Stylus Inking Hardware Specification

Release R1

Developer

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1. Overview

1.1 Introduction

1.1.1 Scope

This document defines the minimum electrical and mechanical design requirements for manufacturers developing active inking accessories intended for inking compatibility with supported host device. The requirements herein focus specifically on the accessory's stimulus (electrical) design and tip/electrode (electrostatic and mechanical) design, which together determine whether the accessory can be reliably sensed.
The following are explicitly out of scope for this document: pairing, communication with the host device, and accessory charging.

1.1.2 Inking Sub-system

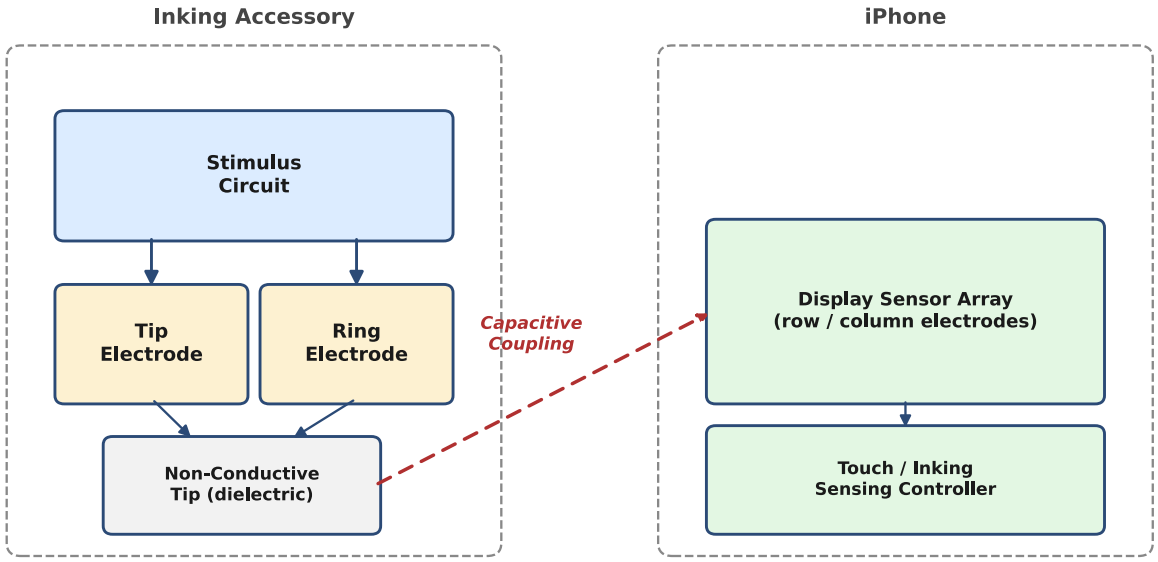
Host device inking relies on an active capacitive sensing scheme between the accessory and a sensor array embedded in the host device display. For tip tracking, the accessory has a tip electrode and for detecting tilt, the accessory has a separate ring electrode. These electrodes couple capacitively to a row/column sensor array inside the display through the accessory's tip.
Because the tip and ring electrodes are physically separated and independently sensed, the host device can jointly resolve the accessory's position, tilt, azimuth (rotation about the tip contact point), and height above the display (z) from the two coupled signals. Accurate, sufficiently strong, and spectrally clean stimulus signals at both electrodes are therefore required for reliable inking performance.

1.2 System Descriptions

1.2.1 Key Components

Tip Electrode: The electrode located at the accessory's writing tip. It is the primary contributor to position (x/y) sensing and is driven by the stimulus circuit.

Figure 1 — Inking Sub-System Block Diagram



Ring Electrode: A secondary electrode located a defined distance from the tip electrode along the accessory body. Combined with the tip electrode signal, it enables the display sensing controller to resolve tilt and azimuth.
Physical / Dielectric Tip: The non-conductive structure that makes physical contact with the display cover glass. It electrically isolates the tip electrode from the display surface while allowing capacitive coupling to the sensor array beneath.

1.2.2 Block Diagram

Figure 1 illustrates the high-level inking signal path. The accessory drives both the tip and ring electrodes. These electrodes couple capacitively, through the non-conductive tip, to the display sensor array inside the host device.

2. Design Requirements & References

To support inking, an accessory stylus must pair to the device using Bluetooth Low Energy (BLE), support Human Interface Device (HID) protocol, implement the stimulation controls described in §2.2, and meet the hardware requirements in the Stylus Inking Hardware Specification.

2.1 Stim Plan

The accessory shall support a stimulus frequency range of 50 kHz - 600 kHz with 1 Hz resolution and ±100 Hz accuracy. The stimulus for the tip and ring is simultaneous at two distinct frequencies.
The Stim plan values are defined and shared via Bluetooth. See section 2 in the StylusInkingHID specification document.

2.1.1 Output Power Requirements

The accessory's stimulus circuit delivers an output signal power, measured at the fundamental stimulation frequency (H1) at both the tip and ring electrodes, that falls within the range specified below.

Min. Output Power @ H1 (dBm)	Max. Output Power @ H1 (dBm)
41.85	42.75

Methodology:

Output power at H1 is derived in two steps. First, the fundamental voltage is measured directly at the tip and ring electrodes using a high-impedance probe (for example, 10 MΩ resistance, 5 pF termination). The TX driver circuit is capable of driving the high impedance probe without effecting signal integrity. Second, the measured RMS voltage is converted to an equivalent power referenced to a 50 Ω load:

$$P\ (\text{dBm}) = 10 \cdot \log_{10}(V_{1,\text{rms}}^2 / 50\ \Omega / 1\ \text{mW})$$

2.1.2 Harmonic Requirements

In addition to sufficient fundamental output power, the stimulus waveform is spectrally clean. Excessive harmonic content can corrupt the sensing signal, degrade position/tilt/azimuth accuracy, and interfere with the host device's other functions. Each

harmonic of the stimulus waveform, from the 2nd through the 7th, is suppressed relative to the fundamental (H1) by at least the amount specified below.

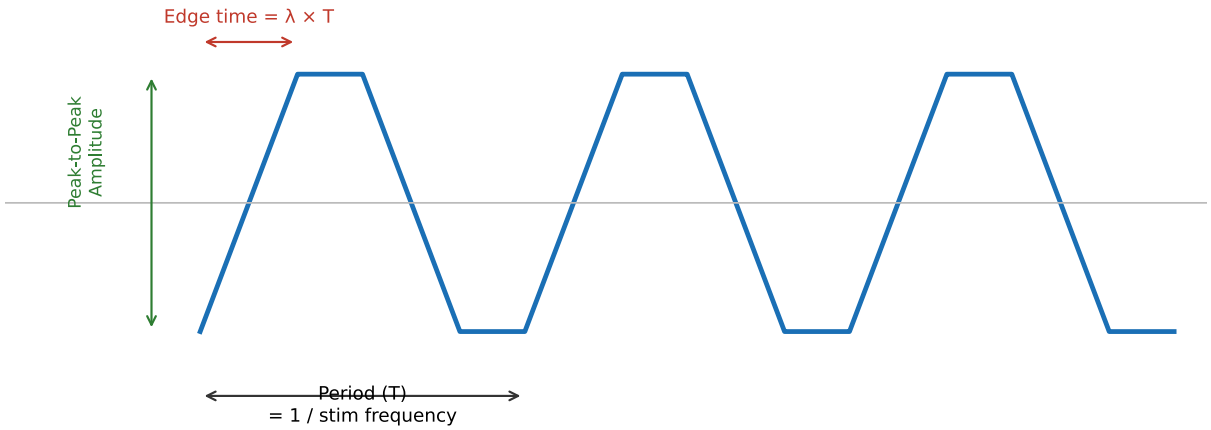
Harmonic Order	Maximum Level Relative to Fundamental (dBc)
2nd (H2)	≤ -47
3rd (H3)	≤ -30
4th (H4)	≤ -49
5th (H5)	≤ -35
6th (H6)	≤ -50
7th (H7)	≤ -35

The power at any other frequency including spurious noise is at least 60 dB below the fundamental frequency.

2.1.3 Example Stim Waveforms

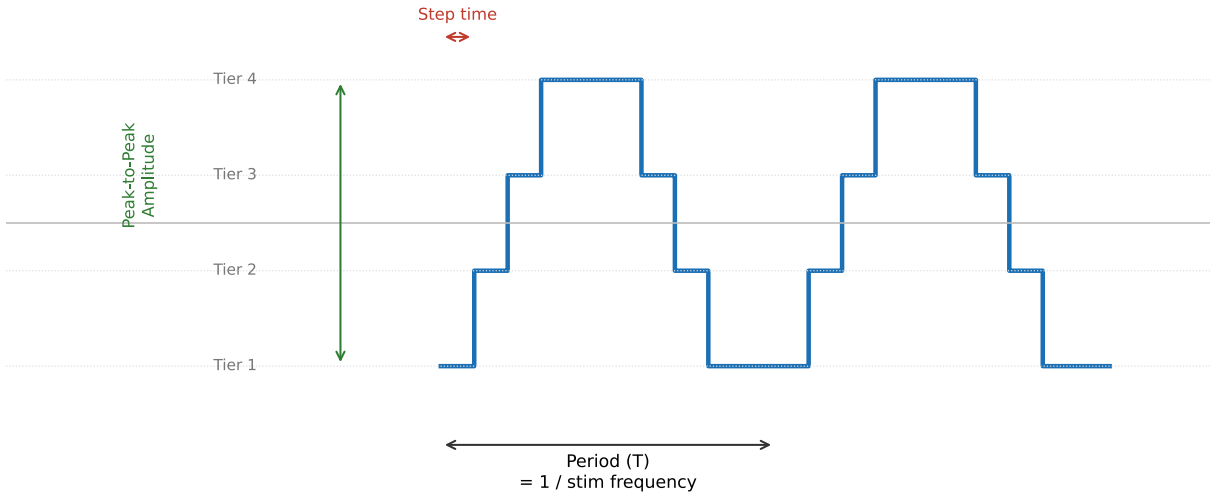
An example stimulus waveform driving each electrode is shown in Figure 2. Here, the waveform is characterized by a period (T, the reciprocal of the stimulation frequency), a peak-to-peak amplitude, and an edge (rise/fall) time expressed as a fraction (λ) of the period. This figure is representative only — it is not a mandated waveform capture, and specific amplitude, frequency, and λ values are left to the accessory manufacturer's design, subject to the requirements in Sections 2.1.1 and 2.1.2.

Figure 2: Exemplary Trapezoidal Stimulus Waveform (Illustrative Only)



The stimulus driver may optionally support multiple output voltage tiers to control transition slew rate and reduce harmonic content, producing a tiered (stepped) trapezoidal waveform as

Figure 3: Exemplary Tiered (Stepped) Trapezoidal Stimulus Waveform (Illustrative Only)



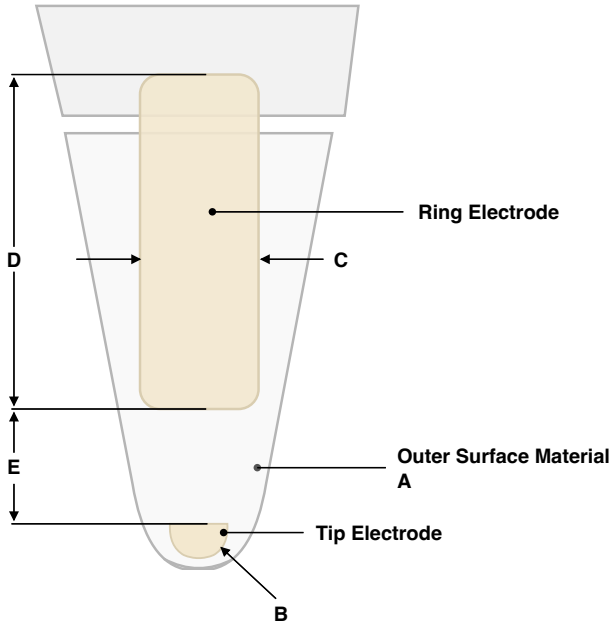
shown in Figure 3. As with Figure 2, the number of tiers and step timing shown are illustrative only.

2.2 Mechanical Design

2.2.1 Reference Diagram

Figure 4 shows a simplified reference cross-section of the accessory's tip region, annotated with the key mechanical dimensions specified in this section. The diagram is illustrative and not to scale; it is intended to clarify dimension callouts rather than convey a specific accessory shape or industrial design.

Figure 4: Mechanical Reference Diagram (Simplified, Not to Scale)



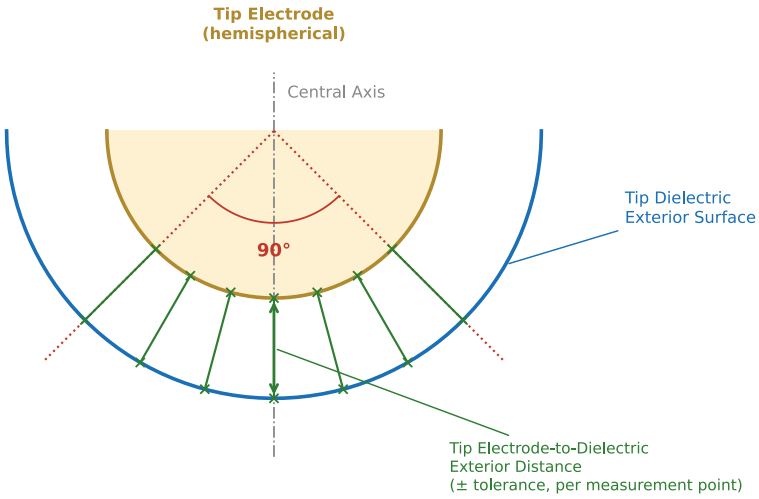
The following table specifies the geometric and material requirements for the tip and electrode design:

Item	Description	Tolerance / Value
A - Tip Dielectric	Relative permittivity of material used for accessory tip (100 kHz and 500 kHz)	3.5 (± 10%)
B.1 - Tip Electrode Shape	The tip electrode is hemispherical	Hemispherical
B.2 - Tip Electrode Diameter	Reference diameter of tip electrode	1200 µm (± 15 µm)
C - Ring Electrode Diameter	Reference diameter of ring electrode	2240 µm (± 30 µm)
D - Ring Electrode Height	Height of the ring electrode along the accessory body	5000 µm (± 100 µm)
E - Tip-to-Ring Distance	Minimum distance to ensure no cross-coupling between tip and ring electrodes	3620 µm

2.2.2 Tip Electrode-to-Dielectric Exterior Distance

To ensure consistent capacitive coupling between the tip electrode and the display, the standoff distance between the tip electrode surface and the exterior surface of the tip dielectric is controlled. This distance is measured at multiple points across a 90° cone centered on, and symmetric about, the accessory's central axis, as shown in Figure 5. Each measurement point is subject to the tolerance specified below.

Figure 5: Tip Electrode-to-Dielectric Exterior Distance, Measured Across a 90° Cone About the Central Axis (Simplified, Not to Scale)



Item	Description	Tolerance / Value
Tip Electrode-to-Dielectric Exterior Distance	Distance from the tip electrode surface to the exterior surface of the tip dielectric, measured at each point within the 90° measurement cone	290 µm (± 26 µm)

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One Apple Park Way

Cupertino, CA 95014

408-996-1010

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