated circuit package containing the integrated circuit. In some embodiments, the components of systems as well as the systems are implemented in a single integrated circuit die. In other embodiments, the components of systems as well as the systems are implemented in more than one integrated circuit die of an integrated circuit device which may include a multi-chip package containing the integrated circuit. For example, in one non-limiting embodiment using **Figure 8**, as illustrated by the example of **Figure 8** and **Figure 15A**, the components of the system are implemented in more than one integrated circuit die. With reference to 1500, a first integrated circuit die 1502 includes the digital sensor 804 and time delay element 808; a second integrated circuit die 1504 includes one or more of the PDM receiver module 812, time delay controller 818, and time delay element 816. In some embodiments the second integrated circuit die 1504 does not include time delay controller 818 and time delay element 816. PDM receiver module 812 together with one or more of time delay controller 818 and time delay element 816 can also be referred to as an Application Processor. In another non-limiting embodiment, as illustrated by the example of **Figure 8** and **Figure 15B**, the components of the system are implemented in more than one integrated circuit die. With reference to 1550 a first integrated circuit die 1502 includes the digital sensor 804; a

second integrated circuit die 1504 includes the PDM receiver module 812, the time delay element 808, and one or more of the time delay controller 818, and time delay element 816. In some embodiments the second integrated circuit die 1504 does not include time delay controller 818 and time delay element 816. PDM receiver module 812 and time delay element 808 together with one or more of time delay controller 818 and time delay element 816 can also be referred to as an Application Processor. Distribution of any of the systems illustrated in the figures above (e.g., any one or more of **Figure 1** through **Figure 14**) can be distributed between one or more integrated circuits dies. The examples of **Figure 15A** and **Figure 15B** are provided merely for illustration and do not limit embodiments of the invention. In some embodiments, the components of systems illustrated in the first integrated circuit die 1502 and the second integrated circuit die 1504 are implemented in a single integrated circuit die. In some embodiments, the entire system is implemented in a single integrated circuit die.

[0088] For purposes of discussing and understanding the embodiments of the invention, it is to be understood that various terms are used by those knowledgeable in the art to describe techniques and approaches. Furthermore, in the description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the present invention. It will be evident, however, to one of ordinary skill in the art that the present invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring the present invention. These embodiments are described in sufficient detail to enable those of ordinary skill in the art to practice the invention, and it is to be understood that other embodiments may be

utilized and that logical, mechanical, electrical, and other changes may be made without departing from the scope of the present invention.

[0089] Some portions of the description may be presented in terms of algorithms and symbolic representations of operations on, for example, data bits within a computer memory. These algorithmic descriptions and representations are the means used by those of ordinary skill in the data processing arts to most effectively convey the substance of their work to others of ordinary skill in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of acts leading to a desired result. The acts are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, waveforms, data, time series or the like.

[0090] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise as apparent from the discussion, it is appreciated that throughout the description, discussions utilizing terms such as "processing" or "computing" or "calculating" or "determining" or "displaying" or the like, can refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other

data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission, or display devices.

[0091] An apparatus for performing the operations herein can implement the present invention. This apparatus may be specially constructed for the required purposes, or it may comprise a general-purpose computer, selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, hard disks, optical disks, compact disk read-only memories (CD-ROMs), and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), electrically programmable read-only memories (EPROM)s, electrically erasable programmable read-only memories (EEPROMs), FLASH memories, magnetic or optical cards, etc., or any type of media suitable for storing electronic instructions either local to the computer or remote to the computer.

[0092] The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general-purpose systems may be used with programs in accordance with the teachings herein, or it may prove convenient to construct more specialized apparatus to perform the required method. For example, any of the methods according to the present invention can be implemented in hard-wired circuitry, by programming a general-purpose processor, or by any combination of hardware and software. One of ordinary skill in the art will immediately appreciate that the invention can be practiced with computer system configurations other than those described, including hand-held devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, digital signal processing (DSP) devices, network

PCs, minicomputers, mainframe computers, and the like. The invention can also be practiced in distributed computing environments where tasks are performed by remote processing devices that are linked through a communications network. In other examples, embodiments of the invention as described in the figures above can be implemented using a system on a chip (SOC), a Bluetooth chip, a digital signal processing (DSP) chip, a codec with integrated circuits (ICs) or in other implementations of hardware and software.

[0093] The methods of the invention may be implemented using computer software. If written in a programming language conforming to a recognized standard, sequences of instructions designed to implement the methods can be compiled for execution on a variety of hardware platforms and for interface to a variety of operating systems. In addition, the present invention is not described with reference to any particular programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein. Furthermore, it is common in the art to speak of software, in one form or another (e.g., program, procedure, application, driver,...), as taking an action or causing a result. Such expressions are merely a shorthand way of saying that execution of the software by a computer causes the processor of the computer to perform an action or produce a result.

[0094] It is to be understood that various terms and techniques are used by those knowledgeable in the art to describe communications, protocols, applications, implementations, mechanisms, etc. One such technique is the description of an implementation of a technique in terms of an algorithm or mathematical expression. That is, while the technique may be, for example, implemented as executing code on a

computer, the expression of that technique may be more aptly and succinctly conveyed and communicated as a formula, algorithm, mathematical expression, flow diagram or flow chart. Thus, one of ordinary skill in the art would recognize a block denoting $A+B=C$ as an additive function whose implementation in hardware and/or software would take two inputs (A and B) and produce a summation output (C). Thus, the use of formula, algorithm, or mathematical expression as descriptions is to be understood as having a physical embodiment in at least hardware and/or software (such as a computer system in which the techniques of the present invention may be practiced as well as implemented as an embodiment).

[0095] Non-transitory machine-readable media is understood to include any mechanism for storing information in a form readable by a machine (e.g., a computer). For example, a machine-readable medium, synonymously referred to as a computer-readable medium, includes read only memory (ROM); random access memory (RAM); magnetic disk storage media; optical storage media; flash memory devices; except electrical, optical, acoustical or other forms of transmitting information via propagated signals (e.g., carrier waves, infrared signals, digital signals, etc.); etc.

[0096] As used in this description, "one embodiment" or "an embodiment" or similar phrases means that the feature(s) being described are included in at least one embodiment of the invention. References to "one embodiment" in this description do not necessarily refer to the same embodiment; however, neither are such embodiments mutually exclusive. Nor does "one embodiment" imply that there is but a single embodiment of the invention. For example, a feature, structure, act, etc. described in "one embodiment" may also be included in other embodiments. Thus, the invention may

include a variety of combinations and/or integrations of the embodiments described herein.

[0097] Thus, embodiments of the invention can be used in various acoustic systems. Some non-limiting examples of such systems are, but are not limited to, use in short boom headsets, such as an audio headset for telephony suitable for enterprise call centers, industrial and general mobile usage, an in-line "ear buds" headset with an input line (wire, cable, or other connector), mounted on or within the frame of eyeglasses, a near-to-eye (NTE) headset display or headset computing device, a long boom headset for very noisy environments such as industrial, military, and aviation applications as well as a gooseneck desktop-style microphone which can be used to provide theater or symphony-hall type quality acoustics without the structural costs.

[0098] While the invention has been described in terms of several embodiments, those of skill in the art will recognize that the invention is not limited to the embodiments described, but can be practiced with modification and alteration within the spirit and scope of the appended claims. The description is thus to be regarded as illustrative instead of limiting.

FIGURE 1

1/20

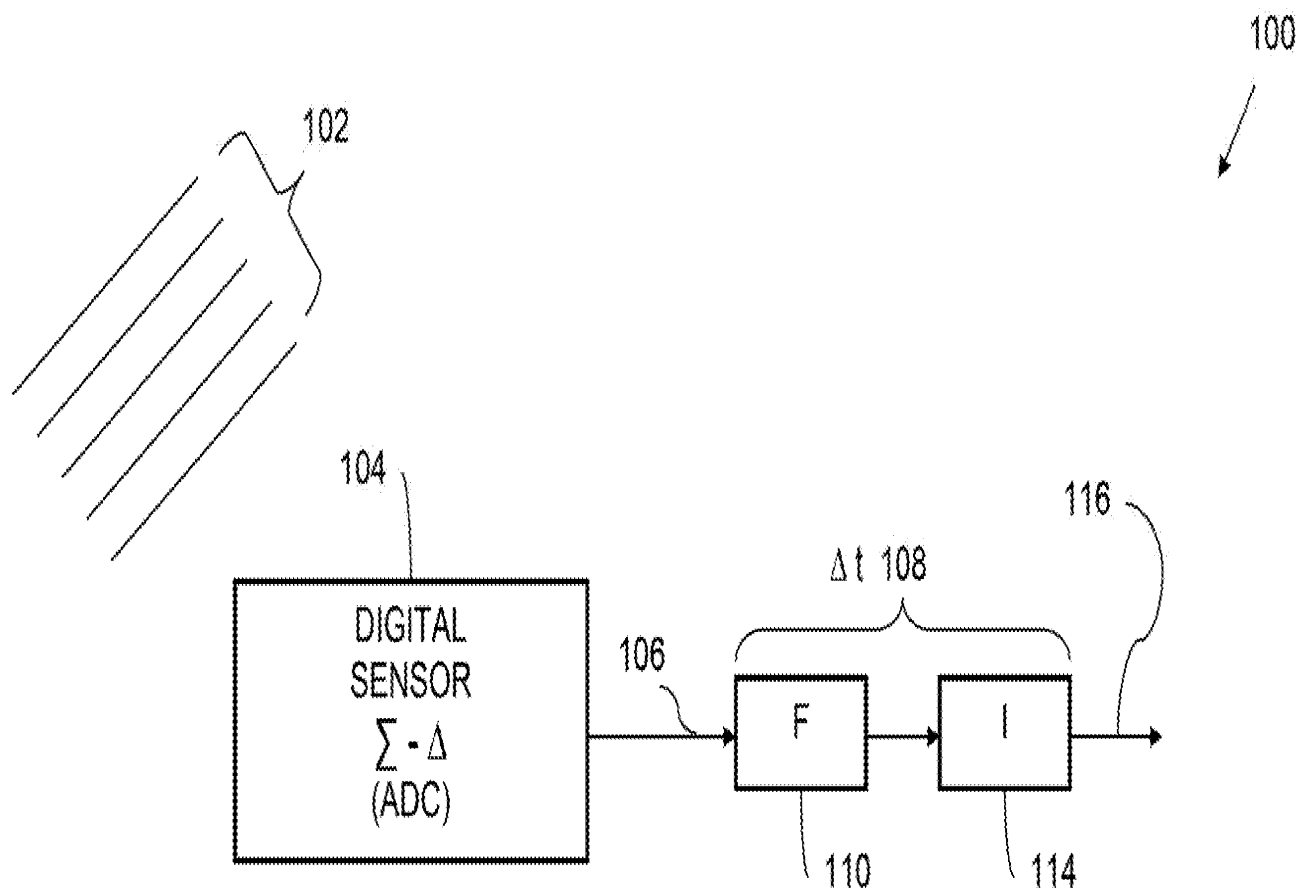


FIGURE 2A

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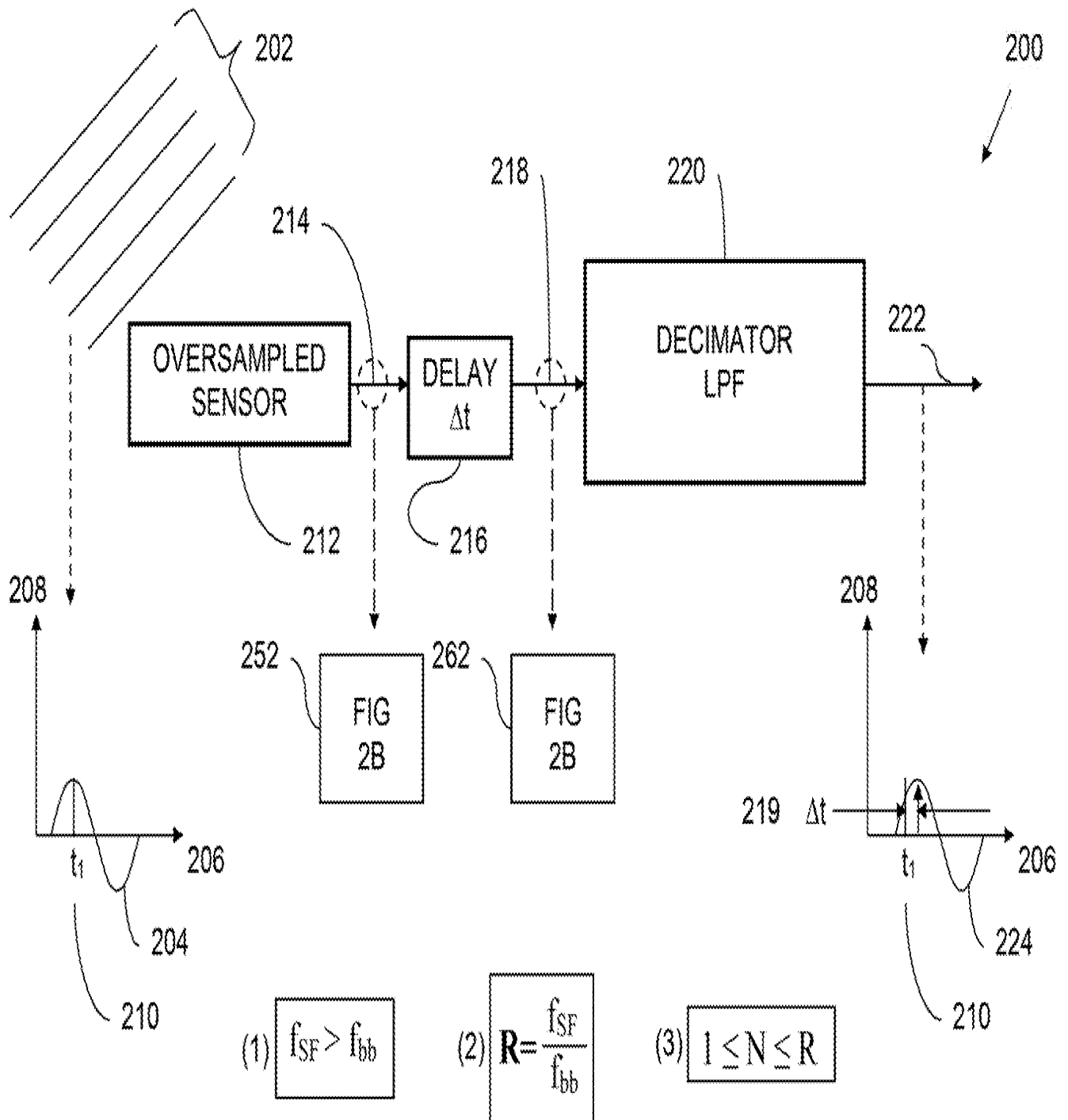
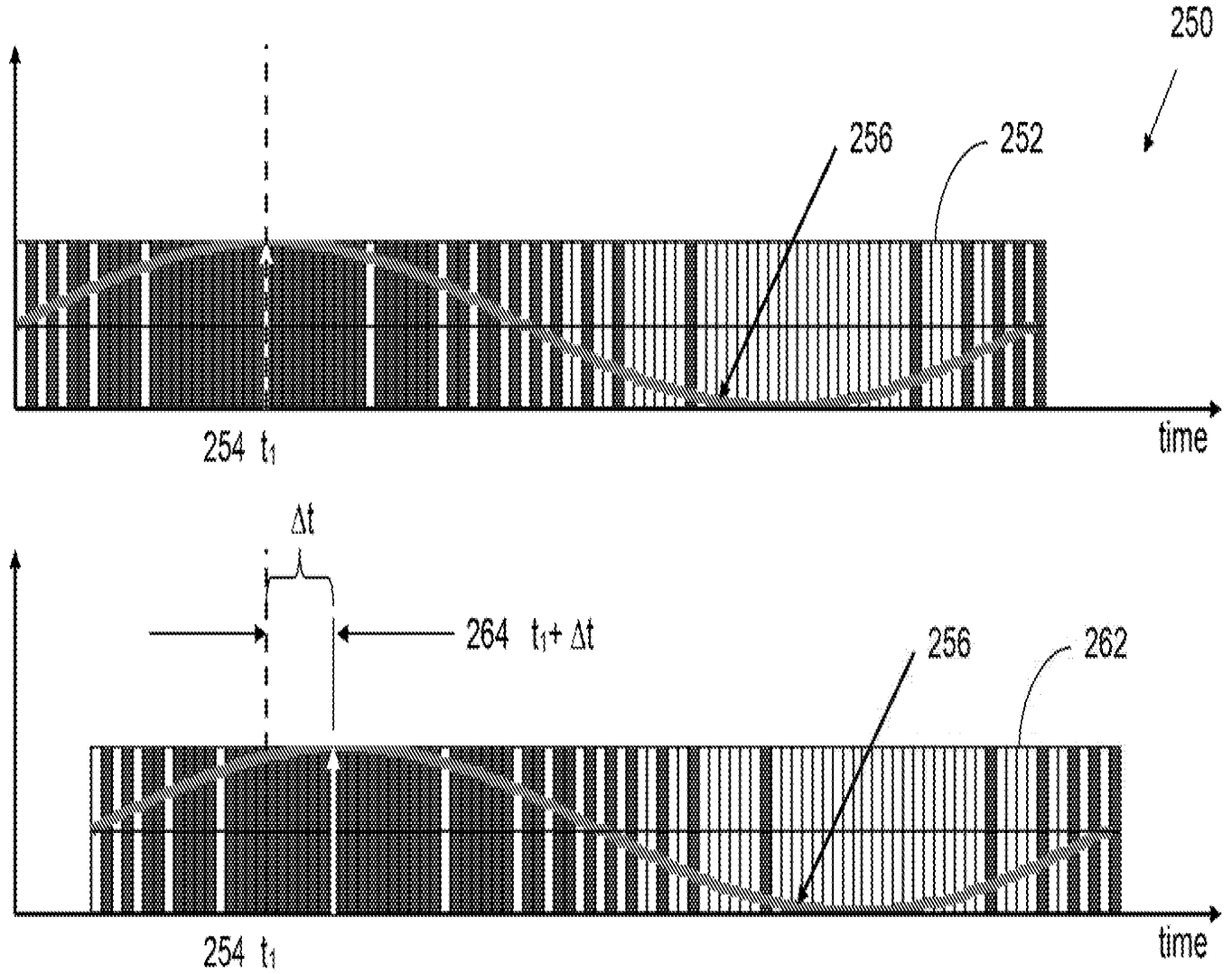


FIGURE 2B

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$$(4) \Delta t = N * \tau_{SF}$$

$$(5) \Delta t = N * (M * \tau_{SF})$$

$$(6) 1 \leq N * M \leq R$$

FIGURE 2C

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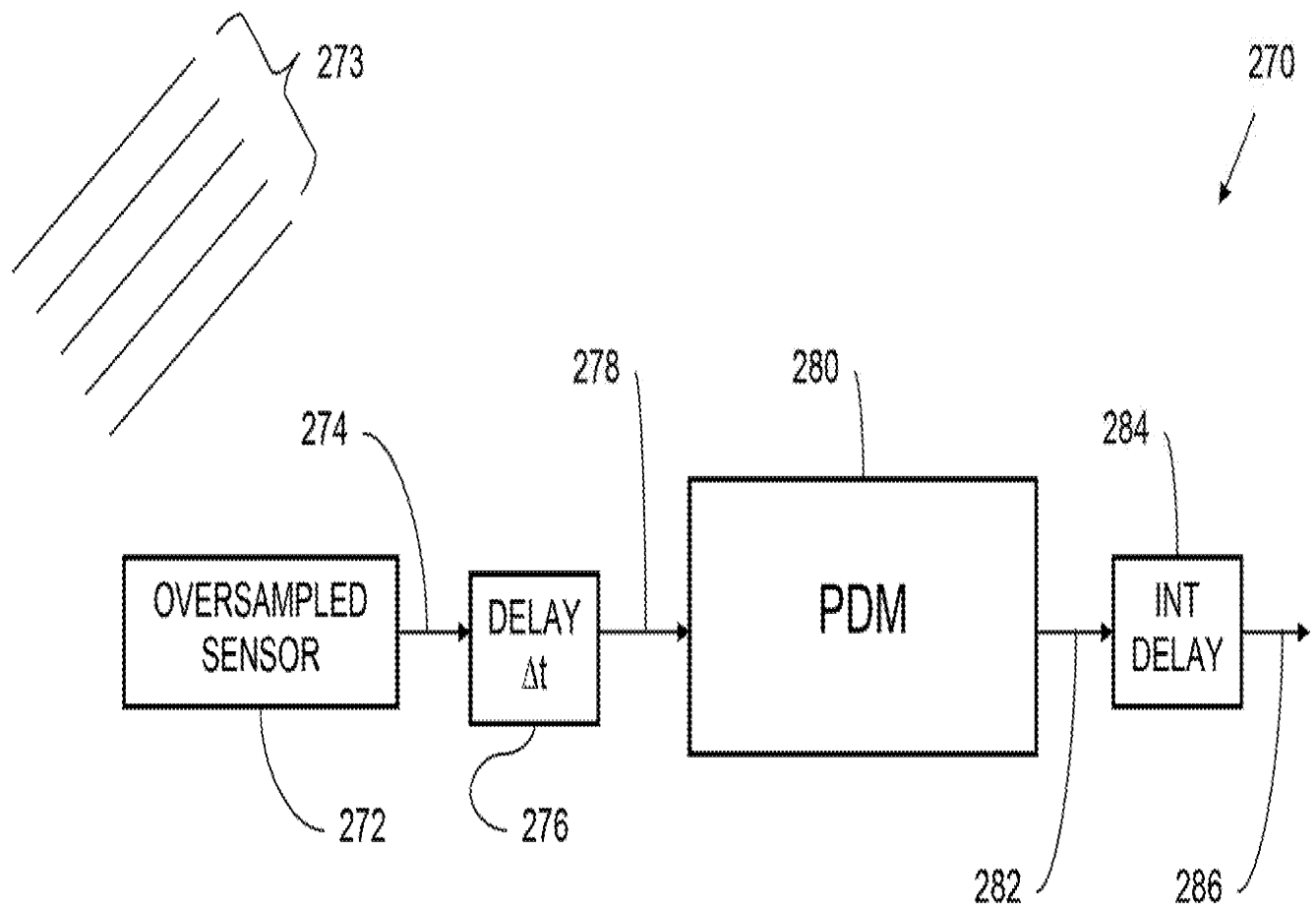


FIGURE 3

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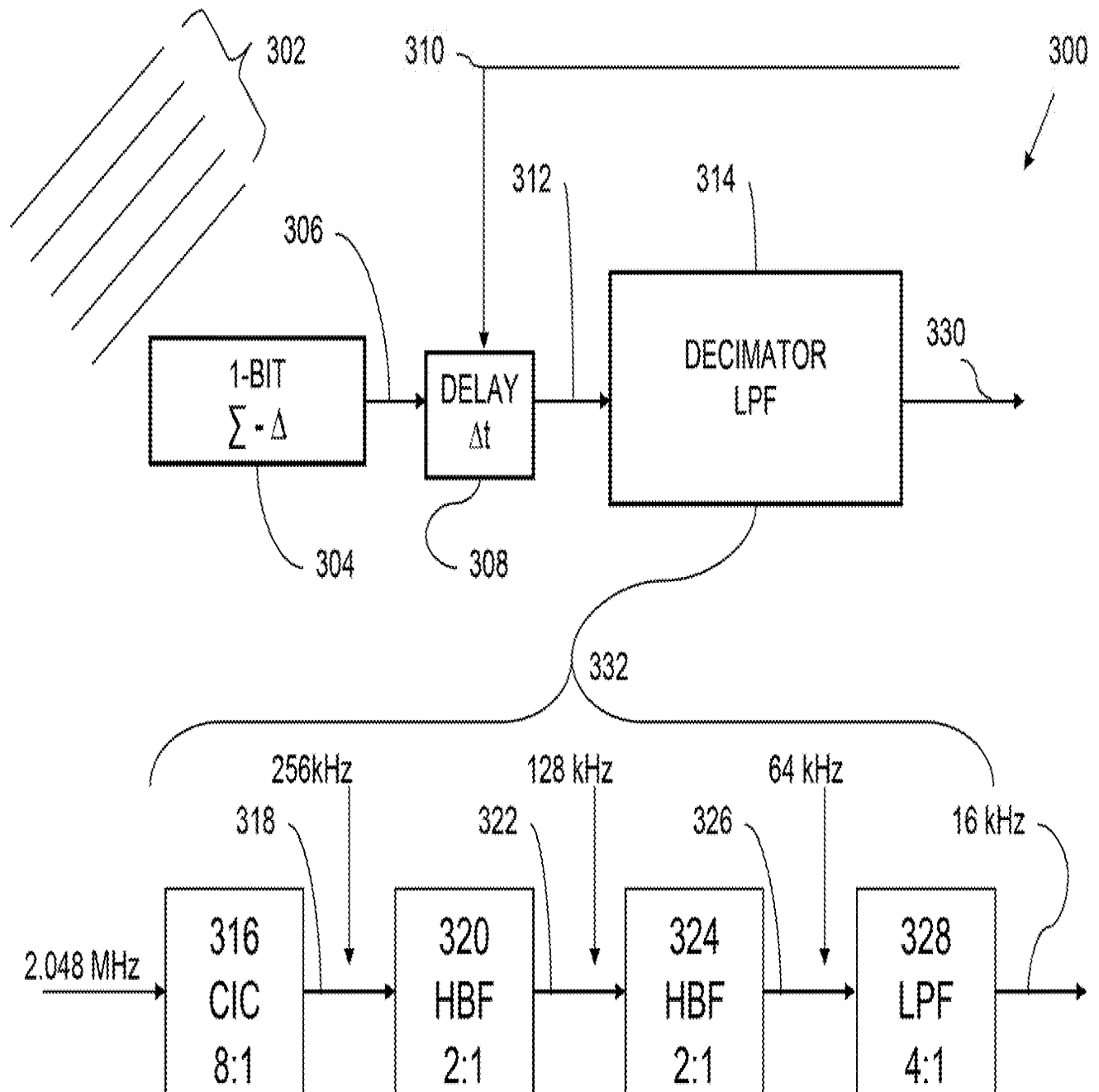


FIGURE 4

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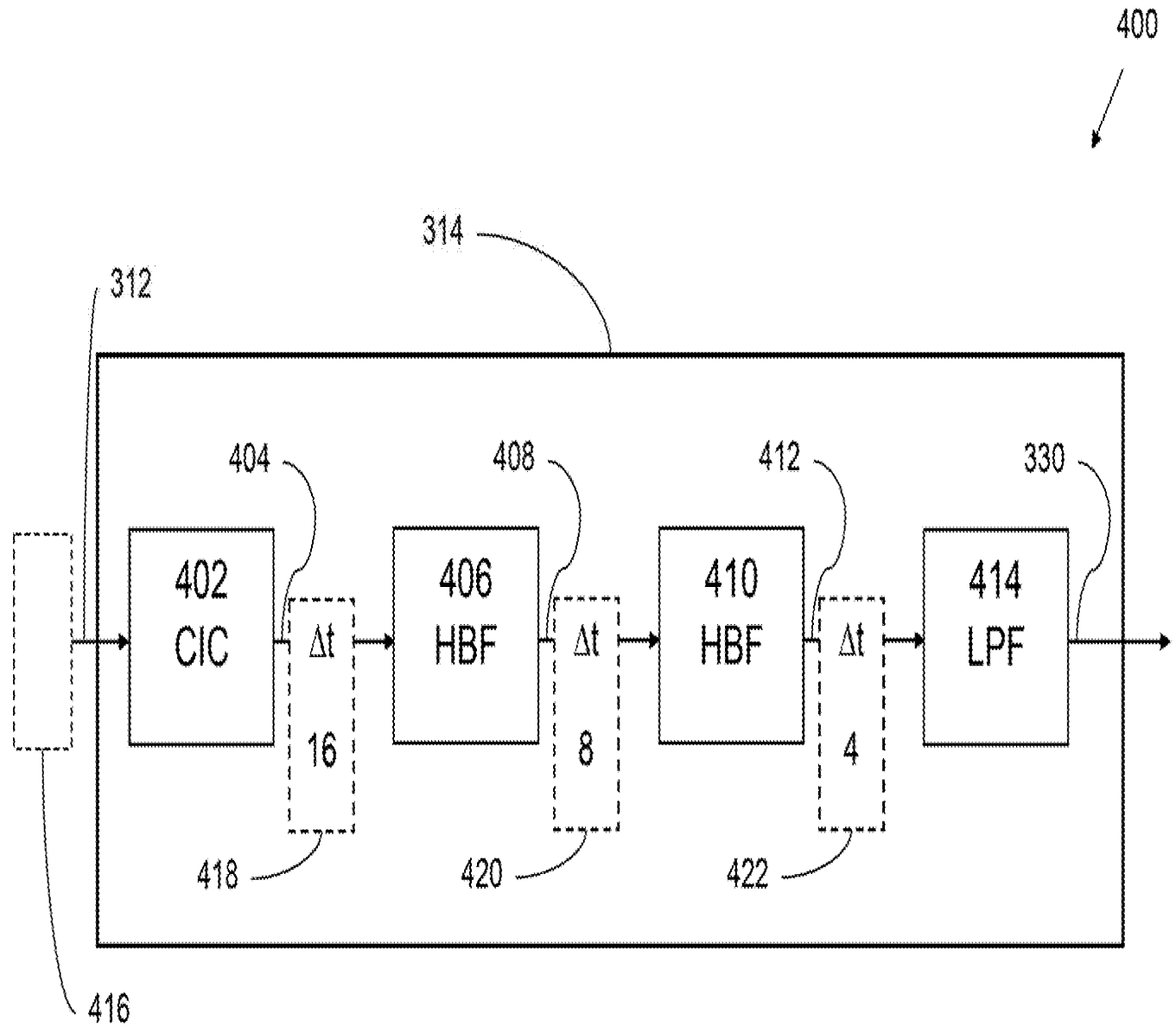


FIGURE 5

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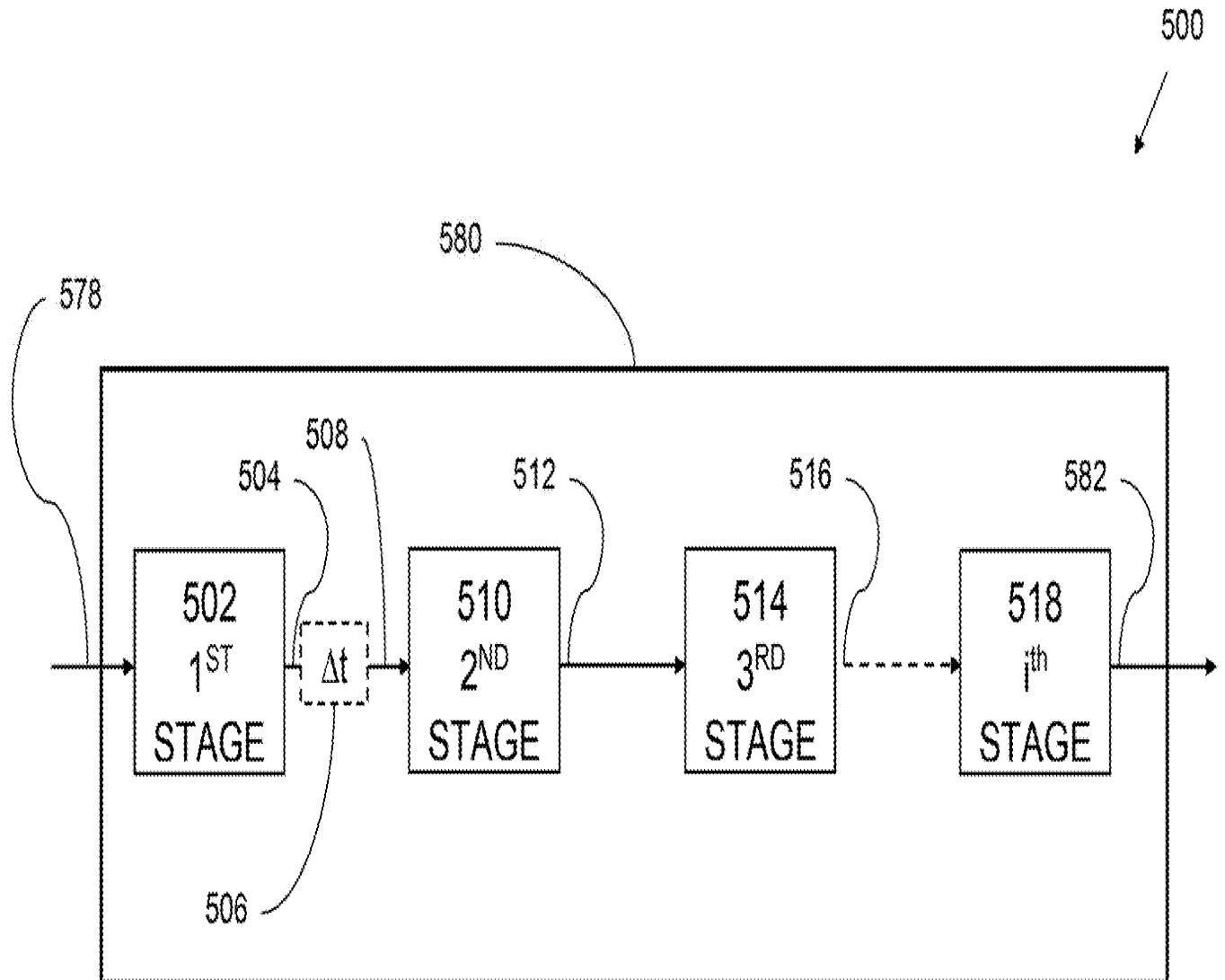


FIGURE 6

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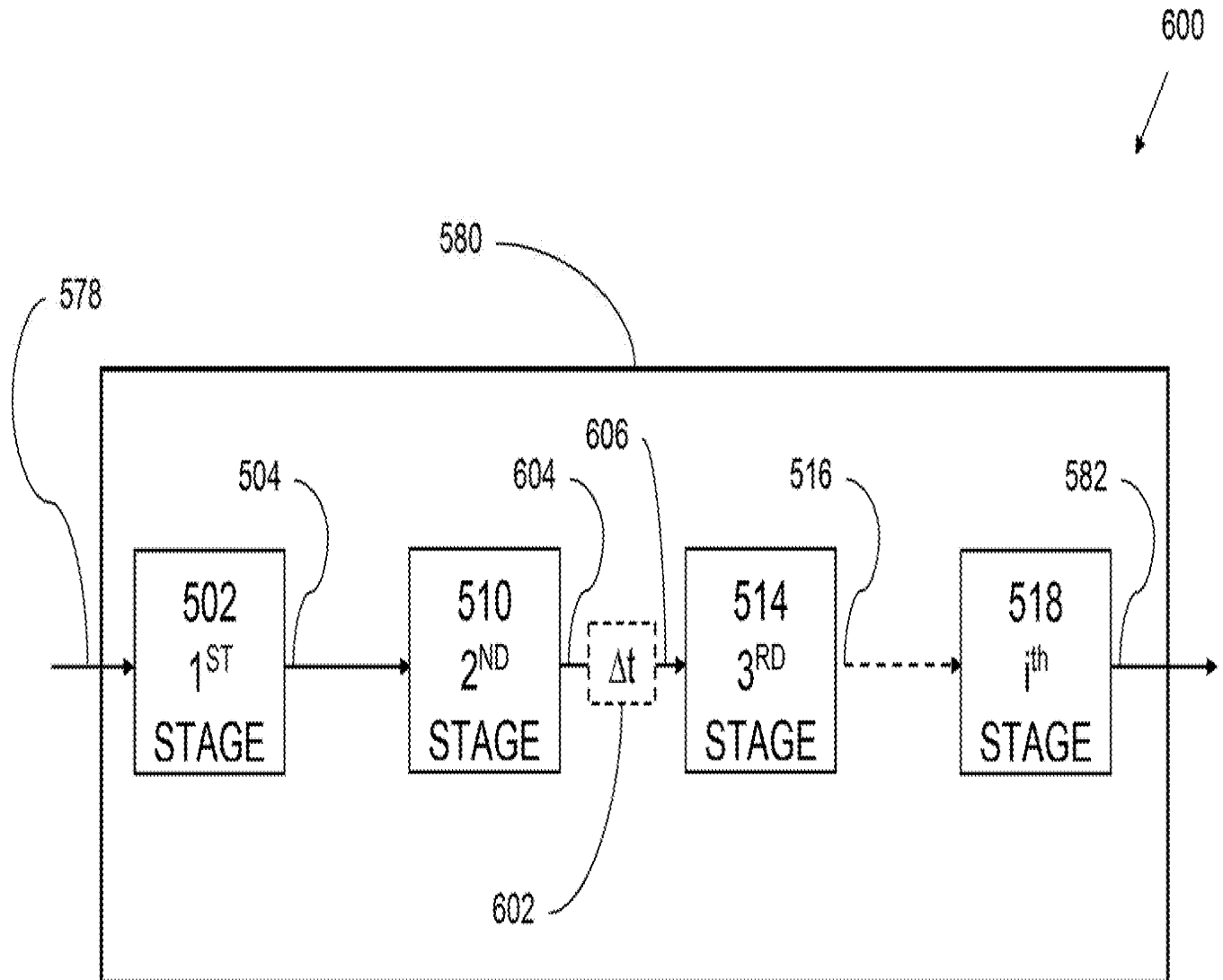


FIGURE 7

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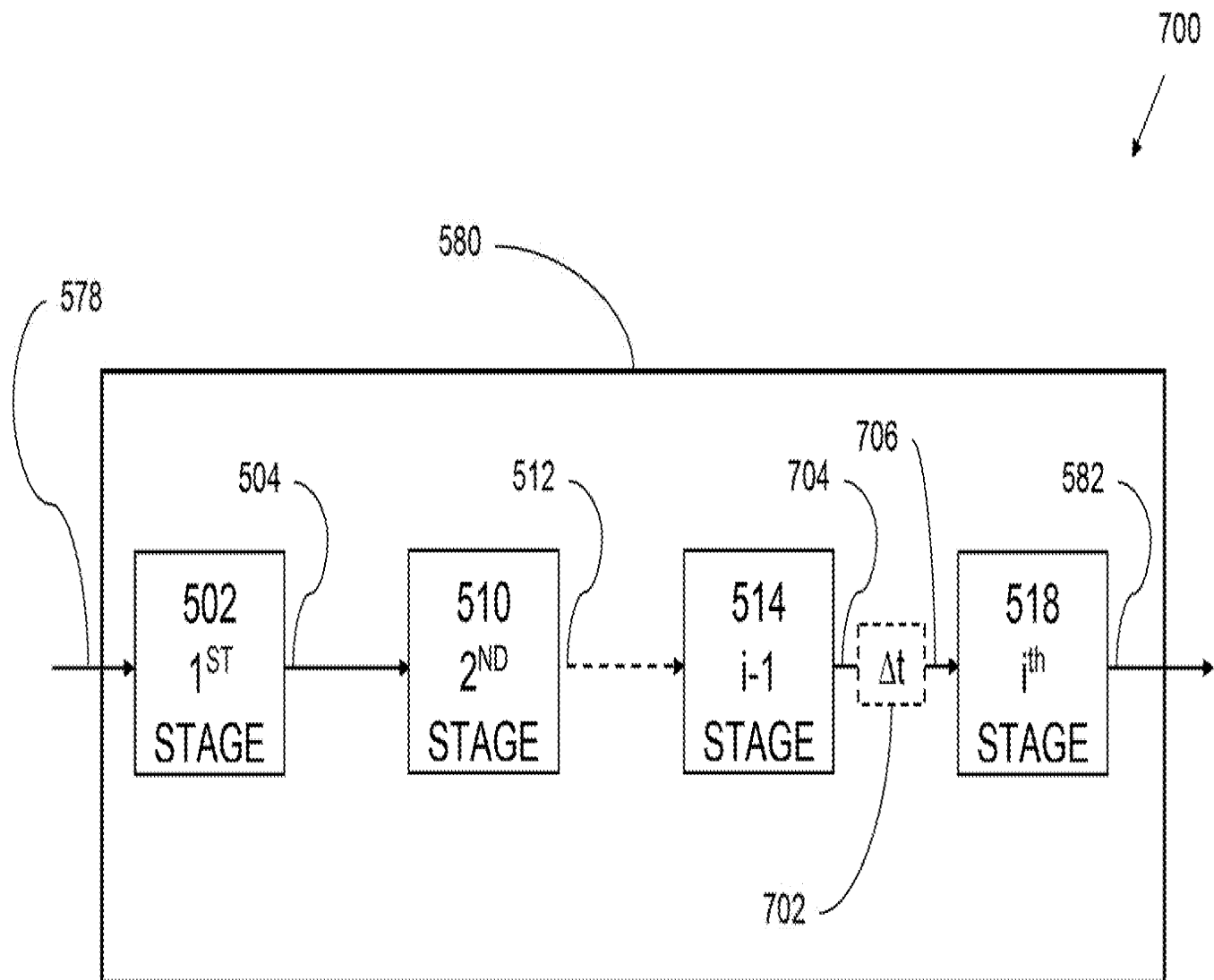


FIGURE 8

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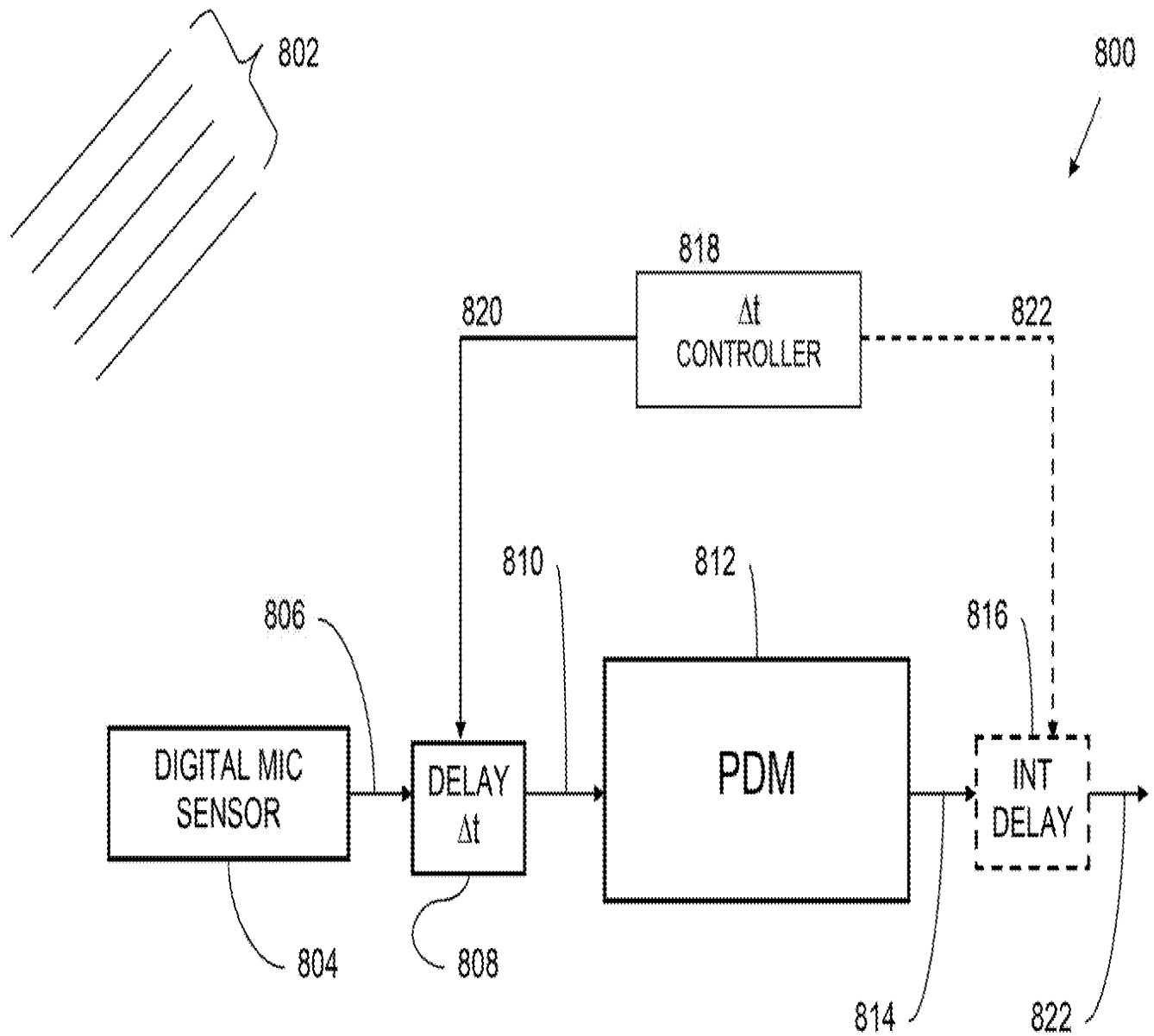


FIGURE 9A

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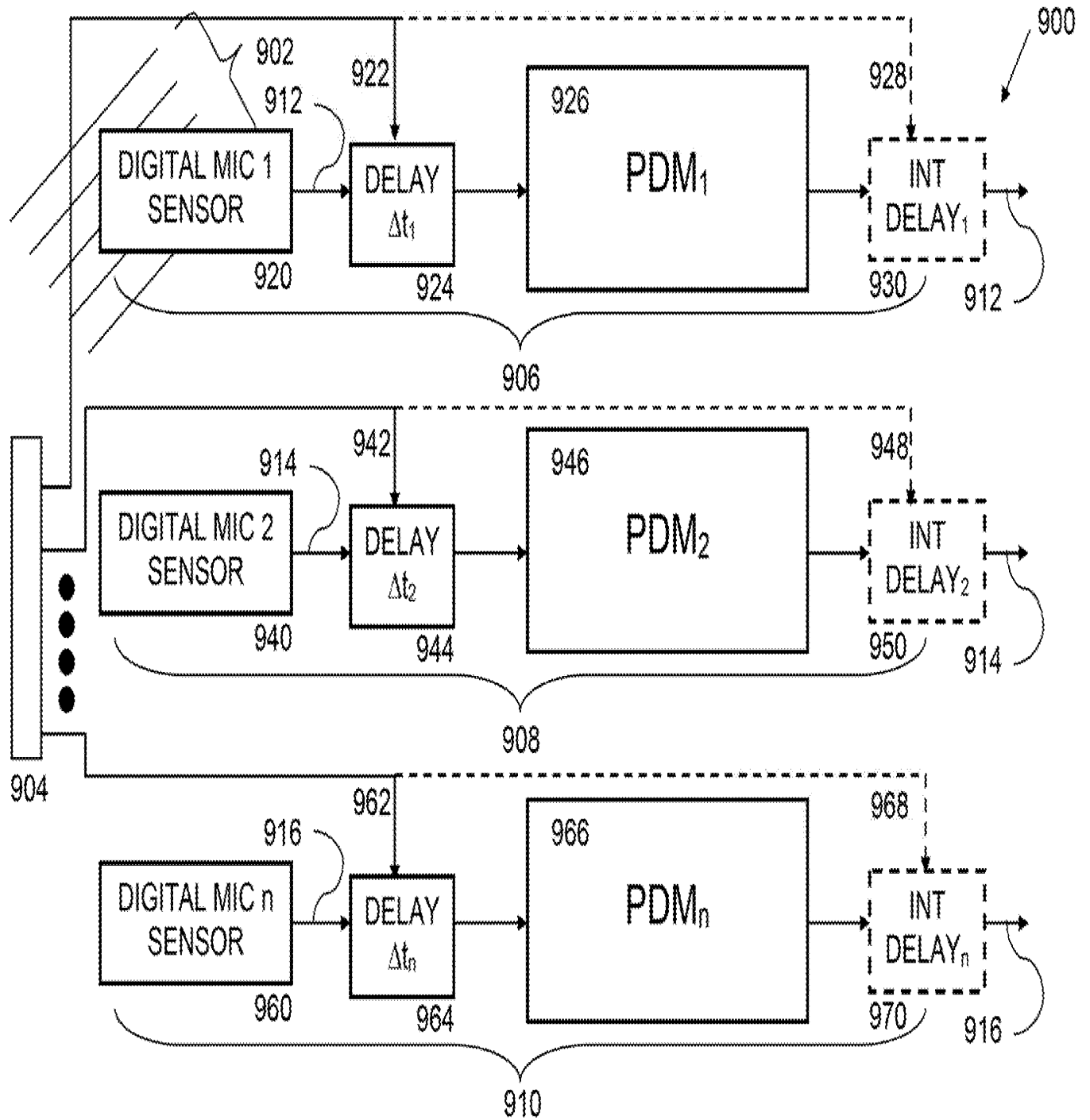


FIGURE 9B

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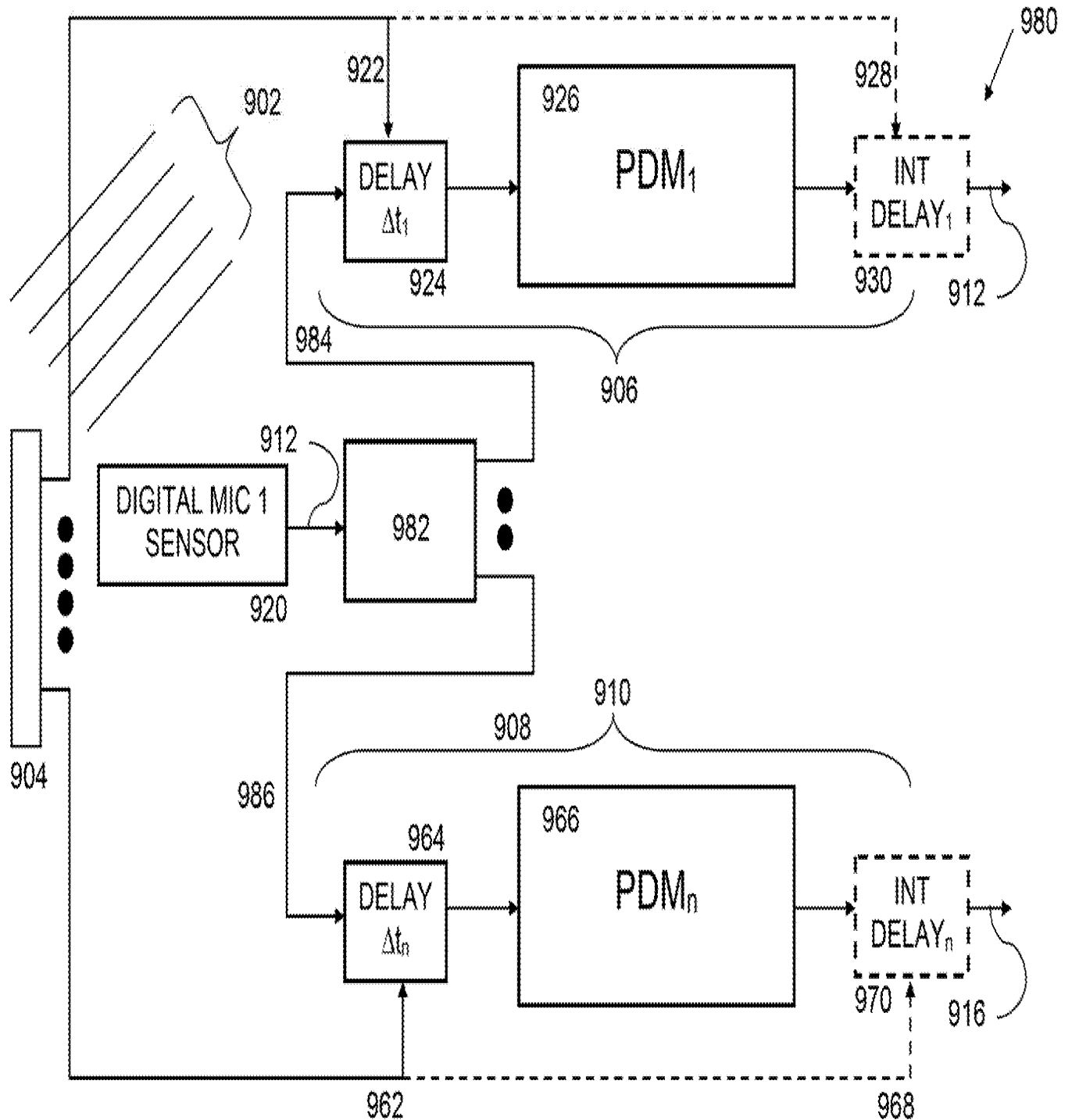


FIGURE 10

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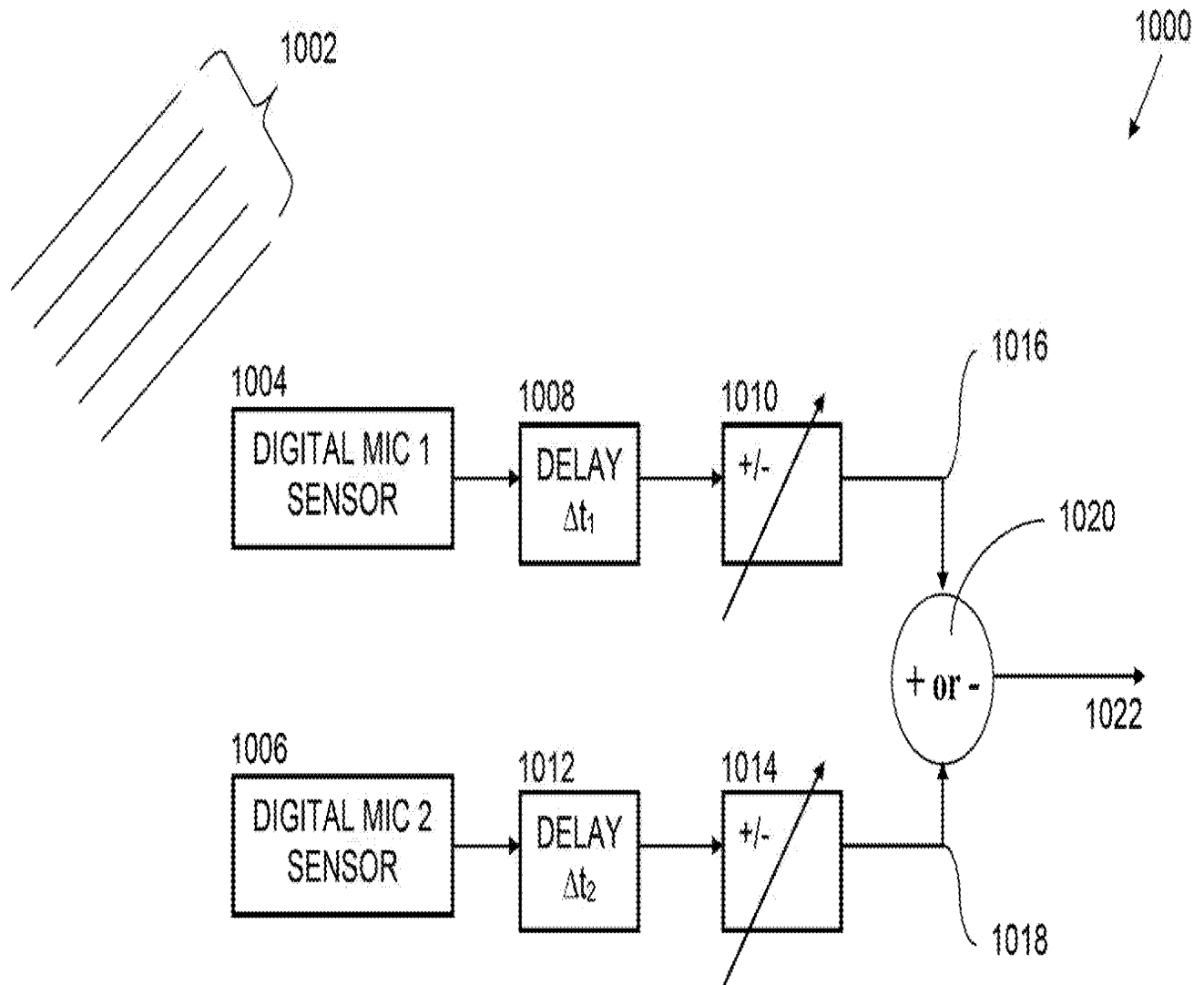


FIGURE 11A

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$$(7) \quad \Delta t = \tau = 1/f$$

$$(8) \quad \Delta t_{\text{integer delay}} = 1/f_{bb}$$

$$(9) \quad \Delta t_{\text{fractional delay}} = 1/f_{SF}$$

$$(10) \quad \frac{1}{R} = \frac{\Delta t_{\text{fractional delay}}}{\Delta t_{\text{integer delay}}}$$

$$(11) \quad \Delta t_{\text{fractional delay}} = \frac{\Delta t_{\text{integer delay}}}{R}$$

FIGURE 11B

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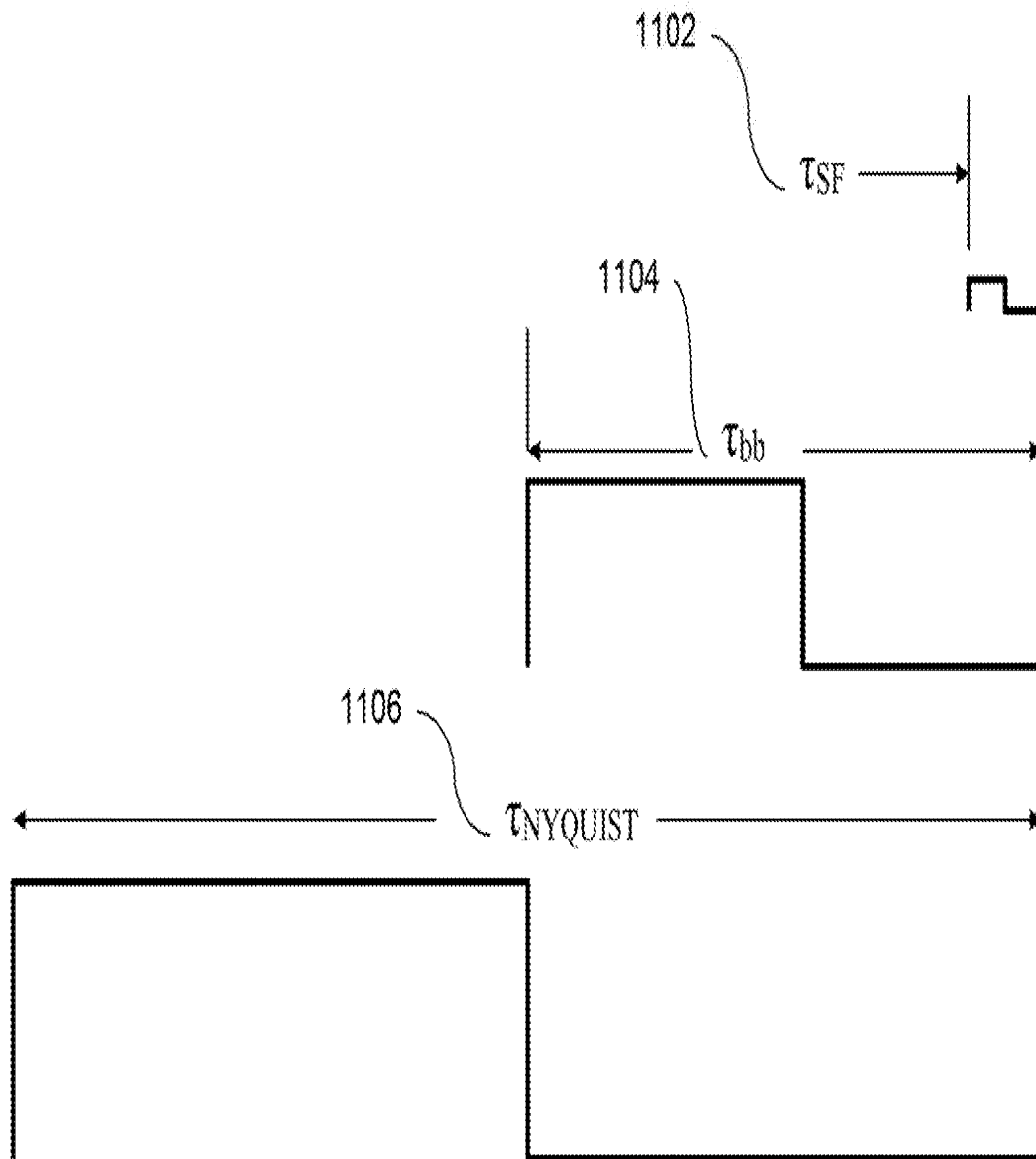


FIGURE 12

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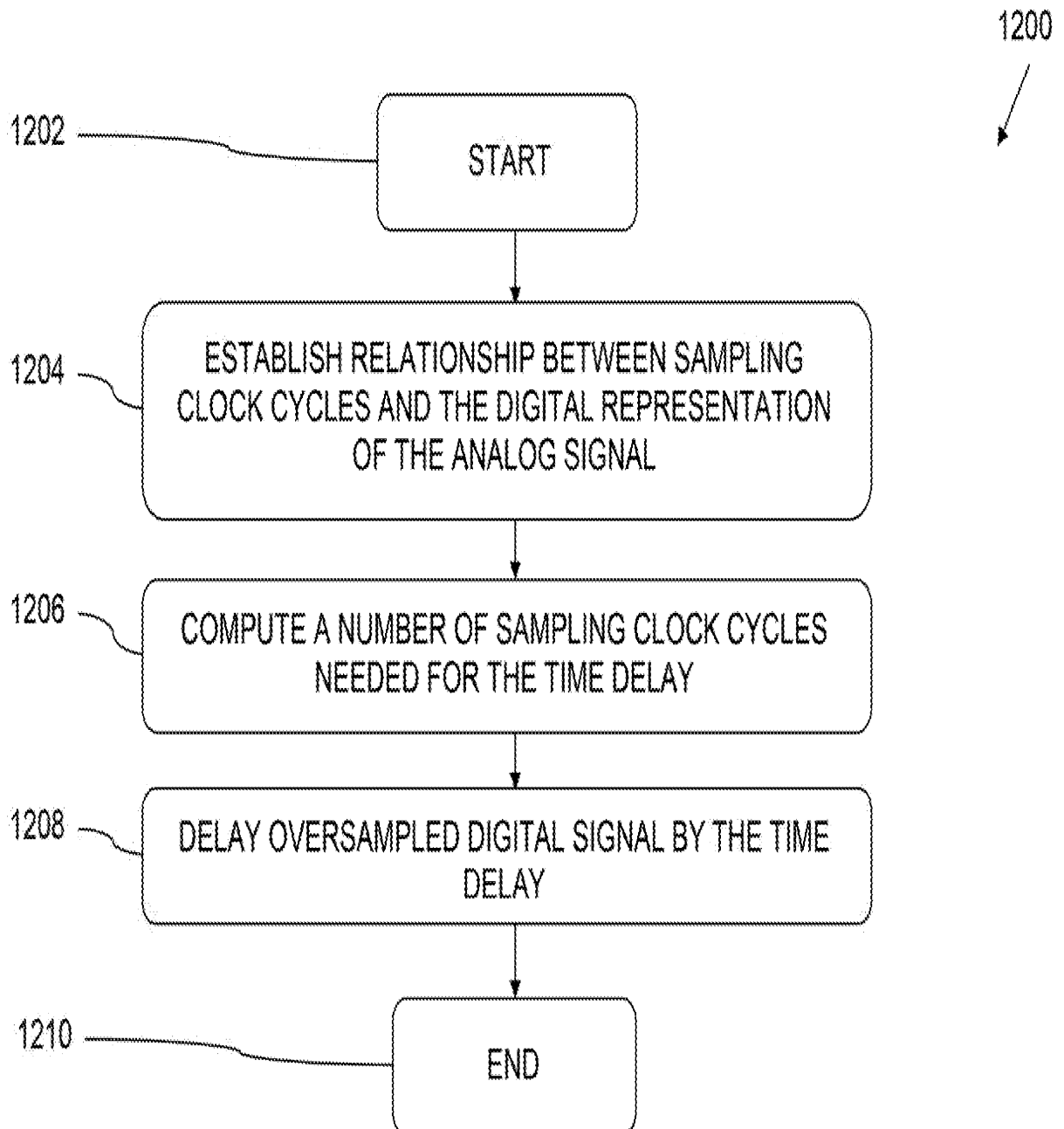


FIGURE 13

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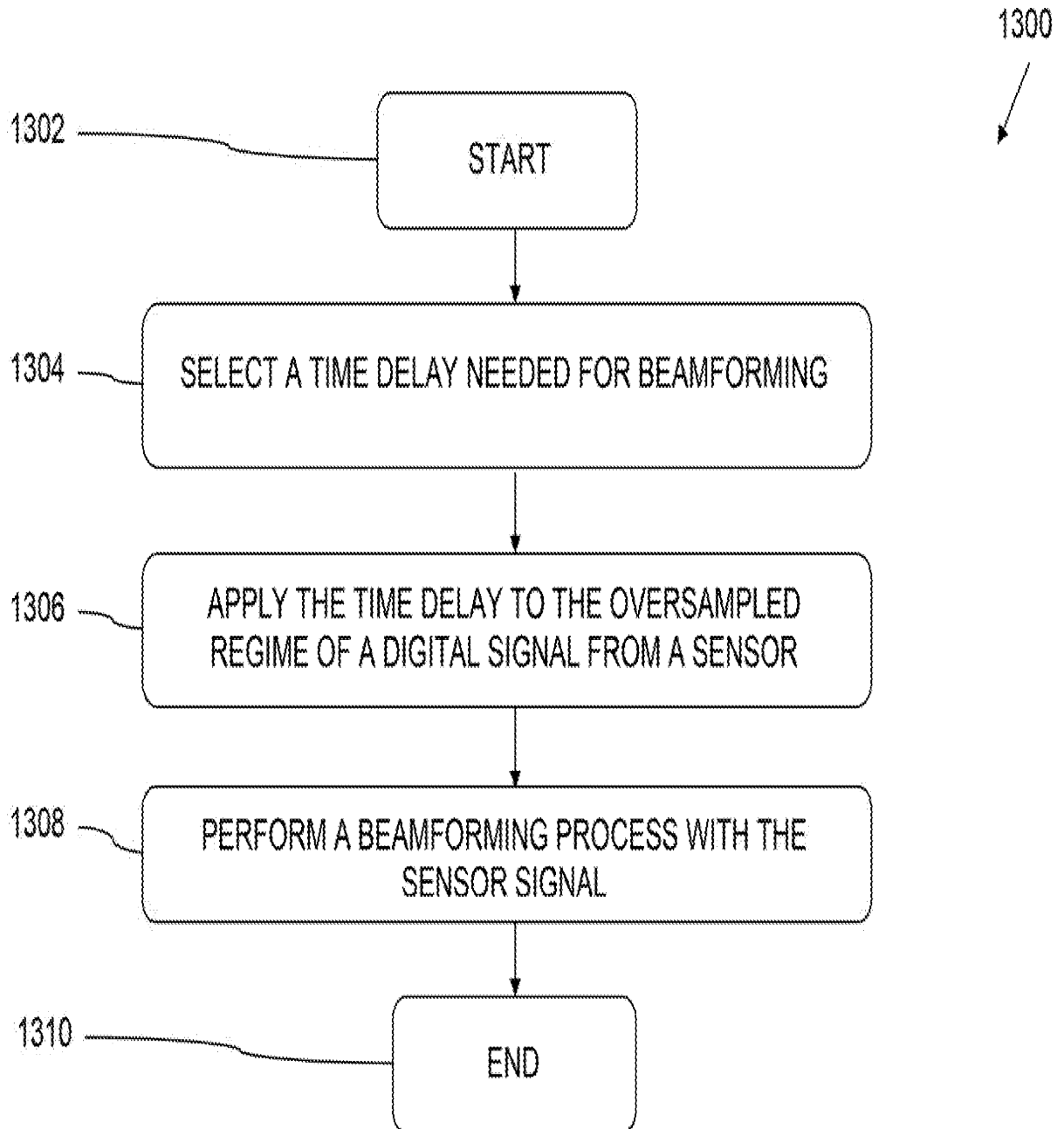


FIGURE 14

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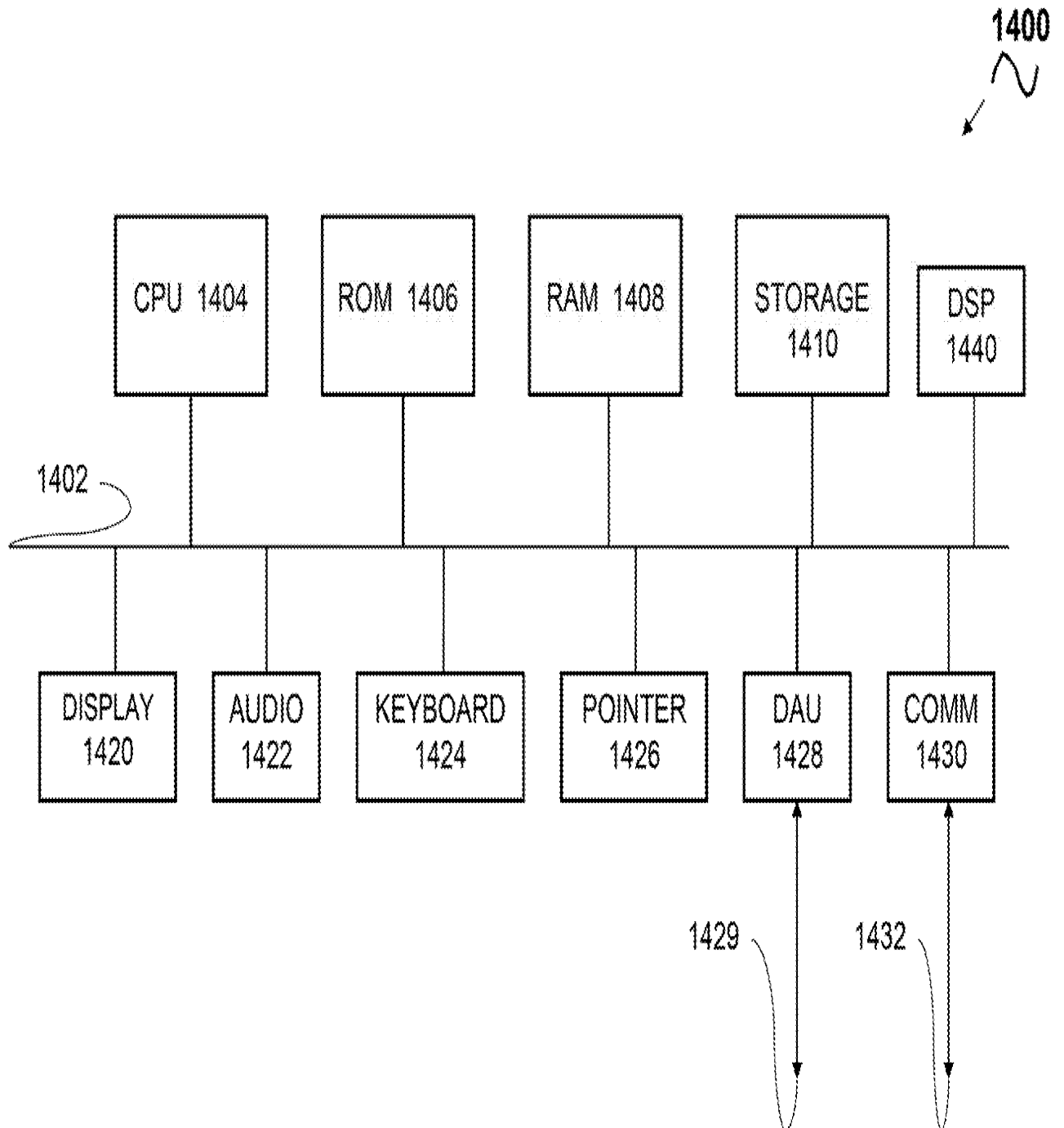


FIGURE 15A

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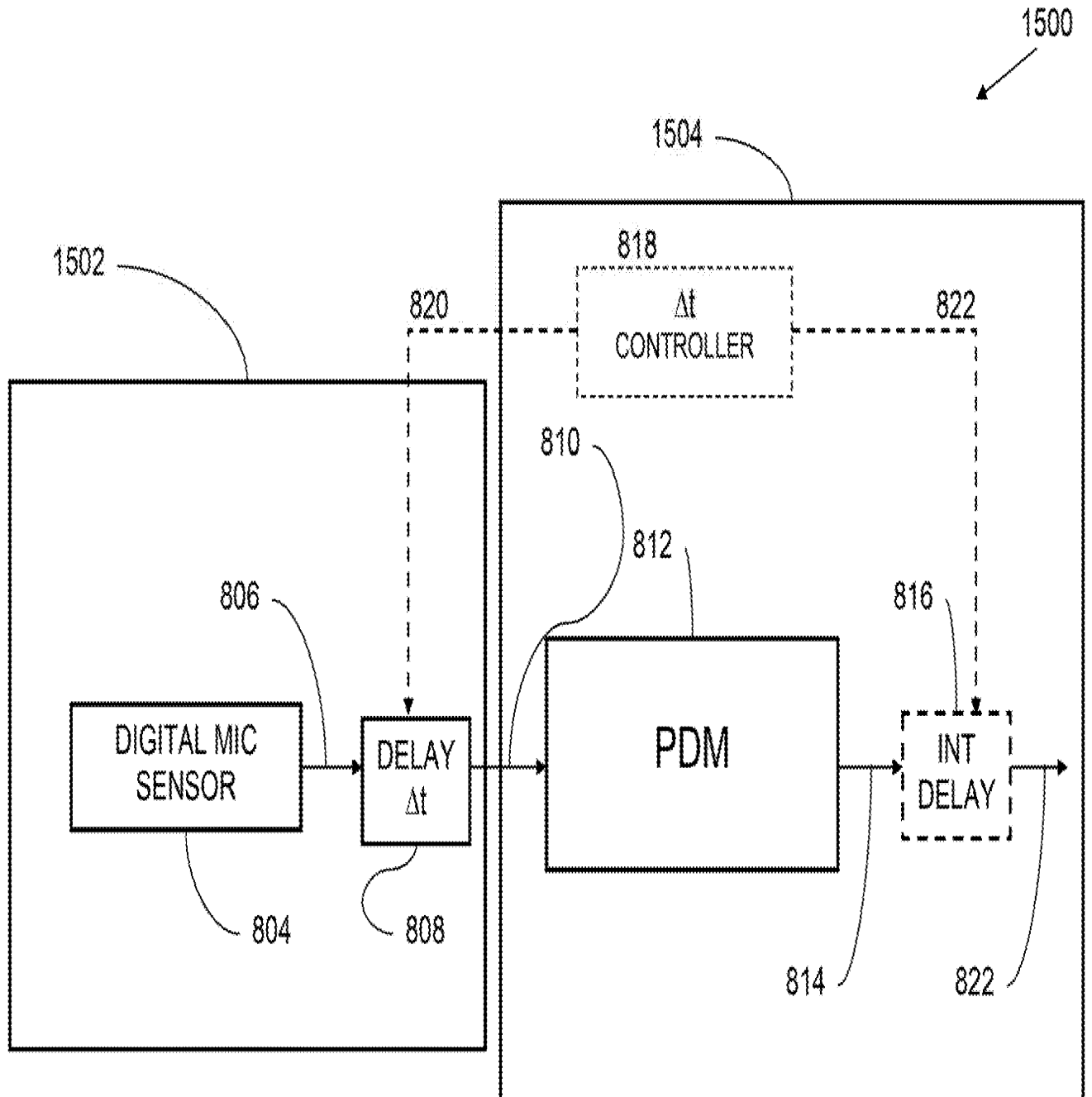
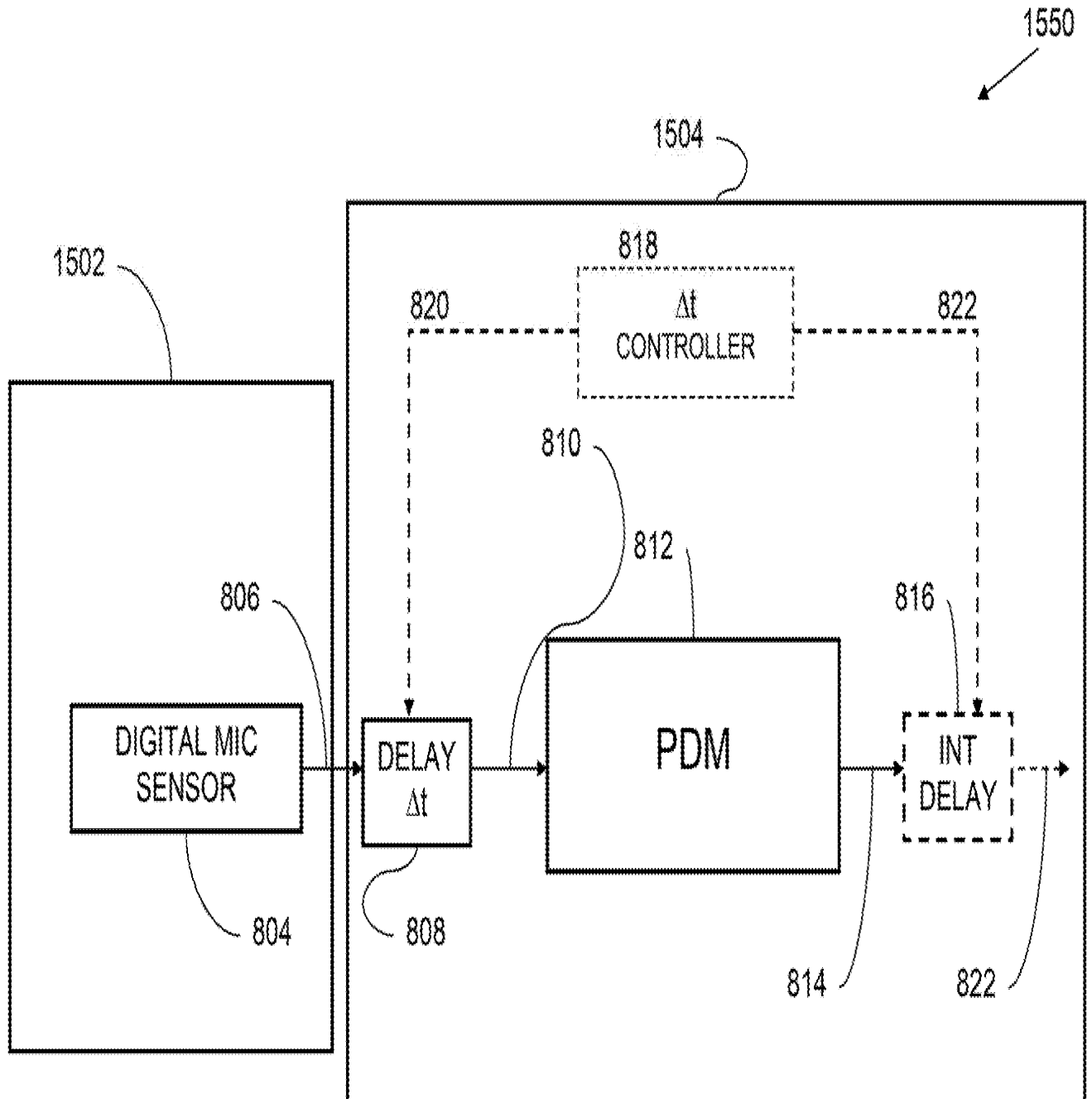


FIGURE 15B

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Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

**NONPUBLICATION REQUEST
UNDER
35 U.S.C. 122(b)(2)(B)(i)**

First Named Inventor

Dashen Fan

Title

BEAMFORMING USING FRACTIONAL TIME DELAY IN DIG

Attorney Docket Number

K41090.P8C2

I hereby certify that the invention disclosed in the attached application **has not and will not be** the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

I hereby request that the attached application not be published under 35 U.S.C. 122(b).

/MARK S PELOQUIN/

April 30, 2019

Signature

Date

MARK S PELOQUIN

50787

Typed or printed name

Registration Number, if applicable

(206) 447-1336

Telephone Number

This request must be signed in compliance with 37 CFR 1.33(b) and submitted with the application **upon filing**.

Applicant may rescind this nonpublication request at any time. If applicant rescinds a request that an application not be published under 35 U.S.C. 122(b), the application will be scheduled for publication at eighteen months from the earliest claimed filing date for which a benefit is claimed.

If applicant subsequently files an application directed to the invention disclosed in the attached application in another country, or under a multilateral international agreement, that requires publication of applications eighteen months after filing, the applicant **must** notify the United States Patent and Trademark Office of such filing within forty-five (45) days after the date of the filing of such foreign or international application. **Failure to do so will result in abandonment of this application (35 U.S.C. 122(b)(2)(B)(iii)).**

This collection of information is required by 37 CFR 1.213(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		
The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76. This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.			

Secrecy Order 37 CFR 5.2:

☐	Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)
--------------------------	---

Inventor Information:

Inventor 1					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	DASHEN		FAN			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	BELLEVUE	State/Province	WA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1		14714 SE 49th ST				
Address 2						
City	BELLEVUE	State/Province	WA			
Postal Code	98006	Country	US			
Inventor 2					Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	JOSEPH	YONG	KWON			
Residence Information (Select One) ☒ US Residency ☐ Non US Residency ☐ Active US Military Service						
City	SAN JOSE	State/Province	CA	Country of Residence	US	
Mailing Address of Inventor:						
Address 1		2789 LAVENDER TERRACE				
Address 2						
City	SAN JOSE	State/Province	CA			
Postal Code	95111	Country	US			
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.						
Add						

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).
--

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

☐ An Address is being provided for the correspondence information of this application.

Customer Number	51340		
Email Address		Add Email	Remove Email

Application Information:

Title of the Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		
Attorney Docket Number	K41090.P8C2	Small Entity Status Claimed	☒
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	20	Suggested Figure for Publication (if any)	13

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☒ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32). Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	☒ Customer Number	☐ US Patent Practitioner	☐ Limited Recognition (37 CFR 11.9)
Customer Number	51340		

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending	Remove			
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
	Continuation of	15947845	2018-04-08		
Prior Application Status	Patented	Remove			
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15947845	Continuation of	15225745	2016-08-01	9941895	2018-04-10

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button.

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)¹ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ¹	Filing Date (YYYY-MM-DD)	Remove	Access Code ¹ (if applicable)

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button.

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.

NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.			
Applicant 1			
If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.			
Clear			
☐ Assignee		☐ Legal Representative under 35 U.S.C. 117	
		☐ Joint Inventor	
☒ Person to whom the inventor is obligated to assign.		☐ Person who shows sufficient proprietary interest	
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:			
Name of the Deceased or Legally Incapacitated Inventor:			
If the Applicant is an Organization check here. ☒			
Organization Name	KOPIN CORPORATION		
Mailing Address Information For Applicant:			
Address 1	125 NORTH DRIVE		
Address 2			
City	WESTBOROUGH	State/Province	MA
Country	US	Postal Code	01581
Phone Number		Fax Number	
Email Address			
Additional Applicant Data may be generated within this form by selecting the Add button.			

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

If the Assignee or Non-Applicant Assignee is an Organization check here. ☒

Organization Name	KOPIN CORPORATION
-------------------	-------------------

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1		125 NORTH DRIVE	
Address 2			
City		WESTBOROUGH	State/Province MA
Country ⁱ	US	Postal Code	01581
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button.

Signature:

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/MARK S. PELOQUIN/		Date (YYYY-MM-DD)	2019-04-30
First Name	MARK	Last Name	PELOQUIN	Registration Number 50787

Additional Signature may be generated within this form by selecting the Add button.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	K41090.P8C2
		Application Number	
Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
UTILITY FILING FEE (ELECTRONIC FILING)	4011	1	75	75
UTILITY SEARCH FEE	2111	1	330	330
UTILITY EXAMINATION FEE	2311	1	380	380
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				785

Electronic Acknowledgement Receipt

EFS ID:	35882766
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	30-APR-2019
Filing Date:	
Time Stamp:	20:19:16
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$ 785
RAM confirmation Number	050119INTEFSW20201800
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	04K41090P8C2POWEROFATTORNEY82A82Bi.pdf	469794	no	2
			853417e6f6183f7fa51fd7dee1c4e515accfd85a		
Warnings:					
Information:					
2		0120190430K41090P8C2v20Final2SPECIFICATIONnumbersasfiledi.pdf	7346587	yes	48
			9b06f03ecc2a54b0771083f2623feb6ec4b61f68		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Abstract		48	48	
	Claims		42	47	
	Specification		1	41	
Warnings:					
Information:					
3	Drawings-other than black and white line drawings	020190430K41090P8C2FIGURES117v08FINAL2i.pdf	2205573	no	20
			2aaeb3a93632719fa1903383ce8d1117f56a6bc06		
Warnings:					
Information:					
4	Nonpublication request from applicant	0320190430K41090P8C2NPRsb0035i.pdf	220397	no	1
			51d3fb8e520ec02cda063d8660482a2bd728c2f2		
Warnings:					
Information:					
5	Application Data Sheet	0020190430K41090P8C2ADSai a0014i.pdf	1391922	no	8
			3c81e62254b9cbdf15dc32bdbb914d2466b86bf5		

Warnings:					
Information:					
This is not an USPTO supplied ADS fillable form					
6	Fee Worksheet (SB06)	fee-info.pdf	35210 191def7ba0085588dc9bf6c1b78bab69240052b	no	2
Warnings:					
Information:					
Total Files Size (in bytes):				11669483	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

SCORE Placeholder Sheet for IFW Content

Application Number: 16399867

Document Date: 04/30/2019

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2

CONFIRMATION NO. 9984

FORMALITIES LETTER



OC000000108133317

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/14/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing.

Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ 80 surcharge.
- \$(0) previous unapplied payment amount.
- \$ 80 TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):

page 1 of 2

Dashen Fan
Joseph Yong Kwon

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at
(571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/ngfissha/



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
16/399,867	04/30/2019	2845	785	K41090.P8C2	20	3

CONFIRMATION NO. 9984

FILING RECEIPT



0000000108133316

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/14/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Dashen Fan, Bellevue, WA;
Joseph Yong Kwon, San Jose, CA;

Applicant(s)

Kopin Corporation, Westborough, MA

Assignment For Published Patent Application

Kopin Corporation, Westborough, MA

Power of Attorney: The patent practitioners associated with Customer Number 51340

Domestic Priority data as claimed by applicant

This application is a CON of 15/947,845 04/08/2018 PAT 10298253
which is a CON of 15/225,745 08/01/2016 PAT 9941895

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 05/13/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/399,867**

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

Early Publication Request: No

**** SMALL ENTITY ****

Title

BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS

Preliminary Class

341

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop

technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/399,867	
APPLICATION AS FILED - PART I							
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
			TOTAL	785		TOTAL	
* If the difference in column 1 is less than zero, enter "0" in column 2.							
APPLICATION AS AMENDED - PART II							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =
	Application Size Fee (37 CFR 1.16(s))					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR	
				TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =
	Application Size Fee (37 CFR 1.16(s))					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR	
				TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.							



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	K41090.PSC2

CONFIRMATION NO. 9984

FORMALITIES LETTER



0000000108133317

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/14/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing.

Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ 80 surcharge.
- \$(0) previous unapplied payment amount.
- \$ 80 TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):

page 1 of 2

Dashen Fan
Joseph Yong Kwon

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebs>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/ngfissba/

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA/82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/399,867
Filing Date	APRIL 30, 2019
First Named Inventor	DASHEN FAN
Title	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
Art Unit	Not yet assigned
Examiner Name	Not yet assigned
Attorney Docket Number	K41090.P8C2

SIGNATURE of Applicant or Patent Practitioner

Signature	/MARK S. PELOQUIN/	Date (Optional)	May 30, 2019
Name	MARK S. PELOQUIN	Registration Number	50,787
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.



*Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Attorney Docket Number K41090.P8C2

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date
16/399,867	APRIL 30, 2019

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

51340

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name

PELOQUIN, PLLC

Address

800 FIFTH AVE, SUITE 4100

City

SEATTLE

State

WA

Zip

98104

Country

US

Telephone

(206) 447-1336

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

KOPIN CORPORATION

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a partition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

H. K. Choi

Date (Optional)

Name

HONG CHOI

Title

CHIEF TECHNOLOGY OFFICER

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.53. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☒ Total of 1 forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1480, Alexandria, VA 22313-1480. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1480, Alexandria, VA 22313-1480.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	16399867			
Filing Date:	30-Apr-2019			
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	2051	1	80	80
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				80

Electronic Acknowledgement Receipt

EFS ID:	36161280
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	30-MAY-2019
Filing Date:	30-APR-2019
Time Stamp:	18:31:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$80
RAM confirmation Number	053119INTEFSW18320100
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	20190514K41090P8C2NTFMPi.pdf	292877	no	2
			f59b1534ff02beaacc7f7a68db0fae7bccf292ff		
Warnings:					
Information:					
2	Power of Attorney	K41090P8C2POWEROFATTORNEY82A82Bexecutedii.pdf	566124	no	2
			2a938d1c4cd8aea444e746e778a5ce40bd2a2677		
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	30736	no	2
			955fc2d6f510e22e8d1d2e1c1146295322517a2b		
Warnings:					
Information:					
Total Files Size (in bytes):			889737		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
 Stylesheet Version v1.2

EPAS ID: PAT5548389

SUBMISSION TYPE:	NEW ASSIGNMENT	
NATURE OF CONVEYANCE:	ASSIGNMENT	
CONVEYING PARTY DATA		
	Name	Execution Date
	JOSEPH YONG KWON	05/07/2019
RECEIVING PARTY DATA		
Name:	KOPIN CORPORATION	
Street Address:	125 NORTH DRIVE	
City:	WESTBOROUGH	
State/Country:	MASSACHUSETTS	
Postal Code:	01581	
PROPERTY NUMBERS Total: 1		
	Property Type	Number
	Application Number:	16399867
CORRESPONDENCE DATA		
Fax Number:	(206)770-6562	
<i>Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.</i>		
Phone:	206-447-1336	
Email:	mark@peloquinlaw.com	
Correspondent Name:	PELOQUIN, PLLC	
Address Line 1:	800 FIFTH AVENUE	
Address Line 2:	SUITE 4100	
Address Line 4:	SEATTLE, WASHINGTON 98104-3100	
ATTORNEY DOCKET NUMBER:	K41090.P8C2	
NAME OF SUBMITTER:	MARK S PELOQUIN	
SIGNATURE:	/MARK S. PELOQUIN/	
DATE SIGNED:	05/30/2019	
	This document serves as an Oath/Declaration (37 CFR 1.63).	
Total Attachments: 2		
source=K41090.P8C2 - AF Assignment JKWON-executed#page1.tif		
source=K41090.P8C2 - AF Assignment JKWON-executed#page2.tif		

Attorney's Docket No.: K41090.P8C2 ASSIGNMENT (For Execution After Filing Patent Application)

In consideration of good and valuable consideration, the receipt of which is hereby acknowledged, we the undersigned, Joseph Yong Kwon, hereby sell, assign, and transfer to Kopin Corporation, a Corporation of DE, having a principal place of business 125 North Drive, Westborough, MA 01581, ("Assignee"), and its successors, assigns, and legal representatives, the entire right, title, and interest for the United States and all foreign countries, in and to any and all improvements that are disclosed in the application for the United States patent that was filed April 30, 2019 and assigned Application No. 16/399,867 and is entitled

**BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY
OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS**

and in and to said application and all divisional applications, continuation applications, continued prosecution applications, continuation-in-part applications, substitute applications, renewal applications, reissue applications, reexaminations, extensions, and all other patent applications that have been or shall be filed in the United States and all foreign countries on any of said improvements; and in and to all original patents, reissued patents, reexamination certificates, and extensions, that have been or shall be issued in the United States and all foreign countries on said improvements; and in and to all rights of priority resulting from the filing of said United States application;

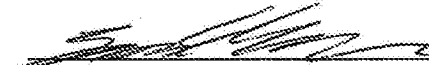
agree that said Assignee may apply for and receive a patent or patents for said improvements in its own name; and that, when requested, without charge to, but at the expense of, said Assignee, its successors, assigns, and legal representatives, to carry out in good faith the intent and purpose of this Assignment, the undersigned will execute all divisional applications, continuation applications, continued prosecution applications, continuation-in-part applications, substitute applications, renewal applications, reissue applications, reexaminations, extensions and all other patent applications on any and all said improvements; execute all rightful oaths, assignments, powers of attorney, and other papers; communicate to said Assignee, its successors, assigns, and representatives all facts known to the undersigned relating to said improvements and the history thereof; and generally assist said Assignee, its successors, assigns, or representatives in securing and maintaining proper patent protection for said improvements and for vesting title to said improvements, and all applications for patents and all patents on said improvements, in said Assignee, its successors, assigns, and legal representatives; and

covenant with said Assignee, its successors, assigns, and legal representatives that no assignment, grant, mortgage, license, or other agreement affecting the rights and property herein conveyed has been made to others by the undersigned, and that full right to convey the same as herein expressed is possessed by the undersigned.

ASSIGNMENT

PATENT

Each Inventor: Please Sign and Date Below:

MAY 7, 2019 

Date Name: Joseph Yong Kwon

Each Inventor: Please also list the date that you signed the accompanying DECLARATION:

_____, 20____

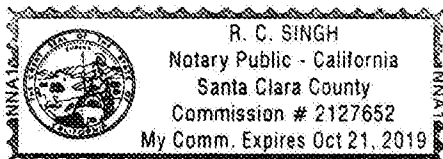
Date

State of: _____ }
County of: _____ }

Assignment Document Return Address:
SS. PELOQUIN, PLLC
800 Fifth Avenue, Suite 4100
Seattle, WA 98104-3100
(206) 447.1336

On this _____ day of _____, 20____, before me, _____, the undersigned Notary Public, personally appeared _____
[] personally known to me [] proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) _____ subscribed to the within instrument, and acknowledged that _____ executed it.
WITNESS my hand and official seal.

Notary's Signature



A notary public or other officer completing this certificate verifies only the identity of the individual who signed the document to which this certificate is attached, and not the truthfulness, accuracy, or validity of that document.

State of California, County of Santa Clara ss. On 05/07/2019 before me R.C. Singh, Notary Public, personally appeared JOSEPH YONG KWON who proved to me on the basis of satisfactory evidence to be the person(s) whose name(s) is/are subscribed to the within instrument and acknowledged to me that he/she/they executed the same in his/her/their authorized capacity(ies), and that by his/her/their signature(s) on the instrument the person(s), or the entity upon behalf of which the person(s) acted, executed the instrument. I certify, under PENALTY OF PERJURY under the laws of the State of California that the foregoing paragraph is true and correct. WITNESS my hand and official seal.





UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2

CONFIRMATION NO. 9984

POA ACCEPTANCE LETTER



OC000000108597232

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/31/2019

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 05/30/2019.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/zabaha/



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
16/399,867	04/30/2019	2845	865	K41090.P8C2	20	3

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

CONFIRMATION NO. 9984
UPDATED FILING RECEIPT



Date Mailed: 05/31/2019

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Dashen Fan, Bellevue, WA;
Joseph Yong Kwon, San Jose, CA;

Applicant(s)

Kopin Corporation, Westborough, MA

Assignment For Published Patent Application

Kopin Corporation, Westborough, MA

Power of Attorney: The patent practitioners associated with Customer Number 51340

Domestic Priority data as claimed by applicant

This application is a CON of 15/947,845 04/08/2018 PAT 10298253
which is a CON of 15/225,745 08/01/2016 PAT 9941895

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see <http://www.uspto.gov> for more information.) - None.

Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 05/13/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 16/399,867**

Projected Publication Date: Request for Non-Publication Acknowledged

Non-Publication Request: Yes

Early Publication Request: No

**** SMALL ENTITY ****

Title

BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS

Preliminary Class

341

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific

countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER
Title 35, United States Code, Section 184
Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

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UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2

CONFIRMATION NO. 9984

INFORMAL NOTICE



51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/31/2019

INFORMATIONAL NOTICE TO APPLICANT

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

The item(s) indicated below are also required and should be submitted with any reply to this notice to avoid further processing delays.

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):
Dashen Fan
Joseph Yong Kwon

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/zabaha/

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875						Application or Docket Number 16/399,867	
APPLICATION AS FILED - PART I							
(Column 1)		(Column 2)		SMALL ENTITY		OTHER THAN SMALL ENTITY	
FOR	NUMBER FILED	NUMBER EXTRA	RATE(\$)	FEE(\$)		RATE(\$)	FEE(\$)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A	75		N/A	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A	330		N/A	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A	380		N/A	
TOTAL CLAIMS (37 CFR 1.16(j))	20	minus 20 = *	x 50 =	0.00	OR		
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	minus 3 = *	x 230 =	0.00			
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$310 (\$155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).			0.00			
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))				0.00			
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL	785		TOTAL	
APPLICATION AS AMENDED - PART II							
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =
	Application Size Fee (37 CFR 1.16(s))					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR	
			TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE(\$)	ADDITIONAL FEE(\$)		RATE(\$)
	Total (37 CFR 1.16(i))	*	Minus **	=	x =	OR	x =
	Independent (37 CFR 1.16(h))	*	Minus ***	=	x =	OR	x =
	Application Size Fee (37 CFR 1.16(s))					OR	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					OR	
			TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest found in the appropriate box in column 1.							



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www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2

CONFIRMATION NO. 9984

FORMALITIES LETTER



000000010813317

51340
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Date Mailed: 05/14/2019

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing.

Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items below to avoid abandonment. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

- Surcharge as set forth in 37 CFR 1.16(f) must be submitted.

The surcharge is due for any one of:

- late submission of the basic filing fee, search fee, or examination fee,
- late submission of inventor's oath or declaration,
- filing an application that does not contain at least one claim on filing, or
- submission of an application filed by reference to a previously filed application.

SUMMARY OF FEES DUE:

The fee(s) required within **TWO MONTHS** from the date of this Notice to avoid abandonment is/are itemized below. Small entity discount is in effect. If applicant is qualified for micro entity status, an acceptable Certification of Micro Entity Status must be submitted to establish micro entity status. (See 37 CFR 1.29 and forms PTO/SB/15A and 15B.)

- \$ 80 surcharge.
- \$(0) previous unapplied payment amount.
- \$ 80 TOTAL FEE BALANCE DUE.

Items Required To Avoid Processing Delays:

Applicant is notified that the above-identified application contains the deficiencies noted below. No period for reply is set forth in this notice for correction of these deficiencies. However, if a deficiency relates to the inventor's oath or declaration, the applicant must file an oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each actual inventor no later than the expiration of the time period set in the "Notice of Allowability" to avoid abandonment. See 37 CFR 1.53(f).

- A properly executed inventor's oath or declaration has not been received for the following inventor(s):

page 1 of 2

Dashen Fan
Joseph Yong Kwon

Replies must be received in the USPTO within the set time period or must include a proper Certificate of Mailing or Transmission under 37 CFR 1.8 with a mailing or transmission date within the set time period. For more information and a suggested format, see Form PTO/SB/92 and MPEP 512.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web, including a copy of this Notice and selecting the document description "Applicant response to Pre-Exam Formalities Notice".
<https://portal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html>

For more information about EFS-Web please call the USPTO Electronic Business Center at 1-866-217-9197 or visit our website at <http://www.uspto.gov/ebc>.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/ngfissba/

Electronic Patent Application Fee Transmittal

Application Number:	16399867			
Filing Date:	30-Apr-2019			
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
LATE FILING FEE FOR OATH OR DECLARATION	2051	1	80	80
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				80

Electronic Acknowledgement Receipt

EFS ID:	36579178
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	15-JUL-2019
Filing Date:	30-APR-2019
Time Stamp:	11:27:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$80
RAM confirmation Number	071519INTEFSW11273100
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	0020190715K41090P8C2RNTF MPi.pdf	295189	no	2
			3ee2d2c181a54831f7fd8ce2a54adbdea7 b77c3		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30737	no	2
			e39db85bb8b974290495186a2f5665e78fa cafc0		
Warnings:					
Information:					
Total Files Size (in bytes):			325926		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

PLUS Search Results for S/N 16399867, Searched Mon Dec 09 10:10:30 EST 2019

The Patent Linguistics Utility System (PLUS) is a USPTO automated search system for U.S. Patents from 1971 to the present PLUS is a query-by-example search system which produces a list of patents that are most closely related linguistically to the application searched. This search was prepared by the staff of the Scientific and Technical Information Center, SIRA.

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5917809 99	

PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
 Stylesheet Version v1.2

EPAS ID: PAT5867611

SUBMISSION TYPE:	NEW ASSIGNMENT	
NATURE OF CONVEYANCE:	ASSIGNMENT	
CONVEYING PARTY DATA		
Name		Execution Date
KOPIN CORPORATION		11/22/2019
RECEIVING PARTY DATA		
Name:	SOLOS TECHNOLOGY LIMITED	
Street Address:	UNIT 211, 2/F., PHOTONICS CENTER, NO. 2 SCIENCE PARK EAST AVENUE	
Internal Address:	HONG KONG SCIENCE PARK, SHATIN, N.T.	
City:	HONG KONG	
State/Country:	HONG KONG	
PROPERTY NUMBERS Total: 22		
Property Type	Number	
Patent Number:	7386135	
Patent Number:	8885850	
Patent Number:	9456275	
Patent Number:	9491544	
Patent Number:	9406293	
Patent Number:	9633670	
Patent Number:	9257952	
Patent Number:	9792927	
Patent Number:	9312826	
Patent Number:	10306389	
Patent Number:	9941895	
Patent Number:	10298253	
Patent Number:	10339952	
Application Number:	14886054	
Application Number:	14886080	
Application Number:	16399867	
Application Number:	16171254	
Application Number:	16171266	
Application Number:	16420082	
Application Number:	62873889	

Property Type	Number
PCT Number:	US2018057869
PCT Number:	US2018057879

CORRESPONDENCE DATA

Fax Number: (206)770-6562

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 206-251-1699

Email: mark@peloquinlaw.com

Correspondent Name: PELOQUIN, PLLC

Address Line 1: 800 FIFTH AVENUE, SUITE 4100

Address Line 4: SEATTLE, WASHINGTON 98104

ATTORNEY DOCKET NUMBER:	KSTL20191112
NAME OF SUBMITTER:	MARK S. PELOQUIN
SIGNATURE:	/MARK S. PELOQUIN/
DATE SIGNED:	12/13/2019
	This document serves as an Oath/Declaration (37 CFR 1.63).

Total Attachments: 4

source=Solos Patent Assignment-executed#page1.tif

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source=Solos Patent Assignment-executed#page3.tif

source=Solos Patent Assignment-executed#page4.tif

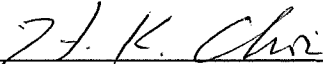
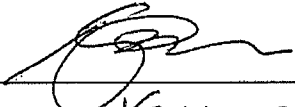
ASSIGNMENT OF UNITED STATES PATENTS, UNITED STATES PATENT APPLICATIONS, AND INTERNATIONAL (PCT) & FOREIGN PATENT APPLICATIONS

Whereas, **Kopin Corporation**, a Delaware corporation, having a place of business at 125 North Drive, Westborough, Massachusetts 01581 (hereinafter "Assignor") is the sole owner of the entire right, title and interest in and to the United States Patents, United States Patent Applications, and International (PCT) and Foreign Patent Applications all of which are described in the **IP Schedule** attached hereto and made a part hereof (hereinafter "Patents"); and

Whereas, **Solos Technology Limited**, a Hong Kong corporation, having a place of business at Unit 211, 2/F., Photonics Centre, No. 2 Science Park East Avenue, Hong Kong Science Park, Shatin, N.T, Hong Kong (hereinafter "Assignee") is desirous of acquiring the entire right, title and interest in and to the Patents.

NOW, THEREFORE, for good and valuable consideration, the receipt of which is hereby acknowledged, the Assignor has sold, assigned and transferred, and by these presents does hereby sell, assign and transfer Assignor's entire right, title and interest in and to the Patents and all reissues and extensions thereof, including all claims, if any, which may have arisen for infringement of the patents prior to the date of this assignment, all said rights to be held and enjoyed by the Assignee for its own use and for the use of its successors, assigns or other legal representatives, to the full end of the term for which the Patents have been or will be granted, extended or reissued, as fully and entirely as the same would have been held and enjoyed by the Assignor if this assignment and sale had not been made.

Assignor further agrees that Assignor will, without demanding any further consideration therefore, at the request but at the expense of Assignee, do all lawful and just acts, including the execution and acknowledgment of instruments, that may be or become necessary for obtaining, sustaining, or reissuing the Patents, and for maintaining and perfecting Assignee's right to the Patents.

ASSIGNOR Kopin Corporation Signature: <u></u> Printed Name: <u>Hong Cho</u> Title: <u>Chief Technology Officer</u> Date: <u>Nov. 22, 2019</u>	ASSIGNEE Solos Technology Limited Signature: <u></u> Printed Name: <u>Kenny Cheung</u> Title: <u>General Manager</u> Date: <u>22 Nov 2019</u>
---	--

IP SCHEDULE
UNITED STATES PATENTS

<u>FILE NUMBER</u>	<u>PATENT NO.</u>	<u>ISSUE DATE</u>	<u>TITLE</u>
41090.C001	7,386,135	June 10, 2008	Cardioid Beam with a Desired Null Based Acoustic Devices, Systems and Methods
41090.C011	8,885,850	November 11, 2014	Cardioid Beam with a Desired Null Based Acoustic Devices, Systems and Methods
41090.C022	9,456,275	September 27, 2016	Cardioid Beam with a Desired Null Based Acoustic Devices, Systems and Methods
41090.C033	9,491,544	November 8, 2016	Frequency Domain Noise Cancellation With A Desired Null Based Acoustic devices, Systems, and Methods
41090.C044	9,406,293	August 2, 2016	Apparatus and Methods to Detect and Obtain Desired Audio
K41090.P001	9,633,670	April 25, 2017	Dual Stage Noise Reduction Architecture For Desired Signal Extraction
K41090.P002	9,257,952	February 9, 2016	Apparatuses and Methods for Multi-Channel Signal Compression During Desired Voice Activity Detection
K41090.P2C1	9,792,927	October 17, 2017	Apparatuses and Methods for Multi-Channel Signal Compression During Desired Voice Activity Detection
K41090.P003	9,312,826	April 12, 2016	Apparatus and Methods for Acoustic Channel Auto-Balancing During Multi-Channel Signal Extraction
K41090.P005	10,306,389	May 28, 2019	Head Wearable Acoustic System with Noise Canceling Microphone Geometry Apparatuses and Methods
K41090.P008	9,941,895	April 10, 2018	Time Delay in Digitally Oversampled Sensor Systems, Apparatuses, and Methods
K41090.P8C1	10,298,253	May 21, 2019	Time Delay in Digitally Oversampled Sensor Systems, Apparatuses, and Methods
K41090.P2C2	10,339,952	July 2, 2019	Apparatuses and Systems for Acoustic Channel Auto-Balancing During Multi-Channel Signal Extraction

HC 

IP SCHEDULE (Continued)
UNITED STATES PATENT APPLICATIONS

FILE NUMBER	SERIAL NO.	FILING DATE	TITLE
K41090.P004	14/886,054	October 18, 2015	Wrist Wearable Apparatuses and Methods with Desired Signal Extraction
K41090.P007	14/886,080	October 18, 2015	Apparatuses and Methods for Enhanced Speech Recognition in Variable Environments
K41090.P8C2	16/399,867	April 30, 2019	Beamforming Using Fractional Time Delay in Digitally Oversampled Sensor Systems, Apparatuses, and Methods
K41090.P013	16/171,254	October 25, 2018	Programmable Fractional Time Delay in Digitally Oversampled Microphone Systems, Circuits, and Methods
K41090.P014	16/171,266	October 25, 2018	Fractional Time Delay Structures in Digitally Oversampled Microphone Systems, Circuits, and Methods
K41090.P016	16/420,082	May 22, 2019	Microphone Configurations for Eyewear Devices Systems, Apparatus, and Methods
K41090.Z017	62/873,889	July 13, 2019	Wearable Devices Apparatuses, Systems, and Methods

HC Jgr

IP SCHEDULE (Continued)
INTERNATIONAL (PCT) & FOREIGN PATENT APPLICATIONS

FILE NUMBER	SERIAL NO.	FILING DATE	TITLE
K41090P08PCT-CN	201780047952.0 (China)	January 31, 2017	Time Delay in Digitally Oversampled Sensor Systems, Apparatuses, and Methods
K41090P08PCT-JP	2019-526185 (Japan)	January 30, 2019	Time Delay in Digitally Oversampled Sensor Systems, Apparatuses, and Methods
K41090P013PCT	PCT/US2018/057869	October 26, 2018	Programmable Fractional Time Delay in Digitally Oversampled Microphone Systems, Circuits, and Methods
K41090P014PCT	PCT/US2018/057879	October 27, 2019	Fractional Time Delay Structures in Digitally Oversampled Microphone Systems, Circuits, and Methods

HC 



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

51340 7590 12/16/2019
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

EXAMINER

MAI, LAM T

ART UNIT

PAPER NUMBER

2845

DATE MAILED: 12/16/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984

TITLE OF INVENTION: BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	03/16/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

51340 7590 12/16/2019
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

Certificate of Mailing or Transmission

I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984

TITLE OF INVENTION: BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUS, AND METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	03/16/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
MAI, LAM T	2845	341-155000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-09 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

1 _____

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

2 _____

3 _____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ☐ Individual ☐ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☐ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: (Please first reapply any previously paid fee shown above)

☐ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☐ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____

Date _____

Typed or printed name _____

Registration No. _____



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984
51340	7590	12/16/2019	EXAMINER	
PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100			MAI, LAM T	
			ART UNIT	PAPER NUMBER
			2845	

DATE MAILED: 12/16/2019

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (Applications filed on or after May 29, 2000)

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 30 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450. Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 16/399,867	Applicant(s) Fan et al.	
	Examiner LAM T MAI	Art Unit 2845	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 4/30/2019.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☒ Notice of References Cited (PTO-892) 2. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____ 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____ 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____	5. ☐ Examiner's Amendment/Comment 6. ☒ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____
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/LAM T MAI/
Primary Examiner, Art Unit 2845

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application, filed on or after March 16, 2013, is being examined under the first inventor to file provisions of the AIA.

Allowable Subject Matter

Claims 1-20 are allowable.

The following is an examiner's statement of reasons for allowance: Claim 1 is allowed over the prior art of record. The prior art of record, considered individually or in combination, fails to fairly teach or suggest claimed features, which is "combining the time delayed first oversampled digital signal with a second oversampled digital signal to obtain the beamformed digital signal, wherein the second oversampled digital signal is responsive to the analog field", structurally and functionally interconnected with other limitations in the manner as cited in the claim and dependent claims.

Claim 11 is allowed over the prior art of record. The prior art of record, considered individually or in combination, fails to fairly teach or suggest claimed features, which is "arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and the second oversampled digital output signal, the arithmetic unit is configured to produce the beamformed digital signal from the time delayed oversampled digital output signal and the second oversampled digital output signal" structurally and functionally interconnected with other limitations in the manner as cited in the claim and dependent claims.

Claim 16 is allowed over the prior art of record. The prior art of record, considered individually or in combination, fails to fairly teach or suggest claimed features, which is "arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and a second oversampled digital output signal, wherein the second oversampled digital output signal is responsive to the analog field, the arithmetic unit is configured to produce the beamformed digital signal from the

Art Unit: 2845

time delayed oversampled digital output signal and the second oversampled digital output signal”, structurally and functionally interconnected with other limitations in the manner as cited in the claim and dependent claims.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled “Comments on Statement of Reasons for Allowance.”

Cited References

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure. Cited references are related to instant application subject matters.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to LAM T MAI whose telephone number is **571 272-1807**. The examiner can normally be reached on Monday-Thursday 7am-530pm.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at <http://www.uspto.gov/interviewpractice>.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Dameon Levi can be reached on 571-272-2105. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic

Art Unit: 2845

Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/LAM T MAI/

Primary Examiner, Art Unit 2845

Notice of References Cited	Application/Control No. 16/399,867		Applicant(s)/Patent Under Reexamination Fan et al.	
	Examiner LAM T MAI		Art Unit 2845	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-20110271957-A1	11-2011	Matis; Robert J.	A61K9/0009	128/203.12
*	B	US-20140009564-A1	01-2014	Cleve; Pascal	H04M3/002	348/14.08
*	C	US-9941895-B2	04-2018	Fan; Dashen	H04B7/0617	1/1
*	D	US-10298253-B1	05-2019	Fan; Dashen	H04B7/0617	1/1
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	CPC Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

<i>Search Notes</i> 	Application/Control No. 16/399,867	Applicant(s)/Patent Under Reexamination Fan et al.
	Examiner LAM T MAI	Art Unit 2845

CPC - Searched*		
Symbol	Date	Examiner
H03M1/1245.cpc.	12/08/2019	lammai
H04B7/0617.cpc.	12/08/2019	lammai
H03M3//462.cpc.	12/08/2019	lammai

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner
341	122-160	12/21/2018	lammai

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Global Dossier/Google Scholar/NPL Search/IP.com/Plus/East Text Search	12/08/2019	lammai
Inventors and Assignee	12/08/2019	lammai
Reviewed Related Application 15/225,745 and 15/947,845	12/08/2019	lammai

/LAM T MAI/ Primary Examiner.Art Unit 2845	
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<i>Search Notes</i> 	Application/Control No. 16/399,867	Applicant(s)/Patent Under Reexamination Fan et al.
	Examiner LAM T MAI	Art Unit 2845

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
H03M1	1245	12/08/2019	lammai
H04B7	0617	12/08/2019	lammai
H03M3	462	12/08/2019	lammai

/LAM T MAI/ Primary Examiner.Art Unit 2845	
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<i>Issue Classification</i> 	Application/Control No. 16/399,867	Applicant(s)/Patent Under Reexamination Fan et al.
	Examiner LAM T MAI	Art Unit 2845

CPC						
Symbol					Type	Version
H03M	/	1	/	1245	F	2013-01-01
H03M	/	3	/	462	I	2013-01-01
H04B	/	7	/	0617	I	2013-01-01

CPC Combination Sets				
Symbol		Type	Set	Ranking
	/		/	

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 20	
/LAM T MAI/ Primary Examiner, Art Unit 2845 (Primary Examiner) _____ (Date) _____		08 December 2019 O.G. Print Claim(s) 1	O.G. Print Figure 10

Issue Classification 	Application/Control No. 16/399,867	Applicant(s)/Patent Under Reexamination Fan et al.
	Examiner LAM T MAI	Art Unit 2845

INTERNATIONAL CLASSIFICATION			
CLAIMED			
H03M1/12	/	1	/ 12
H03M3/00	/	3	/ 00
H04B7/06	/	7	/ 06
NON-CLAIMED			
/		/	

US ORIGINAL CLASSIFICATION	
CLASS	SUBCLASS
341	155

CROSS REFERENCES(S)						
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)					
341	160					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	20	
/LAM T MAI/ Primary Examiner, Art Unit 2845 (Primary Examiner)	08 December 2019 (Date)	O.G. Print Claim(s) 1	O.G. Print Figure 10

Issue Classification 	Application/Control No. 16/399,867	Applicant(s)/Patent Under Reexamination Fan et al.
	Examiner LAM T MAI	Art Unit 2845

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☒ T.D. ☐ R.1.47

CLAIMS															
Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1		10		19										
	2		11		20										
	3		12												
	4		13												
	5		14												
	6		15												
	7		16												
	8		17												
	9		18												

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 20	
/LAM T MAI/ Primary Examiner, Art Unit 2845 (Primary Examiner) _____ (Date) 08 December 2019		O.G. Print Claim(s) 1	O.G. Print Figure 10

EAST Search History

EAST Search History (I nterference)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	2	(beamform\$4 adj digital adj signal and delay\$4 near tim\$4).clm.	US-PGPUB; USPAT	OR	ON	2019/12/08 14:34
L6	6	(beamform\$4 and time near delay\$4 and oversampl\$4).clm.	US-PGPUB; USPAT	OR	ON	2019/12/08 15:45

12/ 8/ 2019 3:46:02 PM
C:\ Users\ Imai1\ Documents\ EAST\ Workspaces\ 16399867.wsp

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	3	H03M1/1245.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:41
L4	3	H03M3/462.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:42
L5	5	H04B7/0617.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:42
S1	348	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:06
S2	27	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:06
S3	0	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:07
S4	8905	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 18:49
S5	41	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 18:49
S6	2282	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:05
S7	4	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:06

S8	15	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:09
S9	33	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 09:59
S10	0	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 09:59
S11	0	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:01
S12	2	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:05
S13	7	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:07
S14	0	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:24
S15	1	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:25
S19	192	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/05/30 11:57

		("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.				
S20	2	S19 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 11:58
S22	0	S19 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 11:59
S23	359	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S24	30	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S25	0	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S26	9268	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S27	46	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S28	2402	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S29	4	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S30	16	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S31	35	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S32	0	oversampl\$4 adj digital adj output with	US-PGPUB;	OR	ON	2017/11/13

		time near delay	USPAT; EPO; JPO; DERWENT; IBM_TDB			09:07
S33	0	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S34	2	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S35	7	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S36	0	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S37	1	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S38	195	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/11/13 09:07
S39	2	S38 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S40	0	S38 and digital near sensor	US-PGPUB; USPAT;	OR	ON	2017/11/13 09:07

			EPO; JPO; DERWENT; IBM_TDB			
S41	46	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:09
S42	0	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:11
S43	0	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:13
S49	375	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S50	35	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S51	2	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S52	9974	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S53	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S54	2615	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S55	6	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S56	19	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S57	39	oversampl\$4 adj digital adj output	US-PGPUB; USPAT;	OR	ON	2018/09/03 18:13

			EPO; JPO; DERWENT; IBM_TDB			
S58	3	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S59	3	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S60	5	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S61	10	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S62	3	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S63	4	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S64	198	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071"))).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 18:13
S65	2	S64 and time near delay	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2018/09/03 18:13

			DERWENT; IBM_TDB			
S66	0	S64 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S67	375	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S68	35	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S69	2	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S70	9974	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S71	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S72	2615	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S73	6	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S74	19	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S75	39	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S76	3	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S77	3	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2018/09/03 18:13

			DERWENT; IBM_TDB			
S78	5	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S79	10	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S80	3	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S81	4	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S82	198	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 18:13
S83	2	S82 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S84	0	S82 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S85	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT;	OR	ON	2018/09/03 18:13

			IBM_TDB			
S86	2	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S87	3	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S95	1	("10298253").PN.	USPAT; USOCR	OR	OFF	2019/12/07 21:39
S96	1	("9941895").PN.	USPAT; USOCR	OR	OFF	2019/12/07 21:40
S97	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S98	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S99	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S100	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S101	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S102	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S103	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S104	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S105	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT;	OR	ON	2019/12/07 21:49

			IBM_TDB			
S106	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S107	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S108	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S109	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S110	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S111	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S112	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S113	2	S112 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49

S114	0	S112 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S115	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S116	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S117	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S118	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S119	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S120	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S121	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S122	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S123	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S124	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S125	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49

S126	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S127	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S128	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S129	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S130	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S131	2	S130 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S132	0	S130 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S133	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S134	3	digital adj sensor with time adj delay and	US-PGPUB;	OR	ON	2019/12/07

		oversampl\$4 adj digital adj output	USPAT; EPO; JPO; DERWENT; IBM_TDB			21:49
S135	4	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S136	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S137	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S138	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S139	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S140	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S141	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S142	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S143	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S144	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S145	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S146	5	oversampl\$4 adj digital adj output same	US-PGPUB;	OR	ON	2019/12/07

		time near delay	USPAT; EPO; JPO; DERWENT; IBM_TDB			21:49
S147	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S148	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S149	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S150	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S151	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S152	2	S151 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S153	0	S151 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S154	392	"Kopin corporation".asn.	US-PGPUB; USPAT;	OR	ON	2019/12/07 21:49

			EPO; JPO; DERWENT; IBM_TDB			
S155	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S156	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S157	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S158	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S159	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S160	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S161	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S162	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S163	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S164	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S165	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S166	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT;	OR	ON	2019/12/07 21:50

			EPO; JPO; DERWENT; IBM_TDB			
S167	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S168	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S169	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:50
S170	2	S169 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S171	0	S169 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S172	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S173	3	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S174	4	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2019/12/07 21:50

			DERWENT; IBM_TDB			
S175	203	beamform\$4 adj digital adj signal	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:11
S176	0	beamform\$4 adj digital adj signal with oversampl\$5 adj digital adj signal	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:13
S192	4	beamform\$4 adj digital adj signal with delay\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:14
S194	41	beamform\$4 adj digital adj signal and delay\$4 near tim\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:16
S195	1	beamform\$4 adj digital adj signal with delay\$4 near tim\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:18

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EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	3	H03M1/1245.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:41
L4	3	H03M3/462.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:42
L5	5	H04B7/0617.cpc. and beamform\$4 with time near delay\$4 with oversampl\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/08 15:42
S1	348	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:06
S2	27	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:06
S3	0	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 16:07
S4	8905	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 18:49
S5	41	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 18:49
S6	2282	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:05
S7	4	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:06

S8	15	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/29 19:09
S9	33	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 09:59
S10	0	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 09:59
S11	0	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:01
S12	2	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:05
S13	7	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:07
S14	0	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:24
S15	1	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 10:25
S19	192	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/05/30 11:57

		("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.				
S20	2	S19 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 11:58
S22	0	S19 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/05/30 11:59
S23	359	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S24	30	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S25	0	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S26	9268	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S27	46	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S28	2402	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S29	4	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S30	16	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S31	35	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S32	0	oversampl\$4 adj digital adj output with	US-PGPUB;	OR	ON	2017/11/13

		time near delay	USPAT; EPO; JPO; DERWENT; IBM_TDB			09:07
S33	0	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S34	2	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S35	7	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S36	0	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S37	1	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S38	195	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2017/11/13 09:07
S39	2	S38 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:07
S40	0	S38 and digital near sensor	US-PGPUB; USPAT;	OR	ON	2017/11/13 09:07

			EPO; JPO; DERWENT; IBM_TDB			
S41	46	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:09
S42	0	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:11
S43	0	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2017/11/13 09:13
S49	375	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S50	35	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S51	2	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S52	9974	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S53	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S54	2615	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S55	6	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S56	19	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S57	39	oversampl\$4 adj digital adj output	US-PGPUB; USPAT;	OR	ON	2018/09/03 18:13

			EPO; JPO; DERWENT; IBM_TDB			
S58	3	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S59	3	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S60	5	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S61	10	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S62	3	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S63	4	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S64	198	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071"))).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 18:13
S65	2	S64 and time near delay	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2018/09/03 18:13

			DERWENT; IBM_TDB			
S66	0	S64 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S67	375	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S68	35	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S69	2	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S70	9974	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S71	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S72	2615	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S73	6	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S74	19	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S75	39	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S76	3	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S77	3	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2018/09/03 18:13

			DERWENT; IBM_TDB			
S78	5	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S79	10	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S80	3	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S81	4	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S82	198	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2018/09/03 18:13
S83	2	S82 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S84	0	S82 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S85	52	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT;	OR	ON	2018/09/03 18:13

			IBM_TDB			
S86	2	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S87	3	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2018/09/03 18:13
S95	1	("10298253").PN.	USPAT; USOCR	OR	OFF	2019/12/07 21:39
S96	1	("9941895").PN.	USPAT; USOCR	OR	OFF	2019/12/07 21:40
S97	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S98	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S99	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S100	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S101	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S102	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S103	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S104	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S105	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT;	OR	ON	2019/12/07 21:49

			IBM_TDB			
S106	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S107	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S108	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S109	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S110	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S111	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S112	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S113	2	S112 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49

S114	0	S112 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S115	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S116	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S117	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S118	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S119	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S120	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S121	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S122	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S123	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S124	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S125	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49

S126	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S127	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S128	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S129	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S130	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S131	2	S130 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S132	0	S130 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S133	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S134	3	digital adj sensor with time adj delay and	US-PGPUB;	OR	ON	2019/12/07

		oversampl\$4 adj digital adj output	USPAT; EPO; JPO; DERWENT; IBM_TDB			21:49
S135	4	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S136	392	"Kopin corporation".asn.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S137	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S138	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S139	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S140	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S141	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S142	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S143	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S144	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S145	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S146	5	oversampl\$4 adj digital adj output same	US-PGPUB;	OR	ON	2019/12/07

		time near delay	USPAT; EPO; JPO; DERWENT; IBM_TDB			21:49
S147	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S148	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S149	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S150	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S151	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:49
S152	2	S151 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S153	0	S151 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S154	392	"Kopin corporation".asn.	US-PGPUB; USPAT;	OR	ON	2019/12/07 21:49

			EPO; JPO; DERWENT; IBM_TDB			
S155	44	Fan.in. and dashen	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S156	5	kwon.in. and "joseph Yong"	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S157	11433	digital adj sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S158	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S159	2999	(microphone (digital adj sensor)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S160	9	(microphone (digital adj sensor)) with sampl\$4 adj clock with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S161	23	(microphone (digital adj sensor)) with (adc ad a/d (analog adj digital)) with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S162	42	oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S163	5	oversampl\$4 adj digital adj output with time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S164	5	oversampl\$4 adj digital adj output same time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S165	9	(microphone (digital adj sensor)) with oversampl\$4 with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:49
S166	11	(digital adj sensor and time adj delay).clm.	US-PGPUB; USPAT;	OR	ON	2019/12/07 21:50

			EPO; JPO; DERWENT; IBM_TDB			
S167	5	tim\$4 near delay\$4 near oversampl\$4 near digital near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S168	6	tim\$4 near delay\$4 near oversampl\$4 near output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S169	200	((("3684829") or ("3755792") or ("3813485") or ("3914746") or ("4021616") or ("4290050") or ("4361729") or ("4414685") or ("4521099") or ("4577219") or ("4605921") or ("4628345") or ("5089820") or ("5089917") or ("5177711") or ("5333063") or ("5459718") or ("5483474") or ("5493581") or ("5594438") or ("5717618") or ("5742351") or ("5771012") or ("5801653") or ("5870051") or ("5910957") or ("5910995") or ("5969798") or ("5982132") or ("6034564") or ("6092130") or ("6188785") or ("6195394") or ("6201490") or ("6590616") or ("6643382") or ("6775684") or ("6947497") or ("6961151") or ("6972828") or ("7068841") or ("7187409") or ("7472206") or ("7583355") or ("7590675") or ("7626592") or ("7680807") or ("7706443") or ("7782439") or ("7817071")).PN.	US-PGPUB; USPAT; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2019/12/07 21:50
S170	2	S169 and time near delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S171	0	S169 and digital near sensor	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S172	60	digital adj sensor with time adj delay	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S173	3	digital adj sensor with time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 21:50
S174	4	digital adj sensor and time adj delay and oversampl\$4 adj digital adj output	US-PGPUB; USPAT; EPO; JPO;	OR	ON	2019/12/07 21:50

			DERWENT; IBM_TDB			
S175	203	beamform\$4 adj digital adj signal	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:11
S176	0	beamform\$4 adj digital adj signal with oversampl\$5 adj digital adj signal	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:13
S192	4	beamform\$4 adj digital adj signal with delay\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:14
S194	41	beamform\$4 adj digital adj signal and delay\$4 near tim\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:16
S195	1	beamform\$4 adj digital adj signal with delay\$4 near tim\$4	US-PGPUB; USPAT; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2019/12/07 22:18

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BIB DATA SHEET

CONFIRMATION NO. 9984

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.	
16/399,867	04/30/2019	341	2845	K41090.P8C2	
RULE					
APPLICANTS Kopin Corporation, Westborough, MA INVENTORS Dashen Fan, Bellevue, WA; Joseph Yong Kwon, San Jose, CA; ** CONTINUING DATA ***** This application is a CON of 15/947,845 04/08/2018 PAT 10298253 which is a CON of 15/225,745 08/01/2016 PAT 9941895 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 05/13/2019					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /LAM T MAI/ Acknowledged Examiner's Signature	☒ Met after Allowance Im Initials	STATE OR COUNTRY WA	SHEETS DRAWINGS 20	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100 UNITED STATES					
TITLE BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS					
FILING FEE RECEIVED 945	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984
7590 PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100			EXAMINER MAI, LAM T	
			ART UNIT 2845	PAPER NUMBER
			MAIL DATE 01/09/2020	DELIVERY MODE PAPER

NOTICE REQUIRING INVENTOR'S OATH OR DECLARATION

☐ An inventor's oath or declaration in compliance with 37 CFR 1.63 or substitute statement in compliance with 37 CFR 1.64 executed by or with respect to each inventor has not yet been submitted.

The inventor's oath or declaration or substitute statement dated 12/13/2019 is defective. The inventor's oath or declaration does not comply with 37 CFR 1.63 or the substitute statement does not comply with 37 CFR 1.64 because it:

☒ does not include a statement that the person executing the oath or declaration or substitute statement believes the named inventor or joint inventor to be the original inventor or an original joint inventor of a claimed invention in the application for which the oath or declaration is being submitted.

☒ does not state that the application was made or was authorized to be made by the person executing the oath or declaration or substitute statement.

☒ does not acknowledge that any willful false statement made in such oath or declaration or substitute statement is punishable under section 1001 of title 18 by fine or imprisonment of not more than 5 years, or both.

☒ does not identify the person executing the oath or declaration or substitute statement by his or her legal name.

☒ does not identify the application to which the oath or declaration or substitute statement is directed.

☒ Other: A properly executed OATH/DECLARATION or SUBSTITUTE STATEMENT for the following Inventor(s) has not been received: ALL

The substitute statement dated _____ does not comply with 37 CFR 1.64 because it:

☐ does not identify the inventor with respect to whom the statement applies.

☐ does not identify the relationship to the non-signing inventor.

☐ does not identify the circumstances permitting execution of the statement.

☐ was signed by someone other than the applicant.

☐ Other: _____

An oath or declaration in compliance with 37 CFR 1.63, or a substitute statement in compliance with 37 CFR 1.64, executed by or with respect to each inventor **MUST** be filed **no later than the date on which the issue fee is paid**. See 35 U.S.C. 115(f). Failure to timely comply will result in ABANDONMENT of this application. This period for reply is not extendable under 37 CFR 1.136(a).

Questions relating to this Notice should be directed to the Application Assistance Unit at 571-272-4200.

(571)-272-4200 or 1(888)-786-0101
Patent Publication Branch
Office of Data Management

Electronic Acknowledgement Receipt

EFS ID:	38834451
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	11-MAR-2020
Filing Date:	30-APR-2019
Time Stamp:	14:26:55
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Oath or Declaration filed	20200109K41090P8C2NOTICED ECSwdecsi.pdf	1099192 c82ec4414c41ce082be78b0732c04aa455985e16	no	3

Warnings:

Information:	
Total Files Size (in bytes):	1099192
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.	



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984
PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100			EXAMINER MAL, LAM T	
			ART UNIT	PAPER NUMBER
			2845	
			MAIL DATE	DELIVERY MODE
			01/09/2020	PAPER

NOTICE REQUIRING INVENTOR'S OATH OR DECLARATION

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☒ does not include a statement that the person executing the oath or declaration or substitute statement believes the named inventor or joint inventor to be the original inventor or an original joint inventor of a claimed invention in the application for which the oath or declaration is being submitted.

☒ does not state that the application was made or was authorized to be made by the person executing the oath or declaration or substitute statement.

☒ does not acknowledge that any willful false statement made in such oath or declaration or substitute statement is punishable under section 1001 of title 18 by fine or imprisonment of not more than 5 years, or both.

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☒ does not identify the application to which the oath or declaration or substitute statement is directed.

☒ Other: A properly executed OATH/DECLARATION or SUBSTITUTE STATEMENT for the following Inventor(s) has not been received: ALL

The substitute statement dated _____ does not comply with 37 CFR 1.64 because it:

☐ does not identify the inventor with respect to whom the statement applies.

☐ does not identify the relationship to the non-signing inventor.

☐ does not identify the circumstances permitting execution of the statement.

☐ was signed by someone other than the applicant.

☐ Other: _____

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**DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN
APPLICATION DATA SHEET (37 CFR 1.76)**

Title of Invention	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
-------------------------------	--

As the below named inventor, I hereby declare that:

This declaration
is directed to:☐

The attached application, or

☒United States application or PCT international application number 16399867filed on April 30, 2019

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001
by fine or imprisonment of not more than five (5) years, or both.**WARNING:**

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTORInventor: JOSEPH YONG KWON

Date (Optional):

5-31-19Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of
Invention

BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED
SENSOR SYSTEMS, APPARATUSES, AND METHODS

As the below named inventor, I hereby declare that:

This declaration
is directed to:



The attached application, or



United States application or PCT international application number 16399867

filed on April 30, 2019

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

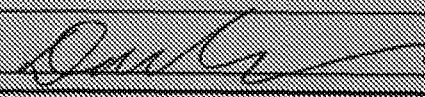
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LEGAL NAME OF INVENTOR

Inventor: DASHEN FAN

Date (Optional)

3-8-2020

Signature: 

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 1 minute to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

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EFS ID:	38854255
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	12-MAR-2020
Filing Date:	30-APR-2019
Time Stamp:	21:22:46
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Amendment after Notice of Allowance (Rule 312)	20200312Amendment1312K41090P8C2ii.pdf	98770 c629383198fcd8ea0dea8ebe376e7aea6efdc79	no	8

Warnings:

Information:	
Total Files Size (in bytes):	98770
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 16/399,867
Applicant : SOLOS TECHNOLOGY LTD
Filed : 04/30/2019
TC/A.U. : 2845
Examiner : MAI, LAM T
Confirmation No. : 9984

Docket No. : K41090.P8C2
Customer No. : 51340

Mail Stop Amendment
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

COMMUNICATED VIA EFS-WEB TO USPTO ON 12 MARCH 2020
AMENDMENT AFTER NOTICE OF ALLOWANCE UNDER 37 C.F.R. 1.312

Sir:

Applicant submits the following amendment under 37 C.F.R. 1.312 to correct informalities in the allowed claims. No new matter has been entered.

Amendments to the Claims are reflected in the listing of claims which begin on page 2 of this paper.

Remarks begins on page 7 of this paper.

Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of the claims in the application:

Listing of Claims

Claim 1 (Original). A method to create a beamformed digital signal, comprising:
outputting a first oversampled digital signal output from an analog-to-digital converter (ADC), wherein the first oversampled digital signal is responsive to an analog field and the first oversampled digital signal is created at a sampling clock frequency;
delaying the first oversampled digital signal by a time delay wherein the time delay is equal to an integer number of sampling clock cycles to produce a time delayed first oversampled digital signal; and
combining the time delayed first oversampled digital signal with a second oversampled digital signal to obtain the beamformed digital signal, wherein the second oversampled digital signal is responsive to the analog field.

Claim 2 (Original). The method of claim 1, wherein the combining is performed in an oversampled signal domain.

Claim 3 (Currently amended). The method of claim 1, wherein the combining is performed ~~in~~ at an intermediate sampling rate.

Claim 4 (Original). The method of claim 1, wherein the combining is performed in a baseband signal domain.

Claim 5 (Original). The method of claim 1, wherein the first oversampled digital signal and the second oversampled digital signal are obtained from different sensors.

Claim 6 (Original). The method of claim 1, wherein the first oversampled digital signal and the second oversampled digital signal are obtained from the same sensor.

Claim 7 (Original). The method of claim 1, further comprising:

applying a low pass filter with decimation to the time delayed first oversampled digital signal to output a baseband digital signal that is delayed by the time delay.

Claim 8 (Original). The method of claim 7, wherein the time delay is equal to a fraction of a baseband sampling period.

Claim 9 (Original). The method of claim 7, wherein the time delay is greater than a baseband sampling period.

Claim 10 (Original). The method of claim 7, wherein the first oversampled digital signal is digitized to create samples which are more than one bit deep.

Claim 11 (Original). A system to create a beamformed digital signal, comprising:

a first digital sensor responsive to an analog field, the first digital sensor is configured to output a first oversampled digital output signal at a sampling clock frequency;

a second digital sensor responsive to the analog field, the second digital sensor is configured to output a second oversampled digital output signal at the sampling clock frequency;

a time delay element, the time delay element is configured to receive as an input, the first oversampled digital output signal and to output a time delayed oversampled digital output signal, wherein the time delayed oversampled digital output signal and the second oversampled digital output signal are separated by a time delay that is imparted by the time delay element; and

an arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and the second oversampled digital output signal, the arithmetic unit is configured to produce the beamformed digital signal from the time delayed oversampled digital output signal and the second oversampled digital output signal.

Claim 12 (Original). The apparatus of claim 11, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal.

Claim 13 (Original). The apparatus of claim 12, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a summation function.

Claim 14 (Original). The apparatus of claim 12, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a subtraction function.

Claim 15 (Original). The apparatus of claim 11, further comprising:

a sigma-delta modulator, the first digital sensor utilizes the sigma-delta modulator and the first digital sensor is configured to produce a pulse density modulated (PDM) output signal at the sampling clock frequency responsive to the analog field.

Claim 16 (Currently amended). A system to create a beamformed digital signal, comprising:

a digital sensor responsive to an analog field, the digital sensor is configured to output an oversampled digital output signal at a sampling clock frequency;

a time delay element, the time delay element is configured to receive as an input, the oversampled digital output signal and to output a time delayed oversampled digital output signal, wherein the time delayed oversampled digital output signal and ~~the a~~ a second oversampled digital output signal are separated by a time delay and the time delay is imparted by the time delay element; and

an arithmetic unit, the arithmetic unit is configured to receive the time delayed oversampled digital output signal and ~~a~~the second oversampled digital output signal, wherein the second oversampled digital output signal is responsive to the analog field, the arithmetic unit is configured to produce the beamformed digital signal from the time delayed oversampled digital output signal and the second oversampled digital output signal.

Claim 17 (Original). The apparatus of claim 16, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal.

Claim 18 (Original). The apparatus of claim 17, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a summation function.

Claim 19 (Original). The apparatus of claim 17, wherein the arithmetic unit combines the time delayed oversampled digital output signal and the second oversampled digital output signal using a subtraction function.

Claim 20 (Original). The apparatus of claim 16, further comprising:

a sigma-delta modulator, the digital sensor utilizes the sigma-delta modulator and the digital sensor is configured to produce a pulse density modulated (PDM) output signal at the sampling clock frequency responsive to the analog field.

REMARKS

Claims

Claims 1 through 20 are allowed. The current amendment to claim 3 corrects a grammatical error in the claim. The current amendments to claim 16 cure antecedent basis informalities. Applicant requests entry of the amendments to claims 3 and 16 under 37 C.F.R. 1.312. No new matter has been entered.

CONCLUSION

Claims 1 through 20 have been allowed.

Communication via cleartext email is authorized.

Respectfully submitted,

PELOQUIN, PLLC

March 12, 2020
Date

/Mark S. Peloquin/
Mark S. Peloquin, Esq.
USPTO Registration # 50,787

Electronic Patent Application Fee Transmittal

Application Number:	16399867			
Filing Date:	30-Apr-2019			
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	2501	1	500	500

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				500

Electronic Acknowledgement Receipt

EFS ID:	38854298
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	12-MAR-2020
Filing Date:	30-APR-2019
Time Stamp:	21:34:05
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$ 500
RAM confirmation Number	E20203BL34418603
Deposit Account	
Authorized User	

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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	K41090P8C2ISSUEFEEi.pdf	617601	no	2
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Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	30590	no	2
			221be81c24f654b606311554729d42129aeeaa76c		
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Information:					
Total Files Size (in bytes):			648191		
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NOTICE OF ALLOWANCE AND FEE(S) DUE

51340 7590 12/16/2019
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

EXAMINER

MAI, LAM T

ART UNIT

PAPER NUMBER

2845

DATE MAILED: 12/16/2019

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P6C2	9984

TITLE OF INVENTION: BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	03/16/2020

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

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If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Maintenance fees are due in utility patents issuing on applications filed on or after Dec. 12, 1980. It is patentee's responsibility to ensure timely payment of maintenance fees when due. More information is available at www.uspto.gov/PatentMaintenanceFees.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: **Mail Stop ISSUE FEE**
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INSTRUCTIONS: This form should be used for transmitting the **ISSUE FEE** and **PUBLICATION FEE** (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

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SI 340 7590 12/16/2019
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

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MARK S. PELOQUIN	(Typed or printed name)
/MARK S. PELOQUIN/	(Signature)
MARCH 12, 2020	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY/LOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dasha Fan	K41090.PSC2	9984

TITLE OF INVENTION: BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUS, AND METHODS

APPL. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	SMALL	\$500	\$0.00	\$0.00	\$500	03/16/2020

EXAMINER	ART UNIT	CLASS-SUBCLASS
MAL LAM T	2845	341-155000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363):

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

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2. For printing on the patent front page, list

(1) The names of up to 3 registered patent attorneys or agents OR, alternatively,

(2) The name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 **PELOQUIN, PLLC**

2 **Mark S. Pelouquin, Esq.**

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

SOLOS TECHNOLOGY LIMITED

SHATIN, N. T., HONG KONG

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. Fees submitted: ☒ Issue Fee ☐ Publication Fee (if required) ☐ Advance Order - # of Copies _____

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5. Change in Entity Status (from status indicated above)

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.

NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.

NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature **/MARK S. PELOQUIN/**

Date **MARCH 12, 2020**

Typed or printed name **MARK S. PELOQUIN**

Registration No. **50,787**

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**Request
for
Continued Examination (RCE)
Transmittal**Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	16/399,867
Filing Date	04/30/2019
First Named Inventor	DASHEN FAN
Art Unit	2845
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P6C2

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.

Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. **Submission required under 37 CFR 1.114** Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).
- a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.
- i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____
- ii. ☐ Other _____
- b. ☒ Enclosed
- i. ☐ Amendment/Reply
- ii. ☐ Affidavit(s)/ Declaration(s)
- iii. ☒ Information Disclosure Statement (IDS)
- iv. ☐ Other _____
2. **Miscellaneous**
- a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)
- b. ☐ Other _____
3. **Fees** The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.
- a. ☐ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. _____
- i. ☒ RCE fee required under 37 CFR 1.17(e)
- ii. ☐ Extension of time fee (37 CFR 1.136 and 1.17)
- iii. ☐ Other _____
- b. ☐ Check in the amount of \$ _____ enclosed
- c. ☐ Payment by credit card (Form PTO-2038 enclosed)
- d. ☒ Payment by EFS-Web

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.**SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED**

Signature	/MARK S PELOQUIN/	Date	March 13, 2020
Name (Print/Type)	MARK S PELOQUIN	Registration No.	50787

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being EFS-Web transmitted to the United States Patent and Trademark Office (USPTO), deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the USPTO on the date shown below.

Signature	/MARK S PELOQUIN/	Date	March 13, 2020
Name (Print/Type)	MARK S PELOQUIN		

This collection of information is required by 37 CFR 1.114. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop RCE, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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Instruction Sheet for RCEs

(not to be submitted to the USPTO)

NOTES:

An RCE is not a new application, and filing an RCE will not result in an application being accorded a new filing date.

Filing Qualifications:

The application must be a utility or plant application filed on or after June 8, 1995. The application cannot be a provisional application, a utility or plant application filed before June 8, 1995, a design application, or a patent under reexamination. See 37 CFR 1.114(e).

Filing Requirements:

Prosecution in the application must be closed. Prosecution is closed if the application is under appeal, or the last Office action is a final action, a notice of allowance, or an action that otherwise closes prosecution in the application (e.g., an Office action under *Ex parte Quayle*). See 37 CFR 1.114(b).

A submission and a fee are required at the time the RCE is filed. If reply to an Office action under 35 U.S.C. 132 is outstanding (e.g., the application is under final rejection), the submission must meet the reply requirements of 37 CFR 1.111. If there is no outstanding Office action, the submission can be an information disclosure statement, an amendment, new arguments, or new evidence. See 37 CFR 1.114(c). The submission may be a previously filed amendment (e.g., an amendment after final rejection).

WARNINGS:

Request for Suspension of Action:

All RCE filing requirements must be met before suspension of action is granted. A request for a suspension of action under 37 CFR 1.103(c) does not satisfy the submission requirement and does not permit the filing of the required submission to be suspended.

Improper RCE will NOT toll Any Time Period:

Before Appeal - If the RCE is improper (e.g., prosecution in the application is not closed or the submission or fee has not been filed) and the application is not under appeal, the time period set forth in the last Office action will continue to run and the application will be abandoned after the statutory time period has expired if a reply to the Office action is not timely filed. No additional time will be given to correct the improper RCE.

Under Appeal - If the RCE is improper (e.g., the submission or the fee has not been filed) and the application is under appeal, the improper RCE is effective to withdraw the appeal. Withdrawal of the appeal results in the allowance or abandonment of the application depending on the status of the claims. If there are no allowed claims, the application is abandoned. If there is at least one allowed claim, the application will be passed to issue on the allowed claim(s). See MPEP 1215.01.

See MPEP 706.07(h) for further information on the RCE practice.

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Reasons for Refusal

Application number: Japanese Patent Application No. 2019-526185

Date of Drafting: Reiwa 2(2020) January 23

Patent examiner: KITAMURA, Norihiko 9297 5K00

Representative/Applicant: MURAI, Yasushi (and 1 others)

Applied Provisions: Article 29(2), Article 36, Article 37

This application should be refused for the reason mentioned below. If the applicant has any opinion(s) against the reason, a written opinion should be submitted within 3 months from the date on which this notification was dispatched.

Reason

1. (Unity of Invention) This patent application does not fulfill the requirement of the provision of Patent Act Article 37 in terms of the item(s) listed below.
2. (Inventive step) The claimed invention(s) listed below of this patent application shall not be granted a patent under the provision of Patent Act Article 29 (2) for the reason that the claimed invention(s) could have easily been made by persons who have common knowledge in the technical field to which the claimed invention(s) pertains, on the basis of the invention(s) described in the distributed publication listed below or made available to the public through electric telecommunication lines in Japan or other foreign countries prior to the filing of the patent application.
3. (Clarity) This patent application does not fulfill the requirement of the provision of Patent Act Article 36(6)(ii) in terms of the item(s) listed below regarding the statement of the scope of claims.

Note (For the cited documents, please refer to the list of cited documents below.)

- Reason 1 (Unity of Invention)

1. Determination of the subject of examination based on special technical features

A special technical feature is found in the invention claimed in claim 1. On the other hand, the invention according to Claim 31-33 has the common technical feature of the invention according to Claim 1 and the common technical feature of "to be used in the analog / digital conversion system.". However, the technical feature does not

contribute to the prior art in light of the disclosed content of the cited document 1, and thus cannot be considered to be a special technical feature. Furthermore, there is no other identical or corresponding special technical feature between the invention according to Claim 1 and the invention according to Claim 31-33.

2. Determination of the subject of examination based on the efficiency of examination

The invention according to Claim 31-33 is not an invention of the same category including all the matters specifying the invention of the invention according to Claim 1. Moreover, as a result of examining the invention subject to examination, the invention according to Claim 31-33 is not an invention that is capable of performing examination without substantially requiring an additional prior art search or determination, and there is no other circumstances in which it can be said that it is efficient to conduct examination together with the invention.

Therefore, the invention according to Claim 31-33 is not a subject to examination concerning a requirement other than the provisions of Article 37 of the Patent Act.

Since the application violates the provisions of Article 37 of the Patent Act, the inventions according to Claims other than Claims 1-30 and 34-54 have not been examined on the requirements other than Article 37 of the Patent Act. Note that since the filing date of the application is April 1, 2007, it should be noted that the amendment does not constitute an amendment that violates Article 17, paragraph (2), item (4) of the Patent Act.

- Reason 2 (Inventive step)

- Claim 1

- Cited Document, etc. 1-4

- Remarks

Cited Document 1 (see, in particular, Column 4, Line 13-57, Column 6, Line 36-50, and Column 8, Line 22-33, and Fig. 2,3 b)A system for delaying signal output from an analogue / digital converter, comprising : a delta-sigma modulator 1 configured to output an oversampled digital output signal at a sampling clock frequency ; andA system is described including a time-delay element (delay memory 2) configured to receive the oversampled digital output signal as input and to output a timedelayed oversampled digital output signal. Here, the cited document 1 does not particularly describe that the digital sensor is provided, and there is no description that the analog signal, which is an input of the delta sigma modulator, is a signal from the digital sensor, which is responsive to the amount of the analog field. However, a system in which a signal from a digital sensor responsive to the amount of an analog field is input to oversampling means such as a delta sigma modulator to perform sampling is disclosed in Cited Document 2 (see the abstract, etc.), and Cited Document 3 (see Fig. 6,7 and the description thereof). As shown in the cited document 4 (see the descriptions in [0027] to [0030], and Fig. 1), no remarkable difficulty is found in that a digital sensor is provided to the invention described in the cited document 1, and a signal from a digital sensor responsive to the amount of an analog

field is sampled. Hence, the invention according to Claim 1 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-4.

- Claim 2,44
- Cited Document, etc. 1-4
- Remarks

The invention described in the cited document 1 further includes a filter (subsampling Filter4), wherein the filters are configured to receive a delayed oversampled digital output signal as input, and the filters are configured to receive the amplified oversampled digital output signal as an input signal. Low-pass filtering the time-delayed oversampled digital output signal and decimating it to a lower sample rate. And output a delayed, thinned, delayed digital output signal, wherein the lower sample rate is less than the sampling clock frequency. Hence, the invention according to Claim 2,44 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-4.

- Claim 3,4,10
- Cited Document, etc. 1-4
- Remarks

It is well known to use PDM signal as an output of a delta sigma modulator, and there is no remarkable difficulty in considering a filter to which PDM signal is input as a PDM receiver. Hence, the invention according to Claim 3,4,10 of the present application is the invention described in Cited Document 1, and It could have been easily conceived by a person skilled in the art based on the well-known art described in the cited document 2-4.

- Claim 5-7
- Cited Document, etc. 1-4
- Remarks

The digital sensor described in the well-known example is a microphone, and the cited document 4 is a MEMS sensor. The cited document 3 uses the MEMS sensor. The digital sensor in the cited document 4 is a microphone. In addition, the amount of acoustic pressure field is used for the analog field. Hence, the invention according to Claim 5-7 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-4.

- Claim 8,9,16,34,39
- Cited Document, etc. 1-4
- Remarks

It is obvious for the operation of the memory that the time delay applied by a time delay element (delay memory 2) in the invention described in the cited document 1 is an integer number of sample clock, and the definition of the baseband sample rate is unclear. The thinned frequency corresponds to the sampling clock frequency being divided by some value. Hence, the invention according to Claim 8,9,16,34,39 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known arts described in the cited document 2-4.

- Claim 11,12,45
- Cited Document, etc. 1-4
- Remarks

In the invention described in cited document 1, the filters are configured to have multiple stages (2 stages in Fig. 2), and it is also within a range that could have been easily conceived by a person skilled in the art to set the number of the filters to 3. Hence, the invention according to Claim 11,12,45 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-4.

- Claim 13-15
- Cited Document, etc. 1-5
- Remarks

Since it is a well-known art to input a signal of a microphone and perform a beam forming operation, as shown in cited document 5 (refer to Fig. 2 and the description thereof), there is no remarkable difficulty in performing a beamforming operation in the invention described in cited document 1. Hence, the invention according to Claim 13-15 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-5.

- Claim 17-19
- Cited Document, etc. 1-6
- Remarks

As described above, in the invention described in Cited Document 1, the filter is configured in multiple stages (2 stages in Fig. 2), and it is within a range that could have been easily conceived by a person skilled in the art to make the number of

filters be 3, and it is a well-known art to convert PDM output of PDM output to PCM output as shown in Cited Document 6 ([0034]). Hence, the invention according to Claim 17-19 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-6.

- Claim 20
- Cited Document, etc. 1-7
- Remarks

It is a well-known art to configure a decimation filter provided at an output stage of an oversampling circuit as a CIC filter or a half band filter, as shown in Cited Document 7 (see the description in [0005]). Hence, the invention according to Claim 20 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-7.

- Claim 21, 22
- Cited Document, etc. 1-7
- Remarks

A person skilled in the art could have appropriately determined to determine what value the sampling frequency to be used is, in view of the input signal, the power consumption, and the like. Hence, the invention according to Claim 21, 22 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-7.

- Claim 23, 24
- Cited Document, etc. 1-7
- Remarks

As described above, the digital sensor described in the well-known example is a microphone, and the cited document 4 is a MEMS sensor. The cited document 3 uses an MEMS sensor as the digital sensor in the cited document 4. In addition, the amount of acoustic pressure field is used for the analog field. Hence, the invention according to Claim 23, 24 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-7.

- Claim 25-28
- Cited Document, etc. 1-7

- Remarks

The time delay element in the invention described in the cited document 1 is a buffer, and a delay line and a programmable delay element as a delay element are well known. Hence, the invention according to Claim 25-28 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-7.

- Claim 29,30,35-38,41-43,46-48

- Cited Document, etc. 1-7

- Remarks

Although the definition of the "baseband" is unclear, no remarkable difficulty is found in considering the output of the ADC system as the baseband signal. Hence, the inventions according to Claims 29,30,35 to 38,41, and to 43,46 of the present application could have been easily conceived by a person skilled in the art based on the invention described in the cited document 1 and the well-known art described in the cited document 2-7. 48.

- Claim 49-51

- Cited Document, etc. 1-4,8

- Remarks

Cited Document 8 (see Fig. 6, etc.) describes that an output of a delta sigma modulator is split to give different delays, and no remarkable difficulty is found in configuring the invention described in Cited Document 1 to have a configuration to give different delays like Cited Document 8. Hence, the invention according to Claim 49-51 of the present application could have been easily conceived by a person skilled in the art based on the inventions described in Cited Documents 1 8 and the well-known arts described in Cited Document 2-4.

- Claim 52

- Cited Document, etc. 1-4,8

- Remarks

As described above, in the invention described in Cited Document 1, the filter is configured to have multiple stages (2 stages in Fig. 2). Hence, the invention according to Claim 52 of the present application could have been easily conceived by a person skilled in the art based on the inventions described in Cited Documents 1 8 and the well-known arts described in Cited Document 2-4.

- Claim 53

- Cited Document, etc. 1-5,8

- Remarks

As described above, it is a well-known art to input a signal of a microphone and perform a beamforming operation, and therefore, there is no remarkable difficulty in performing a beamforming operation in the invention described in the cited document 1. Therefore, no remarkable difficulty is found in performing a beamforming operation in the invention described in the cited document 5. 2. Hence, the invention according to Claim 53 of the present application could have been easily conceived by a person skilled in the art based on the inventions described in Cited Documents 1 8 and the well-known arts described in Cited Document 2-5.

- Claim 54

- Cited Document, etc. 1-4, 8

- Remarks

It is well known that a PDM signal is used as an output of a $\Delta \Sigma$ modulator. Hence, the invention according to Claim 54 of the present application could have been easily conceived by a person skilled in the art based on the inventions described in Cited Documents 1 8 and the well-known arts described in Cited Document 2-4.

- Reason 3 (Clarity)

- Claim 1-30, 34-38, 44-54

The analog / digital converter (AD) described in the Claim 1, 16, 34, 44, 49

Regarding the time delay of the signal output from C), the relationship between the analog / digital converter and the other configuration (in particular, the digital sensor, the delta modulator, etc.) is unclear, and the configuration of the invention is unclear. The same can be said for Claims 2-15 and 17-30, 35-38, 45-48, and 50-54. Therefore, the inventions according to Claims 1 to 30, 34, and to 38 and 44-54 are not clear.

Regarding Claims 9 to 15, 21, and to 24, 29, 30, 35 - 38, 40 to 43, 46, 47, and 9, 11 to 37, 40, it is unclear which signals indicate the signals, and the configuration of the invention is not clear, and the configuration of the invention is not clear in Claims to 42, 46, 47. 13, 21, 29, 30, 35. The same applies to Claim 10, 14, 15, 22 - 24, 38, 43. Therefore, The invention in Claims 9-15 and 21-24, 29, 30, 35-38, 40-43, 46, and 47 is not clear.

- Claim 13-15, 53

Regarding the "beamforming" described in Claim 13, 14, 53, it is unclear which signal is to be used in the system. It is not clear whether the beamforming operation expresses that the configuration described in Claim 13, 14, 53 is implemented by any configuration described in Claim 1. In addition, it is unclear what signal the thirteenth signal of the "beam forming process by the second signal" described in

Claim 2 is. The same applies to Claim 15. Therefore, the inventions according to Claims 13 to 15,53 are not clear.

- Claim 44-48

It is unclear whether or not the description in [...] of Claim 44 is included in the configuration of the invention. The same applies to Claim 45-48. Therefore, the invention according to Claim 44-48 is not clear.

<The list of cited documents etc.>

- 1.The description of US Patent No. 05883822
 2. JP 2010-122191A (Document showing well-known arts)
 3. JP 2000-197180A (Document showing well-known arts)
 - 4.The description of US Publication of Unexamined Patent Application No. 2015/0281836 (Document showing well-known arts)
 5. JP 2016-42036A (Document showing well-known arts)
 6. JP 2007-243931A (Document showing well-known arts)
 7. JP 2002-300224A (Document showing well-known arts)
 - 8.The description of US Publication of Unexamined Patent Application No. 2011/0013488
-

Record of the result of prior art search

- Technical fields searched:

IPC

H03M3/00-9/00

H04B14/02

This record of the result of prior art search does not constitute the reasons for refusal.

<Suggestions in amending>

- (1) When making amendment to the description or the scope of claims, the amended parts should be underlined so as to be clearly identified (please refer to Note 6 and 7 of Form 13, Regulations under the Patent Act).
- (2)The amendment shall be made within the scope of the matters stated in the translation of the description or drawings (limited to descriptions in the drawings) of the international patent application at the international filing date, the translation of the scope of claims of the international patent application at the international filing date (in the case where a translation of the amended scope of claims under the provisions of Article 19 (1) of the Patent Cooperation Treaty is submitted, the relevant translation), or the drawing of the international patent application at the international filing date (except the descriptions in the drawings) (hereinafter referred to as a translation, etc.) (in the case of having amended the description, scope of claims or the drawings by submitting a mistranslation correction document, the translation, etc. or the amended description, amended claims or amended drawings). In addition, for the evidence of the legality of each amendment, allege the legality of each amendment in a written opinion with

clear indication of the corresponding parts in the translation, etc. (in the case of amending the description or drawings by submitting a Correction of Mistranslation, the translation, etc., or the amended description, or the scope of claims, or the drawings).

(3) One should make sure not to perform any corrections that invoke a violation against Patent Act Article 17-2(4) when amending the scope of claims.

If you have any question or are willing to make an interview with the examiner to discuss issues on this notification of reasons for refusal, please contact us at: It transfers from a Roppongi temporary government building to this government building, and the Fourth Examination Department starts the business in this government building on Reiwa 2(2020) Thurs., May 7. A telephone and connection by FAX cannot be accepted during the period on April 30 (Thurs.) to Reiwa 2(2020) May 1 (gold) because of a move. After a move changes a FAX number (a telephone number does not change). Please confirm a FAX number by telephone a priori.

Fourth Examination Department digital communication KITAMURA, Norihiko
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A Director General(p.p.), a Director(p.p.), an examiner, an assistant examiner,
HIROKAWA, Hiroshi, KITAMURA, Norihiko, and 9471 9297



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MAGNETIC MEASURING DEVICE AND AD CONVERSION APPARATUS

Inventor(s): SUZUKI HIROHISA; HASEGAWA KAZUO; TAKAGI TAKASHI;
HIROBE KIYO ± (SUZUKI HIROHISA, ; HASEGAWA KAZUO, ;
TAKAGI TAKASHI, ; HIROBE KIYO)

Applicant(s): SANYO ELECTRIC CO; SANYO SEMICONDUCTOR CO LTD; ALPS
ELECTRIC CO LTD ± (SANYO ELECTRIC CO LTD, ; SANYO
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Classification: - international: *G01R33/09; H03H17/00; H03H17/02; H03M3/02*
- cooperative:

Application number: JP20080298623 20081121 [Global Dossier](#)

Priority number(s): JP20080298623 20081121

Abstract of JP2010122191 (A)

PROBLEM TO BE SOLVED: To provide a magnetic measuring device having a plurality of magnetic sensors in which circuit size of its $\Delta\Sigma$ (delta-sigma) type ADC (Analog-to-Digital conversion apparatus) can be adjusted. ;SOLUTION: A $\Delta\Sigma$ modulator 22 in this device is delta-sigma modulated by input of sensor signal from one of the plurality of magnetic sensors 8 switched with prescribed input switching cycles to be selected. A digital filter 24 generates measurement data based on the data oversampled at cycle T by the $\Delta\Sigma$ modulator 22. The digital filter 24 has a counter 34. For the selected magnetic sensor 8, this counter 34 accumulates the data input every cycle T to generate and output measurement data, while resetting any counted value for this magnetic sensor 8 to newly start accumulation for the next magnetic sensor 8 to be selected then. ;COPYRIGHT: (C)2010,JPO&INPIT

(19) 日本国特許庁 (JP)

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(71) 出願人 000001889
 三洋電機株式会社
 大阪府守口市京阪本通2丁目5番5号
 (71) 出願人 506227884
 三洋半導体株式会社
 群馬県邑楽郡大泉町坂田一丁目1番1号
 (71) 出願人 000010098
 アルプス電気株式会社
 東京都大田区雪谷大塚町1番7号
 (74) 代理人 110000154
 特許業務法人はるか国際特許事務所
 (72) 発明者 鈴木 裕久
 群馬県邑楽郡大泉町坂田一丁目1番1号
 三洋半導体株式会社内

最終頁に続く

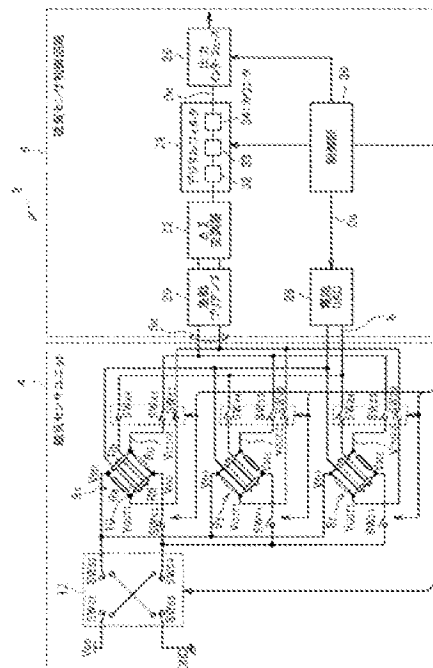
(54) 【発明の名称】 磁気計測装置、及びA/D変換装置

(57) 【要約】

【課題】複数の磁気センサを有した磁気計測装置における $\Delta\Sigma$ 型A/Dの回路規模を抑制する。

【解決手段】 $\Delta\Sigma$ 変調器22は、複数の磁気センサ8のうち所定の入力切替周期で切り換えて選択される1つからのセンサ信号を入力され $\Delta\Sigma$ 変調する。デジタルフィルタ24は、 $\Delta\Sigma$ 変調器22にて周期Tでオーバーサンプリングされたデータに基づいて計測データを生成する。デジタルフィルタ24はカウンタ34を有する。カウンタ34は、選択された磁気センサ8について、周期T毎に入力されるデータを累積加算して計測データを生成して出力し、次に選択される磁気センサ8に対しては前回の磁気センサ8についての計数値をリセットして新たな累積加算を開始する。

【選択図】図1



【特許請求の範囲】

【請求項 1】

複数の磁気センサと、
 所定の切換周期で切り換えられ、前記複数の磁気センサのいずれか 1 つのセンサ信号を選択的に取り出す切換器と、
 前記切換器から出力される前記センサ信号を $\Delta \Sigma$ 変調する $\Delta \Sigma$ 変調器、及び前記 $\Delta \Sigma$ 変調器にてオーバーサンプリングされたデータに基づいて計測データを生成するデジタルフィルタを備えた A/D 変換回路と、
 を有し、
 前記デジタルフィルタは、前記切換周期に同期して、前記 $\Delta \Sigma$ 変調器でのサンプリング周期毎に入力されるデータを累積加算し前記計測データを出力するカウンタを有すること、
 を特徴とする磁気計測装置。

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【請求項 2】

請求項 1 に記載の磁気計測装置において、
 前記デジタルフィルタは、前記サンプリング周期毎に入力されるデータを直近の所定個数について加算し、加算結果のデータを後段へ出力する加算器を、前記カウンタの前段に 1 段又は複数段、直列に接続されること、
 を特徴とする磁気計測装置。

【請求項 3】

複数の磁気センサのうち所定の入力切換周期で切り換えて選択される 1 つからのセンサ信号を計測データに変換する A/D 変換装置であって、
 入力される前記センサ信号を $\Delta \Sigma$ 変調する $\Delta \Sigma$ 変調器と、
 前記 $\Delta \Sigma$ 変調器にてオーバーサンプリングされたデータに基づいて前記計測データを生成するデジタルフィルタと、
 を有し、
 前記デジタルフィルタは、前記入力切換周期に同期して、前記 $\Delta \Sigma$ 変調器でのサンプリング周期毎に入力されるデータを累積加算し前記計測データを出力するカウンタを有すること、
 を特徴とする A/D 変換装置。

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【請求項 4】

請求項 3 に記載の A/D 変換装置において、
 前記デジタルフィルタは、前記サンプリング周期毎に入力されるデータを直近の所定個数について加算し、加算結果のデータを後段へ出力する加算器を、前記カウンタの前段に 1 段又は複数段、直列に接続されること、
 を特徴とする A/D 変換装置。

【発明の詳細な説明】

【技術分野】

【0001】

本発明は、磁気計測装置、及び磁気センサにより得られるセンサ信号を計測データに変換する A/D 変換装置に関する。

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【背景技術】

【0002】

A/D 変換器 (Analog-to-Digital Converter: A/D C) として、 $\Delta \Sigma$ 変調型のものが知られている。 $\Delta \Sigma$ 型 A/D C は、互いに直列に接続された $\Delta \Sigma$ 変調器とデジタルフィルタとを有する。 $\Delta \Sigma$ 変調器は入力されたアナログ信号を目的のサンプリング周波数 f_s より十分に高い周波数 f_o でサンプリング (オーバーサンプリング) し、例えば、1 ビットのデータ列を生成する。その際に生じる量子化誤差は、 $\Delta \Sigma$ 変調器のノイズシェーピング機能により高周波帯域へシフトされる。この高周波帯域への量子化雑音のシフトにより、入力アナログ信号の帯域が包含される低周波帯域では量子化雑音が少なくなる。

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【0003】

デジタルフィルタは、ローパスフィルタとしての機能を有し、高周波帯域を除去することで量子化雑音を低減する。例えば、このローパスフィルタの機能は移動平均処理によって行われる。また、デジタルフィルタは、データレートをオーバーサンプリング周波数 f_{os} から目的のサンプリング周波数 f_s まで落とす処理を行う。

【0004】

例えば、入力アナログ信号がオーディオ信号である場合、ナイキスト周波数を可聴帯域の上限に応じて設定するため、周波数 f_s は32~48kHz程度となる。そのため、周波数 f_s に対応する周期 ξ が、ローパスフィルタリングに要するデータ変換期間より短くなり得る。図8は、この場合を説明する図であり、周期 ξ 毎に設定されるデータ変換期間の相互関係の一例を示す模式図である。この例では、データ変換期間110は周期 ξ の16倍である。例えば、時刻 t_0 に対応する出力データを得るためのデータ変換期間110-1は周期 ξ 毎の期間 $P_1 \sim P_{16}$ に位置し、時刻 $t_0 + \xi$ に対応する出力データを得るためのデータ変換期間110-2は期間 $P_2 \sim P_{17}$ に位置し、両データ変換期間110は重複部分を有する。このように、時刻 $t_0 \sim t_0 + 15\xi$ に対応する16個のデータ変換期間110は重複する部分を有する。

【0005】

この場合に、周期 ξ ずつずれた16個の各データ変換期間110についての移動平均値を求めるには、単純には、並列に動作する16個の加算器等の移動平均手段を設ければよい。しかし、当該構成は回路規模が大きくなる。より回路規模が小さい構成は、長さ ξ の期間 P_1 （例えば、図8に示す期間 $P_1 \sim P_{16}$ ）内のデータレート f_{os} のデータを加算して1つのデータとするデシメーション（間引き）フィルタを用いるものであり、図8の例においては、16個のデシメーションフィルタを設ければ、周期 ξ ずつシフトする各データ変換期間110についての移動平均処理を実現することができる。具体的には、データ変換期間110-1に対しては、16個の期間 $P_1 \sim P_{16}$ それぞれでのデータ加算をデシメーションフィルタで行い、デシメーションフィルタの16個の出力をさらに加算、平均することで、時刻 t_0 に対応する出力データが得られる。次のデータ変換期間110-2に対しては、期間 P_1 に用いたデシメーションフィルタをリセットし、これを用いて期間 P_{17} のデータ加算を実行する。この新たに得られる期間 P_{17} のデシメーションフィルタの出力値と、データ変換期間110-1での処理で既に得られている期間 $P_2 \sim P_{16}$ に対応するデシメーションフィルタの出力値とを用いて、時刻 $t_0 + \xi$ に対応する出力データを得ることができる。以下、同様の処理を繰り返すことで、データレート f_s でデータが得られる。

【特許文献1】特開2005-318204号公報

【発明の開示】

【発明が解決しようとする課題】

【0006】

上述のデシメーションフィルタはDSP（Digital Signal Processor：DSP）やマイコンを用いて構成される。これらDSPやマイコンで構成したデシメーションフィルタは構成が比較的複雑であり、1つの入力データ当たりの処理に複数クロックを要する。そのため、駆動クロックの周波数が高くなるという問題がある。また、DSPにおいて乗算器を用いて構成されるデジタルフィルタは、減衰量を大きくすると回路規模も大きくなるという問題点があった。ΔΣ型ADCは磁気センサの出力信号に対しても用いられる。磁気センサを備えた電子コンパス等の磁気計測装置は、例えば、携帯電話などにも搭載され、小型化が求められている。

【0007】

本発明は上記問題点を解決するためになされたものであり、一層簡単な構成で、回路規模の縮小が図られるAD変換装置を提供し、ひいてはより小型の磁気計測装置を提供することを目的とする。

【課題を解決するための手段】

【0008】

本発明に係る磁気計測装置及びA/D変換装置は、複数の磁気センサのうち所定の入力切
換周期で切り換えて選択される1つからのセンサ信号を $\Delta\Sigma$ 変調する $\Delta\Sigma$ 変調器と、前記
 $\Delta\Sigma$ 変調器にてオーバーサンプリングされたデータに基づいて前記計測データを生成する
デジタルフィルタと、を有し、前記デジタルフィルタは、前記入力切換周期に同期して、
前記 $\Delta\Sigma$ 変調器でのサンプリング周期毎に入力されるデータを累積加算し前記計測データ
を出力するカウンタを有するものである。

【発明の効果】

【0009】

本発明によれば、カウンタが有するローパスフィルタとしての機能に着目し、カウンタ
を $\Delta\Sigma$ 型ADCにおけるデジタルフィルタとして用いる。カウンタを用いたフィルタは、
FIRフィルタなどの乗算器を用いたものに比べて構成が簡単であり、例えば、1つの入
力データ当たりの処理に要するクロック数を1クロックにすることが可能である。また、
例えば、同等の減衰率が得られるフィルタをより小さな回路規模で実現することができる。
すなわち、A/D変換装置及びそれを用いた磁気計測装置の構成をより簡単とし、回路規
模の縮小を図ることができる。

【発明を実施するための最良の形態】

【0010】

以下、本発明の実施の形態（以下実施形態という）について、図面に基づいて説明する。

【0011】

図1は、実施形態に係る磁気計測装置2の概略の回路構成図である。磁気計測装置2は、
磁気センサユニット4と磁気センサ制御回路6とからなる。

【0012】

磁気センサユニット4は、直交座標系（XYZ座標系）の3軸に対応して、3つの磁気
センサ8（磁気センサ8x、8y、8z）を有する。磁気センサ8x、8y、8zはそれ
ぞれ、外部磁界のX軸方向、Y軸方向、Z軸方向の成分を検出する。

【0013】

各磁気センサ8は、抵抗素子Ra、Rb、Rc、Rdからなるブリッジ回路である。抵抗Ra、
Rdは端子V_{IN1}、V_{IN2}の間に直列接続され、また、抵抗Rb、Rcも端子V_{IN1}、
V_{IN2}の間に直列接続される。そして、抵抗Ra、Rdの接続点が出力端子V_{OUT1}
であり、抵抗Rb、Rcの接続点が出力端子V_{OUT2}である。抵抗素子Ra、Rb、Rc、
Rdのうち、磁気抵抗変化を示す素子はRa、Rcである。一方、Rb、Rdは固定抵抗で
ある。このブリッジ回路の一对の入力端子V_{IN1}、V_{IN2}に電圧を印加すると、抵抗
Ra、Rdで分圧された電圧が出力端子V_{OUT1}に得られ、抵抗Rb、Rcで分圧された電
圧が出力端子V_{OUT2}に得られる。抵抗Ra、Rcは外部磁界により抵抗が変化するので、
外部磁界に応じた電圧信号が、出力端子V_{OUT1}、V_{OUT2}から差動形式で出力さ
れる。また、Rb、Rdを磁気抵抗素子、Ra、Rcを固定抵抗素子としても、ブリッジ回路
の差動出力であるため同様に動作する。

【0014】

磁気抵抗素子としては、磁界に対して対称性のある変化を示すものを用いる。このよう
な磁気抵抗素子としては、MR（Magnetoresistance）素子、GIG（Granular In Gap）
素子などが知られている。磁気計測装置2では例えば、MR素子の一種であるGMR（
Giant Magnetoresistance）素子を抵抗Ra、Rcに用いる。

【0015】

磁気センサ8には、コイル10が併設される。コイル10は供給される電流に応じた強
度のバイアス磁界を抵抗Ra、Rcに及ぼし、それらの抵抗を変化させることができる。

【0016】

スイッチSW_{X1}、SW_{Y1}、SW_{Z1}は、3つの磁気センサ8のいずれか1つの端子
V_{IN1}、V_{IN2}に電圧印加を行うために設けられている。

【0017】

磁気センサ8の端子 V_{1s1} 、 V_{1s2} の一方には正電圧 V_{cc} が印加され、他方には接地電位 GND が印加される。この印加電圧の極性は、極性反転部12のスイッチ SW_{s1} ～ SW_{s3} により切り換えることができる。

【0018】

また、磁気センサ8xの出力端子 V_{out1} 、 V_{out2} から磁気センサ制御回路6への信号線にはスイッチ SW_{x2} 、 SW_{x3} が設けられ、同様に、磁気センサ8yの出力端子 V_{out1} 、 V_{out2} にはスイッチ SW_{y2} 、 SW_{y3} が設けられ、磁気センサ8zにはスイッチ SW_{z2} 、 SW_{z3} が設けられる。これら出力端子に設けられたスイッチを切り換えて、3つの磁気センサ8のいずれか1つの出力信号を磁気センサ制御回路6へ入力させることができる。

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【0019】

さらに、各磁気センサ8に併設されるコイル10への電流供給を選択的に行うために、スイッチ SW_{x1} 、 SW_{y1} 、 SW_{z1} が設けられている。

【0020】

磁気センサ制御回路6は、差動プリアンプ20、 $\Delta\Sigma$ 変調器22、デジタルフィルタ24、出力インターフェース26、電流DAC28及び制御部30を有する。

【0021】

差動プリアンプ20は、磁気センサ8の出力端子 V_{out1} 、 V_{out2} から出力される差動形式の磁界計測信号 S_M を増幅する。

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【0022】

$\Delta\Sigma$ 変調器22とデジタルフィルタ24とは $\Delta\Sigma$ 型ADCを構成し、アナログ信号である磁界計測信号 S_M をデジタルデータに変換し磁界計測データ D_M を生成する。差動プリアンプ20にて増幅された磁界計測信号 S_M は $\Delta\Sigma$ 変調器22に輸入される。 $\Delta\Sigma$ 変調器22は、1ビットのAD変換機能を有し、磁界計測信号 S_M を磁界計測データ D_M のサンプルレート（サンプリング周波数 f_s ）よりも十分に高い周波数 f_{os} でオーバーサンプリングして、パルス密度変調（Pulse Density Modulation：PDM）されたパルス列を生成する。このように、少ないビットで粗く量子化された出力には量子化ノイズが多く含まれる。この量子化ノイズは、 $\Delta\Sigma$ 変調器22内部のノイズシェーピング回路で、高周波領域にシフトされる。

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【0023】

$\Delta\Sigma$ 変調器22の出力は、デジタルフィルタ24に輸入される。デジタルフィルタ24は、プリフィルタ32、33とカウンタ34とを備える。デジタルフィルタ24はローパスフィルタ（Low-Pass Filter：LPF）であり、ノイズシェーピング回路にて高周波領域に移された量子化ノイズを減衰させる一方、磁界計測データを表す信号成分が存在する低周波領域を通過させる。

【0024】

カウンタ34は入力されるデータを累積加算する。これは積分処理に相当し、カウンタ34を周波数フィルタとしてみれば一次のLPFの機能を有している。そこで、デジタルフィルタ24は、上述の量子化ノイズを除去するためのメインフィルタとしてカウンタ34を用いている。さらに、デジタルフィルタ24は、カウンタ34の前段にプリフィルタ32、33を備え、高周波領域の減衰率を高めている。

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【0025】

また、デジタルフィルタ24の出力データのデータレートは、カウンタ34からのカウント値の読み出しタイミングに応じて制御できる。すなわち、カウンタ34は、データレートをオーバーサンプリング周波数 f_{os} から目的のサンプリング周波数 f_s に落とすことができる。

【0026】

このように、デジタルフィルタ24は、カウンタ34を用いて、 $\Delta\Sigma$ 変調器22からの高速の1ビットデータにフィルタリングとダウンサンプリングを施し、相対的に低速で多

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ビットのデータとする。これが、磁界計測データ D_M として出力される。

【0027】

デジタルフィルタ 24 にて生成された磁界計測データ D_M は、半導体集積回路等で構成された磁気センサ制御回路 6 からバス等を介してマイコン等へ伝送される。出力インターフェース 26 は時分割で順次得られる X、Y、Z 各軸方向の磁界計測データ D_M をこのデータ伝送に適した形式に変換し、バス等へ送出する。

【0028】

電流 DAC 28 は、バイアス磁界発生手段であるコイル 10 に供給する駆動電流 I_B を生成する。電流 DAC 28 は、制御部 30 から目的バイアス磁界データ D_B を入力され、当該データを、アナログの駆動信号である駆動電流 I_B に変換する。

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【0029】

制御部 30 は、スイッチ $SW_{x1} \sim SW_{x3}$, $SW_{y1} \sim SW_{y3}$, $SW_{z1} \sim SW_{z3}$ を切り換えて、磁気センサ 8x, 8y, 8z のうち、電圧を印加し、その出力を差動プリアンプ 20 へ取り出すものを順番に選択し、また、選択した磁気センサ 8 に対応して、スイッチ SW_{x1} , SW_{y1} , SW_{z1} を切り換えて、当該磁気センサ 8 に併設されたコイル 10 へ電流 DAC 28 から選択的に駆動電流 I_B を供給させる。さらに、制御部 30 は、選択した磁気センサ 8 での 1 回の磁界計測において、極性反転部 12 を制御して印加電圧の極性を反転させる動作を行う。また、制御部 30 は、磁気センサ 8 の切り換えや印加電圧の極性の切り換えに連動してデジタルフィルタ 24 の動作を制御する。さらに、制御部 30 は、磁気センサ 8 の切り換えなどに対応して出力インターフェース 26 の動作を制御する。

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【0030】

図 2 は、プリフィルタ 32 の構成を示す模式的なブロック図である。プリフィルタ 32 は、それぞれ α 個の遅延器 40 及び加算器 42 からなる。各遅延器 40 の遅延時間は、オーバーサンプリングの周期 $T (= 1/f_{os})$ である。遅延器 40-1 $\sim$ 40- α は直列接続され、 $\Delta\Sigma$ 変調器 22 から初段の遅延器 40-1 に入力されるデータは順次、後段の遅延器 40 へ伝達される。初段の加算器 42-1 は、プリフィルタ 32 に入力されるデータと、遅延器 40-1 から出力されるデータとを加算する。2 段目以降の加算器 42-j (j は $2 \leq j \leq \alpha$ なる自然数) は、前段の加算器 42-(j-1) の出力と、遅延器 40-j から出力されるデータとを加算する。最終段の加算器 42- α の出力には、直前にプリフィルタ 32 に入力された ($\alpha + 1$) 個のデータの合計値が得られる。例えば、 $\alpha = 31$ とした場合、加算器 42- α から出力されるデータは 5 ビットのバイナリデータで表される。

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【0031】

図 3 は、プリフィルタ 33 の構成を示す模式的なブロック図である。プリフィルタ 33 は、それぞれ 4 個の遅延器 50 及び加算器 52 からなる。各遅延器 50 の遅延時間は、サンプリング周期 T である。遅延器 50-1 はプリフィルタ 32 から入力されるデータを遅延して、加算器 52-1 に入力する。加算器 52-1 はプリフィルタ 32 から入力されるデータと、遅延器 50-1 から出力されるデータとを加算する。2 段目以降の遅延器 50-j 及び加算器 52-j (ここでは $j = 2, 3, 4$) は、加算器 52-(j-1) からデータを入力される。加算器 52-j は加算器 52-(j-1) から入力されるデータと、遅延器 50-j から出力されるデータとを加算する。例えば、プリフィルタ 32 にて $\alpha = 31$ とした場合、加算器 52-4 から出力されるデータは 9 ビットのバイナリデータで表される。

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【0032】

図 4 は、カウンタ 34 の構成を示す模式的なブロック図である。カウンタ 34 は、全加算器 60 及び D フリップフロップ 62 の対を、計数可能な桁数 (カウンタ長) 分接続した構造を有する。カウンタ 34 は、下位 m ビットの全加算器 60 のデータ入力端子 "A" に計数対象データのビット値 $S0_j$ (ここでは j は $1 \leq j \leq m$ なる自然数) を入力される。残りの上位側のビットの全加算器 60 のデータ入力端子 "A" には、信号 REV が入力される。一方、各全加算器 60 のデータ入力端子 "B" には対をなす D フリップフロップ 62 の出力端子 "Q" の値が入力される。データ信号 REV は最下位ビットの全加算器 60

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のキャリー入力端子 "C I" にも入力される。

【0033】

全加算器60は、端子 "A", "B", "C I" の値に基づいて加算出力端子 "S" 及びキャリー出力端子 "C O" を設定する。加算出力端子 "S" の値は、対をなすDフリップフロップ62の入力端子 "D" に入力される。Dフリップフロップ62はクロック信号C L Kに同期して、入力データをラッチする。一方、キャリー出力端子 "C O" の値はそれぞれ1つ上のビットの全加算器60のキャリー入力端子 "C I" に入力される。

【0034】

制御部30は、極性反転部12から磁気センサ8への印加電圧が正極性の場合には信号R E Vを "0" に設定して、カウンタ34にて現在の計数値に、負極性の場合には "1" に設定する。これにより、正極性の場合には、カウンタ34は、現在の計数値とmビットの計数対象データが表す値とを加算した値を新たな計数値とする。一方、負極性の場合には、カウンタ34は、現在の計数値から計数対象データが表す値を減算した値を新たな計数値とする。

【0035】

カウンタ34の計数値のビット値はDフリップフロップ62の出力端子 "Q" から読み出される。ここで、最上位ビットから所望のビット数だけ読み出せば、読み出さない下位ビット数分の除算をしたのと同様の結果を得ることができる。すなわち、除算器を用いずに平均処理を行うことができる。図4では、カウンタ34は、上位nビットを計数結果のビット値A D_j (ここではjは1 ≤ j ≤ nなる自然数) として出力する。

【0036】

なお、カウンタ34の計数値は、リセット信号R S Tによりリセットすることができる。プリフィルタ32、33及びカウンタ34は共通のクロック信号C L Kで駆動される。クロック信号C L Kの周波数は基本的に、プリフィルタ32への入力データのデータレートf_{in}に等しく設定される。

【0037】

例えば、カウンタ34はカウンタ長を24ビットとすることができる。図4では、入力のS O_mの桁と出力のA D₁の桁とが同じであるが、これは必須ではなく、A D₁の桁はより下位にも、上位にも設定することができる。

【0038】

図5は、デジタルフィルタ24での処理を説明するためのタイミング図である。センサセレクトとして示す波形は、X、Y、Z軸方向のいずれについて磁界計測が行われるかを示している。例えば、X軸の磁気センサ8_xは、X軸のセンサセレクトがH (High)レベルの期間70_xに選択的に、電圧及びバイアス磁界を印加され、磁界計測信号S_mが差動プリアンプ20に入力される。Y軸、Z軸のセンサセレクトも同様のことを示している。X軸、Y軸、Z軸のセンサセレクトは基本的に同じ長さずつ順番に設定される。

【0039】

センサ極性は、極性反転部12の状態を示しており、例えば、L (Low) レベルの期間72が、磁気センサ8への印加電圧が正極性であり、一方、Hレベルの期間74が、印加電圧が正極性とは反転した負極性であるとする。各磁気センサ8の1回の磁界計測期間にて正極性の期間72と負極性の期間74とが同じ長さずつ設定される。図5に示す動作では、各軸のセンサセレクトの期間70_x、70_y、70_zがそれぞれ2等分され、前半が正極性、後半が負極性に設定される。

【0040】

デジタルフィルタ24は、ΔΣ変調器22から出力されるパルス数を例えば、プリフィルタ32、33での前処理の後、カウンタ34で累積加算し、これにより、ΔΣ変調器22の出力スペクトルの高周波領域に対する帯域制限を行う。カウンタ34の累積加算は期間70_x、70_y、70_zのそれぞれにおいて行われ、カウンタ34は各期間70毎に1つの計数結果を出力する。

【0041】

制御部30は正極性の期間72及び負極性の期間74それぞれの期間内に、デジタルフィルタ24を動作させる期間76、78を設定する。期間76と期間78とは同じ長さに設定される。また制御部30は、上述のように信号REVを切り換え、正極性の期間72ではカウンタ34での入力データに対する動作を加算動作とし、負極性の期間74では減算動作とする。このデータ合成を行うことで、後述するように、電流DAC28の出力電流に含まれるフリッカノイズなどに起因して生じる磁界計測信号 S_M のオフセットノイズを低減し、磁界計測データの高精度化を図ることができる。

【0042】

期間78が終了すると、デジタルフィルタ24ではデータ合成処理が完了して1つの磁界計測データ D_M が得られる。制御部30は、得られた磁界計測データ D_M を、次の磁界計測を開始する前の期間80に、加算結果を保持するカウンタ34から読み出し、出力インターフェース26によるデータ転送動作を行う。また、磁界計測データ D_M のデータ転送動作を行うと、続く期間82にて制御部30はカウンタ34をリセットし、次の磁界計測の開始に備える。

【0043】

次に、データ合成処理によるオフセットノイズの低減について説明する。或る外部磁界強度Bでの正極性電圧印加時の磁界計測信号 S_M の値を s_+ 、負極性電圧印加時の磁界計測信号 S_M の値を s_- とする。 s_+ のうち外部磁界の強度に対応する成分を s_o とすると、オフセットノイズ s_M が0でない状態での s_+ は次式で表される。

$$s_+ = s_o + s_M \quad \cdots (1)$$

【0044】

一方、同じ外部磁界強度Bにて s_- は次式で表される。

$$s_- = -s_o + s_M \quad \cdots (2)$$

【0045】

s_+ は、正極性の動作期間76での $\Delta\Sigma$ 変調器22の出力の加算結果に相当し、一方、 s_- は、負極性の動作期間78での加算結果に相当する。(1)式から(2)式を減じると、次式に示されるように、オフセットノイズ s_M が相殺され、外部磁界強度 s_o を求めることができる。

$$s_+ - s_- = 2s_o \quad \cdots (3)$$

【0046】

カウンタ34を期間76では加算動作とし、期間78では減算動作とするデジタルフィルタ24の動作は、(1)、(2)式から(3)式を得る演算に対応しており、この原理により、デジタルフィルタ24にてオフセットノイズが低減される。

【0047】

図6は、プリフィルタ32、33及びカウンタ34それぞれのフィルタ特性の模式図であり、図7はそれらの合成特性の模式図である。図6、図7において横軸は対数スケールで表した周波数であり、縦軸はデシベル表示の減衰率である。これらの図は、 f_{os} 及びクロック信号CLKが6MHzである場合を示している。図6において特性曲線90は、 $\alpha=31$ とした場合のプリフィルタ32のフィルタ特性の包絡線を表し、特性曲線92は、プリフィルタ33のフィルタ特性の包絡線を表し、また、特性曲線94は、カウンタ34での加算回数が 2^{14} 回である場合のカウンタ34のフィルタ特性の包絡線を表している。特性曲線90、92、94のいずれも低周波領域では減衰せず、高周波領域に f_{os} へ向けて減衰率が増加する減衰域を有する。

【0048】

図7の特性曲線100がプリフィルタ32、33及びカウンタ34の合成したフィルタ特性の包絡線である。カウンタ34の前段にプリフィルタ32、33を設けることで、カウンタ34単独の場合(特性曲線94)よりも好適に高周波領域を減衰することができる。なお、プリフィルタの段数及び構成は、上述の実施形態に限定されない。

【0049】

一方、カウンタ34単独のフィルタ特性自体に関しても、加算回数を大きくすることに

より減衰率を向上させることができる。なお、加算回数の増加にはカウンタ長を大きくする必要が生じ得るが、カウンタ長は、上述の全加算器 60 及び D フリップフロップ 62 の対の追加で容易に増加し、加算回数の上限はカウンタ長を 1 つ増やす毎に 2 倍ずつ指数的に増えるので、加算回数の増加が回路規模へ与える影響は少ない。

【図面の簡単な説明】

【0050】

【図1】 本発明の実施形態に係る磁気計測装置の概略の回路構成図である。

【図2】 第1のプリフィルタの構成を示す模式的なブロック図である。

【図3】 第2のプリフィルタの構成を示す模式的なブロック図である。

【図4】 カウンタの構成を示す模式的なブロック図である。

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【図5】 磁気センサ制御回路のデジタルフィルタでの処理を説明するためのタイミング図である。

【図6】 2つのプリフィルタ及びカウンタそれぞれのフィルタ特性の模式図である。

【図7】 2つのプリフィルタ及びカウンタを合成したフィルタ特性の模式図である。

【図8】 オーディオ信号をサンプリングする従来技術において、連続するサンプリングタイミングに対するデータ変換期間を示す模式図である。

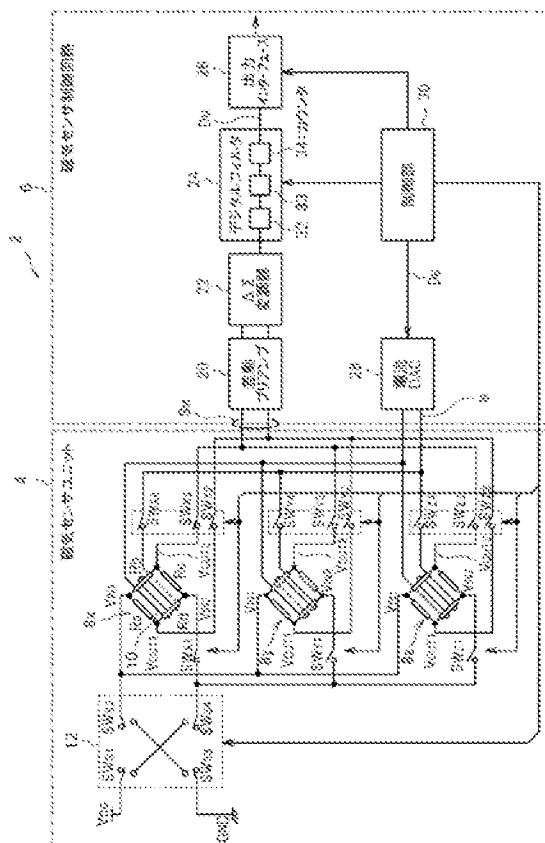
【符号の説明】

【0051】

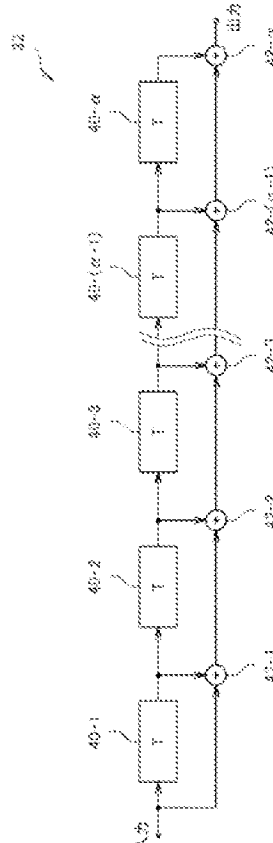
2 磁気計測装置、4 磁気センサユニット、6 磁気センサ制御回路、8 磁気センサ、10 コイル、12 極性反転部、20 差動プリアンプ、22 $\Delta\Sigma$ 変調器、24 デジタルフィルタ、26 出力インターフェース、28 電流DAC、30 制御部、32、33 プリフィルタ、34 カウンタ、40、50 遅延器、42、52 加算器、60 全加算器、62 Dフリップフロップ。

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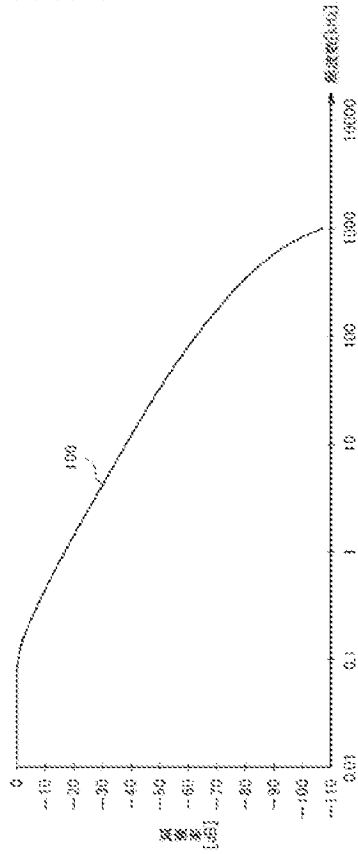
【図1】



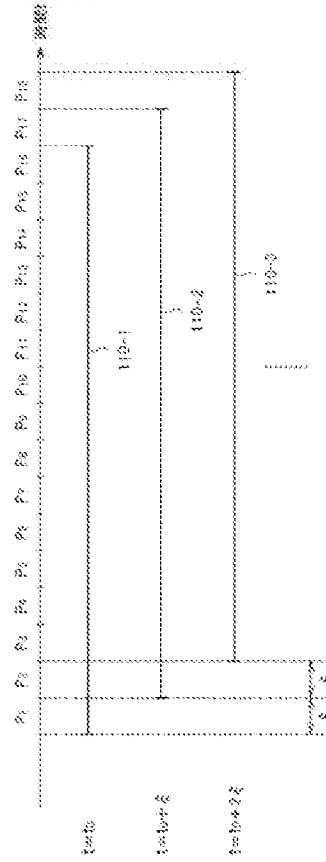
【図2】



【図 7】



【図 8】



フロントページの続き

(72)発明者 長谷川 和男

群馬県邑楽郡大泉町坂田一丁目1番1号 三洋エルエスアイデザイン・システムソフト株式会社内

(72)発明者 高木 尚

東京都大田区雪谷大塚町1番7号 アルプス電気株式会社内

(72)発明者 廣部 希世

東京都大田区雪谷大塚町1番7号 アルプス電気株式会社内

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DIRECTIVITY CONTROLLER FOR MICROPHONE SYSTEM

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Abstract of JP2000197180 (A)

PROBLEM TO BE SOLVED: To enhance precision of delay of a delay device used especially for signal processing of the title controller. **SOLUTION:** The directivity controller obtains a synthesis directivity characteristic by subtracting a signal from one of microphones opposed to each other at a prescribed distance in between and a signal from the other that is delayed by a time in response to the prescribed distance. A means that conducts the time delay processing as above especially consists of an oversampling processing section 42d that samples an incoming digital signal with a sampling frequency at an integer multiple of the frequency of the incoming signal, an LPF 42e that limits a frequency band of the oversampled signal, an oversampling delay section 42f that delays the signal whose frequency band is limited by a prescribed sampling time, and a down sampling processing section 42g that applies down sampling to the delayed signal to restore it to the original sampling signal or the like.

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(71)出願人 000004329

日本ビクター株式会社

神奈川県横浜市神奈川区守屋町3丁目12番
地

(72) 發明者 岡部 義尚

神奈川県横浜市神奈川区守屋町3丁目12番
地 日本ビクター株式会社内

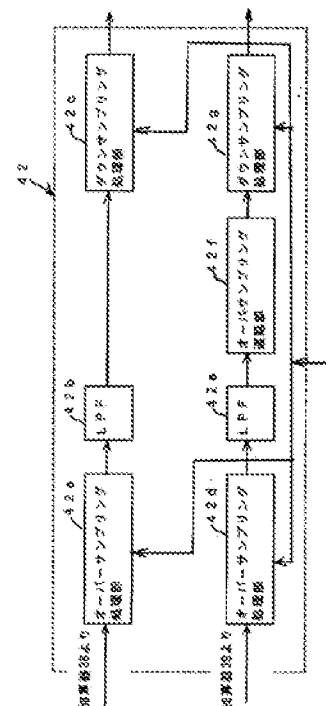
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(54) 【発明の名称】 マイクロホン装置における指向性制御装置

(57) 【契約】

【課題】 マイクロホン装置の指向性制御装置に関し、特にその信号処理に使用する遅延器の遅延精度を向上させることにある。

【解決手段】 所定距離を介して対向配置したマイクロホンの一方側に基づく信号と、他方側に基づく信号を前記所定距離に応じた時間遅延させた信号とを減算して合成指向特性を得るための指向性制御装置であり、特に、前記の時間遅延処理を行わせる手段を、入来デジタル信号の整数倍のサンプリング周波数でサンプリングするオーバーサンプリング処理部4 2 d、このオーバーサンプリングした信号の帯域を制限するLPF 4 2 e、この帯域制限された信号を所定サンプル分遅延させるためのオーバーサンプリング遅延部4 2 f、この遅延した信号をもとのサンプリング信号となるようにダウンサンプリングするダウンサンプリング処理部4 2 g等で構成したものである。



【特許請求の範囲】

【請求項1】 デジタル信号に変換された、所定距離を介して対向配置される一対のマイク手段に基づく信号又はこれらマイク手段に基づく信号と実質的に等価な信号を、一方のマイク手段に基づく信号又はこの一方のマイク手段に基づく信号と実質的に等価な信号と、他方のマイク手段に基づく信号又はこの他方のマイク手段に基づく信号と実質的に等価な信号に前記所定距離に応じた時間遅延を加えた信号と、を演算処理して合成指向特性を得るようにしたマイクロホン装置における指向性制御装置において、

前記所定距離に応じた時間遅延を行う遅延手段を、変換されたデジタル信号のサンプリング周波数の整数倍のサンプリング周波数でオーバーサンプリングする手段と、このオーバーサンプリングされた信号を所定の帯域成分に制限するための帯域フィルタ手段と、この帯域制限された信号を前記時間遅延に対応したサンプル数分だけ遅延するためのオーバーサンプリング信号遅延手段と、この遅延した信号を前記オーバーサンプリングされる前のデジタル信号と同期した同一のサンプリング周波数の信号となるようにダウンサンプリングするための手段とで構成する共に、

前記一方のマイク手段に基づく信号又はこの一方のマイク手段に基づく信号と実質的に等価な信号に、前記オーバーサンプリングする手段、前記帯域フィルタ手段、及び前記ダウンサンプリングするための手段によって生じる遅延時間分に相当する遅延量を調整するための遅延量調整手段を設けたことを特徴とするマイクロホン装置における指向性制御装置。

【請求項2】 請求項1の指向性制御装置を、マイク手段に基づく信号を記録するための記録手段の後段側に設けるようにしたことを特徴するマイクロホン装置における指向性制御装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、複数のマイクロホンを使用して、その出力信号を電気的に演算することにより、マイクロホンの指向特性や指向性軸の方向を可変するマイクロホン装置の指向性制御装置に関する。

【0002】

【従来の技術及び発明が解決しようとする課題】 複数のマイクロホンの出力信号を電気的に演算することでマイクロホンの指向特性を制御する装置としては、ビデオカメラの集音マイクロホン等で可変指向性やズーム特性を得る装置として数々の提案がある。その主な演算処理内容は、加算、減算、遅延処理であり、アナログ処理で行われるものが殆どである。

【0003】 ここで、電気的演算処理を行う例として、図8に示す2個の無指向性マイクに遅延処理を加えて単一指向特性を得る場合を考察してみる。同図において、

無指向性マイクロホンM10の出力と、距離d離れた無指向性マイクロホンM11の出力を、距離dの音波伝達時間に相当する遅延 τ を遅延器12で遅延した信号とで減算すると、図9に示す略ハート形の単一指向特性が得られる。

【0004】 この場合、遅延 τ は全周波数帯域にわたって一定であることが理想であるが、アナログ遅延処理では位相シフトにより遅延を実現することになるので、全周波数帯域にわたって任意の遅延量で遅延特性を一定に保つことは困難である。

【0005】 また、当該出願人は、先に図10に示すように、指向性の中心Oを合わせて、指向性軸X、Yが互いに直交するように2個の一次双指向性マイクロホンM12、M13を配置し、その出力に、それぞれ $\cos\theta$ と $\sin\theta$ とを乗算することにより、図11に示すようにマイクロホンM12の指向特性17とマイクロホンM13の指向特性18との間である角度 θ の位置に合成特性19を得る方法を提案した。

【0006】 この場合、 $\cos\theta$ と $\sin\theta$ の乗算を行うことになるが、アナログ回路で正確に実現するためには、相当複雑な回路構成を必要とすることになり、デジタル処理にて行う方が容易であり、正確である。

【0007】 ところで、前述したように、マイクロホンの指向特性制御をデジタル演算処理にて行うことは大きな利点であるが、遅延処理に必要な遅延量は扱う周波数範囲にもよるが、可聴帯域では大凡25 μ sから100 μ sであり、また、マイクロホン間の距離により任意可変する必要がある。

【0008】 一方、デジタル化された信号データは、そのサンプリング時間単位によってしか遅延量を可変できない。例えば、サンプリング周波数が48kHzならば、約20、8 μ s単位で、又、32kHzならば、31、25 μ s単位でしか遅延量を可変できず、マイクロホン間の距離に応じた可変ができないという問題点があった。

【0009】 そこで、本発明は、所定距離間にあるマイクロホンの出力に所定の演算処理をし、一方の信号に所定の距離間に基づいた遅延量を加算し、互いの出力を減算して合成特性を得るための指向性制御装置において、その遅延量を加算するにあたり、マイクロホン間の距離がどのような距離であっても、その距離に応じた正確な遅延量を生成して、正確な指向特性の制御が可能となる指向性制御装置を提供することにある。

【0010】

【課題を解決するための手段】 本願発明は、上記課題を解決するために、以下の1)及び2)の手段より成るものである。即ち、

【0011】 1) デジタル信号に変換された、所定距離を介して対向配置される一対のマイク手段に基づく信号又はこれらマイク手段に基づく信号と実質的に等価な

信号を、一方のマイク手段に基づく信号又はこの一方のマイク手段に基づく信号と実質的に等価な信号と、他方のマイク手段に基づく信号又はこの他方のマイク手段に基づく信号と実質的に等価な信号に前記所定距離に応じた時間遅延を加えた信号と、を演算処理して合成指向特性を得るようにしたマイクロホン装置における指向性制御装置において、前記所定距離に応じた時間遅延を行う遅延手段を、変換されたデジタル信号のサンプリング周波数の整数倍のサンプリング周波数でオーバーサンプリングする手段と、このオーバーサンプリングされた信号を所定の帯域成分に制限するための帯域フィルタ手段と、この帯域制限された信号を前記時間遅延に対応したサンプル数分だけ遅延するためのオーバーサンプリング信号遅延手段と、この遅延した信号を前記オーバーサンプリングされる前のデジタル信号と同期した同一のサンプリング周波数の信号となるようにダウンサンプリングするための手段とで構成する共に、前記一方のマイク手段に基づく信号又はこの一方のマイク手段に基づく信号と実質的に等価な信号に、前記オーバーサンプリングする手段、前記帯域フィルタ手段、及び前記ダウンサンプリングするための手段によって生じる遅延時間分に相当する遅延量を調整するための遅延量調整手段を設けたことを特徴とするマイクロホン装置における指向性制御装置。

【0012】2) 請求項1の指向性制御装置を、マイク手段に基づく信号を記録するための記録手段の後段側に設けるようにしたことを特徴するマイクロホン装置における指向性制御装置。

【0013】

【発明の実施の形態】以下、本発明の実施の形態につき、好ましい実施例により説明する。図1は、本願発明に係るマイクロホン装置における指向性制御装置を採用するために前提となるマイクロホン装置の一例で、各マイクロホンの配置を示した図であり、前述の図10及び図11で説明したと同様の考え方に基づくものである。まず、このマイクロホン装置の原理及びその構成につき詳細に説明する。

【0014】同図において、M1、M2、M3、M4は、双指向性のマイクロホンで、これらのマイクロホンは、それぞれの指向性軸X、Yが同一平面上で直交すると共に、その直交点Oから各マイクロホンM1、M2、M3、M4に至る距離が等しいように配置された構成となっている。例えば、各マイクロホンM1及びマイクロホンM2の指向特性は、それぞれ同一平面上の直交する指向性軸X及び指向性軸Y上に形成され、図3における符号20、21として示されよう二つの円形を連ねたような特性となっている。

【0015】また、マイクロホンM3及びマイクロホンM4は、それぞれ同一平面上の直交する指向性軸X及び指向性軸Y上に形成され、図3における符号20'、2

1'として示されるような特性となっている。なお、この図3では、それぞれの特性原点が全て一致した状態で示されているが、特性方向と特性範囲の形状とを簡略的に図示したいがために示したもので、実際には各々の特性原点は離れている。これ以降の特性図においても、同一趣旨による図示としてある。

【0016】ここで、例えば、図2におけるマイクロホンM1の指向性軸Xからの角度を ϕ とすると、マイクロホンM1の指向特性は $\cos \phi$ で表され、マイクロホンM2の指向特性は $\sin \phi$ で表される。

【0017】そして、ここで、指向性軸Xに対して、目標とする双指向特性への角度を θ とし、 $0 \leq \theta \leq \pi/2$ の角度範囲の指向性について考察してみる。マイクM1の出力に $\cos \theta$ を、マイクM2の出力に $\sin \theta$ をそれぞれ乗算して加算すると、その合成特性は、 $\cos \theta \times \cos \phi + \sin \theta \times \sin \phi$ で表される。

【0018】図2におけるマイクロホンM1とマイクロホンM2とを結ぶ直線と、目標とする角度 θ の指向性軸Pとの交点Aを指向原点とする双指向性が得られる。その双指向性は、例えば、図3における指向性軸P上の2つの円として示される合成一次双指向性24である。

【0019】また、次に、マイクロホンM3及びマイクロホンM4の合成特性については、マイクロホンM3の出力に $\cos(\pi + \theta)$ を、マイクロホンM4の出力に $\sin(\pi + \theta)$ をそれぞれ乗算し、それらを加算すると、そのときの合成特性は、 $\cos(\pi + \theta) \times \cos \phi + \sin(\pi + \theta) \times \sin \phi$ で表される。

このときの合成特性は、マイクロホンM3とマイクロホンM4とを結ぶ直線と、目標とする角度 θ の指向性軸Pとの交点Bを特性原点とする双指向性が得られる。また、その双指向性特性の形状は、図3における符号24'として示され、特性24と同一形状である。また、この場合においても、前記と同様に、実際には、特性24、24'の特性原点A、Bは同一となっており、図示を簡略化するために便宜上同一点としてある。

【0020】次に、前記のようにして得られたマイクロホンM3、M4の合成出力に、それぞれの合成特性の特性原点A、B間の距離の音波伝搬時間に相当する遅延を加え、その後に互いの合成出力を減算すると、目標指向性方向と反対側からの音は互いに位相がほぼ同一になり、前記マイクロホンM1、M2及びマイクロホンM3、M4合成出力が相殺され、目標指向性方向からの音は、前記の音波伝搬時間の2倍に相当する位相差に基づく出力が得られて、図4における符号25として示される単一狭指向特性25が得られる。

【0021】また、次に、 $\pi/2 < \theta \leq \pi$ の角度範囲において、図5における指向性軸Q上にあるような単一狭指向特性26を得たい場合には、今度はマイクロホンM2

とマイクロホンM3とを一組としてこれらの合成出力を得ると共に、これらに180度対向位置にあるマイクロホンM4とマイクロホンM1とを一組とした合成出力を得て、その一方に両者の特性原点間の距離による音波伝搬時間に相当する遅延を加え、互いに減算することにより単一狭指向特性26が得られる。

【0022】また、 $\pi < \theta \leq 3\pi/2$ と $3\pi/2 < \theta < 2\pi$ との角度範囲における単一狭指向特性を得るためには、マイクロホンM3とマイクロホンM4及びマイクロホンM1とマイクロホンM2、又マイクロホンM4とマイクロホンM1及びマイクロホンM2とマイクロホンM3の組み合わせで前記と同様な処理を行うことで求めることができる。

【0023】そして、上記のように構成する各マイクロホンは、例えば、周知の取り付け法により、ビデオカメラの本体部に取り付けたり、或いは、各ユニットを一つの筐体内に納めて別体にして使用したりすることが可能である。

【0024】次に、上記のような構成をしたマイクロホン装置から、前記の理論に基づいて構成された本発明の実施例に係る指向性制御装置につき説明する。図6は、その実施例に係る指向性制御装置の概略ブロック図である。同図において、指向性制御装置は、各マイクロホンから出力される出力信号を入力するため入力端子30、31、32、33と、それぞれが各マイクロホンに接続され、図示しない制御手段により入力を切り換えられる4回路の入出力マトリックスSW回路（SW内の接続線は図示が複雑になるため省略してある）と、図示しない記憶手段のテーブルに予め用意されている $\cos \theta$ や $\sin \theta$ 等の係数を乗算するための乗算器34、35、36、37と、これら乗算器の出力信号を加算するための加算器38、39と、詳細に後述する本発明の要部となる回路で、入力信号を入力信号間で、各特性原点間の距離による音波伝搬時間に相当する時間（ τ ）等を相対的に遅延させるため遅延器42と、互いの合成出力を減算するための減算器43と、減算された信号をアナログ信号に変換するためのD/A変換器44と、このアナログ信号を出力するための出力端子45とから概略構成されている。

【0025】次に、上記のような構成による動作につき説明する。まず、目標とする指向性の角度が図4に示すような θ の角度方向であるような場合には、例えば、図示しない操作手段により予め角度 θ 方向を選んでおく。この情報が図示しない制御手段に供給され、ここで、制御手段内の図示しない記憶テーブルから $\cos \theta$ 、 $\sin \theta$ 、 $\cos(\pi + \theta)$ 、 $\sin(\pi + \theta)$ の各係数がそれぞれ選ばれる。

【0026】これと同時に、制御手段からマトリックスSW回路に切替信号が供給され、マイクロホンM1と乗算器34とが、マイクロホンM2と乗算器35とが、マ

イクロホンM3と乗算器36とが、マイクロホンM4と乗算器37とが、それぞれ接続されるように切り換えられる。

【0027】そして、双指向性特性のマイクロホンM1、M2、M3、M4から出力されたアナログ信号は、A/D変換器29においてそれぞれデジタル信号に変換されて、マトリックスSW回路を通じて乗算器34、35、36、37にそれぞれ供給される。これら乗算器では、このデジタル信号に前記の予め選択された $\cos \theta$ 、 $\sin \theta$ 、 $\cos(\pi + \theta)$ 、 $\sin(\pi + \theta)$ の各係数が供給されてそれぞれ乗算処理される。

【0028】次に、これら乗算器34、35と乗算器36、37とで処理された信号は、次段の加算器38、39でそれぞれ加算され、一方の加算器38からの合成信号は本発明の要部である遅延手段42内に供給され、ここで、他方の加算器39から供給される合成信号の後述する処理を行う際に生じる遅延量との調整処理がされて減算器43の一方に供給される。また、他方の加算器39から出力される合成信号も遅延器42に供給され、ここで、詳細に後述する特性原点A、B間の距離による音波伝搬時間 τ に相当する正確な両信号間の相対的な時間遅延等の処理がなされるようになっている。

【0029】そして、この遅延された信号と前記の一方より入来した合成信号とが減算器43において互いに減算され、その減算信号がD/A変換器44で再びアナログ信号に変換されて出力端子45から目標角度 θ 方向への単一狭指向特性が得られた信号が取り出されることになる。即ち、図4で示す指向特性25が得られる。

【0030】また、図5における指向特性26で示すような方向での単一狭指向特性を得たい場合には、前記と同様にして操作手段により予めその所望方向を選んでおく。これに基づき制御手段では、今度は、マトリックスSW回路をマイクロホンM2、M3を一組とし、マイクロホンM4、M1を一組とするようにそれぞれ切り換え制御を行う。

【0031】即ち、マイクロホンM2が乗算器34と、マイクロホンM3が乗算器35と、マイクロホンM4が乗算器36と、マイクロホンM1が乗算器37と、それぞれ接続されるように切り換えられ、記憶テーブルから前記の所定の係数が選ばれる。そして、各マイクロホンにおいて集音された信号は、制御装置内で前述と同様の処理が施されて、出力端子45からは図5に示すような単一狭指向特性26が得られることになる。

【0032】次に、今度は、図4に示す指向特性25と180度逆方向の単一狭指向特性を得たいような場合には、前記と同様にして操作手段により予めその所望方向を選んでおく。制御手段では、マトリックスSW回路をマイクロホンM3、M4を一組とし、マイクロホンM1、M2を一組とするようにそれぞれ切り換えられる。

即ち、マイクロホンM3が乗算器34と、マイクロホン

M4が乗算器35と、マイクロホンM1が乗算器36と、マイクロホンM2が乗算器37と、それぞれ接続されるように切り換えられ、前述の所定係数が選ばれる。

【0033】これにより、乗算器38、39から出力される合成出力が減算器43で互いに減算処理され、出力端子44からは、180°～270°度の位置に指向特性25で示すような単一狭指向特性が得られることになる。

【0034】更にまた、図5の特性26と180°度逆方向の単一狭指向特性を得たい場合には、操作手段によりその希望する角度方向を選ぶ。これにより、マトリックスSW回路をマイクロホンM4、M1を一組とし、マイクロホンM2、M3を一組とし、マイクロホンM4が乗算器34と、マイクロホンM1が乗算器35と、マイクロホンM2が乗算器36と、マイクロホンM3が乗算器37と、それぞれ接続されるように切り換えられる。また、前述の所定係数が選ばれる。

【0035】この結果、前述と同じような信号処理が施されて、出力端子45からは図5の特性26と180°度逆方向の単一狭指向特性が得られることになる。このように、操作手段等により所望方向の角度方向を選ぶことにより、水平方向360°度の任意の方向に同一レベルの単一狭指向特性が得られることになる。本願実施例の指向性制御装置は、概略以上のように動作する。

【0036】次に、本願発明の要旨である遅延器42の構成及び動作につき詳細に説明する。図7は、その遅延器42の詳細ブロック図であり、遅延器42は加算器38の合成信号の入来側にオーバーサンプリング部42aと、帯域制限フィルタ(LPF)42bと、ダウンサンプリング処理部42cとが設けられ、加算器39の合成信号の入来側にオーバーサンプリング部42dと、帯域制限フィルタ(LPF)42eと、オーバーサンプリング遅延部42fと、ダウンサンプリング処理部42gとが設けられ、各サンプリング処理部42a、42c、42d、42gには図示しない基準信号生成部より同期信号が入来する構成となっている。

【0037】この遅延器42では、他方側である加算器39から入来する合成特性信号は、オーバーサンプリング部42dに供給され、ここで、もとのサンプリング周波数の整数倍のサンプリング周波数のデジタル信号に変換され、次段のLPF42eに供給される。LPF42eではオーバーサンプリング時に発生する折り返し歪み成分等の余分な帯域成分の除去が行われる。

【0038】そして、帯域制限された信号は、次段のオーバーサンプリング遅延部42fに供給され、ここで、必要とする遅延量のオーバーサンプリング信号データ数分だけ遅延される。即ち、この処理部42fで、特性原点A、B間の距離による音波伝搬時間 τ に相当する正確な時間の遅延がなされることになる。

【0039】例えば、この遅延処理では、元のサンプリング周波数を48kHzとし、8倍のオーバーサンプリ

ング周波数のデジタル信号を得るとすれば、オーバーサンプリング信号1データ遅延当たり、 $1/(8 \times 48 \text{ kHz}) \approx 2.604 \mu\text{s}$ の遅延処理が可能となる。そして、前記のように遅延された信号は、更に次段のダウンサンプリング処理部42gに供給され、ここで、他方から入来する同期信号に同期して、元のサンプリング周波数の信号に同期するようにダウンサンプリングされる。

【0040】また、一方側である加算器38から入来する合成特性信号は、オーバーサンプリング部42aに供給されて、オーバーサンプリング部42dと同じ元のサンプリング周波数の整数倍のサンプリング周波数のデジタル信号に変換され、次段のLPF42bにおいてLPF42cと同じ折り返し歪み成分等の余分な帯域成分の除去が行われ、ダウンサンプリング処理部42cにおいて再びダウンサンプリング処理部42fと同様に元のサンプリング周波数の信号に同期した信号にダウンサンプリングされる。この一方側の各処理部42a、42b、42cは、他方側に設けられるオーバーサンプリング部42d、BPF42e、及びダウンサンプリング処理部42gに対応して設けられたもので、各部で処理を行う際に生じる遅延時間を合わせるために設けたいわゆる遅延量調整手段であり、これにより正確な相対遅延時間を得ることができる。

【0041】そして、前記のようにして精度良く遅延された信号は、図6に示す減算器43に供給され、ここで、他方から入来する合成信号と減算処理されるようになっているものである。

【0042】以上のように、遅延器42では、オーバーサンプリングにより、そのオーバーサンプリング比に応じた遅延量を設定できるため、極めて短い遅延を行う場合にも簡単な構成で、かつ、正確な遅延が行えるものとなる。

【0043】このような遅延器を採用した本実施例の指向性制御装置によれば、所定距離間にあるマイクロホンの出力を合成して、所定の合成特性を得るに際し、その信号処理過程で、正確な遅延量の生成が必要な場合にも、その遅延量に対応した正確な遅延量を生成できるので、水平方向360°度の任意の角度方向に亘って同一レベルの理想的な単一狭指向特性が得られる。

【0044】なお、上記実施例においては、遅延器42を加算器39の後段部に設ける構成としたが、これに限ることなく、乗算器36、37の前段側に用意しても良い。

【0045】また、上記実施例の指向性制御装置は、テープ等が装着される記録手段の前段側に用意することでもできるし、ビデオカメラ等の撮影時に、リアルタイムの指向性制御が難しいような場合には、図6におけるA/D変換器29までの上流側を記録手段の前段側に用意し、入力端子以降の指向性制御装置を記録手段の後段側

に用意しても良い。このような構成の場合には、それぞれの角度方向の音声をチャンネル毎に一旦記録媒体に記録し、その後の編集時等において、再生画像を見ながら、ゆっくりと所望方向の音声を取り出すことができる。

【0046】更に、上記実施例の指向性制御装置は、マイクロホン装置と一体に設けても良く、別体装置としても良い。

【0047】また、更に、上記実施例では、A/D変換器29を、マイクロホン装置側に用意したが、指向性制御装置内に用意しても良い。

【0048】更に、また、前記本発明の要旨である遅延器は、前述したような構成の指向性制御装置に限らず、デジタル信号の遅延量の可変を必要とする信号処理などのような構成の装置でも良く、特に、1サンプリングデータより短い遅延を行わせる場合には好適な回路である。

【0049】また、上記実施例では、一方側と他方側の信号を一对の双指向性マイクロホンから得るようにしているが、これに限らず4個以上の無指向性のマイクロホンを所定の位置に配置し、これらから本実施例の一对の双指向性のマイクロホンから得ると実質的に等価な信号を合成し、これらの信号に基づいて、本実施例で行うような指向性制御を行うようにしても良い。

【0050】

【発明の効果】請求項1記載の指向性制御装置によれば、簡単な構成で正確な遅延処理が行え、理想的な指向特性が得られる。また、特に、請求項2記載の指向特性制御装置によれば、前述の効果に加えて、信号記録後の編集時等において、再生画像を見ながら、ゆっくりと所望方向の音声を取り出すことができる等の効果を奏する。

【図面の簡単な説明】

【図1】本発明に適用されるマイクロホン装置の一実施例に係る各マイクロホンの配置構成図である。

【図2】一実施例に係るマイクロホン装置における各マイクロホンと目標角度方向への指向性を得るための説明*

*図である。

【図3】0～90度方向への合成特性を得るための説明図である。

【図4】0～90度方向への単一狭指向性を得るための説明図である。

【図5】90～180度方向への単一狭指向性を得るための説明図である。

【図6】本発明の一実施例に係る指向性制御の概略構成図である。

【図7】遅延器42の詳細ブロック図である。

【図8】従来のマイクロホン装置の説明図である。

【図9】合成指向特性を示した図である。

【図10】本願出願人が先に提案したマイクロホン装置の説明図である。

【図11】図10のマイクロホン装置における合成特性を示す図である。

【符号の説明】

10, 11, 12, 13 双指向特性

14 単一指向特性

15 無指向特性

20, 20', 21, 21', 24, 24' 指向特性

25, 26 単一狭指向特性

29 A/D変換器

34, 35, 36, 37 乗算器

38, 39 加算器

42 遅延器

42a, 42d オーバサンプリング処理部

42b, 42e BPF

42c, 42g, ダウンサンプリング処理部

42f オーバサンプリング遅延部

43 減算器

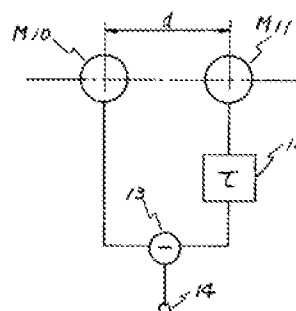
44 D/A変換器

A, B 指向原点

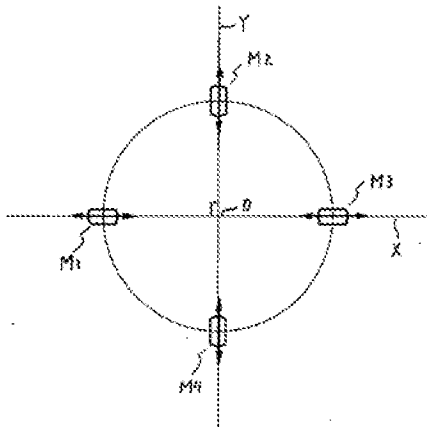
M1, M2, M3, M4 マイクロホン

P, Q 指向性軸

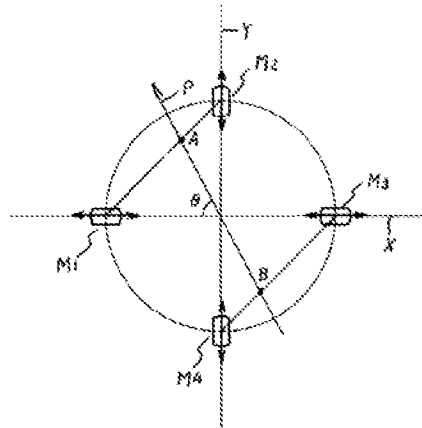
【図8】



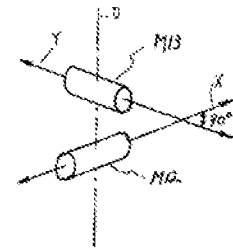
【図1】



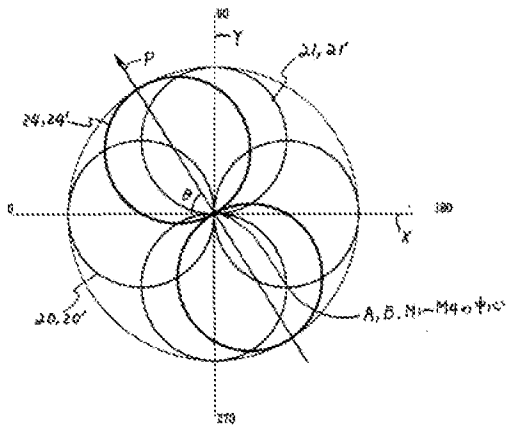
【図2】



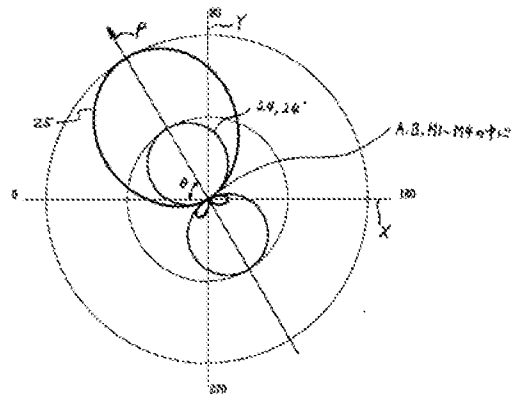
【図10】



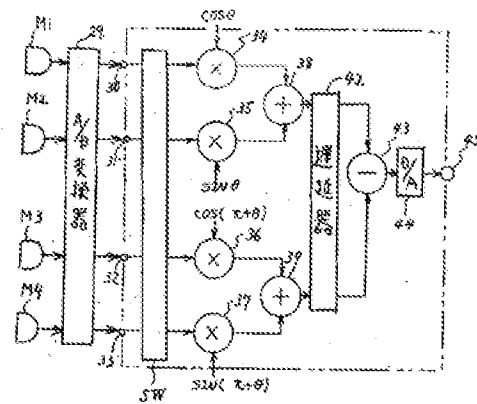
【図3】



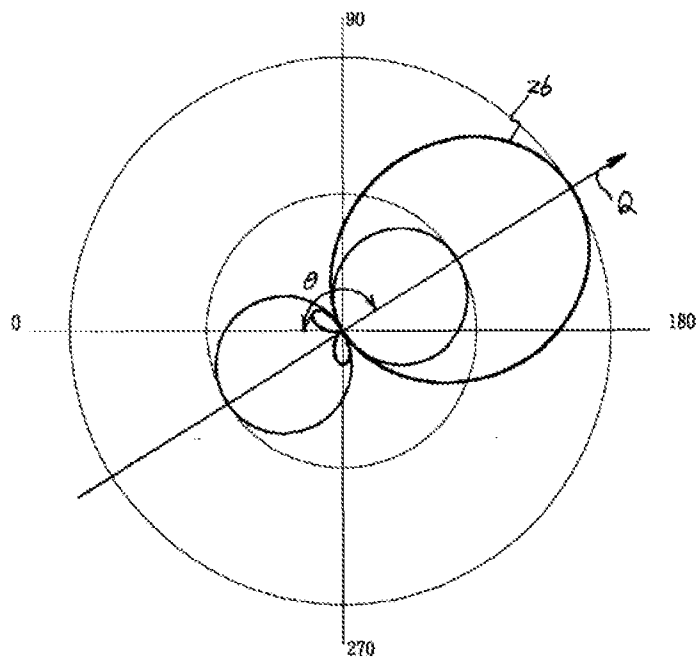
【図4】



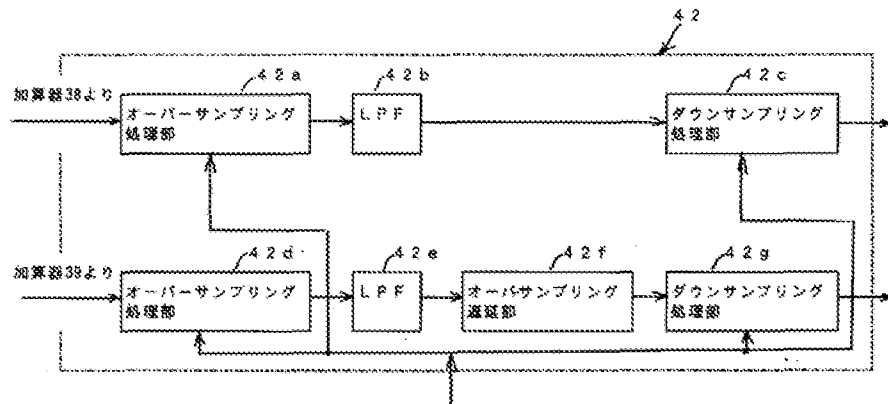
【図6】



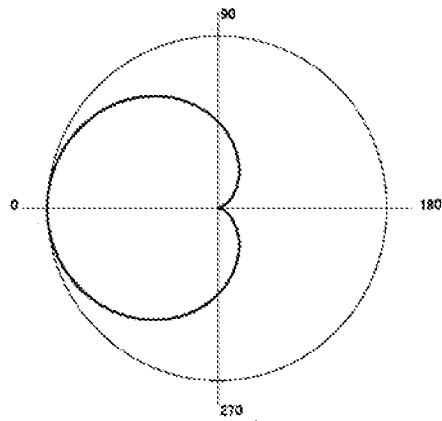
【図5】



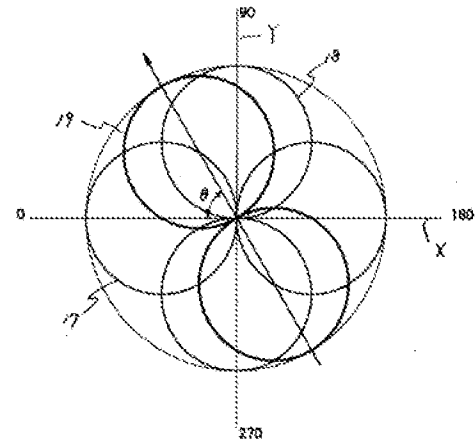
【図7】



【図9】



【図11】





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RECEIVER**Inventor(s):** IDE TERUJI ± (IDE TERUJI)**Applicant(s):** HITACHI INT ELECTRIC INC ± (HITACHI KOKUSAI ELECTRIC INC)**Classification:** - **international:** *H04B1/26; H04B14/04; H04L27/38;* (IPC1-7): H04B1/26; H04B14/04; H04L27/38
- **cooperative:****Application number:** JP20010097977 20010330**Priority number(s):** JP20010097977 20010330**Abstract of JP2002300224 (A)**

PROBLEM TO BE SOLVED: To select a sampling rate of a signal in a demodulation processing regardless of the sampling rate of A/D conversion of an input side in a receiver of an orthogonal demodulation system. SOLUTION: A receiver is provided with a clock oscillator 105 that can select the output frequency of A/D conversion independently of the sampling rate of the A/D conversion, interpolation filters 101 and 102 perform rate conversion of the common mode and orthogonal components of a band-limited baseband by using resample processing by this output clock to be the signal of a desired sampling rate, and demodulation processing is subsequently carried out.

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(71) 出願人 000001122

株式会社日立国際電気

東京都中野区東中野三丁目14番20号

(72) 発明者 井手 輝二

東京都中野区東中野三丁目14番20号 株式

会社日立国際電気内

(74) 代理人 100093872

弁理士 高崎 芳祐

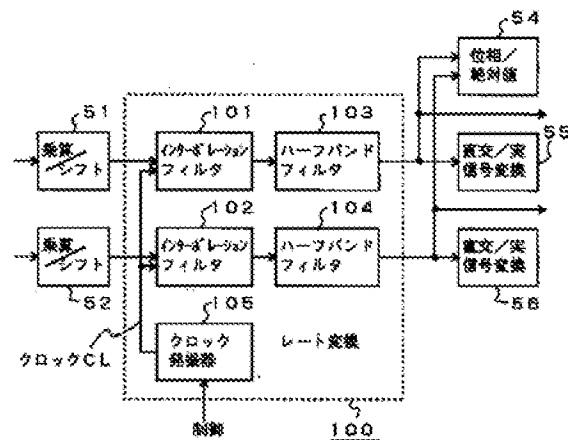
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(54) 【発明の名称】 受信装置

(57) 【要約】

【課題】 直交復調方式の受信装置において、入力側の A/D変換のサンプリングレートに関係なく復調処理のときの信号のサンプリングレートを選べるようにする。

【解決手段】 A/D変換のサンプリングレートとは独立にその出力周波数を選定できるクロック発振器 105 を設け、この出力クロックによるリサンプル処理を用いて、帯域制限されたベースバンドの同相及び直交成分をインターポレーションフィルタ 101、102 でレート変換し、所望のサンプリングレートの信号としての復調処理を行う。



【特許請求の範囲】

【請求項1】 入力中間周波信号をディジタル化するA/D変換手段と、この手段から出力された中間周波信号を同相、直交成分に分けてそれぞれをベースバンド信号へ変換し、その各ベースバンド信号のサンプリングレートをデシメーションフィルタを用いて低減したのち周波数帯域制限を行う直交復調処理手段と、前記A/D変換手段のサンプリングレートとは独立にその出力周波数を設定可能なクロック発振器からのクロックを用いて前記直交復調処理手段からの同相及び直交ベースバンド信号をリサンプルしてサンプリングレートの変換を行うレート変換手段と、この手段によりサンプリングレートが変換されたベースバンド信号の復調処理を行う処理手段と、を備えたことを特徴とする受信装置。

【発明の詳細な説明】

【0001】

【発明の属する技術分野】 本発明は、受信した変調波をマルチレート信号処理によって復調するようにした受信装置に係り、とくに変調方式や変調信号の帯域が異なる種々の変調波を受信・復調可能な受信装置に関する。

【0002】

【従来の技術】 変調信号の帯域あるいはディジタル変調信号の場合のパルスレートが異なったり、変調方式が異なる通信システムが混在する環境下で、これら異なる通信システムの信号を選択して受信可能な受信装置では、受信した変調信号に応じたフィルタリングや復調処理を行う必要がある。また、このような受信装置をDSP等のディジタル処理で実現する場合には、ディジタル処理装置の処理負荷を軽減するために、扱うディジタル信号のサンプリングレートを変換して処理を実行するマルチレート信号処理が用いられる。

【0003】 図4は、上記のような受信装置の構成例を示すブロック図で、入力された中間周波数のディジタル変調波信号がA/D変換器1でA/D変換され、直交復調処理部2へ入力される。直交復調処理部2では、所定のキャリア周波数の互いに直交した信号がキャリア発生器21から出力され、乗算器22、23にて入力信号とそれぞれ乗算される。乗算器22、23の出力ベースバンド信号は、それぞれデシメーションフィルタ24、25によりサンプリングレートが降下され、所定のサンプリングレートとなる。この信号は、入力信号の変調方式、帯域等に適合した帯域制限フィルタ26、27によりそれぞれ帯域制限処理される。この帯域制限フィルタ26、27としてはナイキストフィルタが一般に用いられる。帯域制限フィルタ26、27の出力は復調処理28へ入力され、入力信号の変調方式に適合した復調処理が行われ、復調データとして出力される。ここでデシメーションフィルタは、一般にCICフィルタ(Cascade

d Integrator-Comb Filter)やハーフバンドフィルタ等により構成され、例えば入力信号が1200 baud/sのとき、4倍オーバーサンプリングのレートとするときはデシメーションフィルタ出力のレートは4800Hzとなる。

【0004】 図5は復調処理28の構成例で、図4の帯域制限フィルタ26、27からの信号は、AGCのための乗算/シフト回路51、52へ夫々入力され、この出力はレート変換回路53で再びレート変換され、アナログ信号のときは直交/実信号変換器55、56によって直交信号から実信号への変換が行われる。位相/絶対値回路54は、ディジタル信号のときの位相角を求めて復調に使えるようにし、また振幅を求めてAGCループフィルタ57へ出力する。選択/フォーマット変換回路58は、ディジタル信号のときの多値数に応じた変換処理を行う。レート変換回路53は、2つの入力信号の各々に対して、アップサンブラ531、532、LPF(ローパスフィルタ)533、534、ダウンサンブラ535、536を用いてサンプリングレートの変換を行う。なお図4では省略したが、A/D変換器1と直交復調処理部2との間にも、上記と同様の選択/フォーマット変換回路が設けられ、入力信号の同相・直交成分への分離が行われる。

【0005】

【発明が解決しようとする課題】 上記のように、最初のA/D変換器1では、入力信号の種々の変調方式、帯域に対しても十分なサンプリングレートとなるようなディジタル化が行われ、その後の帯域制限や復調処理では入力信号の変調方式や帯域に適したサンプリングレートでの処理が行われる。そしてこのためにデシメーションフィルタによるサンプリングレートの低減とレート変換回路によるレート変換が行われる。デシメーションフィルタは、CICフィルタ(Cascaded Integrator-Comb Filter)やハーフバンドフィルタ等を用いて構成されるが、デシメーションフィルタ及びレート変換回路の出力側サンプリングレートとA/D変換器1のサンプリングレートとの比は整数比であり、入力信号に適した所望のサンプリングレートを実現できないことがある。

【0006】 本発明の目的は、種々の変調方式や帯域市の信号を直交復調方式により復調する際の復調処理を、その変調方式や帯域市に応じて自由に設定できるようにした受信装置を提供することにある。

【0007】

【課題を解決するための手段】 上記の目的を達成するために、本発明は、入力中間周波信号をディジタル化するA/D変換手段と、この手段から出力された中間周波信号を同相、直交成分に分けてそれぞれをベースバンド信号へ変換し、その各ベースバンド信号のサンプリングレートをデシメーションフィルタを用いて低減したのち周

波数帯域制限を行う直交復調処理手段と、前記A/D変換手段のサンプリングレートとは独立にその出力周波数を設定可能なクロック発振器からのクロックを用いて前記直交復調処理手段からの同相及び直交ベースバンド信号をリサンプルしてサンプリングレートの変換を行うレート変換手段と、この手段によりサンプリングレートが変換されたベースバンド信号の復調処理を行う処理手段と、を備えたことを特徴とする受信装置を提供する。

【0008】

【発明の実施の形態】以下、本発明の実施の形態を説明する。図1は、本発明の特徴とするレート変換回路の構成例で、図5のレート変換回路53に代わって本発明の受信装置で用いられる。受信装置の他の部分の構成は図4、図5と同じである。図1に於いて、レート変換回路100は、インターポレーションフィルタ101、102とハーフバンドフィルタ103、104及びクロック発振器105から構成され、インターポレーションフィルタ101、102への入力は、それぞれ図5の乗算/シフト回路51、52の出力であり、またハーフバンドフィルタ103、104の出力は、やはり図5と同様に直交/実信号変換器55、56と位相/絶対値回路54の

入力となる。クロック発振器105のクロック周波数は、復調処理に適した値をもち、これは入力される信号のサンプリングレートとは独立で、非同期である。

【0009】図2は、インターポレーションフィルタ101の構成を示す図で、インターポレーションフィルタ102も同じ構成である。ゼロ値挿入回路111、ローパスフィルタ112、補間フィルタ113から成り、補間フィルタ113は図3に示す構成をもつ。即ちクロック発振器105からのクロックCLでサンプリングを行

うリサンブラ121、減算器122、乗算器123、遅延回路124、加算器125から成っている。 *

* 【0010】以上のような構成で、クロック発振器105の出力クロックCLの周波数を、レート変換回路100への入力信号のサンプリングレートとは独立に、復調処理に適したサンプリングレートに選んでおき、このクロックCLで入力信号をリサンプルすることで、いつでも希望のサンプリングレートによる復調処理が可能になる。

【0011】なお、図1等の各処理は、DSP (Digital Signal Processing) に限らず、例えばFPGA (Field Programmable Gate Array) やゲートアレイ、汎用ロジック等で実現できることはいうまでもない。

【0012】

【発明の効果】本発明によれば、信号の変調方式や変調速度/帯域中に適したサンプリングレートを入力側A/D変換器のサンプリングレートとは独立に選定できるという効果がある。

【図面の簡単な説明】

【図1】本発明の特徴とするレート変換回路の構成例を示すブロック図である。

【図2】図1のインターポレーションフィルタの構成図である。

【図3】図2の補間フィルタの構成図である。

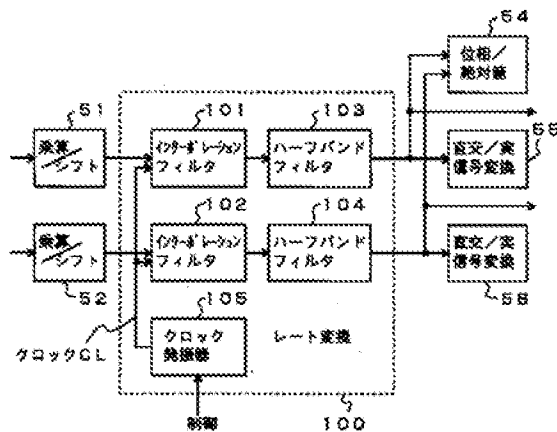
【図4】種々の変調方式や帯域中をもつ信号の受信装置の構成を示す図である。

【図5】図4の復調処理の構成を示す図である。

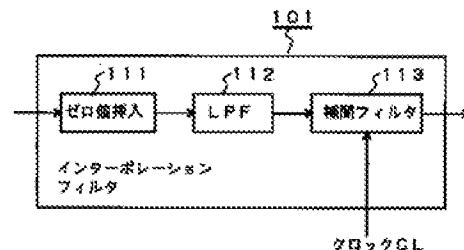
【符号の説明】

100 レート変換回路
101、102 インターポレーションフィルタ
103、104 ハーフバンドフィルタ
105 クロック発振器

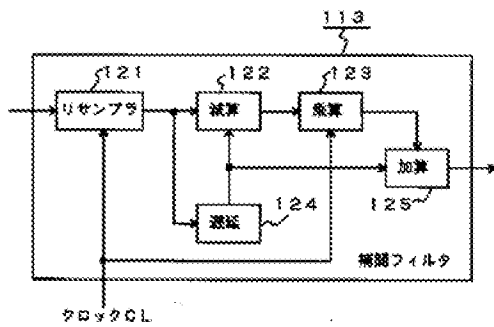
【図1】



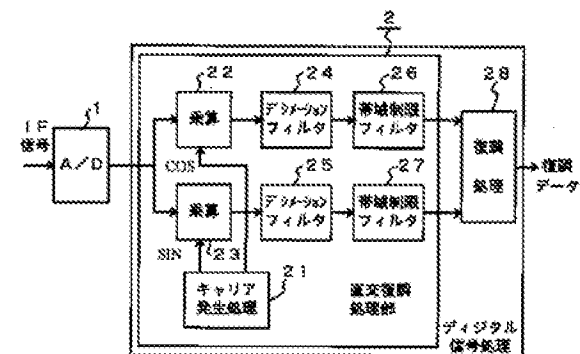
【図2】



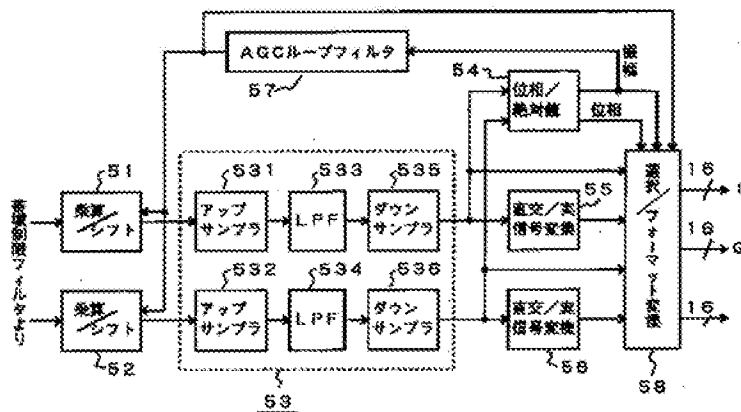
【図3】



【図4】



【図5】



フロントページの続き

Fターム(参考) 5K004 AA05 AA08 FG02 JG01
 5K020 EE04 EE05 HH13 LL00
 5K041 AA08 EE02 HH11 HH40 JJ14
 JJ38

Electronic Patent Application Fee Transmittal

Application Number:	16399867			
Filing Date:	30-Apr-2019			
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
PETITION FEE-37CFR 1.17(H) (GROUP II)	2464	1	70	70
RCE- 1ST REQUEST	2801	1	650	650
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				720



UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

Decision Date : March 13, 2020

In re Application of :

Dashen Fan

DECISION ON PETITION

UNDER CFR 1.313(c)(2)

Application No : 16399867

Filed : 30-Apr-2019

Attorney Docket No : K41090.P8C2

This is an electronic decision on the petition under 37 CFR 1.313(c)(2), filed March 13, 2020 , to withdraw the above-identified application from issue after payment of the issue fee.

The petition is **GRANTED**.

The above-identified application is withdrawn from issue for consideration of a submission under 37 CFR 1.114 (request for continued examination). See 37 CFR 1.313(c)(2).

Petitioner is advised that the issue fee paid in this application cannot be refunded. If, however, this application is again allowed, petitioner may request that it be applied towards the issue fee required by the new Notice of Allowance.

Telephone inquiries concerning this decision should be directed to the Patent Electronic Business Center (EBC) at 866-217-9197.

This application file is being referred to Technology Center AU 2845 for processing of the request for continuing examination under 37 CFR 1.114 .

Office of Petitions

Electronic Acknowledgement Receipt

EFS ID:	38858282
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	13-MAR-2020
Filing Date:	30-APR-2019
Time Stamp:	12:39:58
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$ 720
RAM confirmation Number	E20203CC39543501
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

File Listing:					
Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Petition automatically granted by EFS	petition-request.pdf	31706	no	2
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Information:					
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Warnings:					
Information:					
3	Information Disclosure Statement (IDS) Form (SB08)	20200313K41090JP8C2IDSsb0008abi.pdf	828357	no	2
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This is not an USPTO supplied IDS fillable form					
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Total Files Size (in bytes):			18672594		
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					

Doc Code: PET.AUTO Document Description: Petition automatically granted by EFS-Web		PTO/SB/140 U.S. Patent and Trademark Office Department of Commerce
Electronic Petition Request	PETITION TO WITHDRAW AN APPLICATION FROM ISSUE AFTER PAYMENT OF THE ISSUE FEE UNDER 37 CFR 1.313(c)	
Application Number	16399867	
Filing Date	30-Apr-2019	
First Named Inventor	Dashen Fan	
Art Unit	2845	
Examiner Name	LAM MAI	
Attorney Docket Number	K41090.P8C2	
Title	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS	
An application may be withdrawn from issue for further action upon petition by the applicant. To request that the Office withdraw an application from issue, applicant must file a petition under this section including the fee set forth in § 1.17(h) and a showing of good and sufficient reasons why withdrawal of the application from issue is necessary. APPLICANT HEREBY PETITIONS TO WITHDRAW THIS APPLICATION FROM ISSUE UNDER 37 CFR 1.313(c). A grantable petition requires the following items: (1) Petition fee; and (2) One of the following reasons: (a) Unpatentability of one or more claims, which must be accompanied by an unequivocal statement that one or more claims are unpatentable, an amendment to such claim or claims, and an explanation as to how the amendment causes such claim or claims to be patentable; (b) Consideration of a request for continued examination in compliance with § 1.114 (for a utility or plant application only); or (c) Express abandonment of the application. Such express abandonment may be in favor of a continuing application, but not a CPA under 37 CFR 1.53(d).		
Petition Fee		
☒ Small Entity		
☐ Micro Entity		
☐ Regular Undiscounted		
Reason for withdrawal from issue		

- ☐ One or more claims are unpatentable
- ☒ Consideration of a request for continued examination (RCE) (List of Required Documents and Fees)
- ☐ Applicant hereby expressly abandons the instant application (any attorney/agent signing for this reason must have power of attorney pursuant to 37 CFR 1.32(b)).

RCE request, submission, and fee.

- ☐ I certify, in accordance with 37 CFR 1.4(d)(4) that :
- ☐ The RCE request ,submission, and fee have already been filed in the above-identified application on
- ☒ Are attached.

THIS PORTION MUST BE COMPLETED BY THE SIGNATORY OR SIGNATORIES

I certify, in accordance with 37 CFR 1.4(d)(4) that I am:

- ☒ An attorney or agent registered to practice before the Patent and Trademark Office who has been given power of attorney in this application.
- ☐ An attorney or agent registered to practice before the Patent and Trademark Office, acting in a representative capacity.
- ☐ A sole inventor
- ☐ A joint inventor; I certify that I am authorized to sign this submission on behalf of all of the inventors as evidenced by the power of attorney in the application
- ☐ A joint inventor; all of whom are signing this e-petition

Signature	/MARK S PELOQUIN/
Name	MARK S PELOQUIN
Registration Number	50787

Substitute for form 1449/PTO

(Use as many sheets as necessary)

Sheet	1	of	2
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Application Number	16/399,867
Filing Date	April 30, 2019
First Named Inventor	DASHEN FAN
Art Unit	2872
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P8C2

[illegible]

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	7 ⁵
		Country Code ³ Number ⁴ Kind Code ⁵ (# known)				
		JP2010122191	06-03-2010	SANYO ELECTRIC CO		✓
		JP2000197180	07-14-2000	VICTOR CO OF JAPAN LTD		✓
		JP2002300224	10-11-2002	HITACHI INT ELECTRIC INC		✓
						✓
						✓

Date	Considered
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This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. **DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Page 245 of 275

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Substitute for form 1449/PTO

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Complete if Known

Application Number	16/399,867
Filing Date	April 30, 2019
First Named Inventor	DASHEN FAN
Art Unit	2872
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P8C2

Sheet 2 of 2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		OFFICE ACTION ISSUED IN CORRESPONDING JP PATENT APPLICATION NO. 2019-526185.	✓

Examiner
SignatureDate
Considered

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

Electronic Patent Application Fee Transmittal

Application Number:	16399867			
Filing Date:	30-Apr-2019			
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS			
First Named Inventor/Applicant Name:	Dashen Fan			
Filer:	Mark S. Peloquin			
Attorney Docket Number:	K41090.P8C2			
Filed as Small Entity				
Filing Fees for Utility under 35 USC 111(a)				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Miscellaneous:				
SUBMISSION- INFORMATION DISCLOSURE STMT	2806	1	120	120
Total in USD (\$)				120

Electronic Acknowledgement Receipt

EFS ID:	38858864
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Mark S. Peloquin
Filer Authorized By:	
Attorney Docket Number:	K41090.P8C2
Receipt Date:	13-MAR-2020
Filing Date:	30-APR-2019
Time Stamp:	12:55:04
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	EFT
Payment was successfully received in RAM	\$ 120
RAM confirmation Number	E20203CC55313710
Deposit Account	
Authorized User	

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
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Warnings:**Information:**

Total Files Size (in bytes):	30582
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984
51340	7590	03/17/2020	EXAMINER	
PELOQUIN, PLLC			MAI, LAM T	
800 FIFTH AVENUE				
SUITE 4100				
SEATTLE, WA 98104-3100				
			ART UNIT	PAPER NUMBER
			2845	
			MAIL DATE	DELIVERY MODE
			03/17/2020	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Corrective Notice of Allowability	Application No. 16/399,867	Applicant(s) Fan et al.	
	Examiner LAM T MAI	Art Unit 2845	AIA (FITF) Status Yes

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to 3/13/2020.
☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☒ The allowed claim(s) is/are 1-20. As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a) ☐ All b) ☐ Some *c) ☐ None of the:

1. ☐ Certified copies of the priority documents have been received.

2. ☐ Certified copies of the priority documents have been received in Application No. _____.

3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892) 2. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date <u>3/13/2020</u> . 3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____. 4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.	5. ☐ Examiner's Amendment/Comment 6. ☐ Examiner's Statement of Reasons for Allowance 7. ☐ Other _____.
---	---

/LAM T MAI/ Primary Examiner, Art Unit 2845	
--	--

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APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR/ PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
16/399,867	04/30/2019	Fan et al.	K41090.P8C2

PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100		EXAMINER	
		LAM T MAI	
		ART UNIT	PAPER
		2845	20200316

DATE MAILED: _____

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner for Patents

IDS filed on 3/13/2010 has been considered.

/LAM T MAI/
Primary Examiner, Art Unit 2845



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United States Patent and Trademark Office
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BIB DATA SHEET

CONFIRMATION NO. 9984

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.	
16/399,867	04/30/2019	341	2845	K41090.P8C2	
RULE					
APPLICANTS Kopin Corporation, Westborough, MA INVENTORS Dashen Fan, Bellevue, WA; Joseph Yong Kwon, San Jose, CA; ** CONTINUING DATA ***** This application is a CON of 15/947,845 04/08/2018 PAT 10298253 which is a CON of 15/225,745 08/01/2016 PAT 9941895 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 05/13/2019					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /LAM T MAI/ Acknowledged Examiner's Signature	☒ Met after Allowance Im Initials	STATE OR COUNTRY WA	SHEETS DRAWINGS 20	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100 UNITED STATES					
TITLE BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS					
FILING FEE RECEIVED 945	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.M/

PTO/SB/08a (07-09)

Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449/PTO

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known

Application Number	16/399,867
Filing Date	April 30, 2019
First Named Inventor	DASHEN FAN
Art Unit	2872
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P8C2

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
		US- 5,883,822	03-16-1999	FRANCE TELECOM	
		US- 2015/0281836 A1	10-01-2015	ANALOG DEVICES TECHNOLOGY	
		US- 2016/0157828 A1	06-09-2016	CHIKAYOSHI SUMI	
		US- 2007/0189400 A1	08-16-2007	MITSUMI ELECTRIC CO., LTD.	
		US- 2011/0013488 A1	01-20-2011	WEI MA	
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T ⁶
		Country Code ³ Number ¹ Kind Code ⁵ (if known)				
		JP2010122191	06-03-2010	SANYO ELECTRIC CO		✓
		JP2000197180	07-14-2000	VICTOR CO OF JAPAN LTD		✓
		JP2002300224	10-11-2002	HITACHI INT ELECTRIC INC		✓
						✓
						✓

Examiner
Signature

/LAM T MAI/

Date
Considered

03/16/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.M/

PTO/SB/08b (07-09)

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**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Complete if Known

Application Number	16/399,867
Filing Date	April 30, 2019
First Named Inventor	DASHEN FAN
Art Unit	2872
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P8C2

Sheet 2 of 2

NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No. ¹	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.), date, page(s), volume-issue number(s), publisher, city and/or country where published.	T ²
		OFFICE ACTION ISSUED IN CORRESPONDING JP PATENT APPLICATION NO. 2019-526185.	✓

Examiner
Signature

/LAM T MAI/

Date

Considered

03/16/2020

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¹ Applicant's unique citation designation number (optional). ² Applicant is to place a check mark here if English language Translation is attached. This collection of information is required by 37 CFR 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

If you need assistance in completing the form, call 1-800-PTO-9199 (1-800-786-9199) and select option 2.

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	((("5883822") or ("20150281836") or ("20160157828") or ("20070189400") or ("20110013488") or ("2010122191") or ("2000197180") or ("2002300224")).PN.	USPAT; USOCR	OR	OFF	2020/03/16 12:15
L2	27	((("5883822") or ("20150281836") or ("20160157828") or ("20070189400") or ("20110013488") or ("2010122191") or ("2000197180") or ("2002300224")).PN.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	OFF	2020/03/16 12:15

3/16/2020 12:17:03 PM
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	04/30/2019	Dashen Fan	K41090.P8C2	9984
51340	7590	03/27/2020	EXAMINER	
PELOQUIN, PLLC			MAI, LAM T	
800 FIFTH AVENUE				
SUITE 4100				
SEATTLE, WA 98104-3100				
			ART UNIT	PAPER NUMBER
			2845	
			MAIL DATE	DELIVERY MODE
			03/27/2020	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Response to Rule 312 Communication	Application No. 16/399,867	Applicant(s) Fan et al.	
	Examiner LAM T MAI	Art Unit 2845	AIA (FITF) Status Yes
-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address -- 1. ☒ The amendment filed on <u>12 March 2020</u> under 37 CFR 1.312 has been considered, and has been: a) ☒ entered. b) ☐ entered as directed to matters of form not affecting the scope of the invention. c) ☐ disapproved because the amendment was filed after the payment of the issue fee. Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue. d) ☐ disapproved. See explanation below. e) ☐ entered in part. See explanation below. _____			
/LAM T MAI/ Primary Examiner, Art Unit 2845			

Appl. No. 16/399,867
Response dated March 12, 2020
Reply to Notice of Allowance Mail Date 12/16/2019

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No. : 16/399,867
Applicant : SOLOS TECHNOLOGY LTD
Filed : 04/30/2019
TC/A.U. : 2845
Examiner : MAI, LAM T
Confirmation No. : 9984

Docket No. : K41090.P8C2
Customer No. : 51340

Mail Stop Amendment
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

COMMUNICATED VIA EFS-WEB TO USPTO ON 12 MARCH 2020
AMENDMENT AFTER NOTICE OF ALLOWANCE UNDER 37 C.F.R. 1.312

Sir:

Applicant submits the following amendment under 37 C.F.R. 1.312 to correct informalities in the allowed claims. No new matter has been entered.

Amendments to the Claims are reflected in the listing of claims which begin on page 2 of this paper.

Remarks begins on page 7 of this paper.

OK TO ENTER: /L.T.M/



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United States Patent and Trademark Office
 Address: COMMISSIONER FOR PATENTS
 P.O. Box 1450
 Alexandria, Virginia 22313-1450
 www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 9984

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.	
16/399,867	04/30/2019	341	2845	K41090.P8C2	
RULE					
APPLICANTS Kopin Corporation, Westborough, MA INVENTORS Dashen Fan, Bellevue, WA; Joseph Yong Kwon, San Jose, CA; ** CONTINUING DATA ***** This application is a CON of 15/947,845 04/08/2018 PAT 10298253 which is a CON of 15/225,745 08/01/2016 PAT 9941895 ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED *** SMALL ENTITY ** 05/13/2019					
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and /LAM T MAI/ Acknowledged Examiner's Signature	☒ Met after Allowance Im Initials	STATE OR COUNTRY WA	SHEETS DRAWINGS 20	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS PELOQUIN, PLLC 800 FIFTH AVENUE SUITE 4100 SEATTLE, WA 98104-3100 UNITED STATES					
TITLE BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS					
FILING FEE RECEIVED 945	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit		

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /L.T.M/

PTO/SB/08a (07-09)

Approved for use through 11/30/2020. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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Substitute for form 1449/PTO

**INFORMATION DISCLOSURE
STATEMENT BY APPLICANT**

(Use as many sheets as necessary)

Sheet 1 of 2

Complete if Known

Application Number	16/399,867
Filing Date	April 30, 2019
First Named Inventor	DASHEN FAN
Art Unit	2872
Examiner Name	MAI, LAM T
Attorney Docket Number	K41090.P8C2

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Document Number	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		Number-Kind Code ² (if known)			
Changes applied to document, /T.W./ 4/15/2020		US- 5,883,822	03-16-1999	~~FRANCE TELECOM~~	Le Tourneur et al.
		US- 2015/0281836 A1	10-01-2015	~~ANALOG DEVICES TECHNOLOGY~~	Nguyen et al.
		US- 2016/0157828 A1	06-09-2016	CHIKAYOSHI SUMI	
		US- 2007/0189400 A1	08-16-2007	~~MITSUMI ELECTRIC CO., LTD.~~	Nakano et al.
		US- 2011/0013488 A1	01-20-2011	WEI MA	
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No. ¹	Foreign Patent Document	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T ⁶
		Country Code ³ Number ¹ Kind Code ⁵ (if known)				
		JP2010122191	06-03-2010	SANYO ELECTRIC CO		✓
		JP2000197180	07-14-2000	VICTOR CO OF JAPAN LTD		✓
		JP2002300224	10-11-2002	HITACHI INT ELECTRIC INC		✓
						✓
						✓

Examiner
Signature

/LAM T MAI/

Date
Considered

03/16/2020

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. ¹ Applicant's unique citation designation number (optional). ² See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. ³ Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). ⁴ For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. ⁵ Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. ⁶ Applicant is to place a check mark here if English language Translation is attached.

This collection of information is required by 37 CFR 1.97 and 1.98. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 2 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
16/399,867	05/12/2020	10651866	K41090.P8C2	9984

51340 7590 04/22/2020
PELOQUIN, PLLC
800 FIFTH AVENUE
SUITE 4100
SEATTLE, WA 98104-3100

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b) (application filed on or after May 29, 2000)

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (<http://pair.uspto.gov>).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site <http://pair.uspto.gov> for additional applicants):

Dashen Fan, Bellevue, WA;
Kopin Corporation, Westborough, MA
Joseph Yong Kwon, San Jose, CA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

TRANSMITTAL FOR POWER OF ATTORNEY TO ONE OR MORE REGISTERED PRACTITIONERS

NOTE: This form is to be submitted with the Power of Attorney by Applicant form (PTO/AIA/82B) to identify the application to which the Power of Attorney is directed, in accordance with 37 CFR 1.5, unless the application number and filing date are identified in the Power of Attorney by Applicant form. If neither form PTO/AIA/82A nor form PTO/AIA82B identifies the application to which the Power of Attorney is directed, the Power of Attorney will not be recognized in the application.

Application Number	16/399,867
Filing Date	04/30/2019
First Named Inventor	Dashen Fan
Title	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
Art Unit	2845
Examiner Name	LAM T MAI
Attorney Docket Number	1537-001USC2

SIGNATURE of Applicant or Patent Practitioner

Signature	/Keegan Caldwell/	Date (Optional)	
Name	Keegan Caldwell	Registration Number	73731
Title (if Applicant is a juristic entity)			
Applicant Name (if Applicant is a juristic entity)			

NOTE: This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. If more than one applicant, use multiple forms.

☐

*Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

POWER OF ATTORNEY BY APPLICANT

I hereby revoke all previous powers of attorney given in the application identified in either the attached transmittal letter or the boxes below.

Application Number	Filing Date

(Note: The boxes above may be left blank if information is provided on form PTO/AIA/82A.)

☒ I hereby appoint the Patent Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above:

145340

OR

☐ I hereby appoint Practitioner(s) named in the attached list (form PTO/AIA/82C) as my/our attorney(s) or agent(s), and to transact all business in the United States Patent and Trademark Office connected therewith for the patent application referenced in the attached transmittal letter (form PTO/AIA/82A) or identified above. (Note: Complete form PTO/AIA/82C.)

Please recognize or change the correspondence address for the application identified in the attached transmittal letter or the boxes above to:

☒ The address associated with the above-mentioned Customer Number

OR

☐ The address associated with Customer Number:

OR

☐ Firm or Individual Name

Address

City

State

Zip

Country

Telephone

Email

I am the Applicant (if the Applicant is a juristic entity, list the Applicant name in the box):

Solos Technology Limited

- ☐ Inventor or Joint Inventor (title not required below)
- ☐ Legal Representative of a Deceased or Legally Incapacitated Inventor (title not required below)
- ☒ Assignee or Person to Whom the Inventor is Under an Obligation to Assign (provide signer's title if applicant is a juristic entity)
- ☐ Person Who Otherwise Shows Sufficient Proprietary Interest (e.g., a petition under 37 CFR 1.46(b)(2) was granted in the application or is concurrently being filed with this document) (provide signer's title if applicant is a juristic entity)

SIGNATURE of Applicant for Patent

The undersigned (whose title is supplied below) is authorized to act on behalf of the applicant (e.g., where the applicant is a juristic entity).

Signature

Kenneth Fan

Date (Optional)

Name

Kenneth Fan

Title

Co-Founder

NOTE: Signature - This form must be signed by the applicant in accordance with 37 CFR 1.33. See 37 CFR 1.4 for signature requirements and certifications. If more than one applicant, use multiple forms.

☐ Total of forms are submitted.

This collection of information is required by 37 CFR 1.131, 1.32, and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number

POWER OF ATTORNEY BY APPLICANT

No more than ten (10) patent practitioners total may be appointed as set forth below by name and registration number. This page need not be submitted if appointing the Patent Practitioner(s) associated with a Customer Number (see form PTO/AIA/82B):

Name	Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

STATEMENT UNDER 37 CFR 3.73(c)Applicant/Patent Owner: Solos Technology LimitedApplication No./Patent No.: 16/399,867 ; 10651866 Filed/Issue Date: 04/30/2019 ; 05/12/2020Titled: BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODSSOLOS TECHNOLOGY LIMITED, a Limited Liability Company

(Name of Assignee)

(Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that, for the patent application/patent identified above, it is (choose one of options 1, 2, 3 or 4 below):

1. ☒ The assignee of the entire right, title, and interest.
2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):
- ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.
- ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (e.g., bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose one of options A or B below):

- A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.
- B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: KWON, JOSEPH YONG To: KOPIN CORPORATIONThe document was recorded in the United States Patent and Trademark Office at
Reel 049324, Frame 0997, or for which a copy thereof is attached.2. From: KOPIN CORPORATION To: SOLOS TECHNOLOGY LIMITEDThe document was recorded in the United States Patent and Trademark Office at
Reel 051280, Frame 0099, or for which a copy thereof is attached.

[Page 1 of 2]

This collection of information is required by 37 CFR 3.73(b). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at
 Reel _____, Frame _____, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet(s).

☒ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

/KEEGAN CALDWELL/

Signature

Keegan Caldwell

Printed or Typed Name

08/28/2023

Date

73731

Title or Registration Number

Privacy Act Statement

The **Privacy Act of 1974 (P.L. 93-579)** requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	48500433
Application Number:	16399867
International Application Number:	
Confirmation Number:	9984
Title of Invention:	BEAMFORMING USING FRACTIONAL TIME DELAY IN DIGITALLY OVERSAMPLED SENSOR SYSTEMS, APPARATUSES, AND METHODS
First Named Inventor/Applicant Name:	Dashen Fan
Customer Number:	51340
Filer:	Keegan M. Caldwell/Rachel Riley
Filer Authorized By:	Keegan M. Caldwell
Attorney Docket Number:	K41090.P8C2
Receipt Date:	28-AUG-2023
Filing Date:	30-APR-2019
Time Stamp:	14:52:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	1537-001USC2_POA.pdf	268767	no	4
			ae35e5b15b9e469370de7ea0004444b1df8cc8c2		

Warnings:

Information:					
2	Assignee showing of ownership per 37 CFR 3.73	1537-001USC2_373_Statement.pdf	83342	no	3
			38a336d8688d78742c4150443f6ccee4b316c9d		
Warnings:					
Information:					
Total Files Size (in bytes):				352109	
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503. <u>New Applications Under 35 U.S.C. 111</u> If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application. <u>National Stage of an International Application under 35 U.S.C. 371</u> If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course. <u>New International Application Filed with the USPTO as a Receiving Office</u> If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.					



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	1537-001USC2

CONFIRMATION NO. 9984

POA ACCEPTANCE LETTER



OC000000061503049

145340
Caldwell Intellectual Property Law
200 Clarendon Street
59th Floor
Boston, MA 02116

Date Mailed: 09/07/2023

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/28/2023.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/wrhopkins/



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
16/399,867	04/30/2019	Dashen Fan	1537-001USC2

CONFIRMATION NO. 9984

51340
PELOQUIN, PLLC
PO Box 748
VASHON, WA 98070-0748

POWER OF ATTORNEY NOTICE



OC000000061503021

Date Mailed: 09/07/2023

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/28/2023.

- The Power of Attorney to you in this application has been revoked by the applicant. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at (571) 272-4000 or (571) 272-4200 or 1-888-786-0101.

/wrhopkins/

AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court _____ for the District of Massachusetts _____ on the following

☐ Trademarks or ☒ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT for the District of Massachusetts
PLAINTIFF Solos Technology Limited		DEFENDANT Meta Platforms, Inc., Meta Platforms Technologies, LLC, Oakley, Inc., Luxottica of America, Inc., and EssilorLuxottica USA, Inc.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 10,306,389	5/28/2019	Solos Technology Limited
2 11,082,055	8/3/2021	Solos Technology Limited
3 11,871,174	1/9/2024	Solos Technology Limited
4 12,216,339	2/4/2025	Solos Technology Limited
5 10,651,866	5/12/2020	Solos Technology Limited

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
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Copy 1—Upon initiation of action, mail this copy to Director Copy 3—Upon termination of action, mail this copy to Director
Copy 2—Upon filing document adding patent(s), mail this copy to Director Copy 4—Case file copy