

U.S. Patent No. 9,941,830 (“’830 Patent”)

Accused Instrumentalities

Apple products with Taptic Engine technology,, including without limitation iPhone products (iPhone 6s, 6s Plus, 7, 7 Plus, 8, 8 Plus, X, XR, XS, XS Max, 11, 11 Pro, 11 Pro Max, SE (second generation), 12, 12 mini, 12 Pro, 12 Pro Max, 13, 13 mini, 13 Pro, 13 Pro Max, SE (third generation), 14, 14 Plus, 14 Pro, 14 Pro Max, 15, 15 Plus, 15 Pro, 15 Pro Max), MacBook products (MacBook Pro from 2015, MacBook from 2018, MacBook Air from 2018) and Apple Watch products (1st generation, Series 1, Series 2, Series 3, Series 4, Series 5, SE, Series 6, Series 7, SE (second generation), Series 8, Ultra, Series 9, Ultra 2), and all variants and iterations thereof (collectively, “Accused Products”), infringe at least Claims 1, 2, 3, 4, 5, 6, 7, 8, 14, 15, 16, 17, 19, and 20 of the ’830 Patent.

Each Accused Product infringes the claims in substantially the same way, and the evidence shown in this chart is similarly applicable to each Accused Product. Each claim limitation is literally infringed by each Accused Product. However, to the extent any claim limitation is not met literally, it is nonetheless met under the doctrine of equivalents because the differences between the claim limitation and each Accused Product would be insubstantial, and each Accused Product performs substantially the same function, in substantially the same way, to achieve the same result as the claimed invention. Notably, Defendant has not yet articulated which, if any, particular claim limitations it believes are not met by the Accused Products.

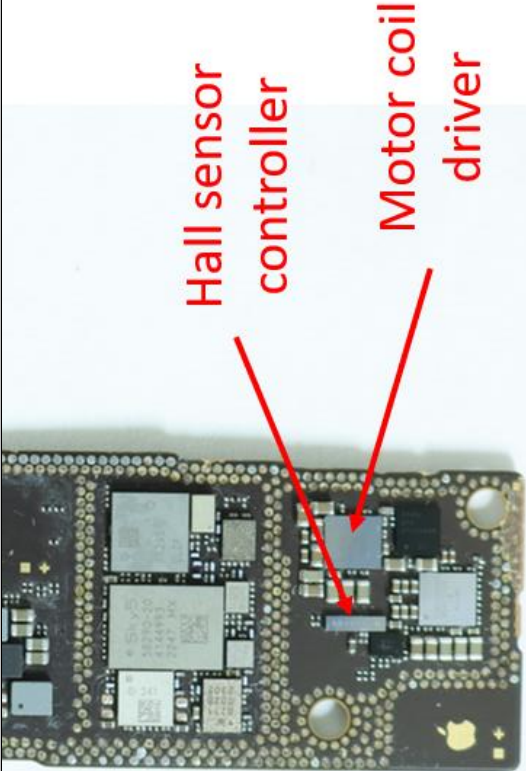
Claim 1

Claim 1	Accused Products
[1pre]. A vibration module comprising:	To the extent the preamble is limiting, each Accused Product includes or constitutes a vibration module. For example, each of the Apple iPhone 14 and the Apple Watch Ultra contain a linear actuator (“Taptic Engine”), haptic controller(s), and associated circuitry, as described in connection with the claim limitations below. <i>See, e.g.:</i>



Photograph of iPhone 14 with rear cover removed, with A15 Bionic SoC at center right and Taptic Engine at bottom left.

Claim 1	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

Claim 1	Accused Products
	 Photograph of Hall sensor controller and motor control driver from the iPhone 14.

Claim 1	Accused Products
	The following devices contain a Taptic Engine: • iPhone 14 Pro Max • iPhone 14 Pro • iPhone 14 Plus • iPhone 14 • iPhone SE (3rd generation) • iPhone 13 Pro Max • iPhone 13 Pro • iPhone 13 • iPhone 13 mini • iPhone 12 Pro Max • iPhone 12 Pro • iPhone 12 • iPhone 12 mini • iPhone SE (2nd generation) • iPhone 11 Pro Max • iPhone 11 Pro • iPhone 11 • iPhone XS Max • iPhone XS • iPhone XR • iPhone X • iPhone 8 Plus • iPhone 8 • iPhone 7 Plus • iPhone 7 • iPhone 6s Plus • iPhone 6s Accessory Design Guidelines for Apple Devices, Release R20, available at https://developer.apple.com/accessories/Accessory-Design-Guidelines.pdf

Claim 1	Accused Products
	 Photograph of Apple Watch Ultra.

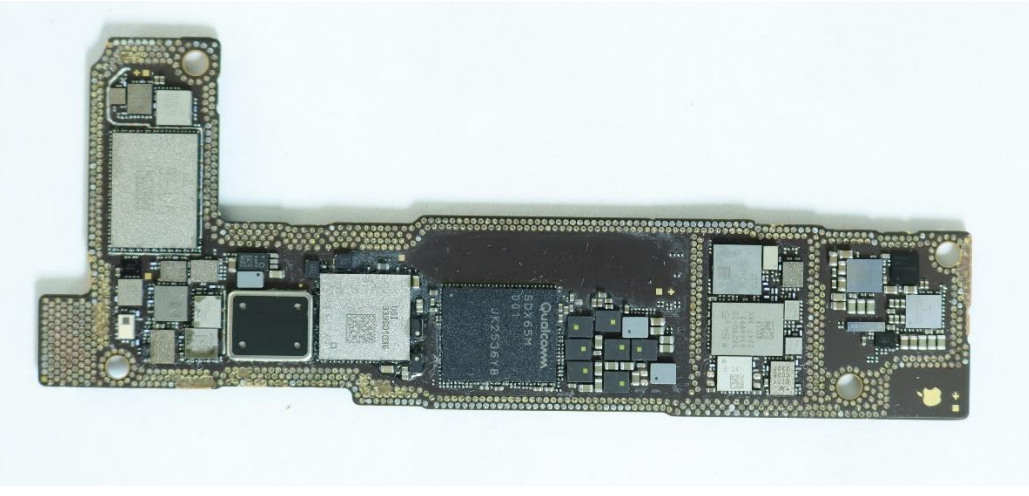
Claim 1	Accused Products
	Main board Linear motor TAPTIC ENGINE Wrist side, cover removed Wrist side, cover and main board removed Display side, display removed Annotated photographs of Apple Watch Ultra showing linear actuator (Taptic engine) and main system board.
[1a] a housing;	Each Accused Product comprises a housing. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra has a hollow cavity that is soldered together to form a housing surrounding the moveable component and coils. See, e.g.:

Claim 1	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

Claim 1	Accused Products
	 Photograph of Taptic Engine housing from Apple Watch Ultra.
[1b] a moveable component;	Each Accused Product comprises a moveable component. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra includes a moveable component comprising permanent magnet(s) and a mass. <i>See, e.g.:</i>

Claim 1	Accused Products
	 Photograph of moveable component (at right, connected to housing with springs) from the iPhone 14.  Photograph of moveable component from Apple Watch Ultra.

Claim 1	Accused Products
[1c] a power supply;	Each Accused Product comprises a power supply. For example, the linear motor coil driver (described below) in each of the iPhone 14 and Apple Watch Ultra receives power from one or more voltage regulators on or near the Accused Product's system board. See, e.g.:

Claim 1	Accused Products
	A photograph of an iPhone 14 system board, showing various components like the processor, memory, and connectors. The board is gold-colored with black components. A large black chip in the center is labeled 'Qualcomm' and 'SD9X65'. To its left is a silver chip labeled 'SD1000'. To its right is a silver chip labeled 'SD1000'. The board has a complex shape with many small components and connectors. Photograph of iPhone 14 system board.

Claim 1	Accused Products This is a detailed X-ray image of an Apple Watch Ultra system board. The board is rectangular with a complex layout of components. It features two large, square integrated circuits (chips) in the center, surrounded by numerous smaller components including capacitors, resistors, and other microchips. The board has a distinctive shape with rounded corners and several cutouts. The image is in grayscale, highlighting the metallic and ceramic components against a dark background. X-ray image of Apple Watch Ultra system board.
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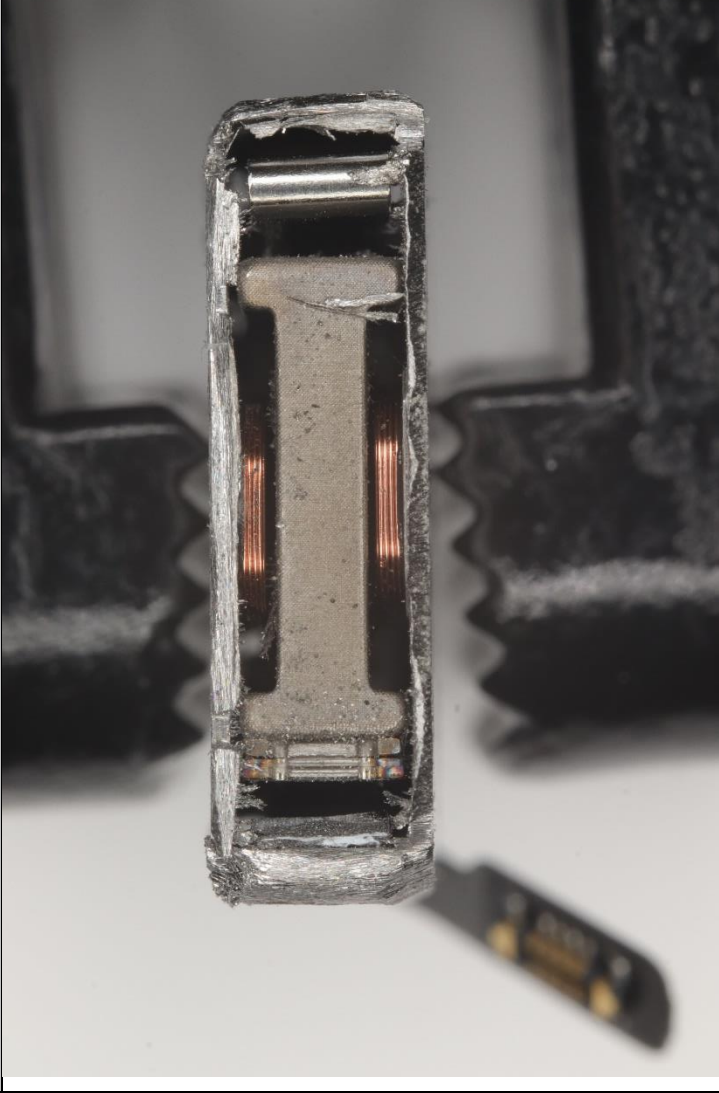
Claim 1	Accused Products
	See <i>also</i> claim elements below.
[1d] user-input features;	Each Accused Product comprises user-input features. For example, each of the iPhone 14 and Apple Watch Ultra comprises a touchscreen, buttons, and other user-input features. See, e.g.:

Claim 1	Accused Products
	 Photograph of iPhone 14 touchscreen, buttons, and switch, available at https://www.apple.com/iphone-14/.

Claim 1	Accused Products
	
[1e] a driving component that drives the moveable component to oscillate within the housing; and	Photograph of Apple Watch Ultra touchscreen, dial, and buttons. Each Accused Product includes a driving component that drives the moveable component to oscillate within the housing. For example, the Taptic Engine includes one or more coils to form electromagnetic fields for driving the moveable component in two directions.

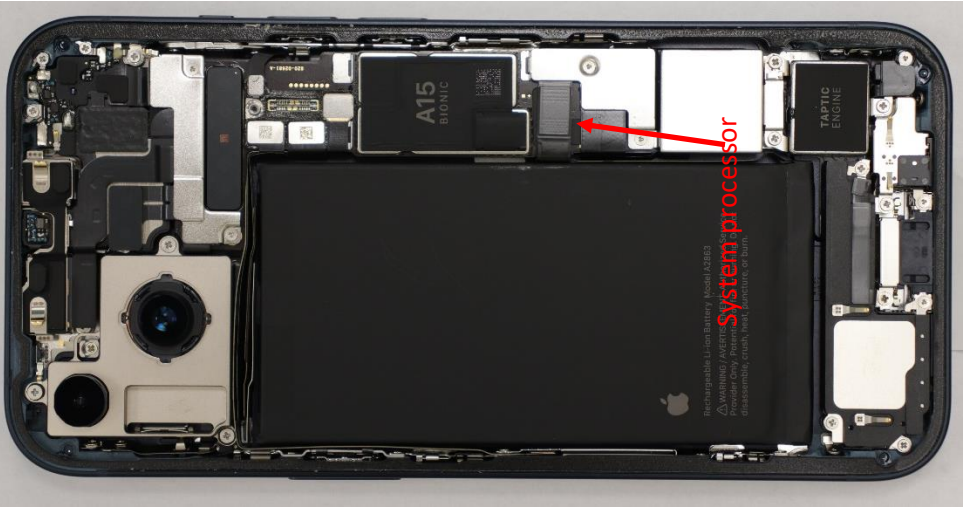
Claim 1	Accused Products
	See, e.g.:  Photograph of driving coils within disassembled Taptic Engine from the iPhone 14. The two visible coils would be positioned above and below the moveable component when assembled.

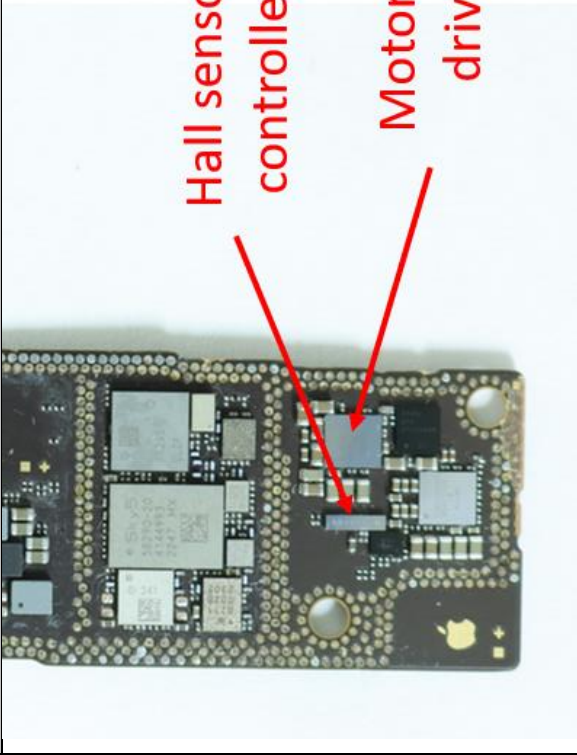
Claim 1	Accused Products
	 Photograph showing one driving coil (at right) within disassembled Taptic Engine from the iPhone 14, with moveable component in place at left. The moveable component travels up and down from this perspective.

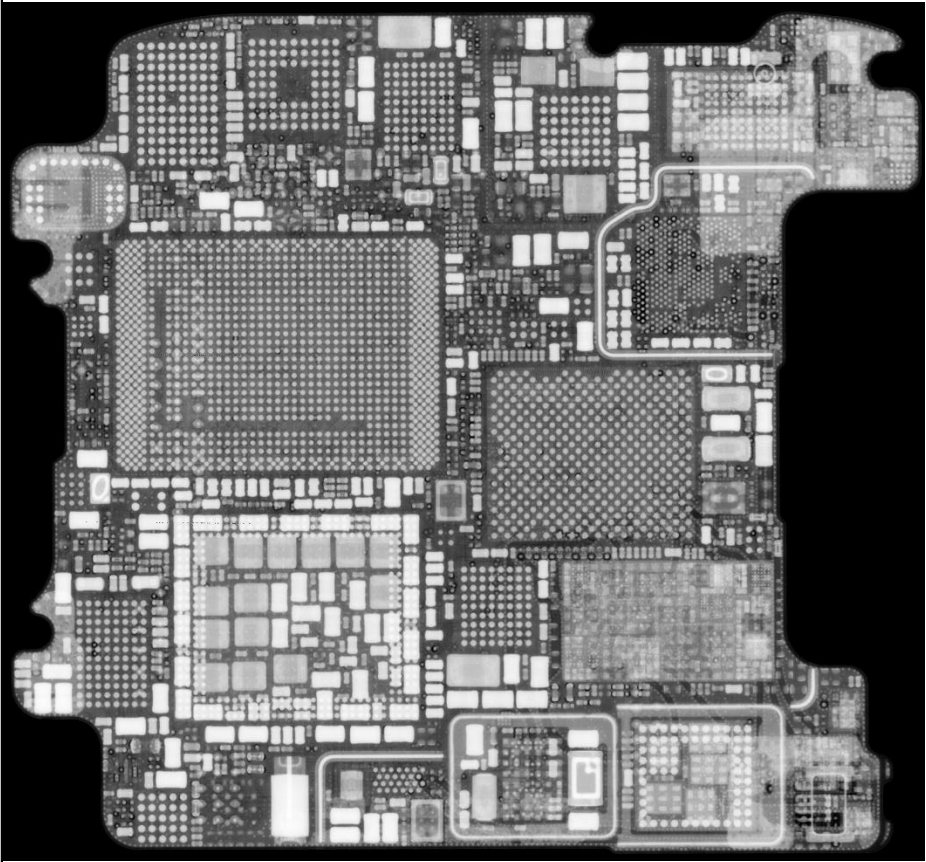
Claim 1	Accused Products
	 Photograph of internals of Taptic Engine from the iPhone 14, showing drive coils (top and bottom) surrounding the moveable component. The moveable component travels left and right from this perspective.

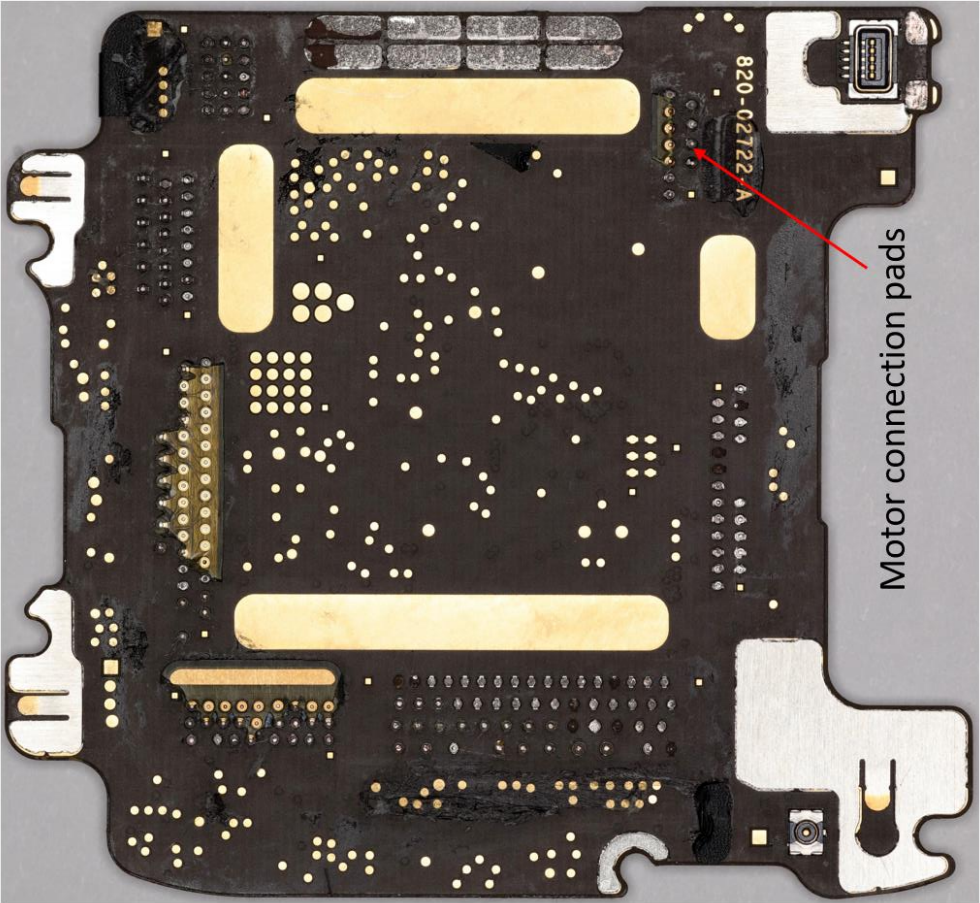
Claim 1	Accused Products
	 Photograph of drive coils within disassembled Taptic Engine from Apple Watch Ultra. The two visible coils would be positioned above and below the movable component when assembled.

Claim 1	Accused Products
[1f] a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values.	Each Accused Product comprises a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values. For example, each Accused Product includes a main system processor, a linear motor coil driver, and a Hall sensor controller, which alone or in combination form a control component as claimed to drive the coils and thus move the magnetic mass in a linear oscillating motion, as described below. This control component can drive the moveable component at specified frequencies and amplitude, as demonstrated by public APIs and by testing. The public APIs, as well as any proprietary Apple APIs and interfaces, specify intensity and sharpness (exemplary stored values) that directly and/or indirectly control the frequency and amplitude of the oscillation and that are stored at least within the system processor and associated volatile and non-volatile memory. On information and belief, the system processor and/or linear motor control driver include additional stored values specifying frequency and/or amplitude. <i>See, e.g.:</i>

Claim 1	Accused Products
	 Photographs showing iPhone 14 system board with A15 Bionic processor.

Claim 1	Accused Products
	 Hall sensor controller Motor coil driver Annotated photograph of Hall sensor controller and motor coil driver from the iPhone 14.

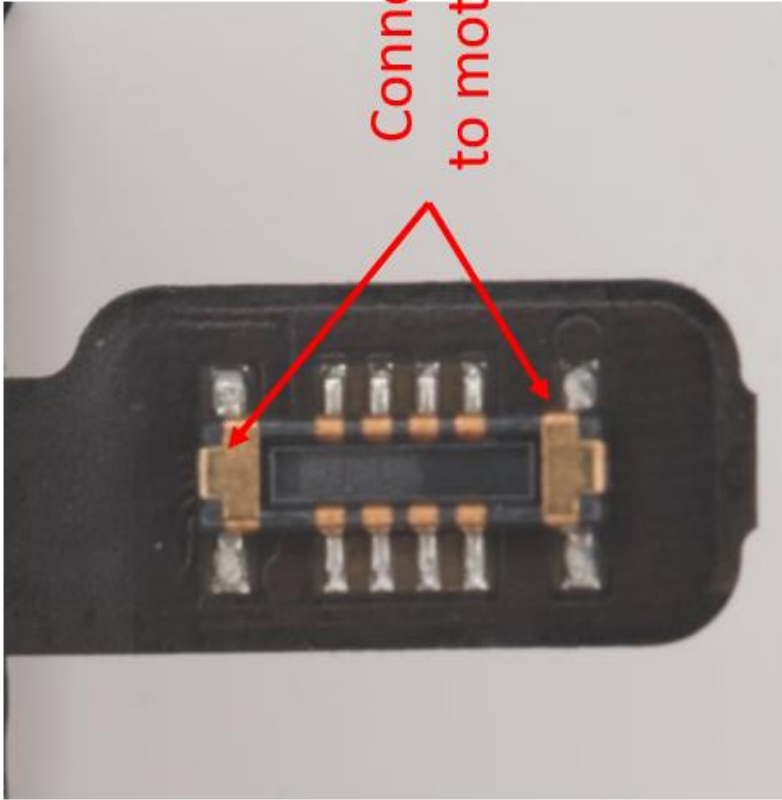
Claim 1	Accused Products
	An X-ray image of an Apple Watch Ultra system board, showing the internal components and layout of the circuit board. The board is rectangular with rounded corners and features a dense arrangement of components, including a large central processor, various memory modules, and numerous smaller integrated circuits and passive components. The image is in grayscale, highlighting the metallic and ceramic components against a dark background. X-ray image of Apple Watch Ultra system board.

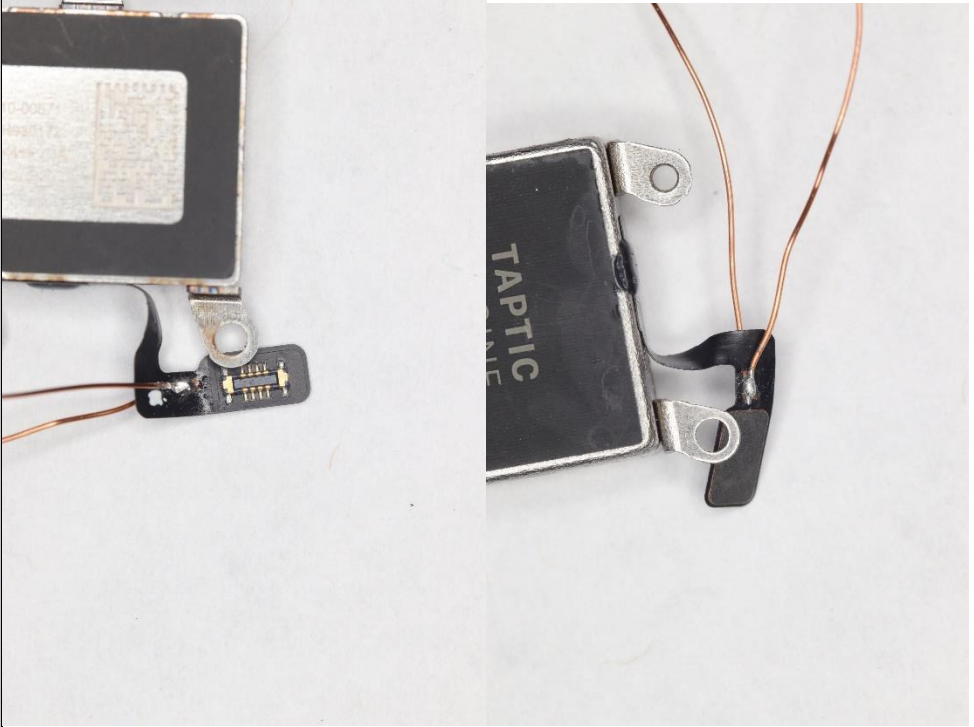
Claim 1	Accused Products
	 Motor connection pads Annotated photograph of partially disassembled Apple Watch Ultra system board, showing connection points for haptic motor.

Claim 1	Accused Products
Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. The figure consists of two side-by-side graphs. The left graph is titled 'Transient' and shows a single blue rectangular pulse on a coordinate system where the vertical axis is 'Intensity' and the horizontal axis is 'Time'. The right graph is titled 'Continuous' and shows a sustained orange rectangular block on a similar coordinate system, representing a haptic pattern that lasts for a duration of time. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent	

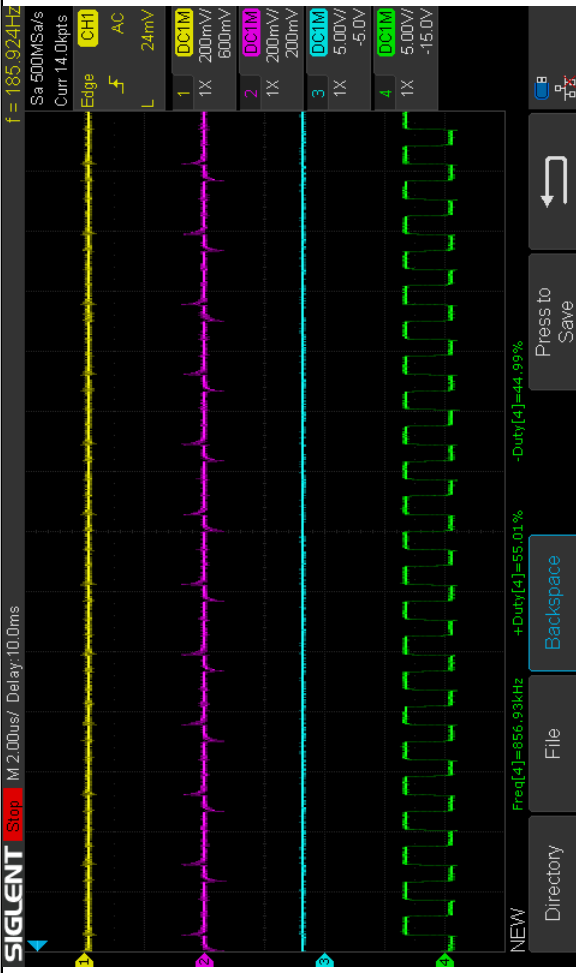
Claim 1	Accused Products
Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;	

Claim 1	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

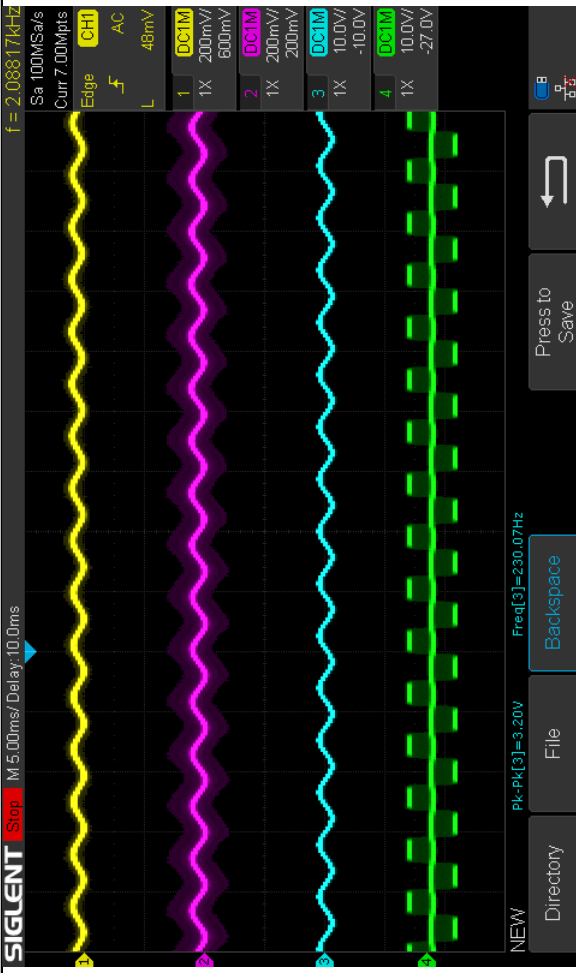
Claim 1	Accused Products
	 Annotated photograph of Taptic Engine connector from the iPhone 14 showing positive and negative coil driving pins.

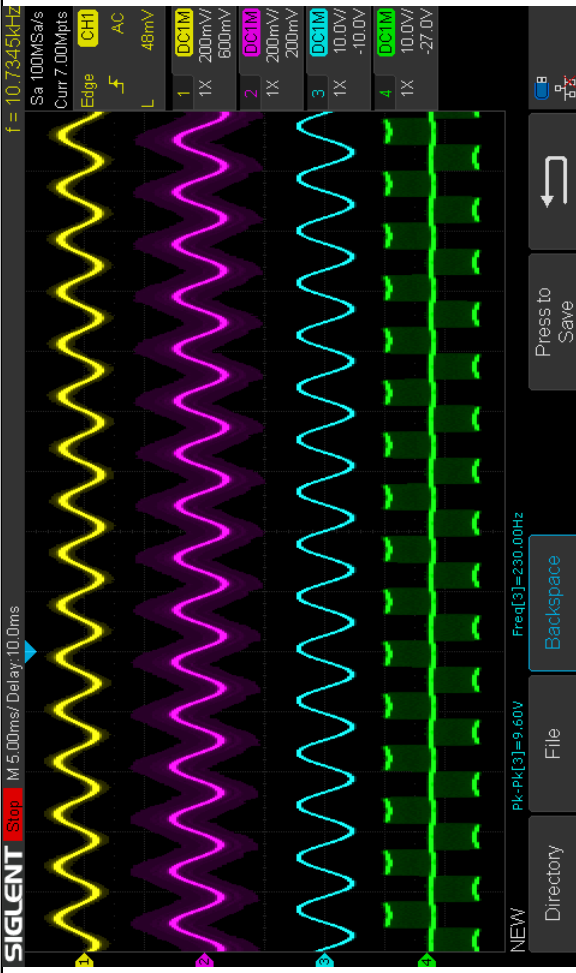
Claim 1	Accused Products
	 Photographs of test apparatus with electrical leads connected to motor coil drive traces of iPhone 14.

Claim 1	Accused Products
	Photograph of test apparatus for measuring motor coil drive signal (from tapped connection) and actual motion (from attached vibration transducer) of iPhone 14. Note RC low-pass filter networks at top right with $R = 220\ \Omega$, $C = 2.2\ \mu\text{F}$.

Claim 1	Accused Products
	 Oscilloscope trace showing, in green (CH4), the drive voltage applied by the iPhone 14 haptic controller(s); in this case, a pulse width modulated positive signal (modulation frequency 857 kHz) to drive the moveable component in one of two directions.

Claim 1	Accused Products
	Oscilloscope trace showing, in green (CH4), the PWM-modulated drive voltage applied by the iPhone 14 haptic controller(s), with positive and negative voltages to drive the moveable component in a first and second direction. Channels 1 and 2 (yellow and purple) show the actual motion of the iPhone 14 resulting (pursuant to Newton's third law) from the motion of the moveable component.

Claim 1	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 0.5, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 3.2 V (peak-to-peak, through RC low-pass filter).

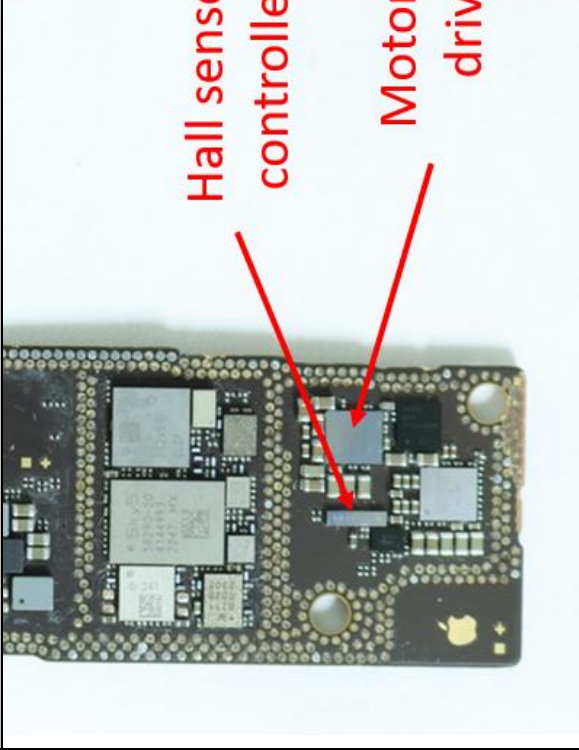
Claim 1	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 9.6V (peak-to-peak, through RC low-pass filter). Note that the externally measured vibration amplitude (yellow and purple traces, same scale as previous trace) is also significantly higher at intensity = 1 than 0.5.

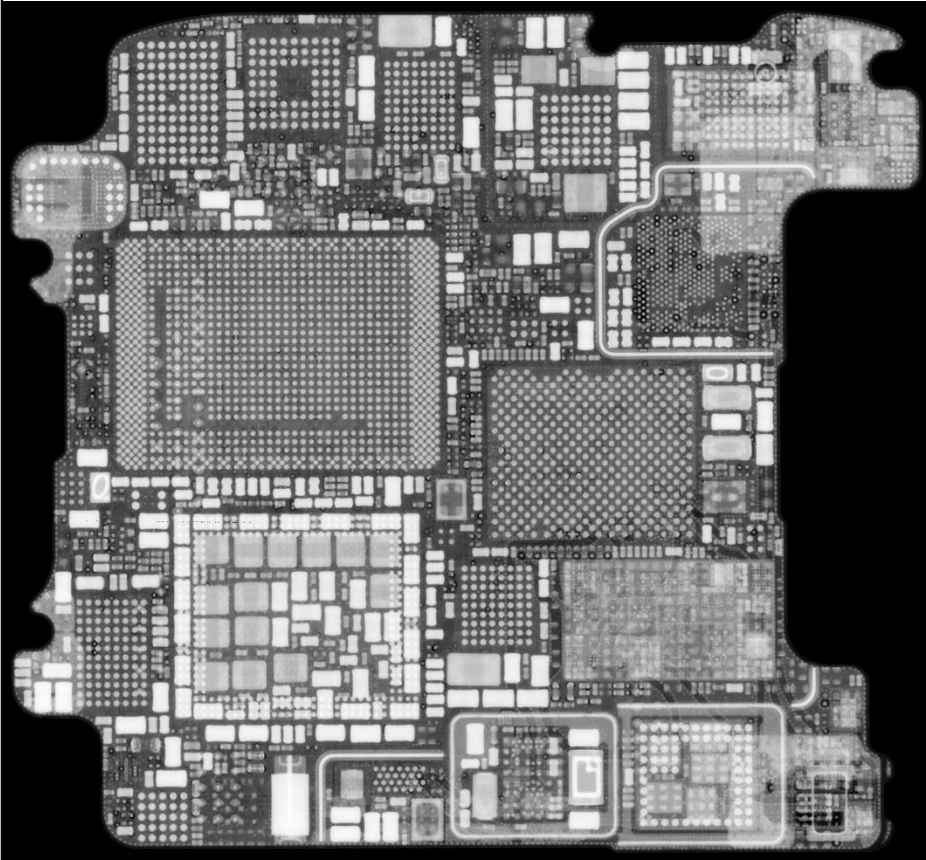
Claim 1	Accused Products
	The screenshot shows a Siglent oscilloscope interface with four channels. Channel 1 (yellow) is set to 1X, 500mV, 1.500V. Channel 2 (magenta) is set to 1X, 500mV, 500mV. Channel 3 (cyan) is set to 1X, 10.0V, -10.0V. Channel 4 (green) is set to 1X, 10.0V, -30.0V. The frequency is 80.01Hz and the peak-to-peak voltage for channel 3 is 10.80V. The interface also includes a 'STOP' button, a 'Directory' button, a 'File' button, a 'Backspace' button, and a 'Press to Save' button. Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 0, with frequency of 80 Hz and motor drive amplitude of 10.8 V (peak-to-peak, through RC low-pass filter). To the extent Defendant contends and/or shows that this limitation is not literally present in the Accused Products, it is present under the doctrine of equivalents. There are no substantial differences between the accused functionality and the claimed invention. For example, each Accused Product contains one or more microprocessors that coordinate(s) operation of the Taptic Engine, which performs substantially the same function (e.g., controlling supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values) in substantially the same way (e.g., using digital logic) to achieve substantially the same result (e.g., producing oscillations at a desired frequency and amplitude).

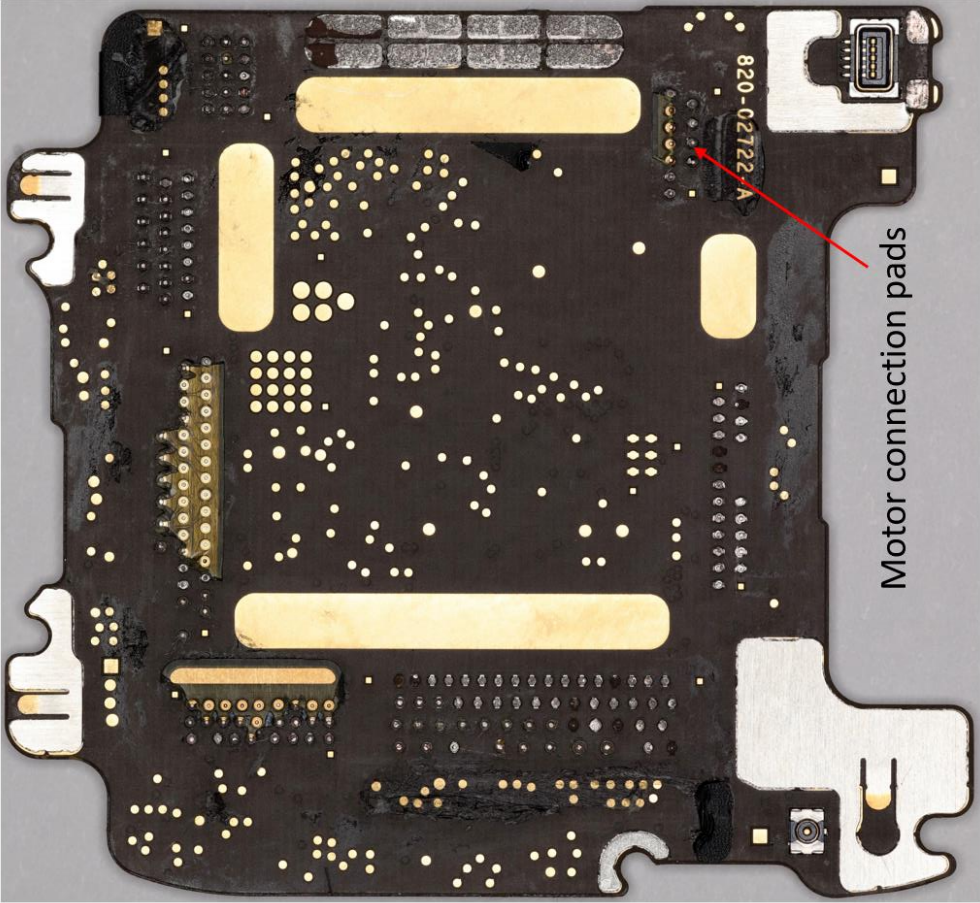
Claim 2

Claim 2	Accused Products
[2pre] The vibration module of claim 1 wherein the control component is one of:	Each Accused Product comprises the vibration module of claim 1 wherein the control component meets claim limitation [2b].
[2a] an variable oscillator circuit with additional control circuitry; and	See <i>infra</i> claim element [2b].
[2b] a control component that includes	Each Accused Product comprises a control component as claimed.
[2c] a microprocessor,	See <i>supra</i> claim element [1f] and <i>infra</i> claim elements [2c]-[2d]. In each Accused Product, the control component includes a microprocessor. For example, each Accused Product includes a main system processor, a linear motor coil driver, and a Hall sensor controller, which alone or in combination form a microprocessor within the control component. See, e.g.:

Claim 2	Accused Products
	 Photographs showing iPhone 14 system board with A15 Bionic processor.

Claim 2	Accused Products
	 Hall sensor controller Motor coil driver Annotated photograph of Hall sensor controller and motor coil driver from the iPhone 14.

Claim 2	Accused Products
	 X-ray image of Apple Watch Ultra system board.

Claim 2	Accused Products
	 Motor connection pads Annotated photograph of partially disassembled Apple Watch Ultra system board, showing connection points for haptic motor.
[2d] a control program, stored in an electronic memory	In each Accused Product, a control component includes a control program, stored in an electronic memory within, or separate from, the microprocessor, the control program executed by the

Claim 2	Accused Products
within, or separate from, the microprocessor, the control program executed by the microprocessor to control supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by the one or more stored values.	microprocessor to control supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by the one or more stored values. For example, one or more of the system processor and/or linear motor coil driver forming the microprocessor contains confidential and proprietary software and/or firmware to control the linear resonant vibration motor. When the control program is executed by the microprocessor, the control component can drive the moveable component at specified frequencies and amplitude, as demonstrated by public APIs and by testing. The public APIs, as well as any proprietary Apple APIs and interfaces, specify intensity and sharpness (exemplary stored values) that directly and/or indirectly control the frequency and amplitude of the oscillation and that are stored at least within the system processor and associated volatile and non-volatile memory. On information and belief, the system processor and/or linear motor control driver include additional stored values specifying frequency and/or amplitude. <i>See supra</i> claim element [1f].

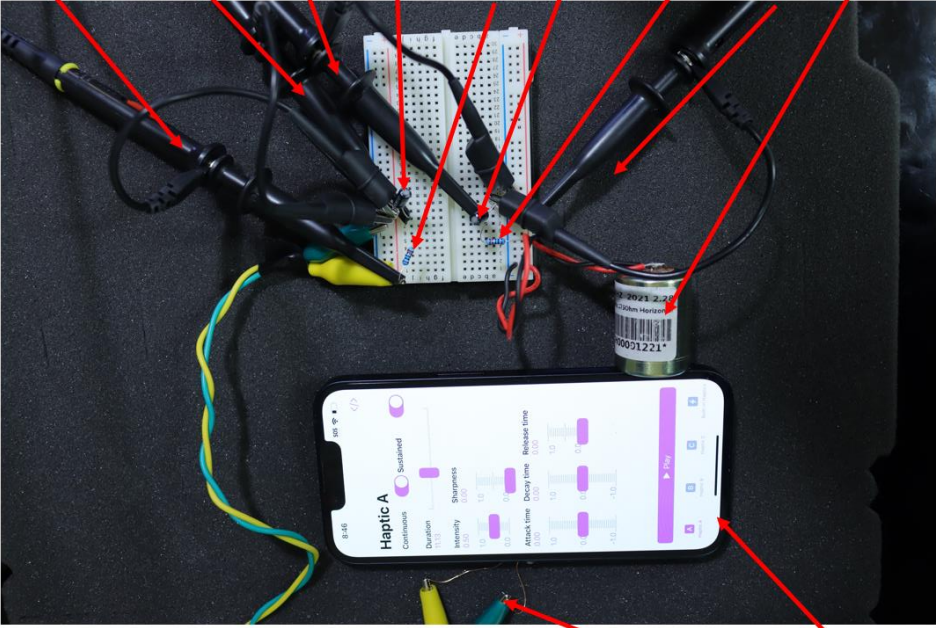
Claim 3

Claim 3	Accused Products
[3] The vibration module of claim 1 wherein the control component receives output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors.	Each Accused Product comprises the vibration module of claim 1 wherein the control component receives output signals from sensors within the vibration module during operation of the vibration module and adjusts one or more operational control outputs of the control component according to the received output signals from the sensors. For a further example, the control component generates electrical outputs to the driving coils (actuator) that cause alternating magnetic fields, moving the mass and therefore producing a vibration response as directed by the application processor and software running on the application processor. On information and belief, the control outputs are generated based on the closed-loop feedback received from the Hall effect sensor(s), as demonstrated by, for example, the presence of the Hall effect sensor(s) themselves and the precision and quality of the resulting vibration response.

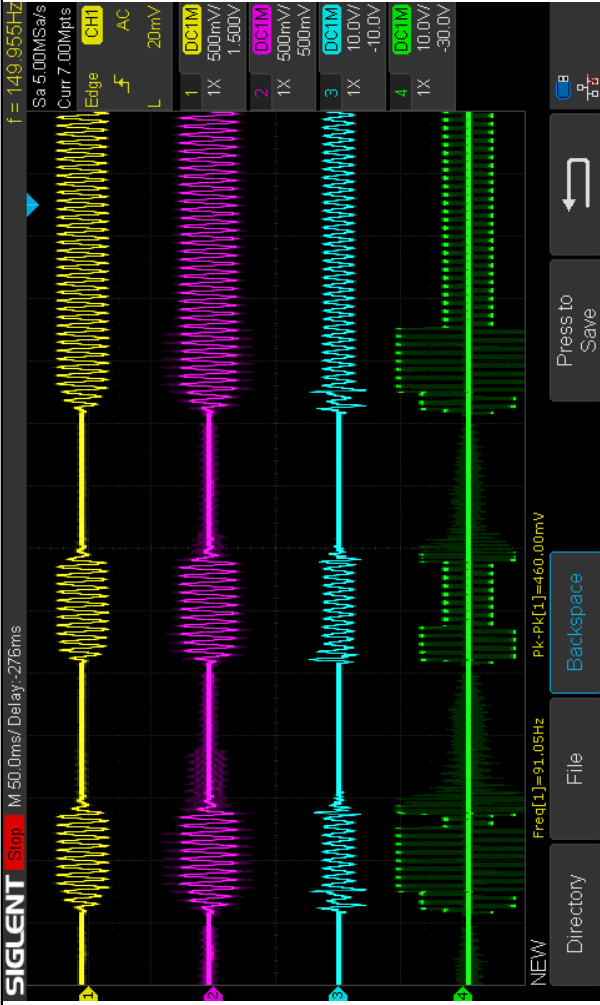
Claim 3	Accused Products
	See, e.g.: Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds.  The figure contains two side-by-side graphs. The left graph is titled 'Transient' and shows a single blue rectangular pulse on a coordinate system where the vertical axis is 'Intensity' and the horizontal axis is 'Time'. The right graph is titled 'Continuous' and shows a sustained orange rectangular block on a similar coordinate system, representing a haptic pattern that lasts for a duration of time. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent, describing vibration patterns resulting from various control inputs

Claim 3	Accused Products
Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;	

Claim 3	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

Claim 3	Accused Products
	 Raw linear motor probe (CH4) Filtered linear motor probe (CH3) Filtered transducer probe (CH1) Capacitor Resistor Capacitor Resistor Raw transducer probe (CH2) Vibration transducer Tapped linear motor control signal iPhone 14 Photograph of test apparatus for measuring motor coil drive signal (from tapped connection) and actual motion (from attached vibration transducer) of iPhone 14.

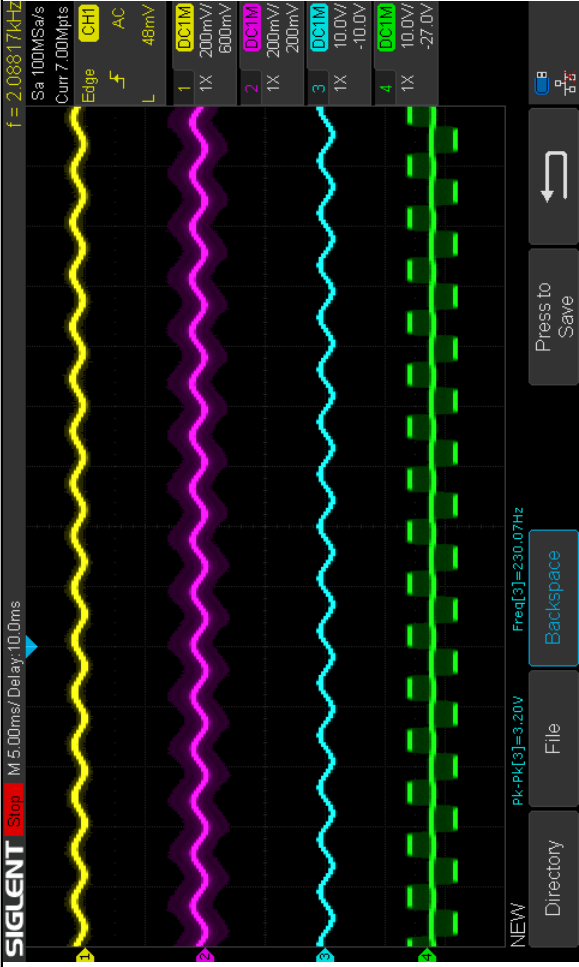
Claim 3	Accused Products Oscilloscope trace showing, in green (CH4), the drive voltage applied by the iPhone 14 haptic controller(s); in this case, a pulse width modulated positive signal (modulation frequency 857 kHz) to drive the moveable component to oscillate.
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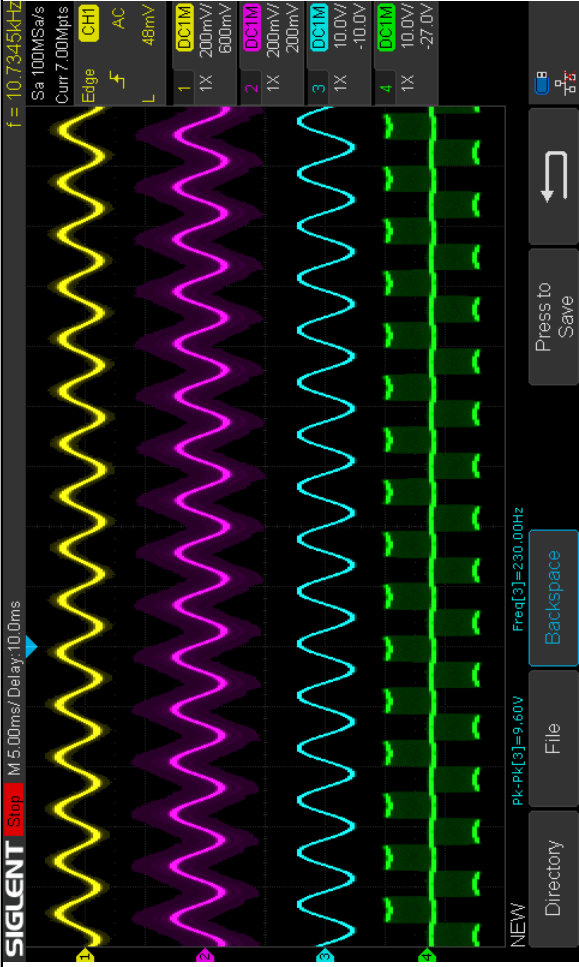
Claim 3	Accused Products
	 Oscilloscope trace showing, in green (CH4), the PWM-modulated drive voltage applied by the iPhone 14 haptic controller(s), with positive and negative voltages to drive the moveable component in a first and second direction. Channels 1 and 2 (yellow and purple) show the actual motion of the iPhone 14 resulting (pursuant to Newton's third law) from the oscillation of the moveable component. To the extent Defendant contends and/or shows that this limitation is not literally present in the Accused Products, it is present under the doctrine of equivalents. There are no substantial differences between the accused functionality and the claimed invention. For example, the control component in each Accused Product may adjust one or more operational control outputs according to signals or values derived from the received output signals from one or more sensors, which performs substantially the same function (<i>e.g.</i>, adjusting one or more operational control outputs of the control component according to the received output signals from the sensors) in substantially the same way (<i>e.g.</i>, making adjustments based on information from sensors within the linear resonant vibration module) to achieve substantially the same result (<i>e.g.</i>, causing the

Claim 3	Accused Products
	moveable component to oscillate at a frequency and an amplitude specified by one or more stored values).

Claim 4

Claim 4	Accused Products
[4] The vibration module of claim 1 wherein the control component adjusts the one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters.	Each Accused Product comprises the vibration module of claim 1 wherein the control component adjusts the one or more operational control outputs of the control component according to the received output signals from the sensors in order that subsequent operation of the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters. For example, each Accused Product adjusts the operational control outputs such as amplitude, frequency, and/or phase of the drive voltage applied by the control component. On information and belief, the operational control outputs are adjusted in a way to produce desired outputs of at least amplitude and frequency of a signal from a Hall effect sensor, which correspond to one or more operational control parameters “intensity” and “sharpness” that may be selected in various public APIs, as well as any proprietary Apple APIs and interfaces. See <i>supra</i> claim element [1f]. See, e.g.:

Claim 4	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 0.5, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 3.2 V (peak-to-peak, through RC low-pass filter).

Claim 4	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 9.6V (peak-to-peak, through RC low-pass filter). Note that the externally measured vibration amplitude (yellow and purple traces, same scale as previous trace) is also significantly higher at intensity = 1 than 0.5.

Claim 4	Accused Products
	Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 0, with frequency of 80 Hz and motor drive amplitude of 10.8 V (peak-to-peak, through RC low-pass filter). To the extent Defendant contends and/or shows that this limitation is not literally present in the Accused Products, it is present under the doctrine of equivalents. There are no substantial differences between the accused functionality and the claimed invention. For example, the control component in each Accused Product may adjust one or more operational control outputs according to signals or values derived from the received output signals from one or more sensors, which performs substantially the same function (<i>e.g.</i>, adjusts the one or more operational control outputs of the control component according to the received output signals from the sensors) in substantially the same way (<i>e.g.</i>, making adjustments based on information from sensors within the linear resonant vibration module) to achieve substantially the same result (<i>e.g.</i>, adjusting operational control outputs in order that subsequent operation of the vibration module produces desired outputs from the one or more sensors corresponding to one or more operational control parameters).

Claim 5

Claim 5	Accused Products
[5] The vibration module of claim 4 wherein the one or more operational control parameters is a strength of vibration produced by the oscillation of the moveable component; and wherein the one or more operational control outputs is a frequency at which the control component drives the moveable component to oscillate, the control component dynamically adjusting the power supplied to the driving component to produce oscillation of the moveable component at a resonant frequency for the vibration module.	Each Accused Product comprises the vibration module of claim 4 wherein the one or more operational control parameters is a strength of vibration produced by the oscillation of the moveable component; and wherein the one or more operational control outputs is a frequency at which the control component drives the moveable component to oscillate, the control component dynamically adjusting the power supplied to the driving component to produce oscillation of the moveable component at a resonant frequency for the vibration module. For example, each Accused Product includes a strength of vibration operational control parameter, corresponding to an “intensity” parameter that may be selected in various public APIs, as well as any proprietary Apple APIs and interfaces. <i>See supra</i> claim element [1f]. For example, each Accused Product includes a frequency for driving the moveable component to oscillate as an operational control output. The desired oscillation frequency corresponding to a “sharpness” parameter may be selected in various public APIs, as well as any proprietary Apple APIs and interfaces. When the “sharpness” parameter is chosen to be substantially similar to a pre-determined resonant frequency of the vibration module, the power supplied to the driving component will be adjusted in order to produce the selected resonant frequency. <i>See supra</i> claim element [1f]. <i>See, e.g.:</i>

Claim 5	Accused Products
	Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent, describing vibration patterns resulting from various control inputs

Claim 5	Accused Products
Haptic Event Parameter IDs <pre> static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration.</pre> Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;	

Claim 5	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

Claim 6	Accused Products
[6pre] The vibration module of claim 4	Each Accused Product comprises the vibration module of claim 4.
[6a] wherein the one or more operational control parameters include both a strength of vibration produced by the oscillation of the moveable component and a current operational mode; and	In each Accused Product, the one or more operational control parameters include both a strength of vibration produced by the oscillation of the moveable component and a current operational mode. For example, each Accused Product includes a strength of vibration operational control parameter, corresponding to an “intensity” parameter that may be selected in various public APIs, as well as any proprietary Apple APIs and interfaces. The default operational mode may correspond to a single haptic event with constant intensity and sharpness. Other operational modes, including more complex operational modes also exist as shown by the existence of complex and time-

Claim 6	Accused Products
	dependent vibrational behaviors not supported by the default operational mode. <i>See supra</i> claim element [1f] and <i>infra</i> claim 15. <i>See also, e.g.:</i>

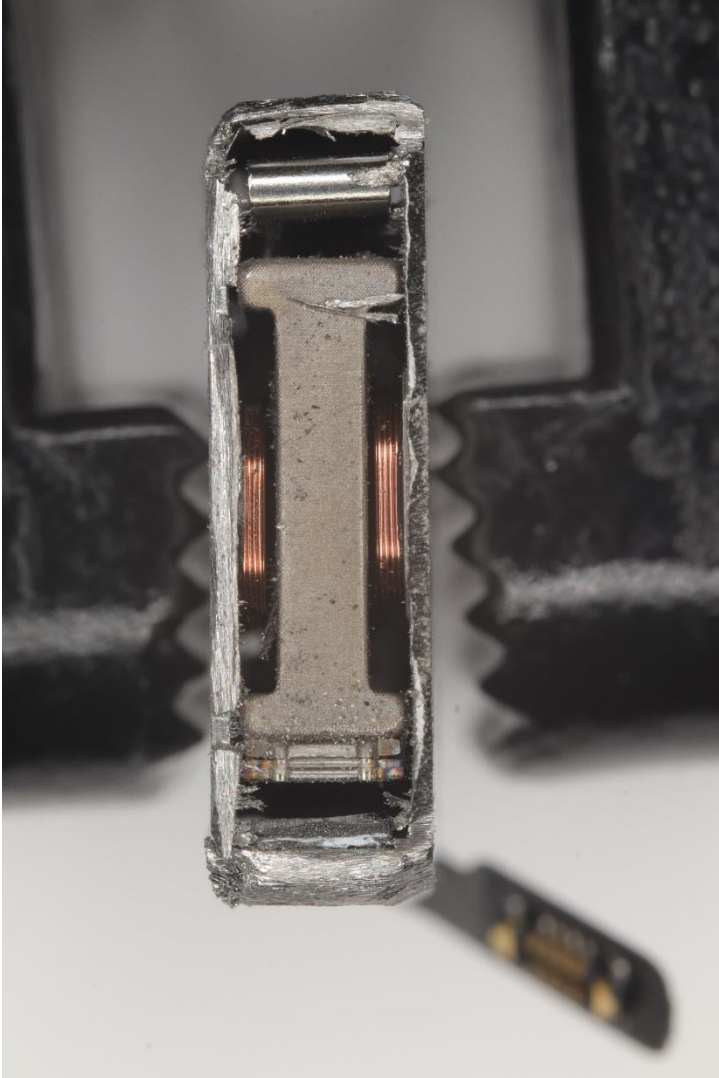
Claim 6	Accused Products
Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event type determines whether it's audio or haptic. Use a CHHapticPatternPlayer object obtained through CHHapticEngine factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. The figure consists of two side-by-side graphs. The left graph is titled 'Transient' and shows a single blue rectangular pulse on a coordinate system where the vertical axis is 'Intensity' and the horizontal axis is 'Time'. The right graph is titled 'Continuous' and shows a sustained orange rectangular block on a similar coordinate system, representing a haptic pattern that lasts for a duration of time. Specify when an event begins by setting its relativeTime property. Specify the length of the event by setting its duration property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID hapticIntensity. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent, describing vibration patterns resulting from various control inputs	

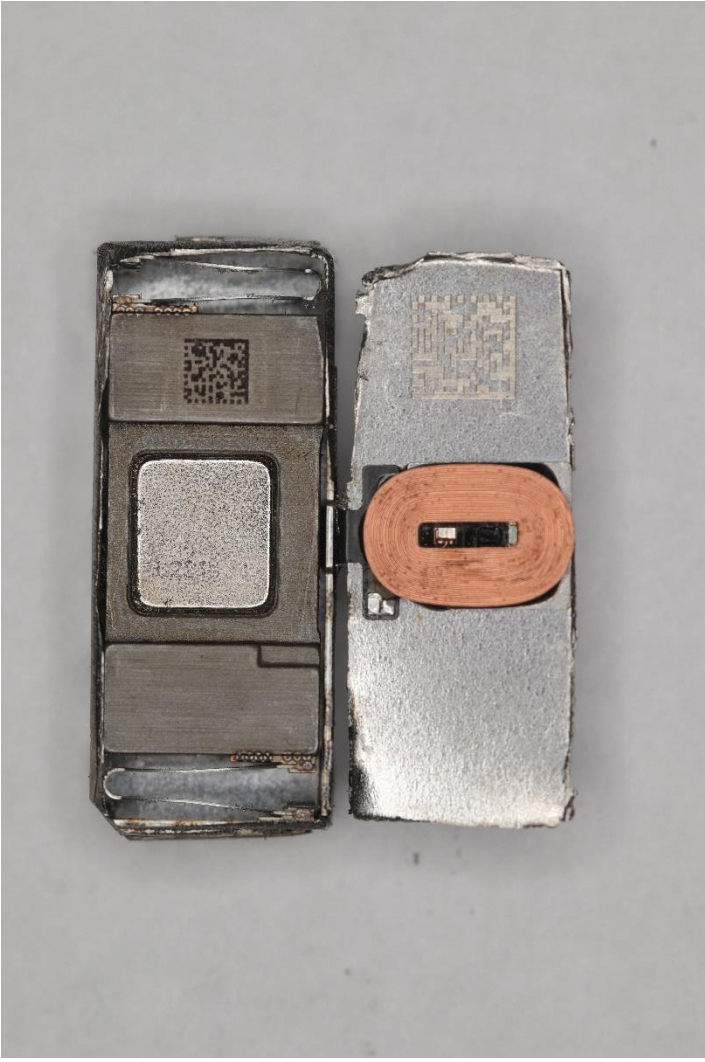
Claim 6	Accused Products
Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;	

Claim 6	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.
[6b] wherein the one or more operational control outputs is a control output that determines a current supplied by the power supply to the driving component and a frequency at which the control component drives the moveable component to oscillate.	In each Accused Product, the one or more operational control outputs is a control output that determines a current supplied by the power supply to the driving component and a frequency at which the control component drives the moveable component to oscillate. For example, the strength of vibration is determined from the force exerted on the permanent magnet in the moveable component by the magnetic field produced by electromagnetic coils in each Accused Product. Since the magnetic field is proportional to current in the electromagnetic coils, this indicates current supplied by the power supply to the driving component is a control output used to produce a desired vibration strength. For example, each Accused Product includes a frequency for driving the moveable component to oscillate as an operational control output. <i>See supra</i> claim element [1f].

Claim 7

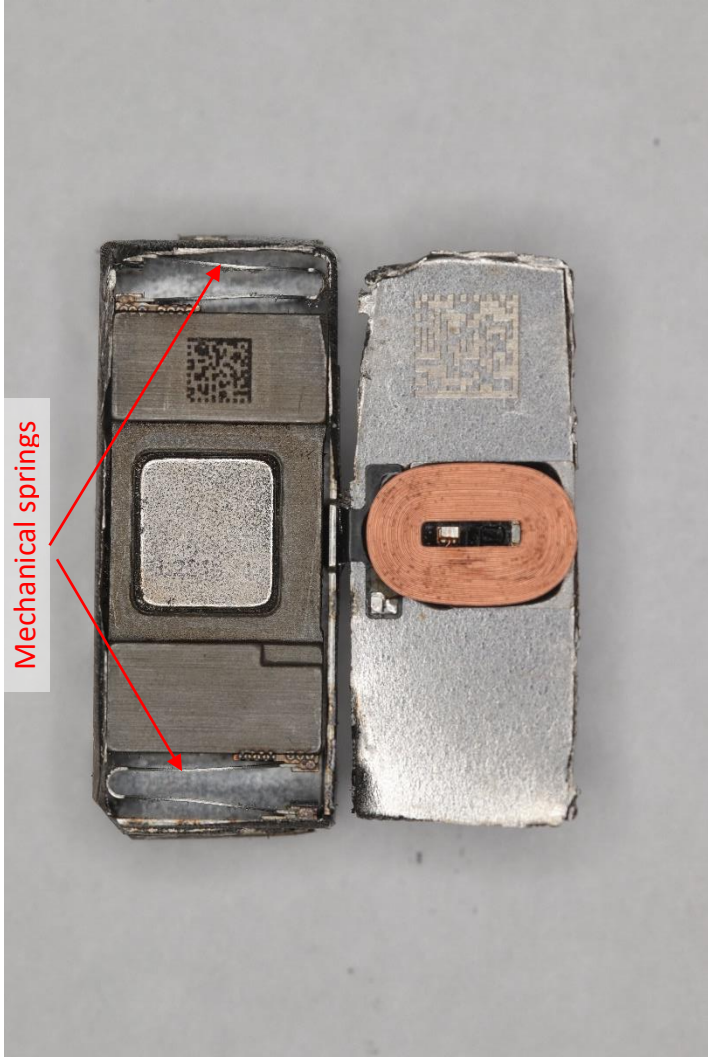
Claim 7	Accused Products
[7] The vibration module of claim 1 wherein the driving component comprises one or more electromagnetic coils that generate magnetic fields parallel to the directions in which the moveable component is driven by the driving component.	Each Accused Product comprises the vibration module of claim 1 wherein the driving component comprises one or more electromagnetic coils that generate magnetic fields parallel to the directions in which the moveable component is driven by the driving component. For example, each Accused Product comprises two electromagnetic coils that generate magnetic fields substantially parallel to the directions in which the moveable component is driven by the driving component. See, e.g.:  Photograph showing one driving coil (at right) within disassembled Taptic Engine from the iPhone 14, with moveable component in place at left. The moveable component travels up and down from

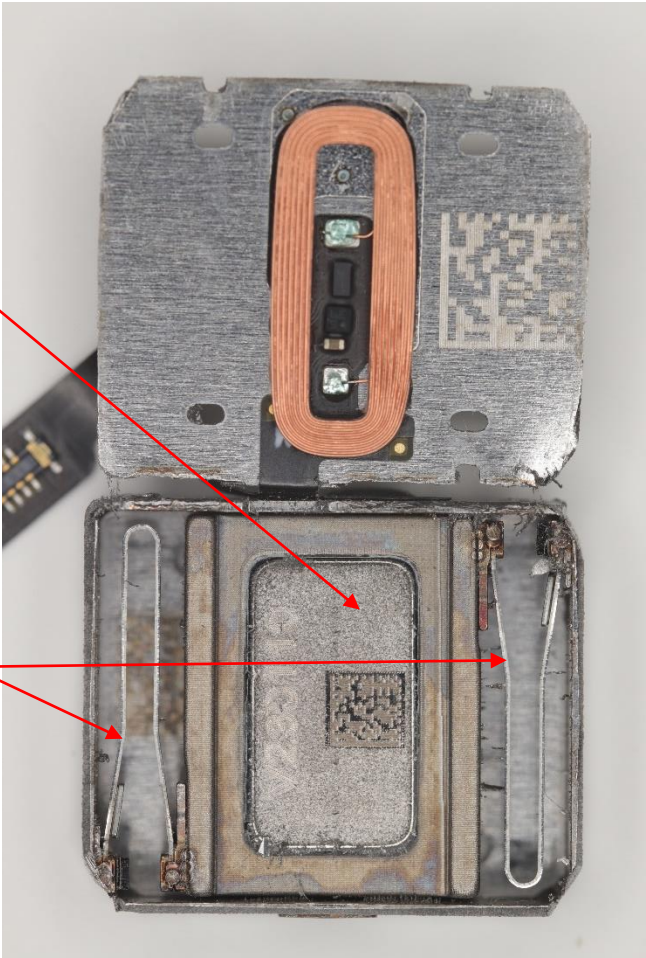
Claim 7	Accused Products
	this perspective, which is the same direction as magnetic field lines originating from the driving coils.  Photograph of internals of Taptic Engine from the iPhone 14, showing drive coils (top and bottom) surrounding the moveable component. The moveable component travels left and right from this perspective (red arrows) against mechanical springs. The drive coils produce a magnetic field direction substantially parallel to the left and right directions of motion of the moveable mass.

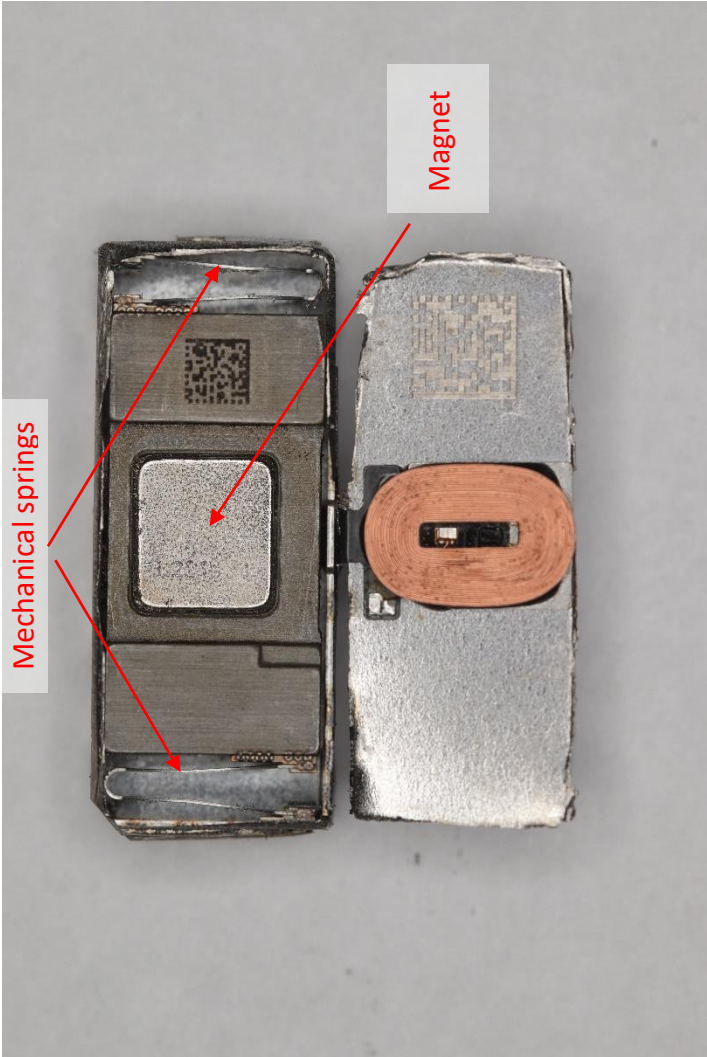
Claim 7	Accused Products
	 Photograph of drive coils within disassembled Taptic Engine from Apple Watch Ultra. The two visible coils would be positioned above and below the movable component when assembled. The moveable component travels left and right from this perspective, which is the same direction as magnetic field lines originating from the drive coils.

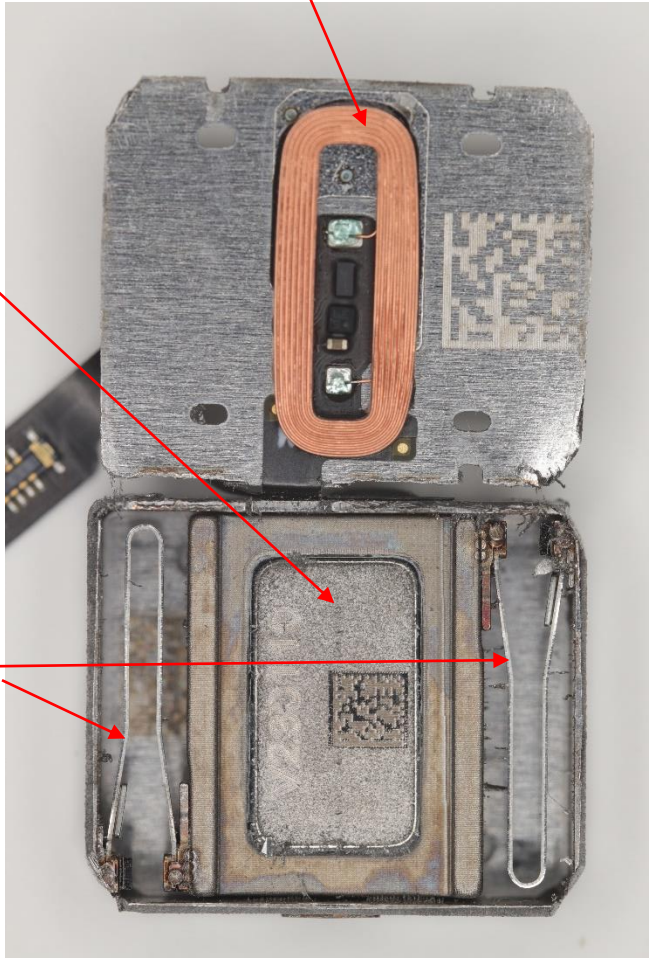
Claim 8	Accused Products
[8pre] The vibration module of claim 1	Each Accused Product comprises the vibration module of claim 1.
[8a] wherein the housing is a tube, capped at both ends by	In each Accused Product, the housing is a tube, capped at both ends by movable-component-repelling components selected from one of mechanical springs and magnets.

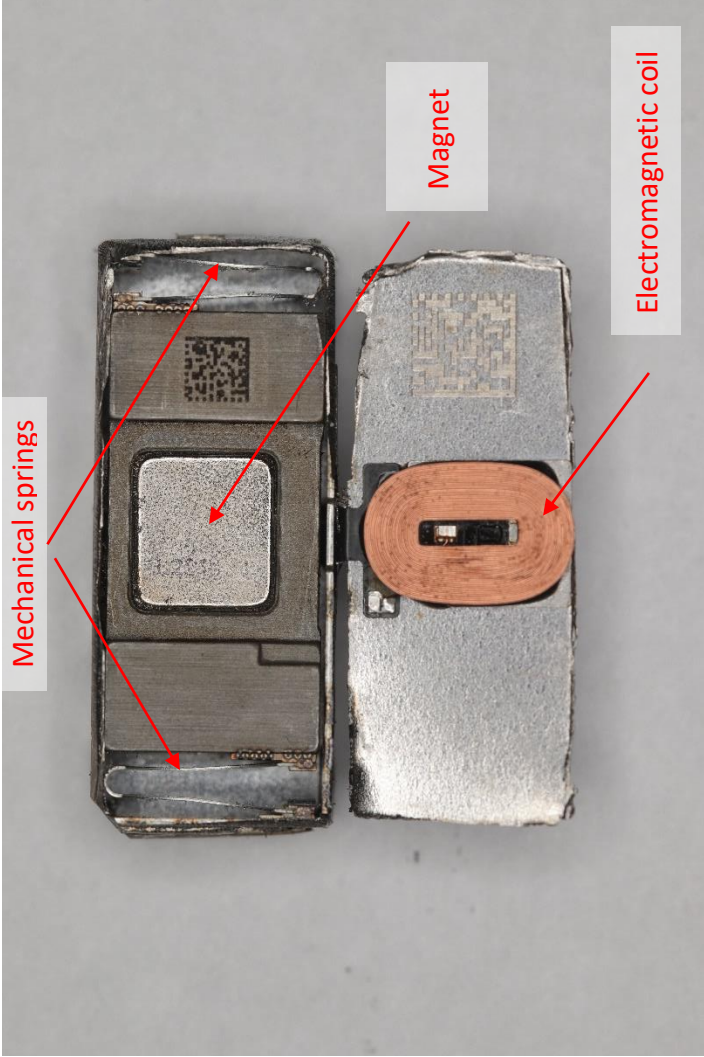
Claim 8	Accused Products
movable-component- repelling components selected from one of mechanical springs and magnets;	For example, in each Accused Product, the housing is a rectangular tube capped at both ends by mechanical springs. See, e.g.: Mechanical springs  Photograph showing one driving coil (at right) within disassembled Taptic Engine from the iPhone 14, with moveable component in place at left inside a rectangular tube. The moveable component travels up and down from this perspective against two mechanical springs on the top and bottom.

Claim 8	Accused Products
	 Photograph of drive coils within disassembled Taptic Engine from Apple Watch Ultra, with the moveable component in place at the top inside a rectangular tube. The moveable component travels left and right from this perspective against two mechanical springs on the left and right.
[8b] wherein the movable component is a magnet shaped to slide within the tube; and	In each Accused Product, the moveable component is a magnet shaped to slide within the tube. <i>See, e.g.:</i>

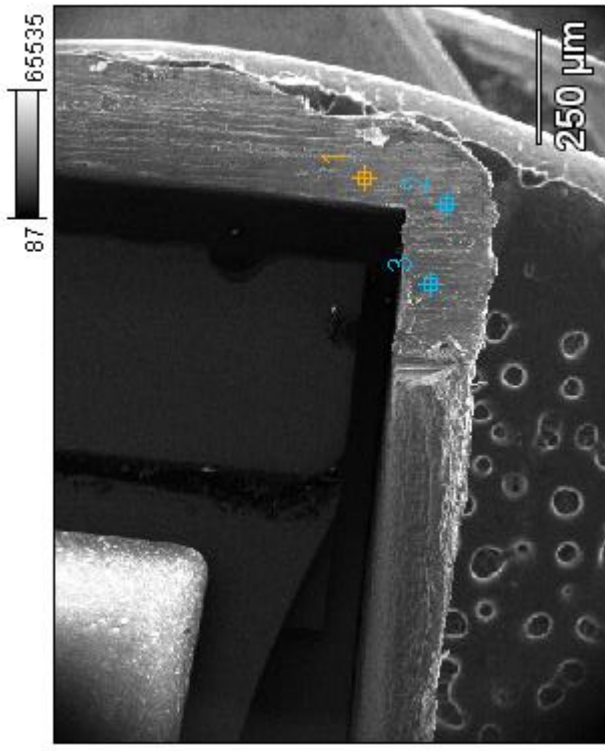
Claim 8	Accused Products
	 Mechanical springs Magnet Photograph of a disassembled Taptic Engine from the iPhone 14 showing a magnet shaped to slide within a rectangular tube.

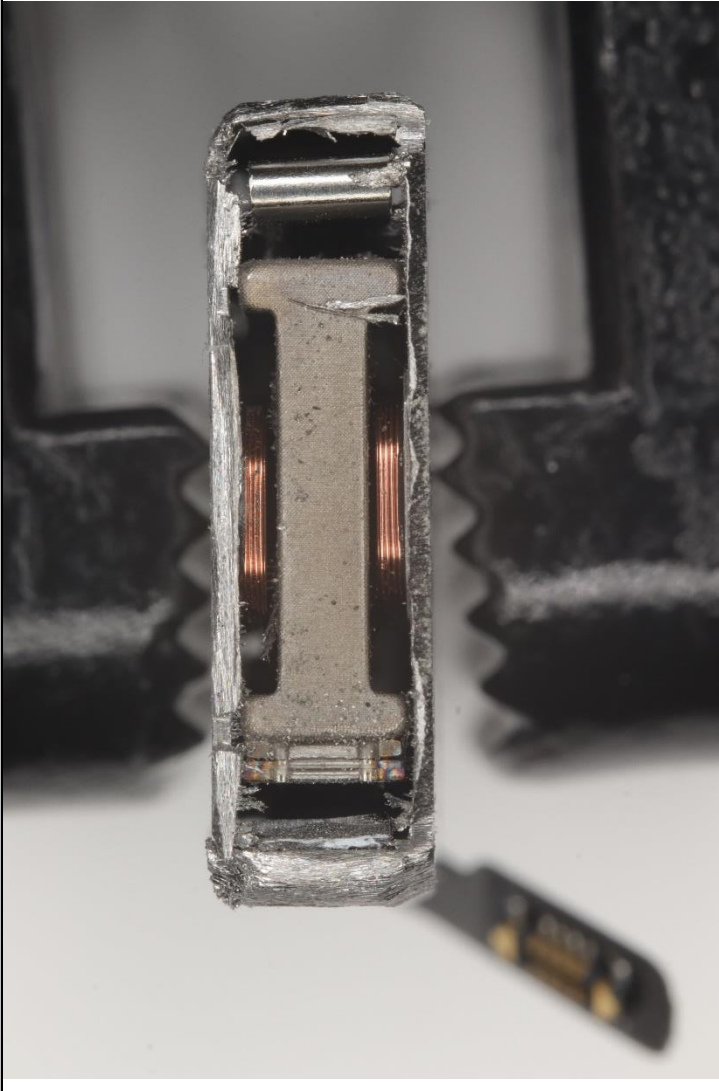
Claim 8	Accused Products
	 Photograph of a disassembled Taptic Engine from Apple Watch Ultra showing a magnet shaped to slide within a rectangular tube.
[8c] wherein the driving component is an electromagnetic coil.	In each Accused Product, the driving component is an electromagnetic coil.

Claim 8	Accused Products
	<i>See, e.g.:</i>  Mechanical springs Magnet Electromagnetic coil Photograph of a disassembled Taptic Engine from the iPhone 14 showing an electromagnetic coil.

Claim 8	Accused Products
	 Photograph of a disassembled Taptic Engine from Apple Watch Ultra showing an electromagnetic coil.

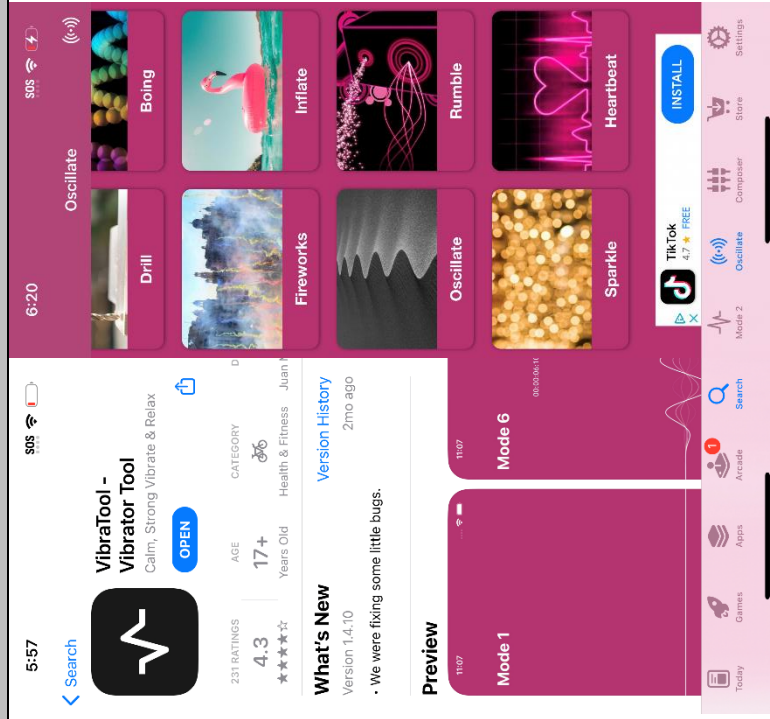
Claim 14	Accused Products
[14] The vibration module of claim 1 further including flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.	Each Accused Product comprises the vibration module of claim 1 further including flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module. For example, the elemental composition of the housing of the Taptic Engine in the iPhone 14 was determined from energy-dispersive X-ray spectroscopy (EDS). The housing primarily consists of

Claim 14	Accused Products																																	
more magnetic circuits within the vibration module.	an iron and chromium alloy, which indicates it is a ferritic stainless steel with paramagnetic properties and high magnetic permeability. The housing surrounds the driving coils and moveable component and is positioned to reduce the reluctance of the magnetic circuit formed by the driving coils, moveable component, and housing. See, e.g.: Base(6) <table><thead><tr><th>Line</th><th>Wt.%</th><th>Error</th></tr></thead><tbody><tr><td>C K</td><td>0.00</td><td>0.00</td></tr><tr><td>O K</td><td>0.00</td><td>0.00</td></tr><tr><td>Si K</td><td>0.32</td><td>0.03</td></tr><tr><td>Ti K</td><td>0.13</td><td>0.02</td></tr><tr><td>V K</td><td>0.19</td><td>0.04</td></tr><tr><td>Cr K</td><td>18.56</td><td>0.09</td></tr><tr><td>Fe K</td><td>80.20</td><td>0.22</td></tr><tr><td>Ni K</td><td>0.21</td><td>0.04</td></tr><tr><td>Nd L</td><td>0.00</td><td>0.00</td></tr><tr><td>Tl L</td><td>0.39</td><td>0.20</td></tr></tbody></table> Scanning electron microscopic image of the housing of the Taptic Engine of the iPhone 14 depicting 3 points where EDS measurements were taken. The elemental composition by weight averaged from the 3 EDS measurements is shown in the table on the right. The iron and chromium composition suggests the housing consists of a ferritic stainless steel alloy with paramagnetic properties and high magnetic permeability.	Line	Wt.%	Error	C K	0.00	0.00	O K	0.00	0.00	Si K	0.32	0.03	Ti K	0.13	0.02	V K	0.19	0.04	Cr K	18.56	0.09	Fe K	80.20	0.22	Ni K	0.21	0.04	Nd L	0.00	0.00	Tl L	0.39	0.20
Line	Wt.%	Error																																
C K	0.00	0.00																																
O K	0.00	0.00																																
Si K	0.32	0.03																																
Ti K	0.13	0.02																																
V K	0.19	0.04																																
Cr K	18.56	0.09																																
Fe K	80.20	0.22																																
Ni K	0.21	0.04																																
Nd L	0.00	0.00																																
Tl L	0.39	0.20																																

Claim 14	Accused Products
	 Photograph of internals of Taptic Engine from the iPhone 14, showing the magnetic circuit formed by the driving coils, moveable component, and housing composed of a paramagnetic material.

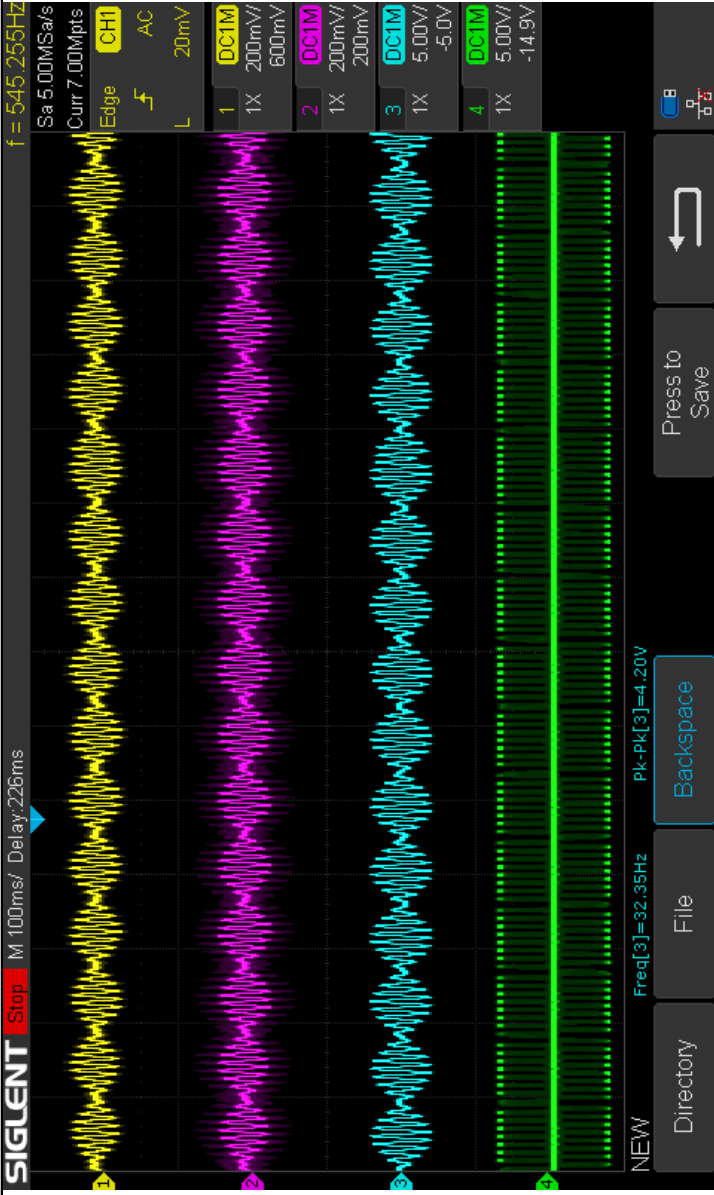
Claim 15	Accused Products
[15] The vibration module of claim 1 wherein the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes. For example, the iPhone 14 is configured to drive the moveable component in a complex drive mode that includes at least two frequencies when used with software sold by Apple through its	

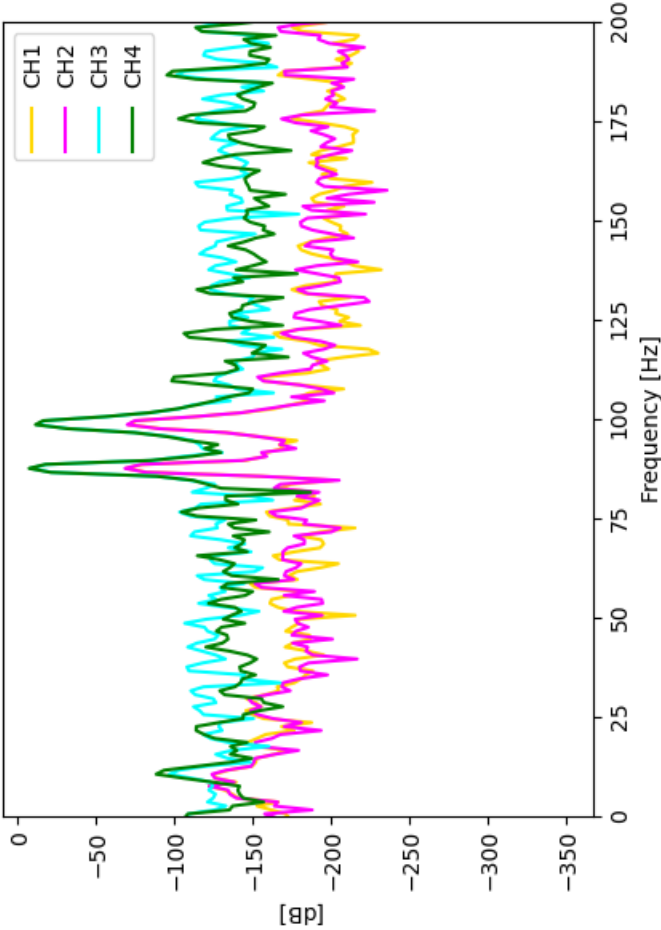
Claim 15	Accused Products
more frequencies to generate complex vibration modes.	App Store. On information and belief, the Apple Watch Ultra supports the same or similar functionality. For a further example, each Accused Product is configured to drive the moveable component in a complex drive mode when used with public APIs, as well as any proprietary Apple APIs. In the Apple Core Haptics API, one or more haptic patterns, which each includes a selected frequency, may be played simultaneously to produce two or more frequencies that generate complex vibration modes. See, e.g.:



Screenshots of exemplary “VibraTool” software, sold by Apple through its App Store.

Claim 15	Accused Products
	Photograph of test apparatus for measuring motor coil drive signal (from tapped connection) and actual motion (from attached vibration transducer) of iPhone 14. Note RC low-pass filter networks at top right with $R = 220\ \Omega$, $C = 2.2\ \mu\text{F}$.

Claim 15	Accused Products  Oscilloscope trace showing “Oscillate” pattern from VibraTool, showing complex drive modes.
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Claim 15	Accused Products
	 Spectrum analysis of “Oscillate” pattern from VibraTool, showing two or more peak frequencies (88 Hz and 99 Hz) of complex drive mode.

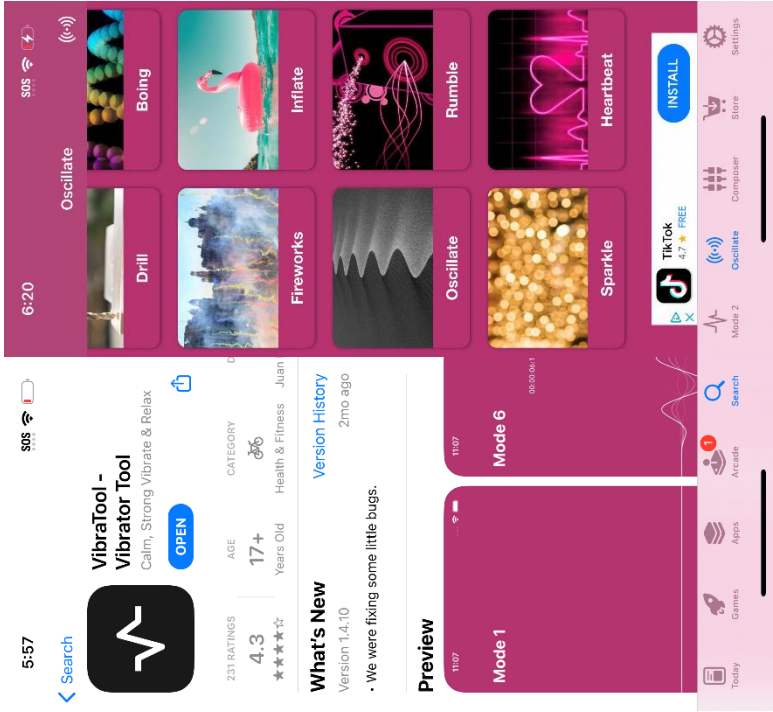
Claim 15	Accused Products
	Play the AHAP Assuming the engine has started, call the engine's method, <code>playPattern(from:)</code>, passing it the URL to playing the file. <pre>// Tell the engine to play a pattern. try engine?.playPattern(from: URL(fileURLWithPath: path))</pre> This method of playback follows a <i>fire and forget</i> model; each haptic pattern plays until it reaches its end, then stops automatically. Once the haptic starts playing, you can't stop it, and pressing other buttons layers those haptics on top of any existing haptic patterns in the middle of playback. This layering allows you to combine a haptic pattern with a more continuous intent, like the rumble of thunder, with a more impulse-driven haptic pattern built from transient taps, like the strike of lightning. Core Haptics layers simultaneously playing haptics automatically. If you don't want the layering, your app should wait out the duration of the first haptic before starting subsequent haptic players. Note Haptic patterns don't blend like audio waveforms, and not all combinations produce a discernible effect. Playing two haptic events of the same type at the same time makes them hard to tell apart. Experiment with various combinations to ensure that the result feels right. Documentation of the Apple Core Haptics API showing that more than one haptic pattern, which includes a frequency, may be played simultaneously to produce two or more frequencies that generate complex vibration modes. Source: https://developer.apple.com/documentation/corehaptics/playing_a_custom_haptic_pattern_from_a_file

Claim 16

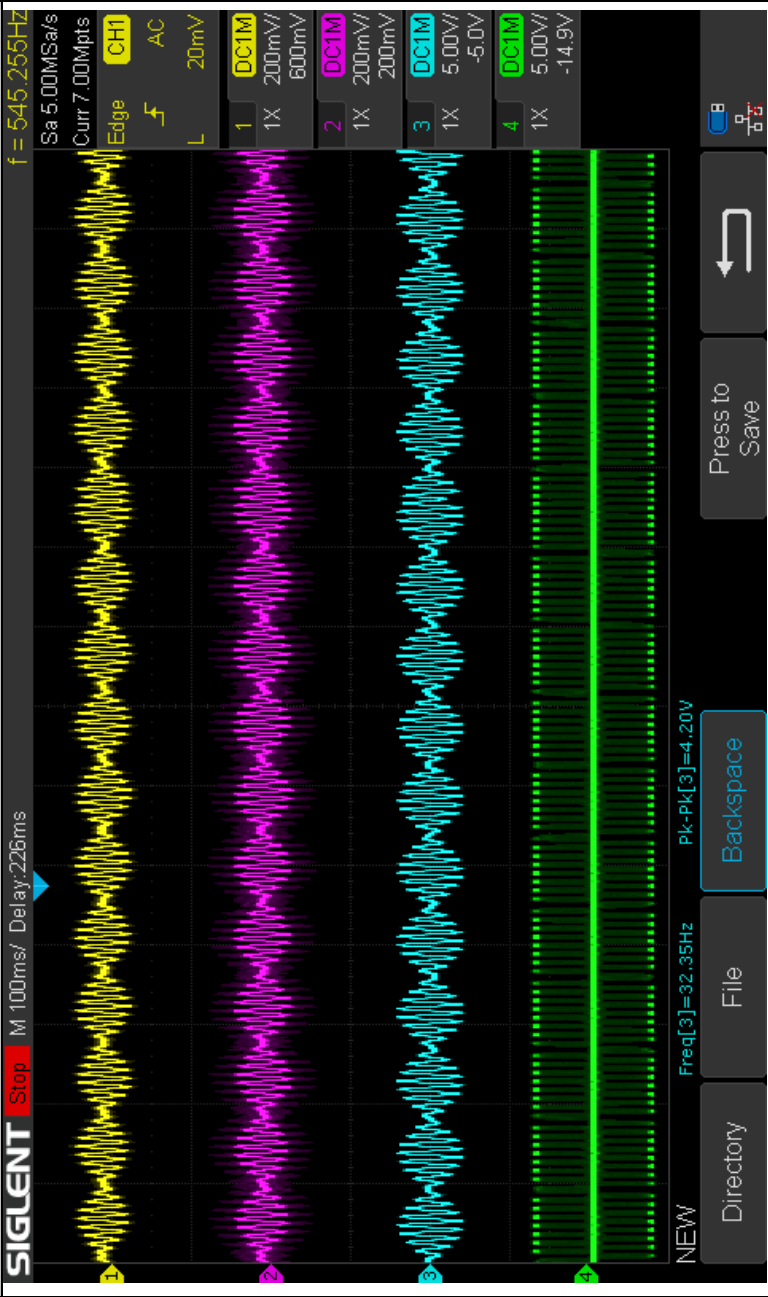
Claim 16	Accused Products
[16pre] The vibration module of claim 15 wherein the complex vibration modes include:	Each Accused Product comprises the vibration module of claim 15.
[16a] a primary oscillation frequency modulated by a modulating oscillation frequency;	In each Accused Product, the complex vibration modes include a primary oscillation frequency modulated by a modulating oscillation frequency. For example, as demonstrated by testing, the iPhone 14 is configured to drive the moveable component in a complex drive mode that includes a primary oscillation frequency modulated by a modulating oscillation frequency when used with software sold by Apple through its App Store such as VibraTool. On information and belief, the Apple Watch Ultra supports the same or similar functionality. See <i>supra</i> claim 15. See <i>also, e.g.:</i>

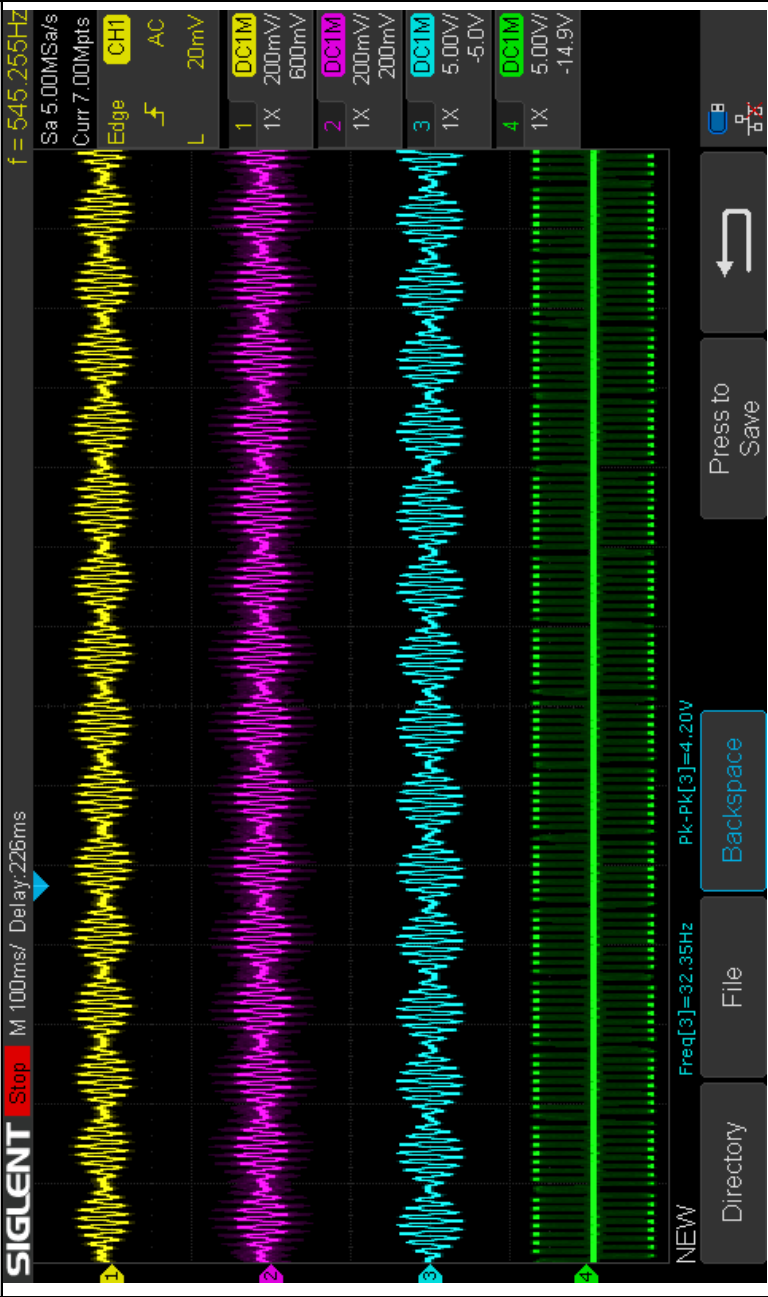
Claim 16

Accused Products

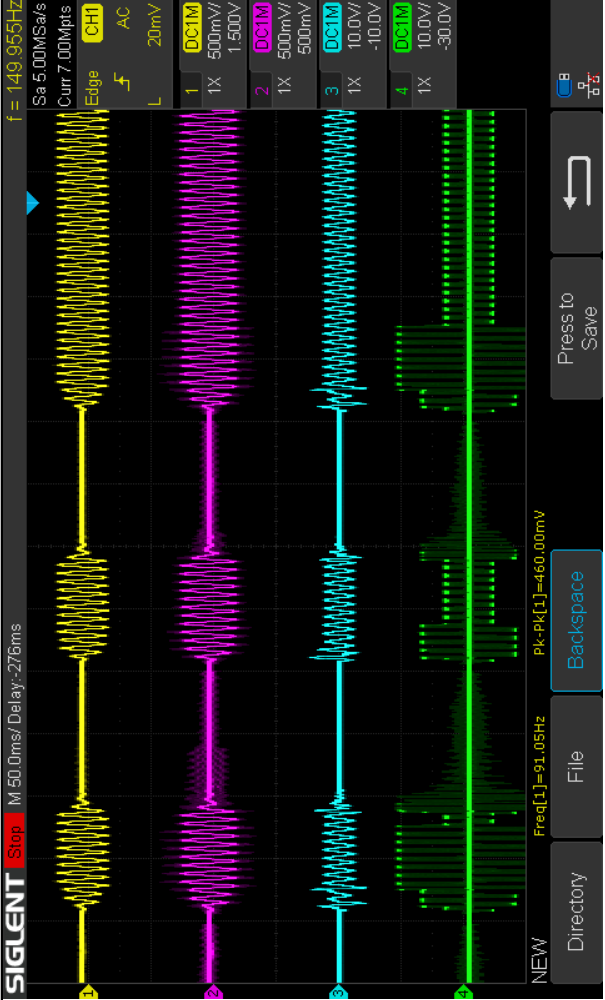


Screenshots of exemplary “VibraTool” software, sold by Apple through its App Store.

Claim 16	Accused Products 
[16b] a beat frequency; and	Oscilloscope trace from the testing apparatus showing “Oscillate” pattern from VibraTool, showing a primary oscillation frequency modulated by a lower modulating oscillation frequency. In each Accused Product, the complex vibration modes include a beat frequency. For example, as demonstrated by testing, the iPhone 14 is configured to drive the moveable component in a complex drive mode that includes a beat frequency when used with software sold by Apple through its App Store such as VibraTool. On information and belief, the Apple Watch Ultra supports the same or similar functionality. See <i>supra</i> claim 15. See, e.g.:

Claim 16	Accused Products 
[16c] an aperiodic oscillation waveform.	Oscilloscope trace from the testing apparatus showing “Oscillate” pattern from VibraTool, showing a beat frequency. In each Accused Product, the complex drive modes include an aperiodic oscillation waveform. For example, as demonstrated by testing, the iPhone 14 is configured to drive the moveable component in a complex drive mode that includes an aperiodic oscillation waveform such as during the “Reflection” ringtone. On information and belief, the Apple Watch Ultra supports the same or similar functionality. See <i>supra</i> claim 15. See, e.g.:

Claim 16	Accused Products 10:00 Settings Sounds & Haptics < Back RINGTONE AND ALERT VOLUME 10:00 Vibration Symphony > STORE Tone Store Download All Purchased Tones This will download all ringtones and alerts purchased using the "gabinder@autoseismics.com" account. SOUNDS AND HAPTIC PATTERNS Ringtone Text Tone New Voicemail New Mail Sent Mail Calendar Alerts Reminder Alerts Reflection > Note > Tri-tone > None > Choo Choo > Chord > Chord > RING / SILENT MODE SWITCH Keyboard Feedback Lock Sound Sound & Haptic > Play Haptics in Ring Mode Screenshots of “Sounds & Haptics” and “Ringtone” settings from the iPhone 14, which allow selection of aperiodic oscillation waveforms such as “Reflection”.
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Claim 16	Accused Products
	 Oscilloscope trace from the testing apparatus showing the “Reflection” ringtone from the Apple iPhone 14, showing an aperiodic oscillation waveform.

Claim 17	Accused Products
[17] The vibration module of claim 1 wherein the control component controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude that are independently specified by user input received from the user-input features.	Each Accused Product comprises the vibration module of claim 1 wherein the control component controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude that are independently specified by user input received from the user-input features.

Claim 17	Accused Products
user input received from the user-input features.	For example, in each Accused Product, the control component can drive the moveable component at independently specified frequencies and amplitude, as demonstrated by public APIs and by testing. The public APIs, as well as any proprietary Apple APIs and interfaces, independently specify intensity and sharpness that directly and/or indirectly control the frequency and amplitude of the oscillation. These frequencies and amplitudes are independently specified by user input received from the user-input features, for example via Apple's "Sounds & Haptics" controls, via touch and/or force sensors (keyboard and button feedback), or via third-party applications. See <i>supra</i> claim element [1f]. See, e.g.:

Claim 17	Accused Products
	Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent

Claim 17	Accused Products
	Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;

Claim 17	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

Claim 17

Accused Products

10:00

SOS

Settings

Sounds & Haptics

10:00

SOS

Back

Ringtone

RINGTONES AND ALERT VOLUME

Change with Buttons

The volume of the ringer and alerts will not be affected by the volume buttons.

SOUNDS AND HAPTIC PATTERNS

Ringtone

Reflection >

Text Tone

Note >

New Voicemail

Tri-tone >

New Mail

None >

Sent Mail

Choo Choo >

Calendar Alerts

Chord >

Reminder Alerts

Chord >

Keyboard Feedback

Sound & Haptic >

Lock Sound

RING / SILENT MODE SWITCH

Play Haptics in Ring Mode

RINGTONES

Reflection (Default)

Apex

Beacon

Bulletin

By The Seaside

Chimes

Circuit

Constellation

Cosmic

Crystals

STORE

Tone Store

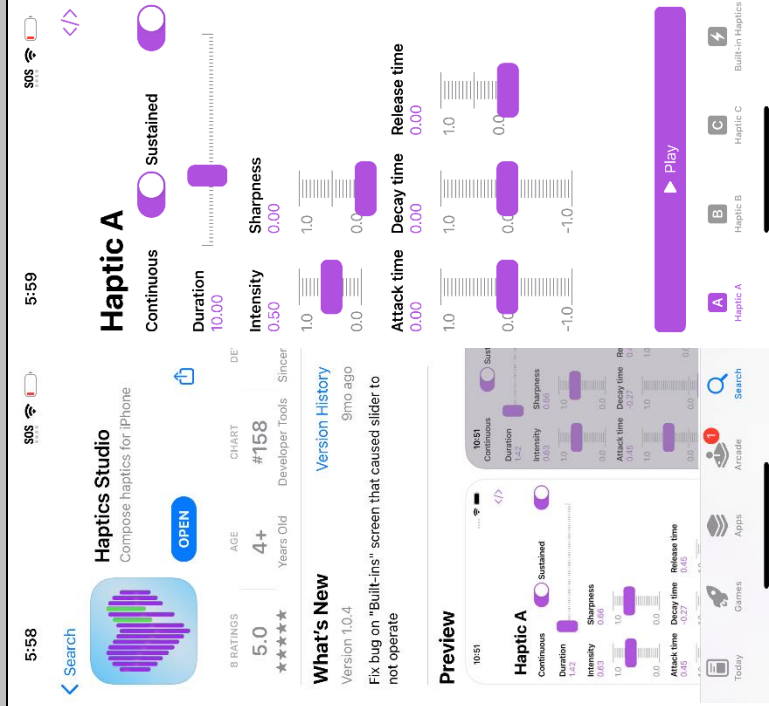
Download All Purchased Tones

This will download all ringtones and alerts purchased using the "gabinder@autoseismics.com" account.

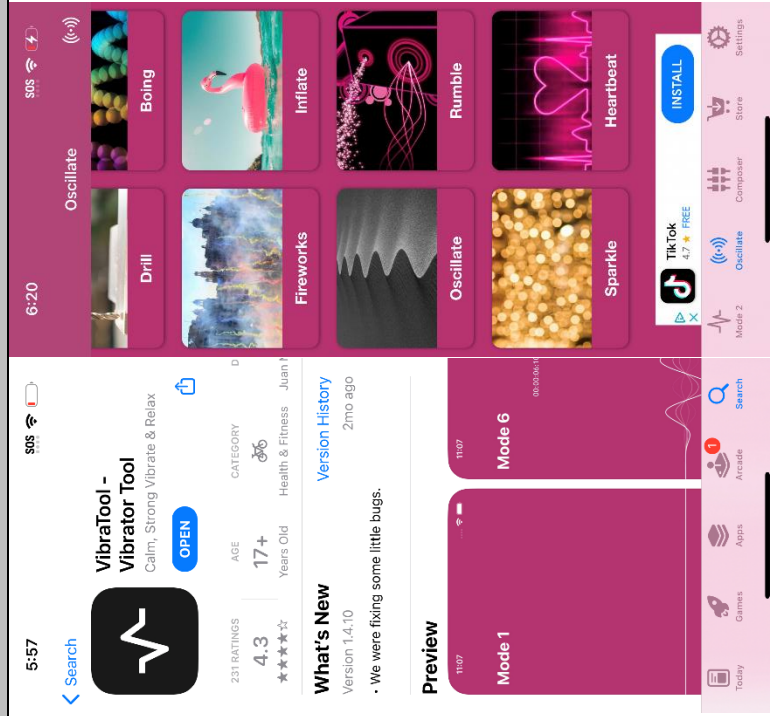
Vibration

Symphony >

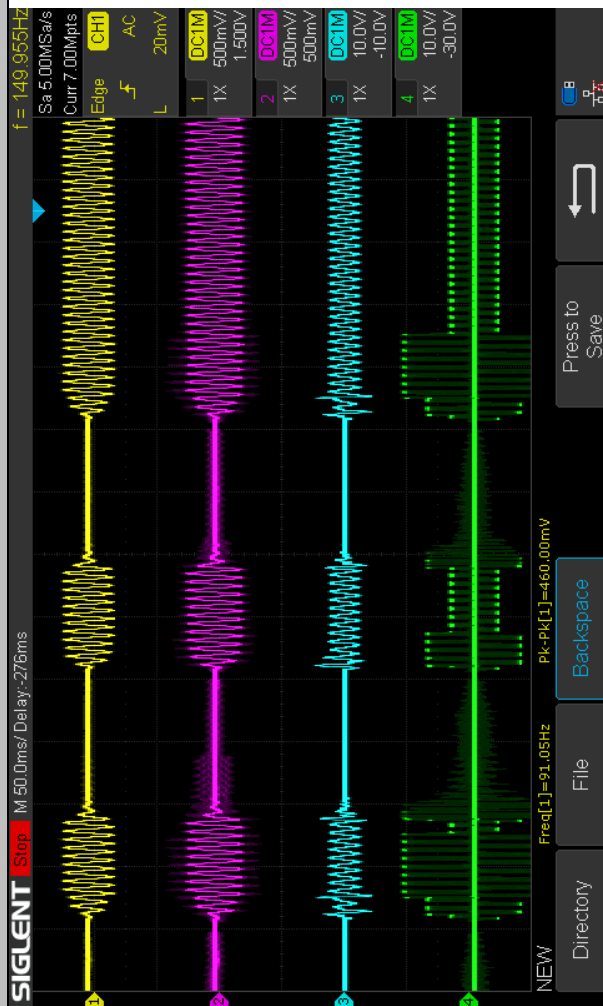
Screenshots of "Sounds & Haptics" and "Ringtone" settings, which allow selection of frequency and/or amplitude.



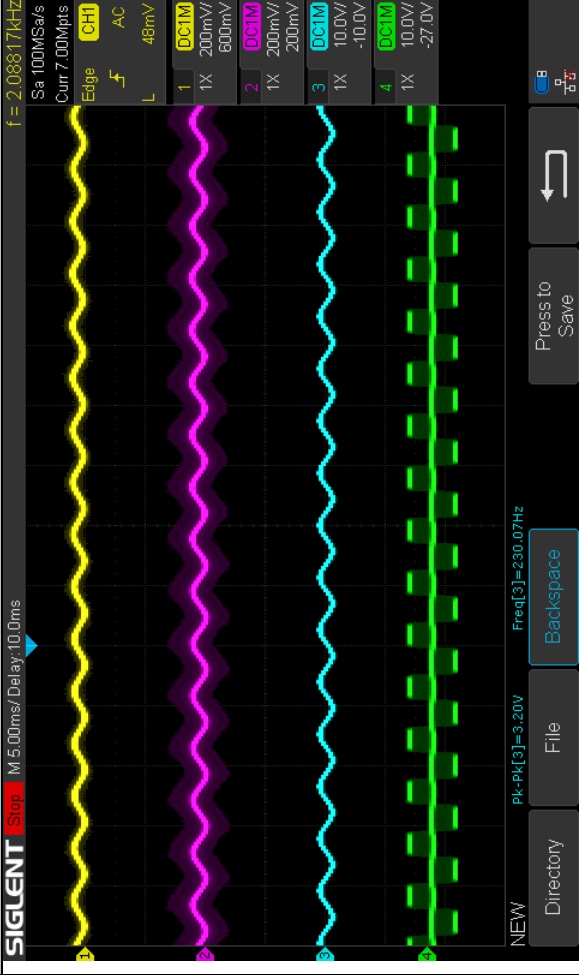
Screenshots of exemplary “Haptics Studio” software, sold by Apple through its App Store, with independent user-input controls for frequency (“sharpness”) and amplitude (“intensity”).

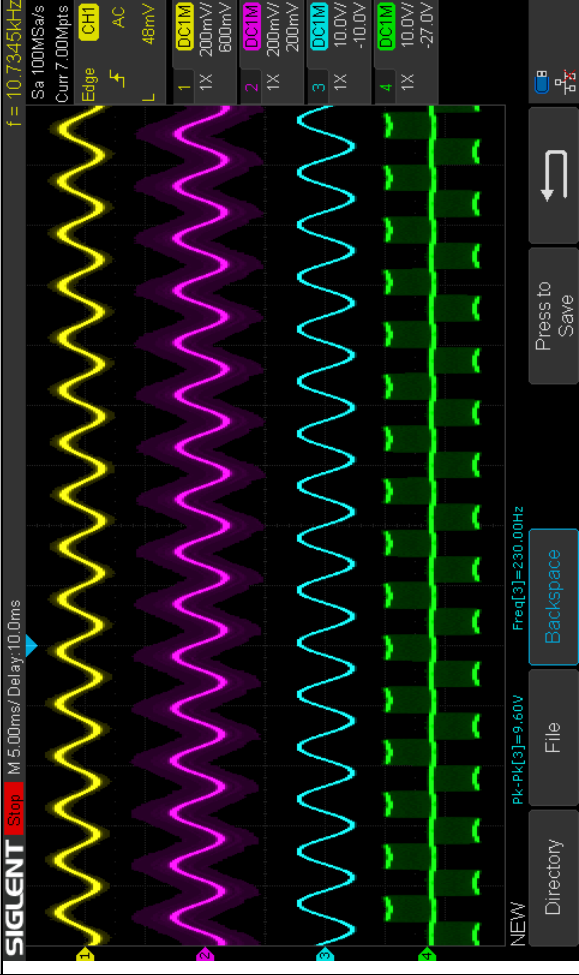


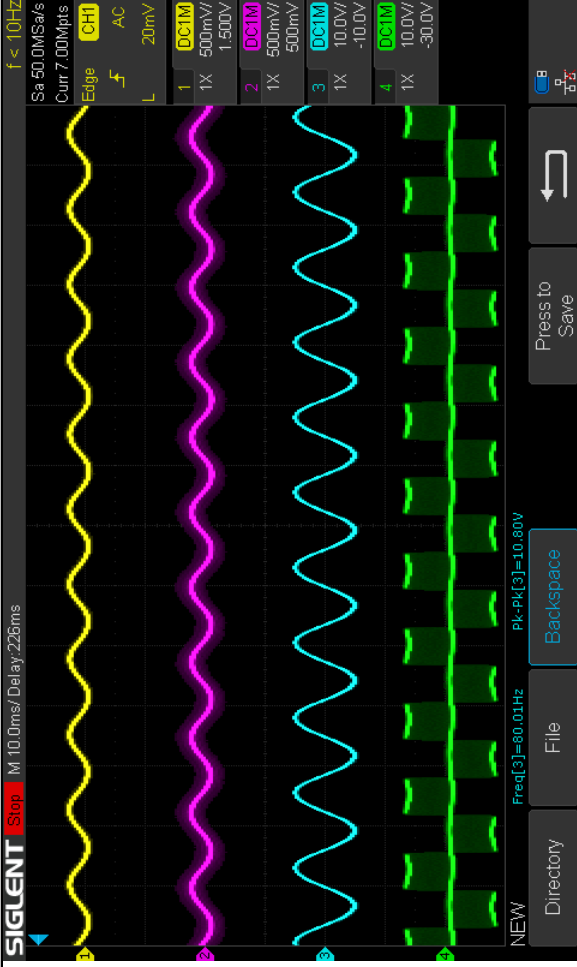
Screenshots of exemplary “VibraTool” software, sold by Apple through its App Store, with user-input controls for selecting frequency and amplitude.



Oscilloscope trace showing, in green (CH4), the PWM-modulated drive voltage applied by the iPhone 14 haptic controller(s), with positive and negative voltages to drive the moveable component in a first and second direction. Channels 1 and 2 (yellow and purple) show the actual motion of the iPhone 14 resulting (pursuant to Newton's third law) from the motion of the moveable component.

Claim 17	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 0.5, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 3.2 V (peak-to-peak, through RC low-pass filter).

Claim 17	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 9.6V (peak-to-peak, through RC low-pass filter). Note that the externally measured vibration amplitude (yellow and purple traces, same scale as previous trace) is also significantly higher at intensity = 1 than 0.5.

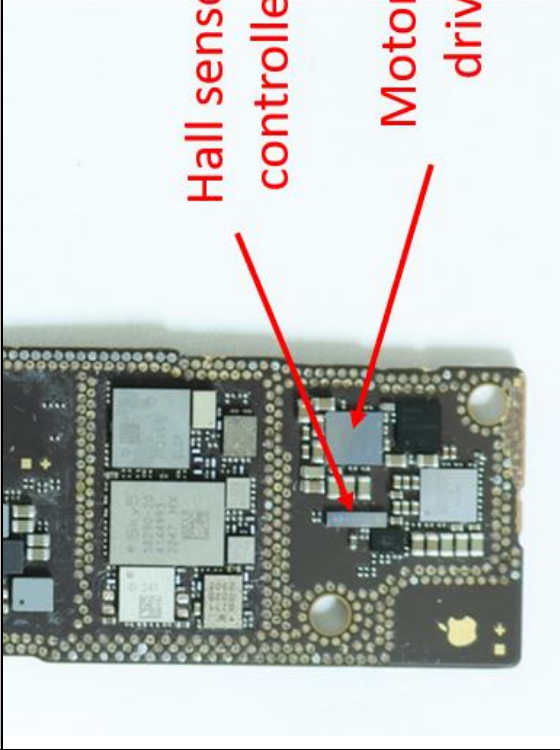
Claim 17	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 0, with frequency of 80 Hz and motor drive amplitude of 10.8 V (peak-to-peak, through RC low-pass filter).

Claim 19	Accused Products
[19pre] A vibration module comprising:	To the extent the preamble is limiting, each Accused Product includes a vibration module. For example, each of the Apple iPhone 14 and the Apple Watch Ultra contain a linear actuator (“Taptic Engine”), haptic controller(s), and associated circuitry, as described in connection with the claim limitations below. See, e.g.:



Photograph of iPhone 14 with rear cover removed, with A15 Bionic SoC at center right and Taptic Engine at bottom left.

Claim 19	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

Claim 19	Accused Products
	 Hall sensor controller Motor coil driver Photograph of Hall sensor controller and motor control driver from the iPhone 14.

Claim 19	Accused Products
	The following devices contain a Taptic Engine: • iPhone 14 Pro Max • iPhone 14 Pro • iPhone 14 Plus • iPhone 14 • iPhone SE (3rd generation) • iPhone 13 Pro Max • iPhone 13 Pro • iPhone 13 • iPhone 13 mini • iPhone 12 Pro Max • iPhone 12 Pro • iPhone 12 • iPhone 12 mini • iPhone SE (2nd generation) • iPhone 11 Pro Max • iPhone 11 Pro • iPhone 11 • iPhone XS Max • iPhone XS • iPhone XR • iPhone X • iPhone 8 Plus • iPhone 8 • iPhone 7 Plus • iPhone 7 • iPhone 6s Plus • iPhone 6s Accessory Design Guidelines for Apple Devices, Release R20, available at https://developer.apple.com/accessories/Accessory-Design-Guidelines.pdf

Claim 19	Accused Products
	 Photograph of Apple Watch Ultra.

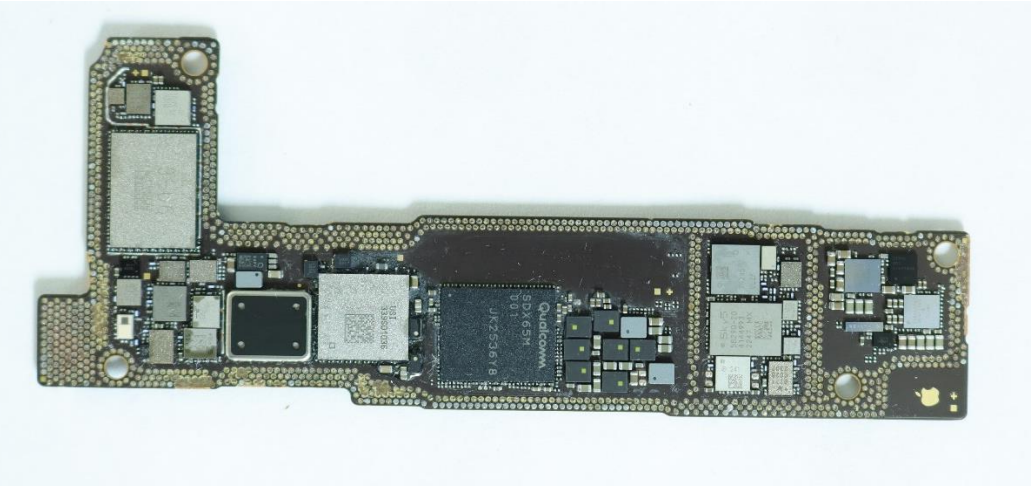
Claim 19	Accused Products
	Main board Linear motor TAPTIC ENGINE Wrist side, cover removed Wrist side, cover and main board removed Display side, display removed Annotated photographs of Apple Watch Ultra showing linear actuator (Taptic engine) and main system board.
[19a] a housing;	Each Accused Product comprises a housing. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra has a hollow cavity that is soldered together to form a housing surrounding the moveable component and coils. See, e.g.:

Claim 19	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

Claim 19	Accused Products
	
[19b] a moveable component;	Photograph of Taptic Engine housing from Apple Watch Ultra. Each Accused Product comprises a moveable component. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra includes a moveable component comprising permanent magnet(s) and a mass. <i>See, e.g.:</i>

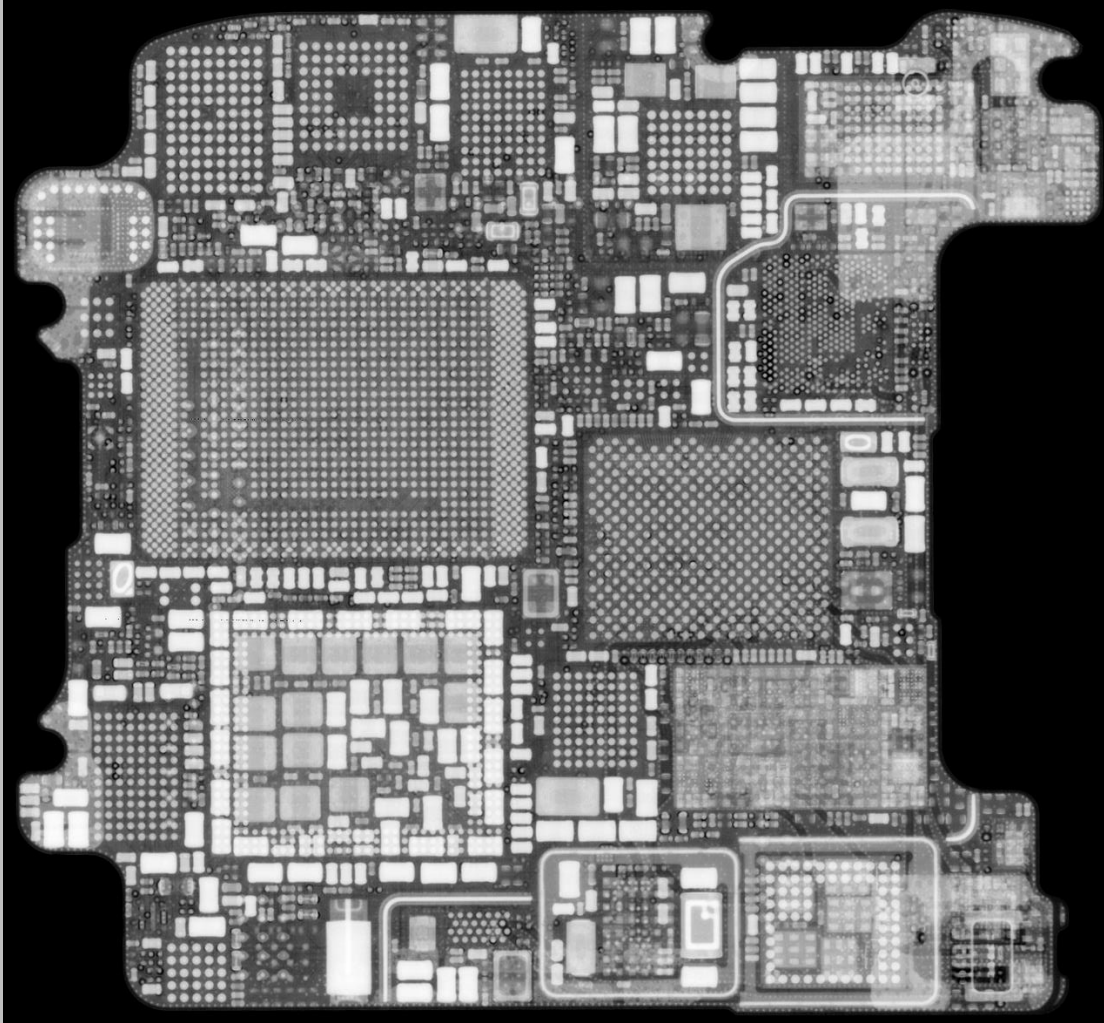
Claim 19	Accused Products
	 Photograph of moveable component (at right, connected to housing with springs) from the iPhone 14.  Photograph of moveable component from Apple Watch Ultra.

Claim 19	Accused Products
[19c] a power supply;	Each Accused Product comprises a power supply. For example, the linear motor coil driver (described below) in each of the iPhone 14 and Apple Watch Ultra receives power from one or more voltage regulators on or near the Accused Product's system board. See, e.g.:

Claim 19	Accused Products
	 Photograph of iPhone 14 system board.

Claim 19

Accused Products



X-ray image of Apple Watch Ultra system board.

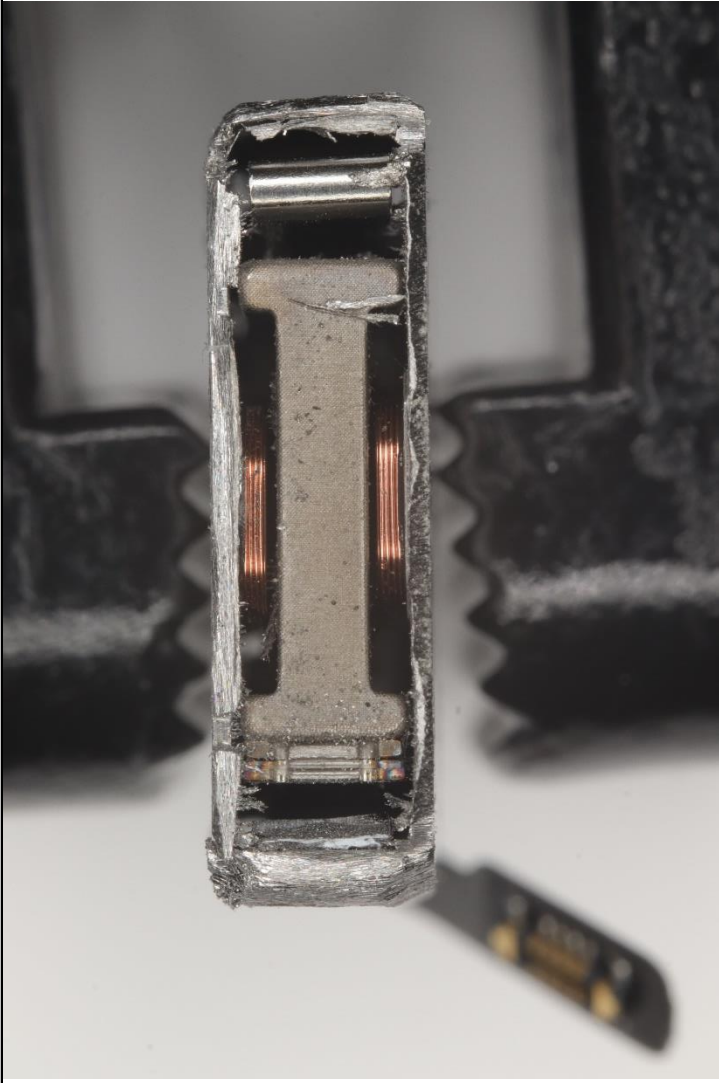
Claim 19	Accused Products
[19d] user-input features;	<i>See also</i> claim elements below. Each Accused Product comprises user-input features. For example, each of the iPhone 14 and Apple Watch Ultra comprises a touchscreen, buttons, and other user-input features. <i>See, e.g.:</i>

Claim 19	Accused Products
	 Photograph of iPhone 14 touchscreen, buttons, and switch, available at https://www.apple.com/iphone-14/.

Claim 19	Accused Products
	
[19e] a driving component that drives the moveable component to oscillate within the housing;	Photograph of Apple Watch Ultra touchscreen, dial, and buttons. Each Accused Product comprises a driving component that drives the moveable component to oscillate within the housing. For example, the Taptic Engine includes one or more coils to form electromagnetic fields for driving the moveable component in two directions.

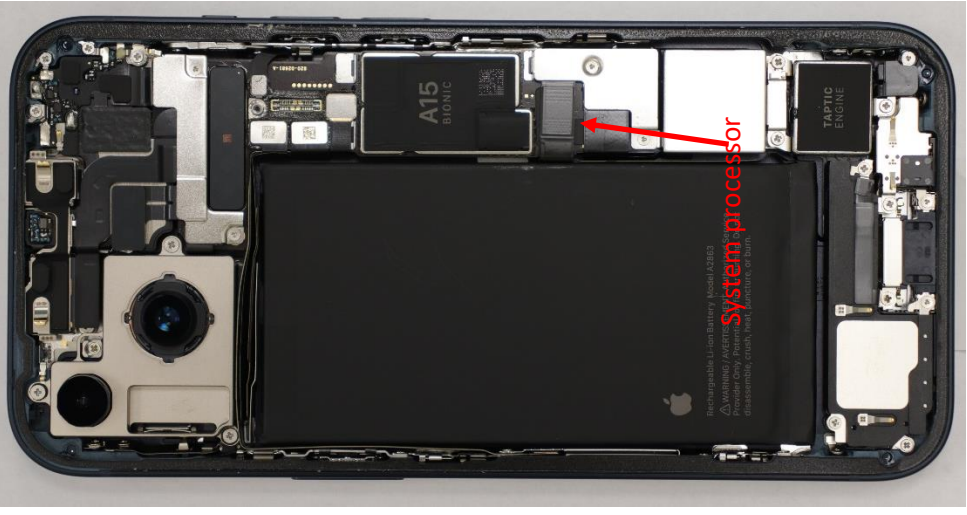
Claim 19	Accused Products
	<i>See, e.g.:</i>  Photograph of driving coils within disassembled Taptic Engine from the iPhone 14. The two visible coils would be positioned above and below the moveable component when assembled.

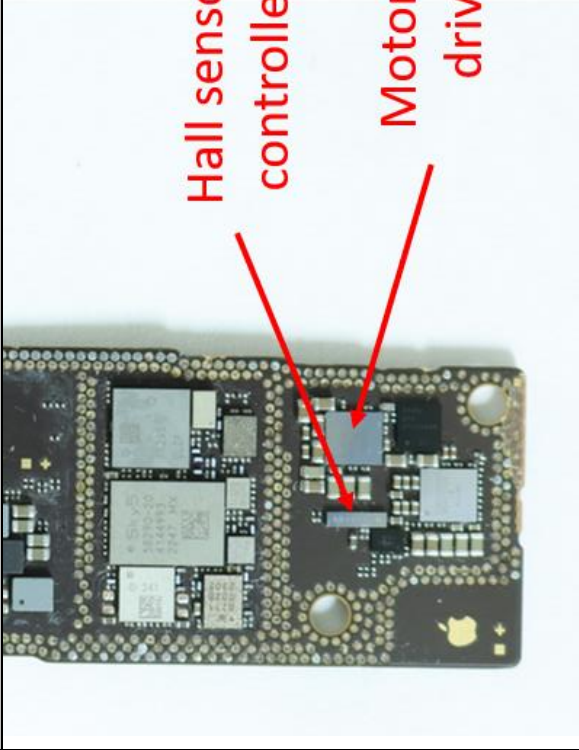
Claim 19	Accused Products
	A photograph showing the internal components of an iPhone 14. The device is disassembled, revealing the internal frame and various components. A prominent feature is a large, rectangular, copper-colored coil (the driving coil) mounted on a metal plate. To the right of the coil, there is a small, rectangular, black component (the moveable component) which is shown in its disassembled position. The entire assembly is mounted on a metal plate with various holes and markings. The photograph is taken from a perspective that shows the internal components clearly. Photograph showing one driving coil (at right) within disassembled Taptic Engine from the iPhone 14, with moveable component in place at left. The moveable component travels up and down from this perspective.

Claim 19	Accused Products
	 Photograph of internals of Taptic Engine from the iPhone 14, showing drive coils (top and bottom) surrounding the moveable component. The moveable component travels left and right from this perspective.

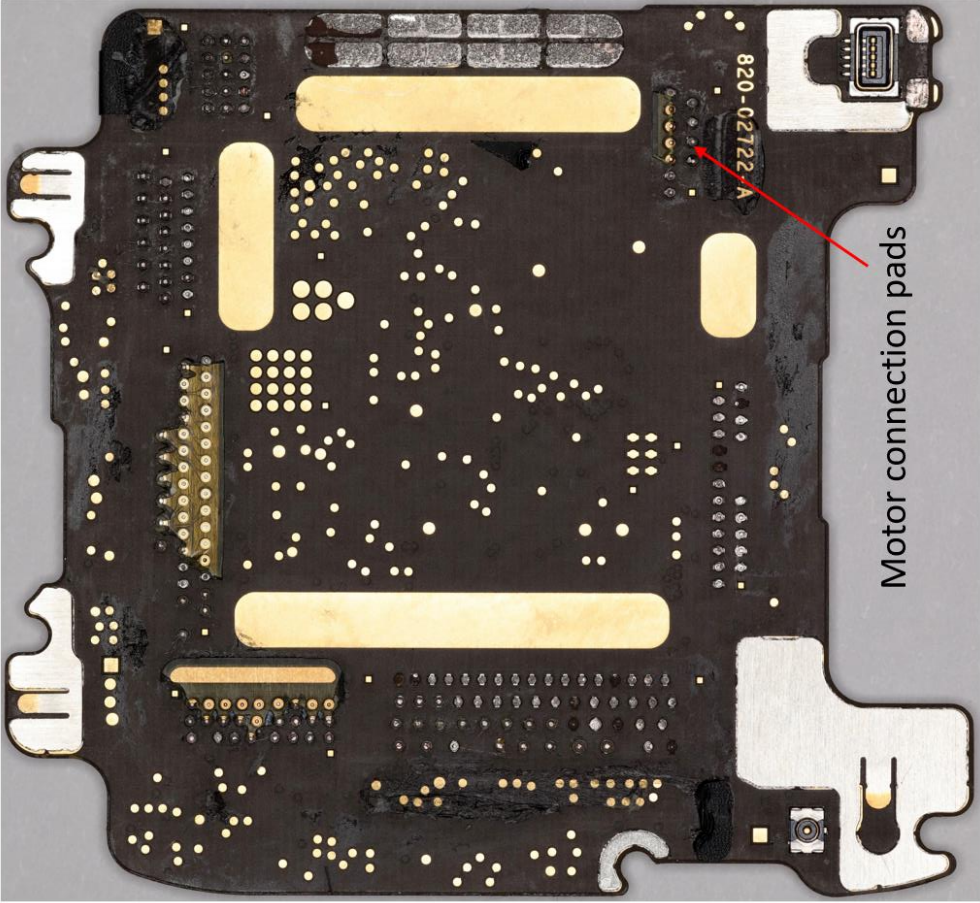
Claim 19	Accused Products
	 Photograph of drive coils within disassembled Taptic Engine from Apple Watch Ultra. The two visible coils would be positioned above and below the movable component when assembled.
[19f] a control component that controls supply of power from the power supply to the driving	Each Accused Product comprises a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values.

Claim 19	Accused Products
component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values; and	For example, each Accused Product includes a main system processor, a linear motor coil driver, and a Hall sensor controller, which alone or in combination form a control component as claimed to drive the coils and thus move the magnetic mass in a linear oscillating motion, as described below. This control component can drive the moveable component at specified frequencies and amplitude, as demonstrated by public APIs and by testing. The public APIs, as well as any proprietary Apple APIs and interfaces, specify intensity and sharpness (exemplary stored values) that directly and/or indirectly control the frequency and amplitude of the oscillation and that are stored at least within the system processor and associated volatile and non-volatile memory. On information and belief, the system processor and/or linear motor control driver include additional stored values specifying frequency and/or amplitude. <i>See, e.g.:</i>

Claim 19	Accused Products
	 Photographs showing iPhone 14 system board with A15 Bionic processor.

Claim 19	Accused Products
	 Hall sensor controller Motor coil driver Annotated photograph of Hall sensor controller and motor coil driver from the iPhone 14.

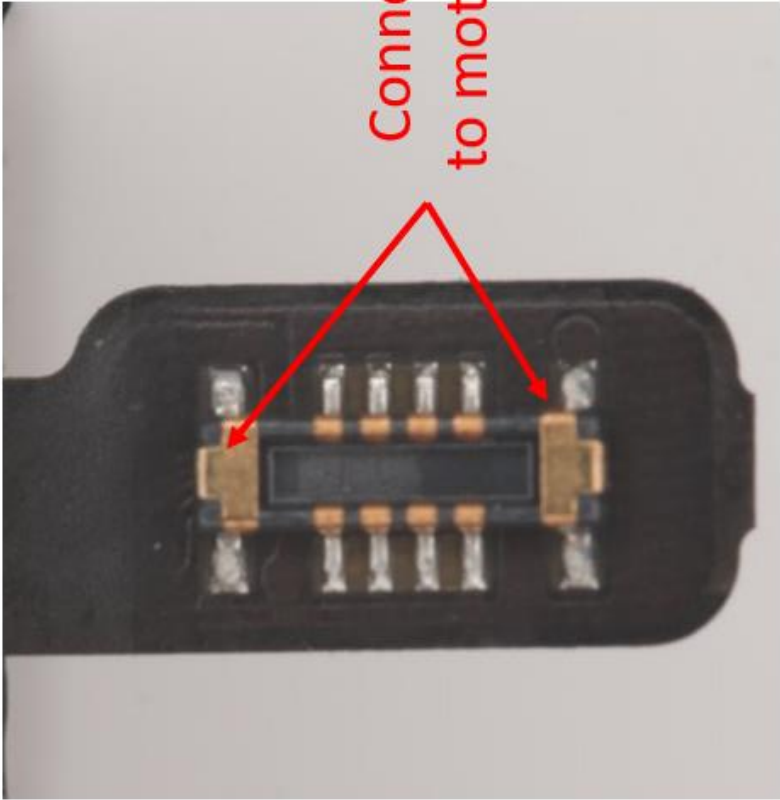
Claim 19	Accused Products
X-ray image of Apple Watch Ultra system board.	

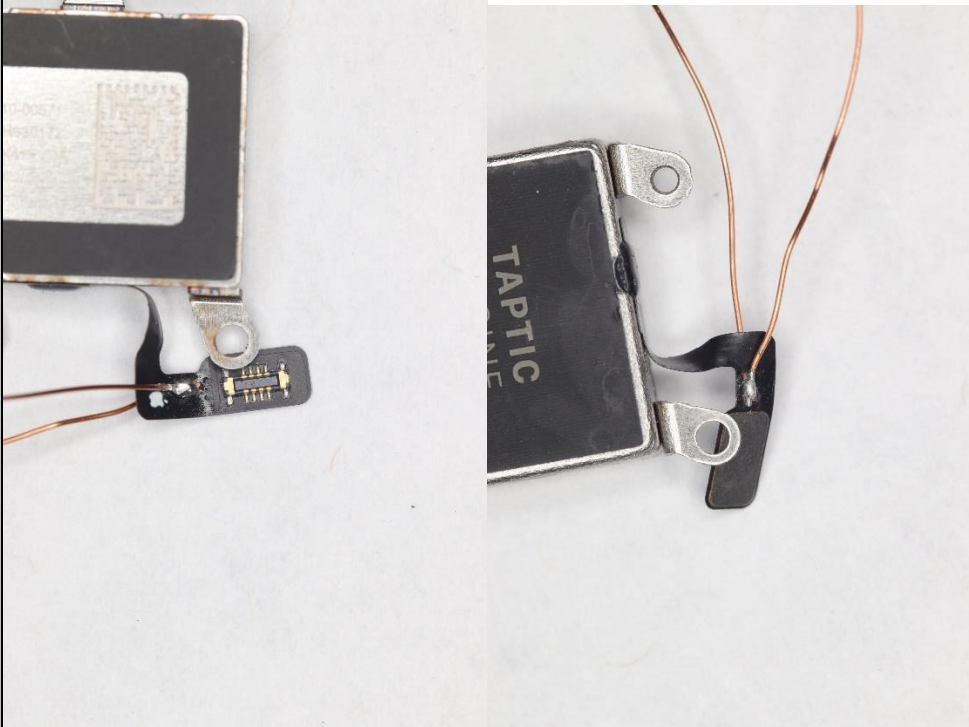
Claim 19	 Motor connection pads Annotated photograph of partially disassembled Apple Watch Ultra system board, showing connection points for haptic motor.
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Claim 19	Accused Products
	Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent

Claim 19	Accused Products
Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid:	

Claim 19	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

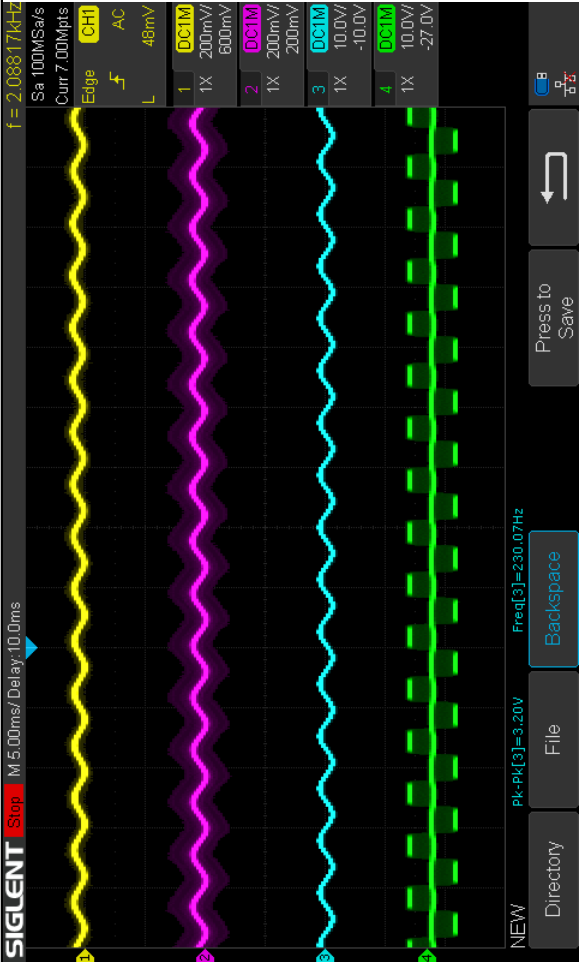
Claim 19	Accused Products
	 Annotated photograph of Taptic Engine connector from the iPhone 14 showing positive and negative coil driving pins.

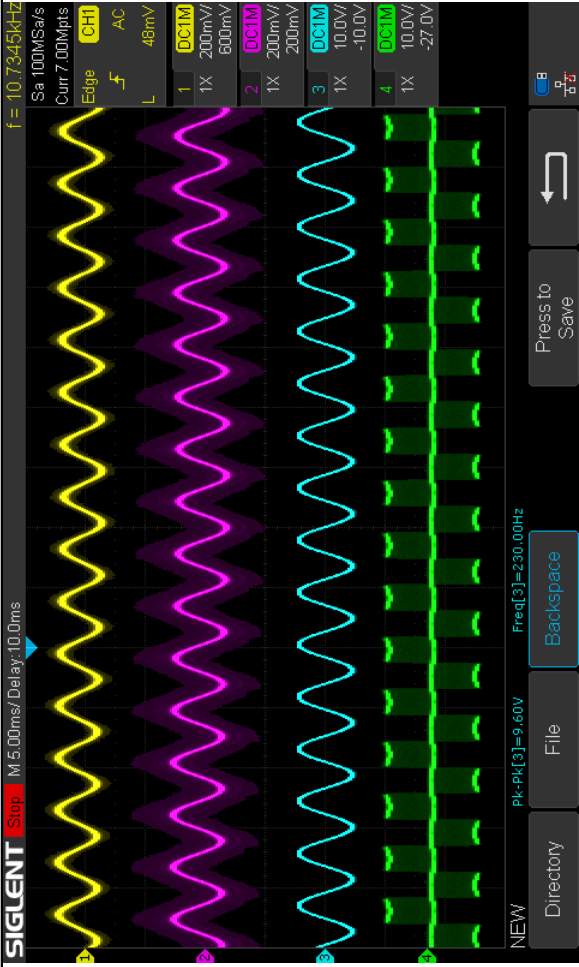
Claim 19	Accused Products
	 Photographs of test apparatus with electrical leads connected to motor coil drive traces of iPhone 14.

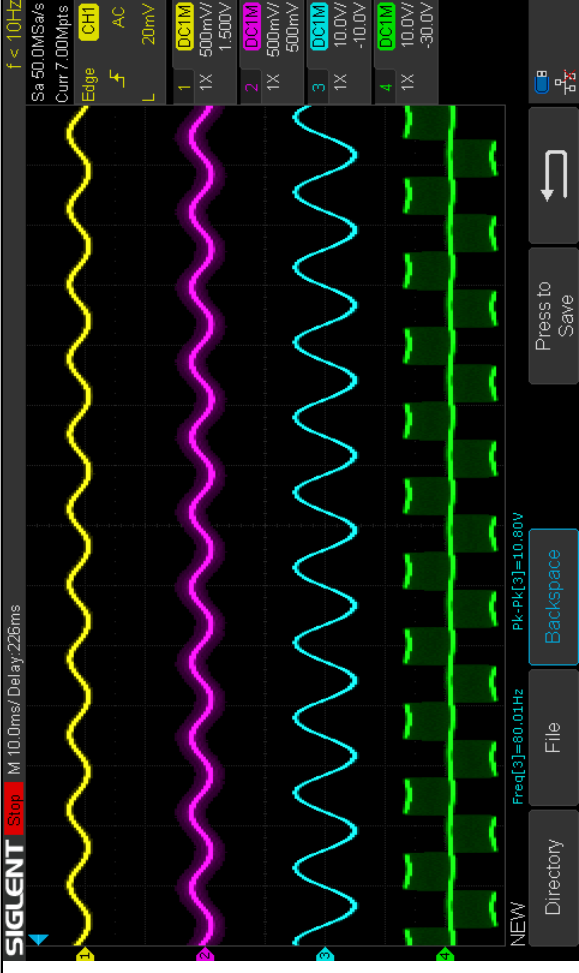
Claim 19	Accused Products
	Photograph of test apparatus for measuring motor coil drive signal (from tapped connection) and actual motion (from attached vibration transducer) of iPhone 14. Note RC low-pass filter networks at top right with $R = 220\ \Omega$, $C = 2.2\ \mu\text{F}$.

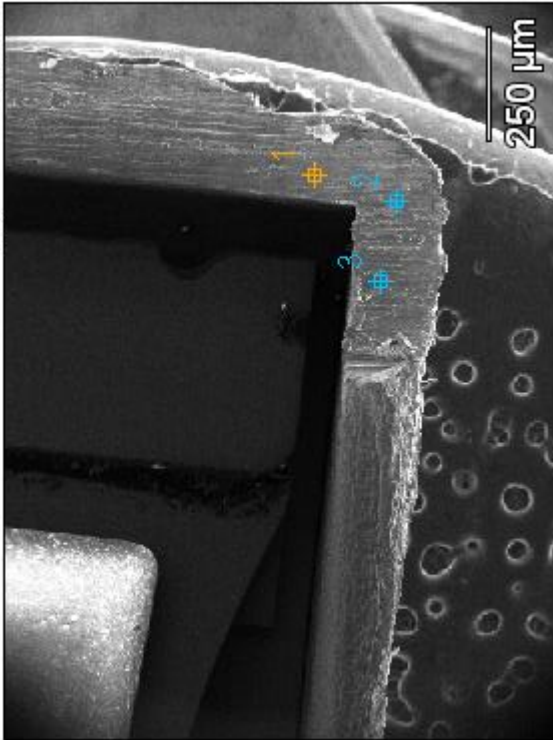
Claim 19	Accused Products Oscilloscope trace showing, in green (CH4), the drive voltage applied by the iPhone 14 haptic controller(s); in this case, a pulse width modulated positive signal (modulation frequency 857 kHz) to drive the moveable component in one of two directions.
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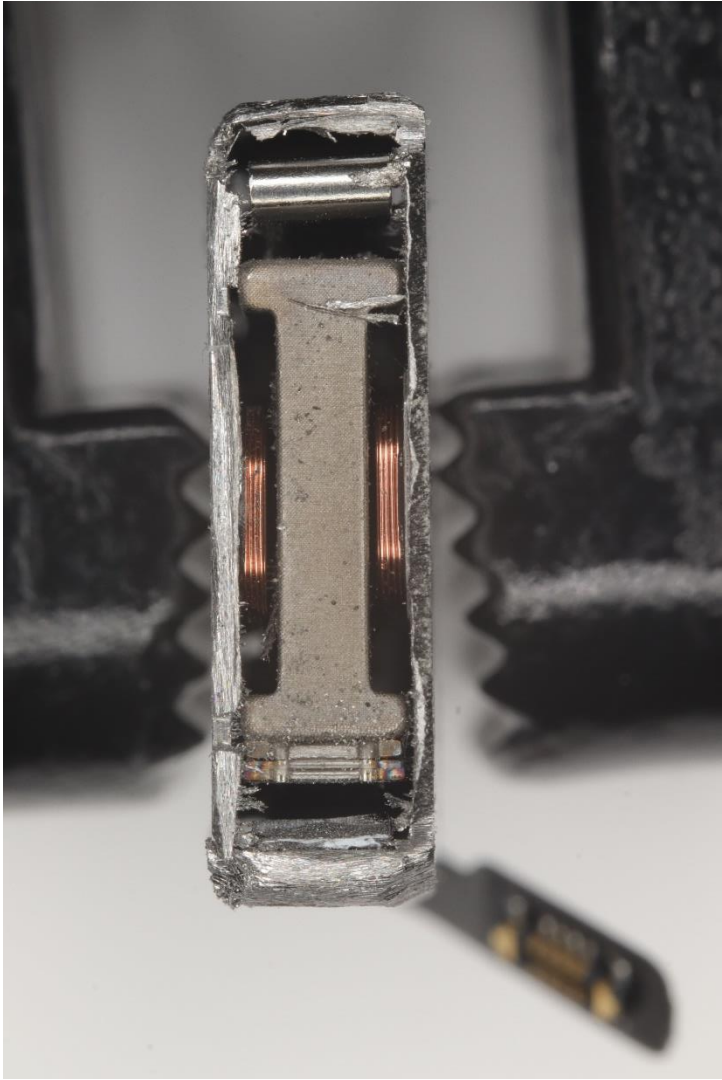
Claim 19	Accused Products Oscilloscope trace showing, in green (CH4), the PWM-modulated drive voltage applied by the iPhone 14 haptic controller(s), with positive and negative voltages to drive the moveable component in a first and second direction. Channels 1 and 2 (yellow and purple) show the actual motion of the iPhone 14 resulting (pursuant to Newton's third law) from the motion of the moveable component.
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Claim 19	Accused Products  Oscilloscope trace showing the result of CHHapticEvent with intensity = 0.5, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 3.2 V (peak-to-peak, through RC low-pass filter).
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Claim 19	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 9.6V (peak-to-peak, through RC low-pass filter). Note that the externally measured vibration amplitude (yellow and purple traces, same scale as previous trace) is also significantly higher at intensity = 1 than 0.5.

Claim 19	Accused Products  Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 0, with frequency of 80 Hz and motor drive amplitude of 10.8 V (peak-to-peak, through RC low-pass filter). To the extent Defendant contends and/or shows that this limitation is not literally present in the Accused Products, it is present under the doctrine of equivalents. There are no substantial differences between the accused functionality and the claimed invention. For example, each Accused Product contains one or more microprocessors that coordinate(s) operation of the Taptic Engine, which performs substantially the same function (e.g., controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values) in substantially the same way (e.g., using digital logic) to achieve substantially the same result (e.g., producing oscillations at a desired frequency and amplitude). Each Accused Product comprises flux paths comprising a paramagnetic material that is shaped and positioned to reduce the reluctance of one or more magnetic circuits within the vibration module.
[19g] flux paths comprising a paramagnetic material that is shaped and positioned to	

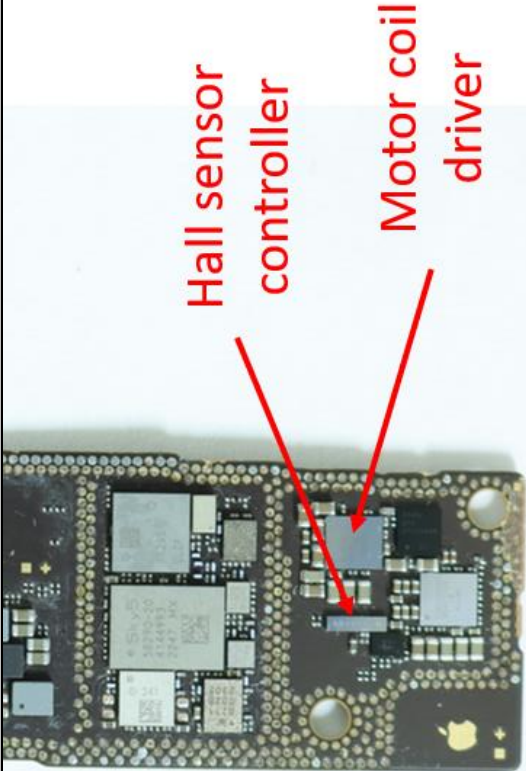
Claim 19	Accused Products																																	
reduce the reluctance of one or more magnetic circuits within the vibration module.	For example, the elemental composition of the housing of the Taptic Engine in the iPhone 14 was determined from energy-dispersive X-ray spectroscopy (EDS). The housing primarily consists of an iron and chromium alloy, which indicates it is a ferritic stainless steel with paramagnetic properties and high magnetic permeability. The housing surrounds the driving coils and moveable component and is positioned to reduce the reluctance of the magnetic circuit formed by the driving coils, moveable component, and housing. See, e.g.: Base(6) <table><tr><th>Line</th><th>Wt.%</th><th>Error</th></tr><tr><td>C K</td><td>0.00</td><td>0.00</td></tr><tr><td>O K</td><td>0.00</td><td>0.00</td></tr><tr><td>Si K</td><td>0.32</td><td>0.03</td></tr><tr><td>Ti K</td><td>0.13</td><td>0.02</td></tr><tr><td>V K</td><td>0.19</td><td>0.04</td></tr><tr><td>Cr K</td><td>18.56</td><td>0.09</td></tr><tr><td>Fe K</td><td>80.20</td><td>0.22</td></tr><tr><td>Ni K</td><td>0.21</td><td>0.04</td></tr><tr><td>Nd L</td><td>0.00</td><td>0.00</td></tr><tr><td>Tl L</td><td>0.39</td><td>0.20</td></tr></table> Scanning electron microscopical image of the housing of the Taptic Engine of the iPhone 14 depicting 3 points where EDS measurements were taken. The elemental composition by weight averaged from the 3 EDS measurements is shown in the table on the right. The iron and chromium composition suggests the housing consists of a ferritic stainless steel alloy with paramagnetic properties and high magnetic permeability.	Line	Wt.%	Error	C K	0.00	0.00	O K	0.00	0.00	Si K	0.32	0.03	Ti K	0.13	0.02	V K	0.19	0.04	Cr K	18.56	0.09	Fe K	80.20	0.22	Ni K	0.21	0.04	Nd L	0.00	0.00	Tl L	0.39	0.20
Line	Wt.%	Error																																
C K	0.00	0.00																																
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V K	0.19	0.04																																
Cr K	18.56	0.09																																
Fe K	80.20	0.22																																
Ni K	0.21	0.04																																
Nd L	0.00	0.00																																
Tl L	0.39	0.20																																

Claim 19	Accused Products
	 Photograph of internals of Taptic Engine from the iPhone 14, showing the magnetic circuit formed by the driving coils, moveable component, and housing composed of a paramagnetic material.

Claim 20	Accused Products
[20pre] A vibration module comprising:	To the extent the preamble is limiting, each Accused Product includes a vibration module. For example, each of the Apple iPhone 14 and the Apple Watch Ultra contain a linear actuator (“Taptic Engine”), haptic controller(s), and associated circuitry, as described in connection with the claim limitations below.

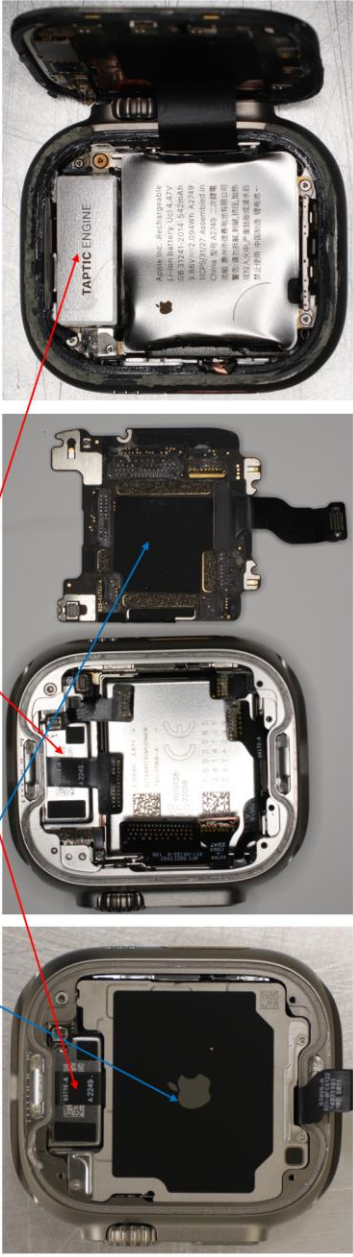
Claim 20	Accused Products
	See, e.g.:  Photograph of iPhone 14 with rear cover removed, with A15 Bionic SoC at center right and Taptic Engine at bottom left.

Claim 20	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

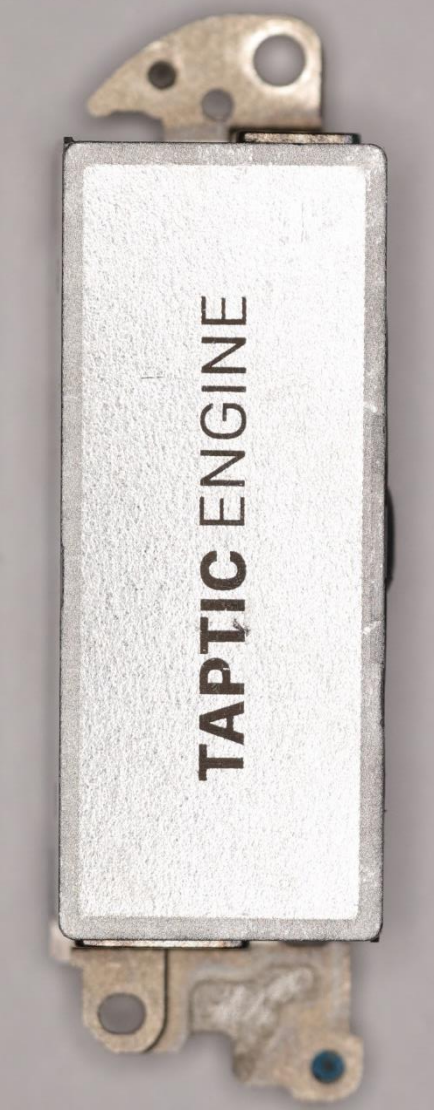
Claim 20	Accused Products
	 Hall sensor controller Motor coil driver Photograph of Hall sensor controller and motor control driver from the iPhone 14.

Claim 20	Accused Products
	The following devices contain a Taptic Engine: • iPhone 14 Pro Max • iPhone 14 Pro • iPhone 14 Plus • iPhone 14 • iPhone SE (3rd generation) • iPhone 13 Pro Max • iPhone 13 Pro • iPhone 13 • iPhone 13 mini • iPhone 12 Pro Max • iPhone 12 Pro • iPhone 12 • iPhone 12 mini • iPhone SE (2nd generation) • iPhone 11 Pro Max • iPhone 11 Pro • iPhone 11 • iPhone XS Max • iPhone XS • iPhone XR • iPhone X • iPhone 8 Plus • iPhone 8 • iPhone 7 Plus • iPhone 7 • iPhone 6s Plus • iPhone 6s Accessory Design Guidelines for Apple Devices, Release R20, available at https://developer.apple.com/accessories/Accessory-Design-Guidelines.pdf

Claim 20	Accused Products
	 Photograph of Apple Watch Ultra.

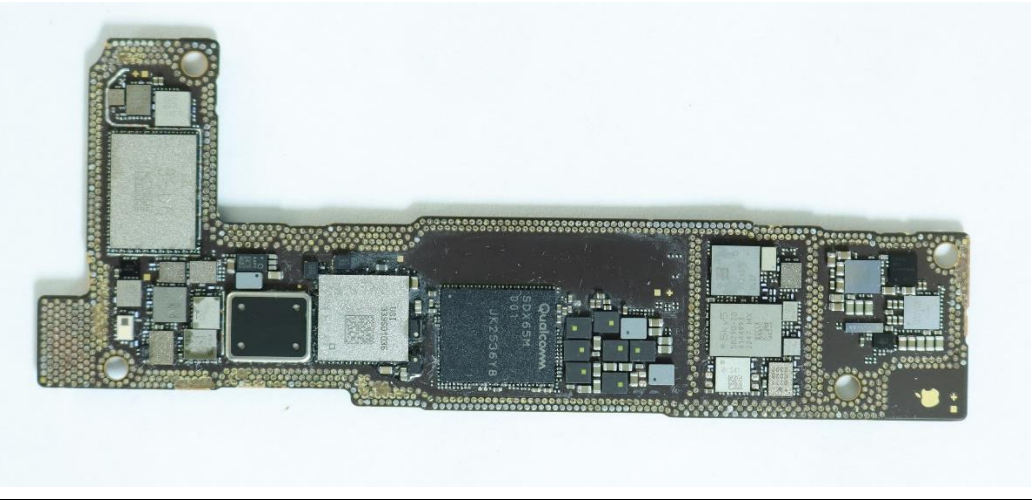
Claim 20	Accused Products
	Main board Linear motor  Wrist side, cover removed Wrist side, cover and main board removed Display side, display removed Annotated photographs of Apple Watch Ultra showing linear actuator (Taptic engine) and main system board.
[20a] a housing;	Each Accused Product comprises a housing. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra has a hollow cavity that is soldered together to form a housing surrounding the moveable component and coils. <i>See, e.g.:</i>

Claim 20	Accused Products
	 Photograph of Taptic Engine housing from the iPhone 14.  Photograph of Taptic Engine housing from the iPhone 14.

Claim 20	Accused Products
	
[20b] a moveable component;	Photograph of Taptic Engine housing from Apple Watch Ultra. Each Accused Product comprises a moveable component. For example, the Taptic Engine in each of the iPhone 14 and Apple Watch Ultra includes a moveable component comprising permanent magnet(s) and a mass. See, e.g.:

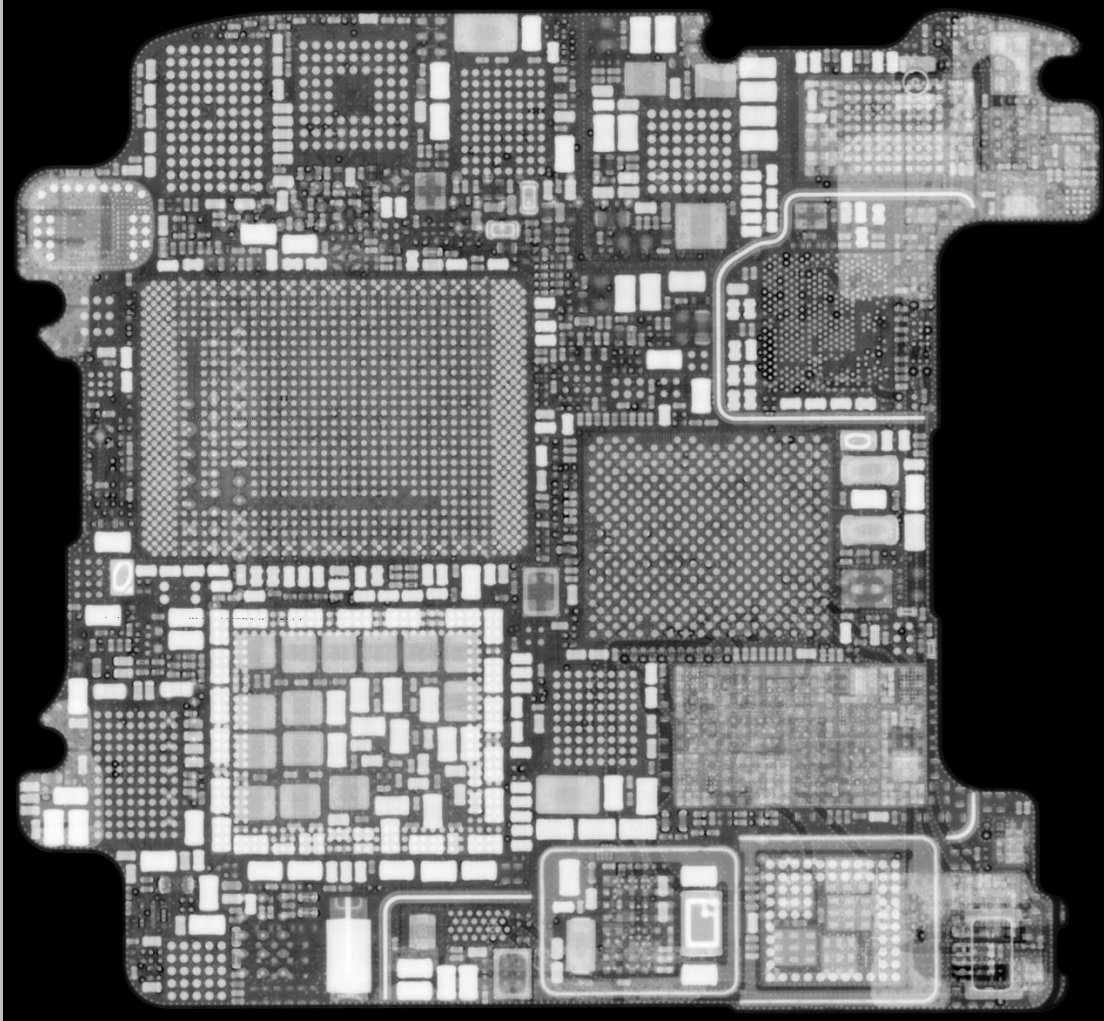
Claim 20	Accused Products
	 Photograph of moveable component (at right, connected to housing with springs) from the iPhone 14.  Photograph of moveable component from Apple Watch Ultra.

Claim 20	Accused Products
[20c] a power supply;	Each Accused Product comprises a power supply. For example, the linear motor coil driver (described below) in each of the iPhone 14 and Apple Watch Ultra receives power from one or more voltage regulators on or near the Accused Product's system board. See, e.g.:

Claim 20	Accused Products
	 Photograph of iPhone 14 system board.

Claim 20

Accused Products



X-ray image of Apple Watch Ultra system board.

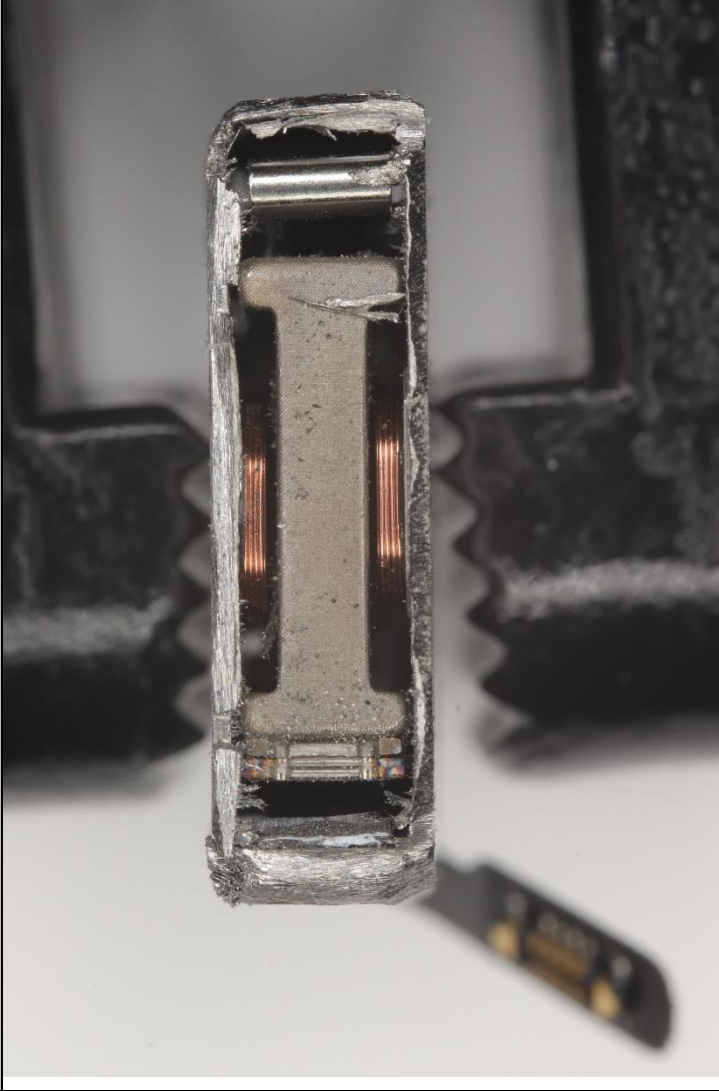
Claim 20	Accused Products
[20d] user-input features;	See <i>also</i> claim elements below. Each Accused Product comprises user-input features. For example, each of the iPhone 14 and Apple Watch Ultra comprises a touchscreen, buttons, and other user-input features. See, e.g.:

Claim 20	Accused Products
	 Photograph of iPhone 14 touchscreen, buttons, and switch, available at https://www.apple.com/iphone-14/.

Claim 20	Accused Products
	
[20e] a driving component that drives the moveable component to oscillate within the housing; and	Photograph of <u>Apple Watch Ultra</u> touchscreen, dial, and buttons. Each Accused Product comprises a driving component that drives the moveable component to oscillate within the housing. For example, the Taptic Engine includes one or more coils to form electromagnetic fields for driving the moveable component in two directions.

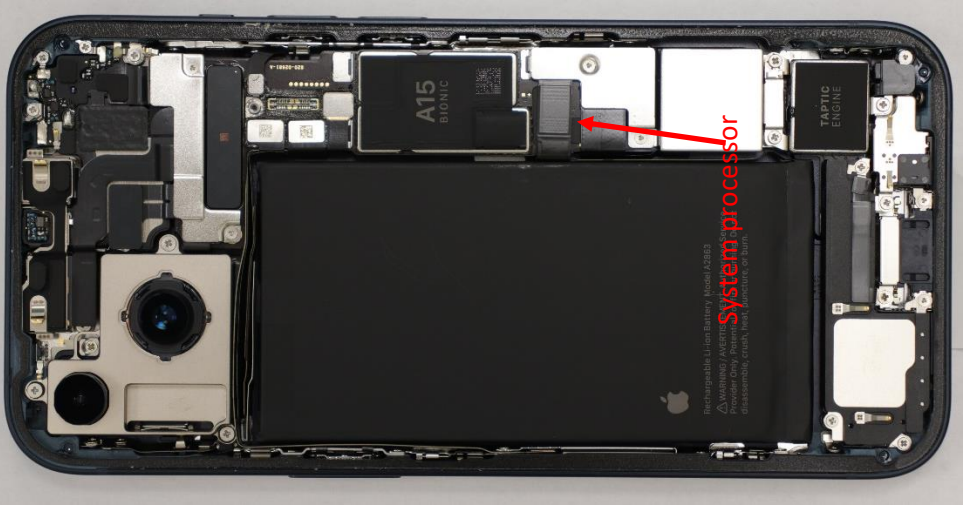
Claim 20	Accused Products
	See, e.g.:  Photograph of driving coils within disassembled Taptic Engine from the iPhone 14. The two visible coils would be positioned above and below the moveable component when assembled.

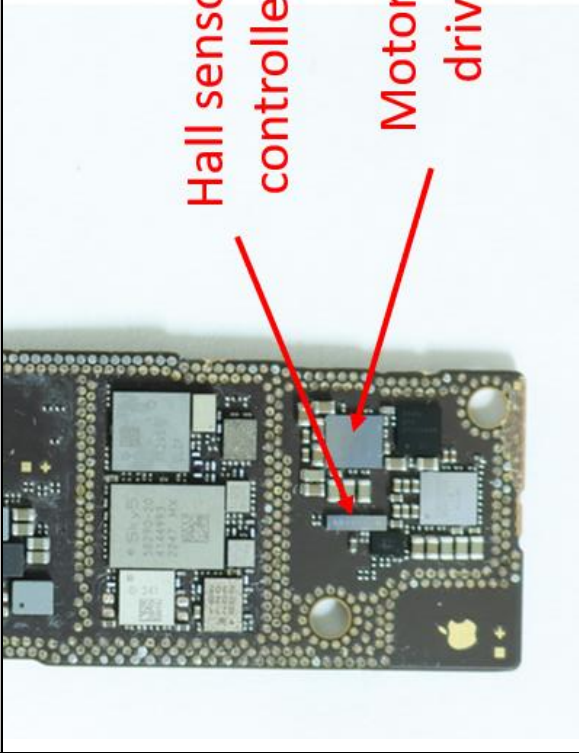
Claim 20	Accused Products
	 Photograph showing one driving coil (at right) within disassembled Taptic Engine from the iPhone 14, with moveable component in place at left. The moveable component travels up and down from this perspective.

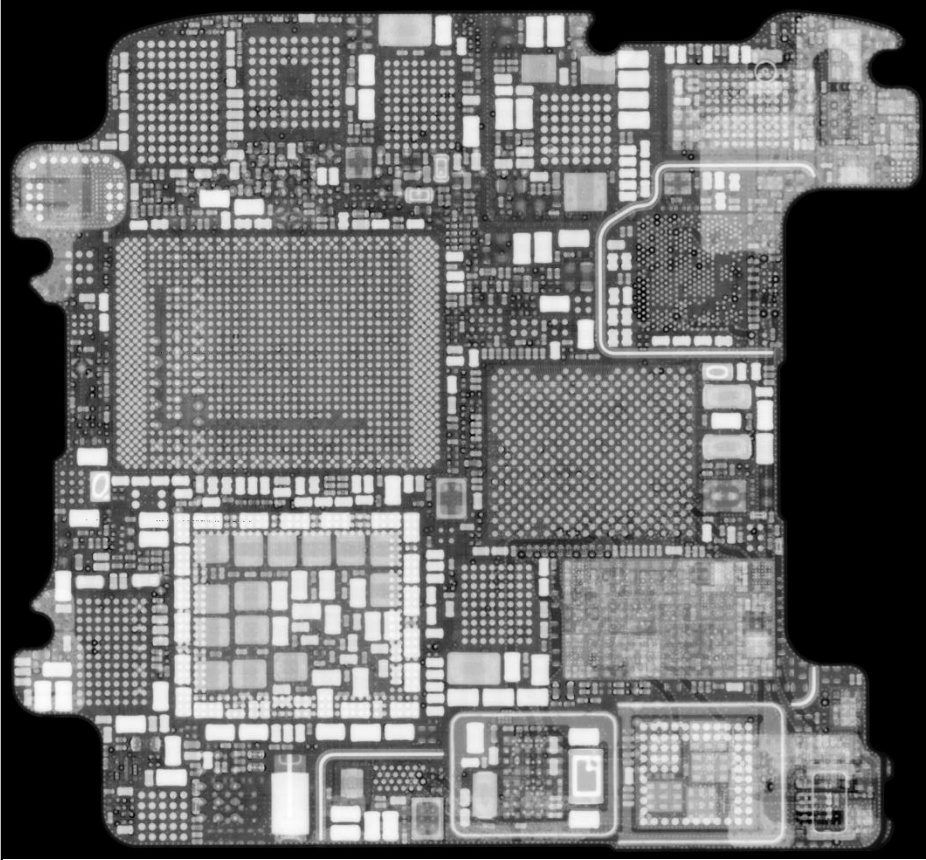
Claim 20	Accused Products
	A photograph showing a cross-section of a Taptic Engine component. The component is rectangular and has been cut open to reveal its internal structure. In the center, there is a moveable component, which appears to be a small, light-colored, rectangular piece. This moveable component is surrounded by two sets of drive coils, which are visible as copper-colored wire windings. The entire assembly is housed within a dark, possibly metal, casing. The background is a plain, light-colored surface. Photograph of internals of Taptic Engine from the iPhone 14, showing drive coils (top and bottom) surrounding the moveable component. The moveable component travels left and right from this perspective.

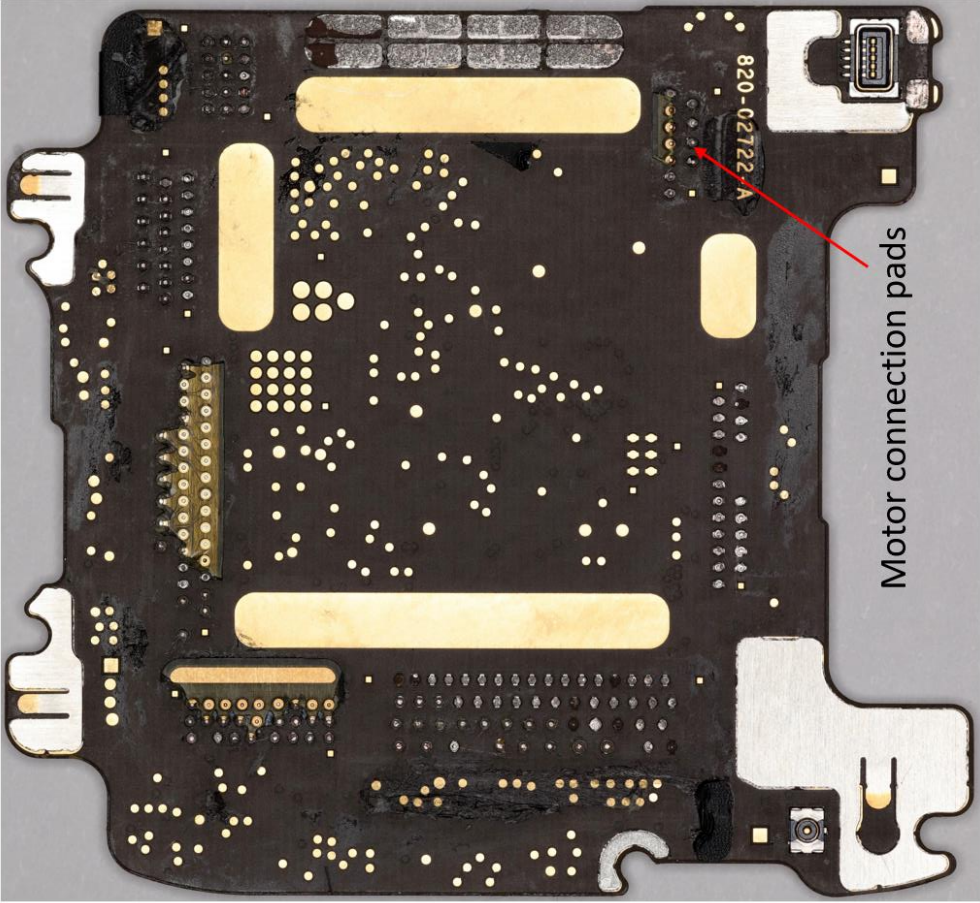
Claim 20	Accused Products
	
[20f] a control component that controls supply of power from the power supply to the driving	Photograph of drive coils within disassembled Taptic Engine from Apple Watch Ultra. The two visible coils would be positioned above and below the movable component when assembled. Each Accused Product comprises a control component that controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values.

Claim 20	Accused Products
component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values,	For example, each Accused Product includes a main system processor, a linear motor coil driver, and a Hall sensor controller, which alone or in combination form a control component as claimed to drive the coils and thus move the magnetic mass in a linear oscillating motion, as described below. This control component can drive the moveable component at specified frequencies and amplitude, as demonstrated by public APIs and by testing. The public APIs, as well as any proprietary Apple APIs and interfaces, specify intensity and sharpness (exemplary stored values) that directly and/or indirectly control the frequency and amplitude of the oscillation and that are stored at least within the system processor and associated volatile and non-volatile memory. On information and belief, the system processor and/or linear motor control driver include additional stored values specifying frequency and/or amplitude. <i>See, e.g.:</i>

Claim 20	Accused Products
	 Photographs showing iPhone 14 system board with A15 Bionic processor.

Claim 20	Accused Products
	 Hall sensor controller Motor coil driver Annotated photograph of Hall sensor controller and motor coil driver from the iPhone 14.

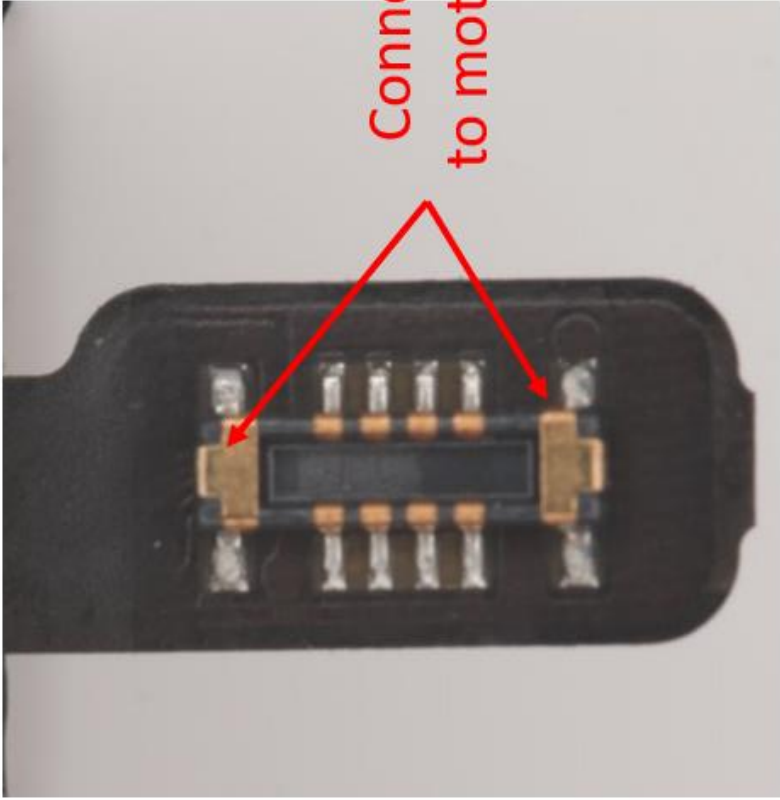
Claim 20	Accused Products
	 X-ray image of Apple Watch Ultra system board.

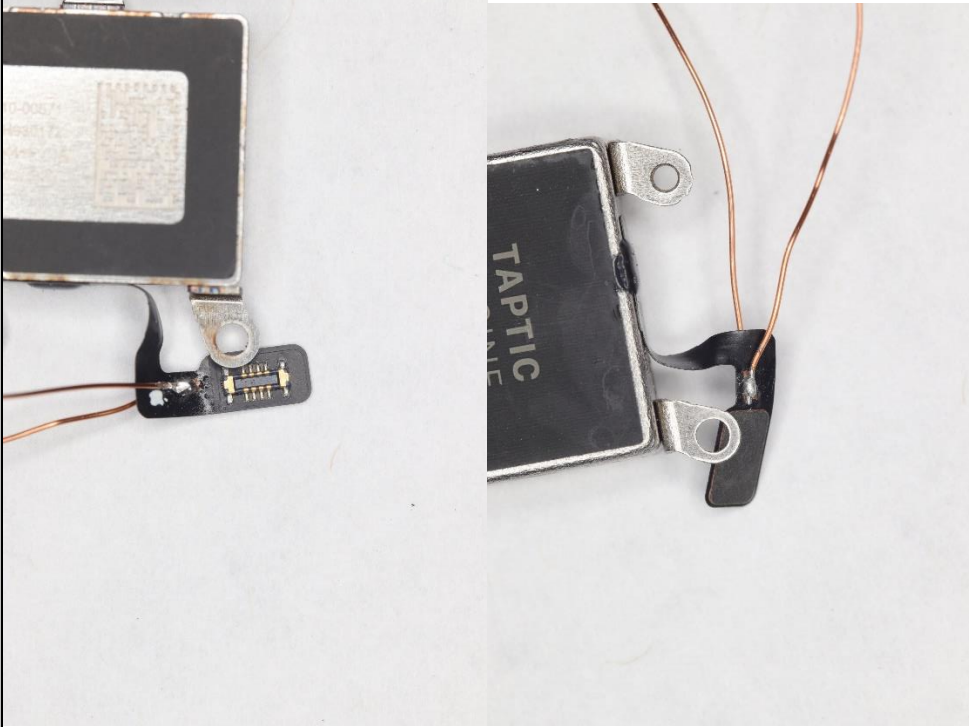
Claim 20	Accused Products
	 Motor connection pads Annotated photograph of partially disassembled Apple Watch Ultra system board, showing connection points for haptic motor.

Claim 20	Accused Products
	Declaration <pre>class CHHapticEvent : NSObject</pre> Overview Each event represents a single haptic or audio signal. The event <code>type</code> determines whether it's audio or haptic. Use a <code>CHHapticPatternPlayer</code> object obtained through <code>CHHapticEngine</code> factory methods to play events. Haptic events can be transient or continuous. Transient haptic patterns are brief impulses that occur at a specific point in time, such as the haptic feedback you feel from swiping through a picker or toggling a switch. Continuous haptic patterns, like the vibration from a ringtone, take the form of lengthier feedback over a period of time. In the following graphic, transient haptic patterns on the left trigger at a specific time with a specific intensity. Continuous haptic patterns on the right sustain the haptic feedback over a specific duration of time, such as three seconds. Specify when an event begins by setting its <code>relativeTime</code> property. Specify the length of the event by setting its <code>duration</code> property. Set optional parameters to customize event properties. For example, you can specify the intensity of a haptic event by creating an event parameter with ID <code>hapticIntensity</code>. Documentation of CHHapticEvent object, https://developer.apple.com/documentation/corehaptics/chhapticevent

Claim 20	Accused Products
	Haptic Event Parameter IDs static let hapticIntensity: CHHapticEvent.ParameterID The strength of a haptic event. static let hapticSharpness: CHHapticEvent.ParameterID The feel of a haptic event. static let attackTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins increasing. static let decayTime: CHHapticEvent.ParameterID The time at which a haptic pattern's intensity begins decreasing. static let releaseTime: CHHapticEvent.ParameterID The time at which to begin fading the haptic pattern. static let sustained: CHHapticEvent.ParameterID A Boolean value that indicates whether to sustain a haptic event for its specified duration. Documentation of haptic event parameters, https://developer.apple.com/documentation/corehaptics/chhapticevent/parameterid;

Claim 20	Accused Products
	4. The Continuous “Sharpness” parameter maps to frequency. For continuous events, we found that the sharpness parameter maps to frequency. On an iPhone 8, the lower sharpness boundary (0.0) of the Taptic Engine is 80 Hz; the higher sharpness boundary (1.0) is 230 Hz. This provides an effective range of 150 Hz, or roughly 1.5 octaves — which is impressive for a mobile phone released in 2017. Other phones or devices supporting Core Haptics might have different upper or lower boundaries since the frequency range is tied to the capabilities of the hardware actuator. https://medium.com/lofelt/10-things-you-should-know-about-designing-for-apple-core-haptics-9219fdebdc9a.

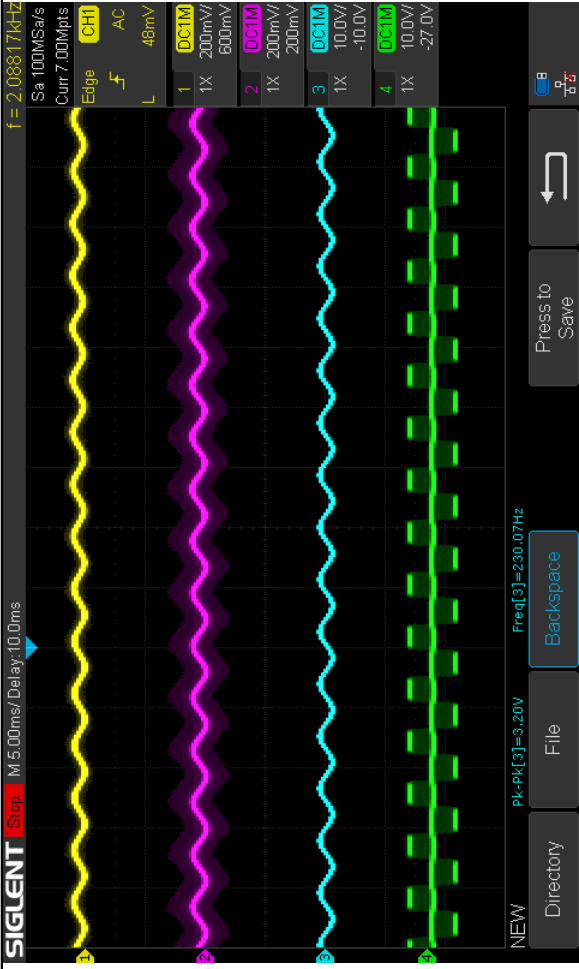
Claim 20	Accused Products
	 Annotated photograph of Taptic Engine connector from the iPhone 14 showing positive and negative coil driving pins.

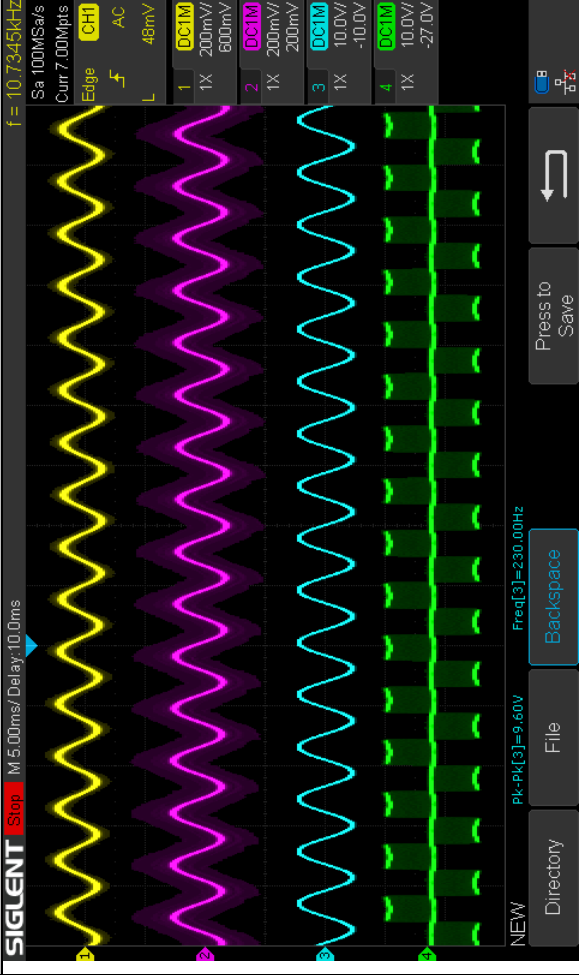
Claim 20	Accused Products
	 Photographs of test apparatus with electrical leads connected to motor coil drive traces of iPhone 14.

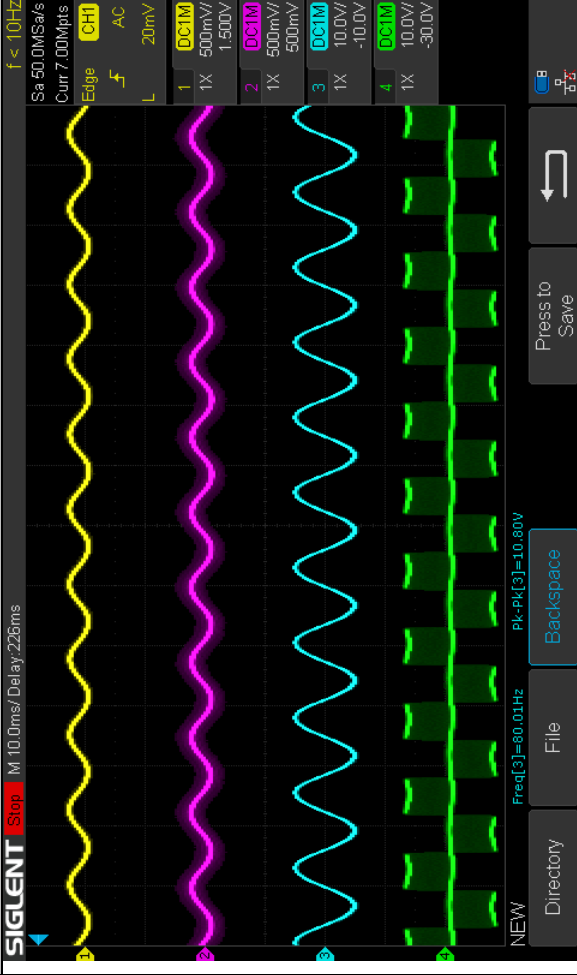
Claim 20	Accused Products
	Photograph of test apparatus for measuring motor coil drive signal (from tapped connection) and actual motion (from attached vibration transducer) of iPhone 14. Note RC low-pass filter networks at top right with $R = 220\ \Omega$, $C = 2.2\ \mu\text{F}$.

Claim 20	Accused Products
	Oscilloscope trace showing, in green (CH4), the drive voltage applied by the iPhone 14 haptic controller(s); in this case, a pulse width modulated positive signal (modulation frequency 857 kHz) to drive the moveable component in one of two directions.

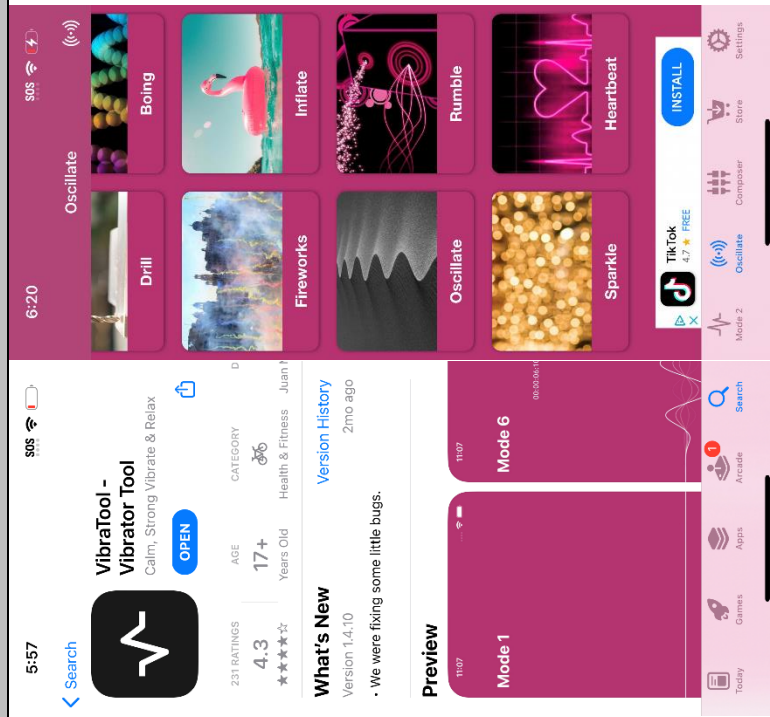
Claim 20	Accused Products
	Oscilloscope trace showing, in green (CH4), the PWM-modulated drive voltage applied by the iPhone 14 haptic controller(s), with positive and negative voltages to drive the moveable component in a first and second direction. Channels 1 and 2 (yellow and purple) show the actual motion of the iPhone 14 resulting (pursuant to Newton's third law) from the motion of the moveable component.

Claim 20	Accused Products  Oscilloscope trace showing the result of CHHapticEvent with intensity = 0.5, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 3.2 V (peak-to-peak, through RC low-pass filter).
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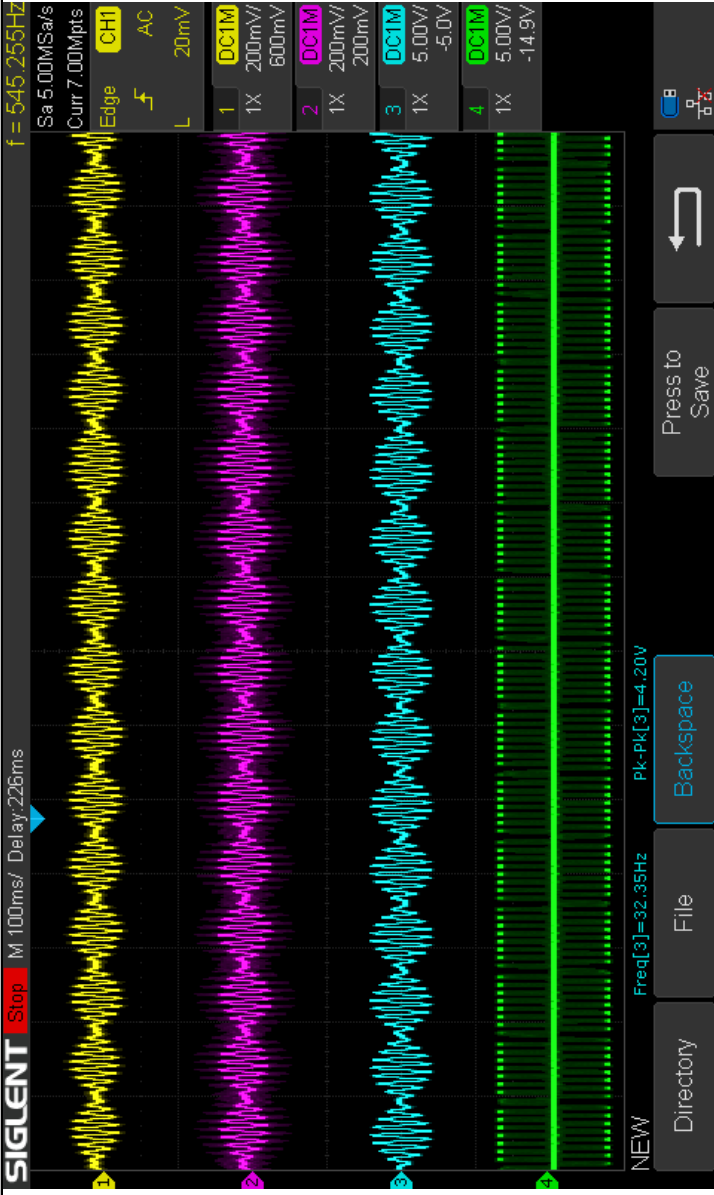
Claim 20	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 1, with frequency of 230 Hz and motor drive amplitude of 9.6V (peak-to-peak, through RC low-pass filter). Note that the externally measured vibration amplitude (yellow and purple traces, same scale as previous trace) is also significantly higher at intensity = 1 than 0.5.

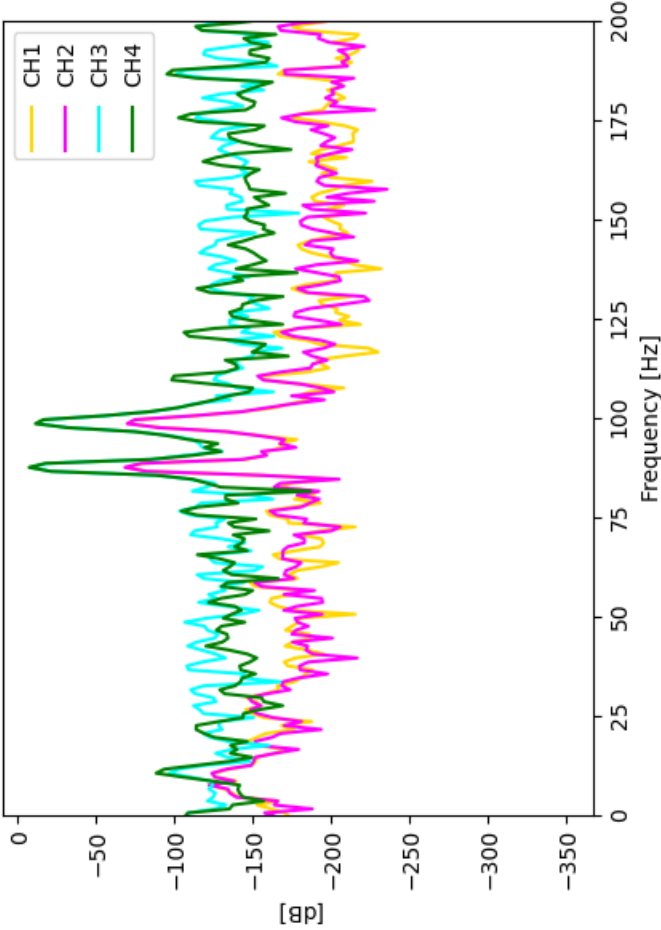
Claim 20	Accused Products
	 Oscilloscope trace showing the result of CHHapticEvent with intensity = 1, sharpness = 0, with frequency of 80 Hz and motor drive amplitude of 10.8 V (peak-to-peak, through RC low-pass filter). To the extent Defendant contends and/or shows that this limitation is not literally present in the Accused Products, it is present under the doctrine of equivalents. There are no substantial differences between the accused functionality and the claimed invention. For example, each Accused Product contains one or more microprocessors that coordinate(s) operation of the Taptic Engine, which performs substantially the same function (e.g., controls supply of power from the power supply to the driving component to cause the moveable component to oscillate at a frequency and an amplitude specified by one or more stored values) in substantially the same way (e.g., using digital logic) to achieve substantially the same result (e.g., producing oscillations at a desired frequency and amplitude).
[20g] wherein the control component drives simultaneous oscillation of the	In each Accused Product, the control component drives simultaneous oscillation of the moveable component at two or more frequencies to generate complex vibration modes.

Claim 20	Accused Products
moveable component at two or more frequencies to generate complex vibration modes.	For example, the iPhone 14 is configured to drive the moveable component in a complex drive mode that includes at least two frequencies when used with software sold by Apple through its App Store. On information and belief, the Apple Watch Ultra supports the same or similar functionality. For another example, each Accused Product is configured to drive the moveable component in a complex drive mode when used with public APIs, as well as any proprietary Apple APIs. In the Apple Core Haptics API, one or more haptic patterns, which each includes a selected frequency, may be played simultaneously to produce two or more frequencies that generate complex vibration modes. <i>See, e.g.:</i>



Screenshots of exemplary “VibraTool” software, sold by Apple through its App Store.

Claim 20	Accused Products  Oscilloscope trace showing “Oscillate” pattern from VibraTool, showing complex drive modes.
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Claim 20	Accused Products
	 Spectrum analysis of “Oscillate” pattern from VibraTool, showing two or more peak frequencies (88 Hz and 99 Hz) of complex drive mode.

Claim 20	Accused Products
	Play the AHAP Assuming the engine has started, call the engine's method, <code>playPattern(from:)</code>, passing it the URL to playing the file. <pre>// Tell the engine to play a pattern. try engine?.playPattern(from: URL(fileURLWithPath: path))</pre> This method of playback follows a <i>fire and forget</i> model; each haptic pattern plays until it reaches its end, then stops automatically. Once the haptic starts playing, you can't stop it, and pressing other buttons layers those haptics on top of any existing haptic patterns in the middle of playback. This layering allows you to combine a haptic pattern with a more continuous intent, like the rumble of thunder, with a more impulse-driven haptic pattern built from transient taps, like the strike of lightning. Core Haptics layers simultaneously playing haptics automatically. If you don't want the layering, your app should wait out the duration of the first haptic before starting subsequent haptic players. Note Haptic patterns don't blend like audio waveforms, and not all combinations produce a discernible effect. Playing two haptic events of the same type at the same time makes them hard to tell apart. Experiment with various combinations to ensure that the result feels right. Documentation of the Apple Core Haptics API showing that more than one haptic pattern, which includes a frequency, may be played simultaneously to produce two or more frequencies that generate complex vibration modes. Source: https://developer.apple.com/documentation/corehaptics/playing_a_custom_haptic_pattern_from_a_file