Stylus Inking Accessory Design Specification

Release R1

Developer

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1. HID Inking Accessory — Introduction

Purpose. An accessory stylus is an active stylus. It applies electrical stimulation (*also referred as stim*) signals to its electrodes — one at its tip and one at its ring — and the device's touch subsystem detects these signals to track and report the stylus position. The device sets the stimulation frequencies, and turns stimulation on and off, using Apple-defined HID usages.

Scope. This document describes what a stylus implements to support inking: the stimulation controls, and how the device uses them.

Normative convention. Accessory requirements use **must** (unconditional) and **should** (strong recommendation). Host behavior uses **will** — that behavior is Apple-controlled and not configurable by the accessory — and **may** for permitted but not guaranteed behavior.

2. Requirements

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 Top-Level Application Collection

The HID report descriptor must contain exactly one top-level application collection with Usage Page **`0x0D`** (*Digitizer Page*) and Usage ID **`0x0020`** (*Stylus*).

2.2 Stimulation Controls

The stylus must implement all usages defined in §6.1, which specifies their usage types, units, and reserved usages. All stimulation control usages are implemented as HID Feature report items; the device configures them via Feature report writes and reads them back via Feature report reads. The stimulation control usages are declared under Apple vendor HID Usage Page **`0xFF60`**, within the **`0x0D`** top-level application collection defined in §2.1.

The device configures a stylus for inking only when its report descriptor contains all of those usages. If any usage is absent, the device does not configure inking and no error is reported.

Logical ranges

Usage	Logical Minimum	Logical Maximum	Notes
Transducer Stim Tip Frequency	Stylus-declared	Stylus-declared	Must encompass HW spec range
Transducer Stim Ring Frequency	Stylus-declared	Stylus-declared	Must encompass HW spec range
Transducer Stim Enable	0	1	-

The device will only write stim frequency values within the range required by the **Stylus Inking Hardware Specification** (see H2). A valid example descriptor, report format, and example reports are provided in §6.3.

Accessory Requirements

Requirements A1–A8 govern the descriptor and pairing prerequisites. Requirements A9–A17 (§3) govern run-time stimulation behavior.

#	Requirement
A1	The accessory must pair to the device using Bluetooth LE via **Apple's USB-Triggered Bluetooth Pairing** or **Proximity-Triggered Pairing**.
A2	The accessory must support the **Human Interface Device (HID)** protocol.
A3	The accessory must also implement the Apple Vendor Usage Generic Attribute Profile (GATT) Characteristic **(**UUID **`D463ECFD-A39B-49ED-AE94-B8C84D44BA11`)** defined in §6.2, which signals to the device that vendor usages in the report descriptor should be interpreted according to Apple definitions.
A4	The accessory must implement all Stimulation Controls defined in §2.2 and apply stimulation as specified in §3.
A5	The accessory must meet the stimulation hardware requirements in the **Stylus Inking Hardware Specification**.
A6	The HID report descriptor must contain exactly one top-level application collection with Usage Page **`0x0D`** (Digitizer Page) and Usage ID **`0x0020`** (Stylus). Additional top-level application collections for other features are permitted.
A7	For *Transducer Stim Tip Frequency*, and *Transducer Stim Ring Frequency*, *Logical Minimum* and *Logical Maximum* must declare the full range the stylus supports; each declared range must include the range required by §2.1 in **Stylus Inking Hardware Specification**.
A8	*Transducer Stim Enable* must have a *Logical Minimum* of *0* and a *Logical Maximum* of *1*.

Host Requirements

#	Requirement
H1	The device will configure the stylus for inking only when its report descriptor contains all usages defined in §2.2. If any usage is absent, the device will not configure inking and will not report an error to the user or the stylus.
H2	The device will only write *Transducer Stim Tip Frequency* and *Transducer Stim Ring Frequency* values within the range required by the **Stylus Inking Hardware Specification**.

3. Stimulation Behavior

The device configures the stylus by writing Feature reports, and may read them back at any time after HID enumeration. The device sends stimulation reports only over Bluetooth LE.

The stylus applies all stimulation control values as written. While *Transducer Stim Enable* is *1*, the stylus stimulates at the most recently written frequencies. While it is *0*, the stylus does not stimulate.

When the device reads a stimulation report, the stylus returns the most recently accepted values, including the current state of *Transducer Stim Enable*. Before the device's first write in a connection, all fields read as *0*.

Across connections, the stylus resets to a known state: All stimulation control fields reset to *0* at power-on and at the start of each new connection. The stylus never carries stimulation parameters forward from a previous connection.

Accessory Requirements

#	Requirement
A9	The accessory must apply all stimulation control values as written by the device. **Note:** The accessory should apply updated values as quickly as possible.
A10	While *Transducer Stim Enable* is *1*, the accessory must stimulate at the most recently written frequencies.
A11	While *Transducer Stim Enable* is *0*, the accessory must not stimulate.
A12	When the device reads a stimulation Feature report, the accessory must return the most recently accepted values, including the current state of *Transducer Stim Enable*.
A13	Before the device's first write in a connection, the frequencies and enable fields must read as *0*. **Note:** The device treats these *0*-value frequencies as null and does not apply them as a valid stim configuration.
A14	At power-on and at the start of each new connection, the accessory must reset all stimulation control fields to *0* (As referred in A13)
A15	The accessory must not stimulate until, during the current connection, the device has written the stimulation parameters and set *Transducer Stim Enable* to *1*.
A16	The accessory must not apply stimulation parameters received during a previous connection.
A17	The accessory must stop stimulation as soon as it detects that the connection has ended — for example, on link supervision timeout.

Host Requirements (Informative)

#	Behavior
H3	The device may send the initial stim configuration at any point during the connection.
H4	The device will set *Transducer Stim Enable* to *1* when scanning for stylus touch input and *0* when not scanning.
H5	Some device platforms will change the stim frequencies dynamically during a connection.
H6	The device may read or update stimulation Feature reports at any time during the connection.
H7	The device sends stimulation reports only over BLE.

4. Scenarios

(This section is informative. It indexes key connection-time states to confirm behavioral coverage. Cross-cutting requirements — reset on connect (A14), no parameter carry-over (A16), and stop on disconnect (A17) — appear as their own rows rather than being buried in context descriptions.)

#	Scenario	Descriptor	Stim state at event	Context	Expected behavior
1	First connection, full descriptor	All required usages present	Enable=0 (reset per A14)	Stylus connects for the first time	Device configures inking (H1): writes f_tip, f_ring with Enable=0 (H3); sets Enable=1 when scanning (H4)
2	Connection, incomplete descriptor	One or more required usages or Apple Vendor Usage GATT characteristic absent	Enable=0	Stylus with a missing usage connects	Device does not configure inking (H1); stylus remains unstimulated; no error reported to user or stylus
3	Device enables scanning	All required usages present	Enable=0 → 1	Device touch subsystem becomes ready after parameters are written	Device writes Enable=1 (H4); stylus begins stimulating per A10

#	Scenario	Descriptor	Stim state at event	Context	Expected behavior
4	Device stops scanning	All required usages present	Enable=1 → 0	Device touch subsystem stops scanning	Device writes Enable=0 (H4); stylus stops stimulating per A11
5	Dynamic parameter change	All required usages present	Enable=1	Device platform updates operating frequencies mid-connection	Device writes new frequency values while *Transducer Stim Enable* remains *1* (H5); stylus applies updated frequencies per A9/A10 as quickly as possible and continues stimulating without interruption.
6	Connection drops while stimulating	All required usages present	Enable=1	Link supervision timeout or other connection loss	Stylus stops stimulation immediately per A17; prior parameters not carried into the next connection per A16
7	Reconnect	All required usages present	Enable=0	Previously bonded stylus reconnects	Stylus clears Enable to 0 at connection start per A14; device re-sends f_tip and f_ring, and re-enables when scanning

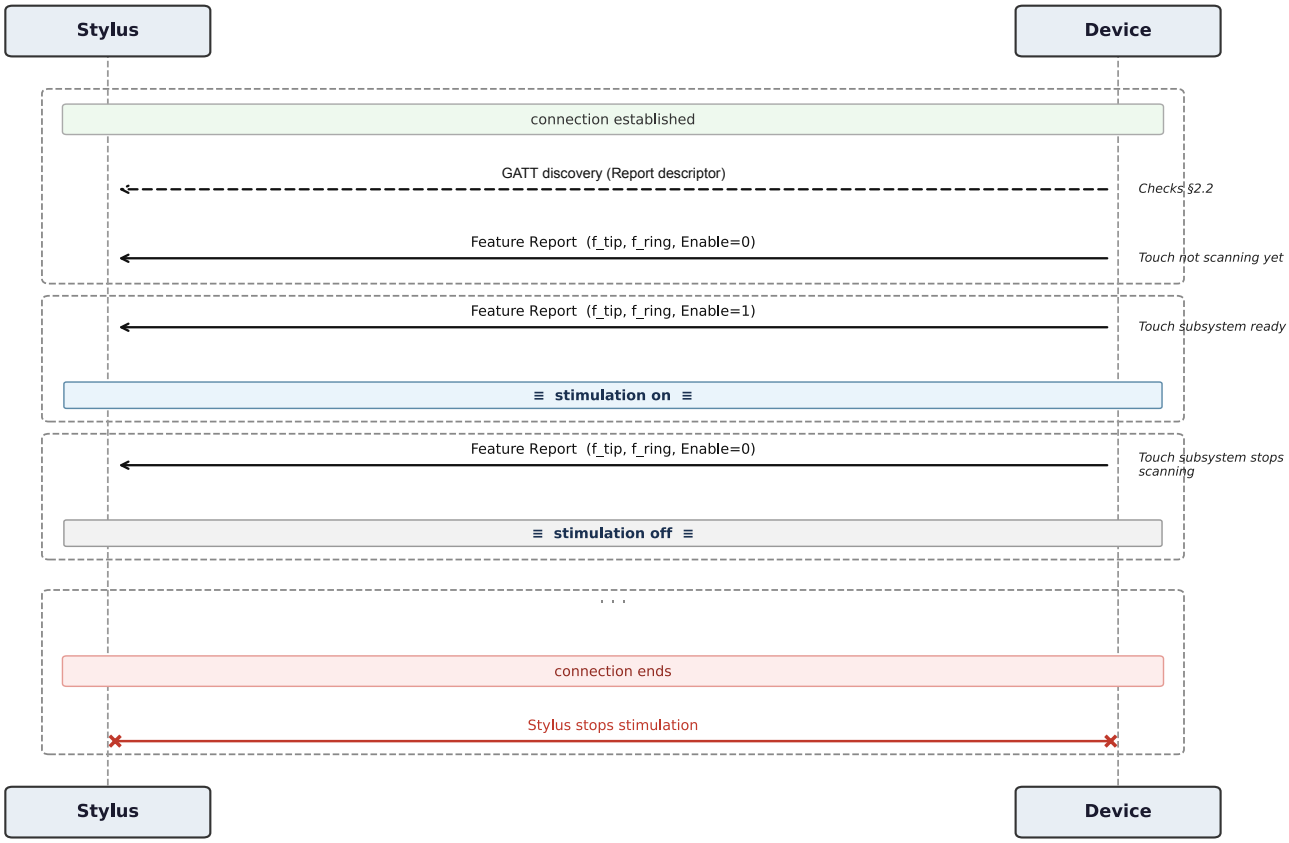
5. Expected Device Behavior

(This section is informative. It describes how the device uses the stimulation controls so developers can anticipate the report sequence.)

- After each connection, the device checks the stylus's report descriptor during GATT discovery to determine whether it supports inking (§2.2).
- The device then sends the stim frequencies.
- The device sets *Transducer Stim Enable* to *1* when it is scanning for stylus touch input and *0* when it is not. How quickly the stylus starts stimulating affects only how soon it can begin interacting with the device.
- If the device is scanning for stylus touch input on connection, it sets *Transducer Stim Enable* to *1* shortly after sending the stim frequencies.
- Some device platforms will change the stim frequencies dynamically during a connection. The stylus is expected to adjust its stimulation accordingly.
- The device may read or set stimulation reports at any time after HID enumeration.

- The device sends stimulation reports only over BLE.

Figure 1 — Expected report sequence between a stylus and the device, assuming a single-report layout.



6. HID Usages and Definitions

6.1 Apple Inking Usage Page

The Apple Stylus Inking Usage Page (**`0xFF60`**) is an Apple-specific vendor-defined usage page for stimulation control on inking accessories. It defines usages for setting stimulation frequencies and enabling or disabling stimulation. Usage IDs not defined in this section are reserved for Apple use. The accessory must implement the Apple Vendor Usage GATT Characteristic (§6.2) to indicate that these usages are Apple-defined.

Usage ID	Usage Name	Usage Types	Description
FF601101	Transducer Stim Tip Frequency	DV	The stimulation frequency applied at the transducer tip when stimulation is enabled. Default units are Hertz (Hz).
FF601102	Transducer Stim Ring Frequency	DV	The stimulation frequency applied at the transducer ring when stimulation is enabled. Default units are Hertz (Hz).
FF601103	Transducer Stim Enable	DF	Enables or disables transducer stimulation. When enabled, the accessory applies stimulation using the most recently set Tip Frequency and Ring Frequency Values.

6.2 Apple Vendor Usage GATT Characteristic

To indicate to Apple devices that vendor-defined usage IDs in its report descriptor should be interpreted according to Apple definitions, accessories must define a vendor specific characteristic on the GATT HID service with the following UUID. The characteristic value is unused.

Apple Vendor Usage GATT Characteristic
D463ECFD-A39B-49ED-AE94-B8C84D44BA11

6.3 Examples (Informative)

Report Descriptor

The following example illustrates a single Feature report (Report ID 1) containing the three stimulation control usages defined in §6.1, with tip and ring frequencies as 32-bit values and Stim Enable as a 1-bit field.

```
0x05, 0x0D,                    // Usage Page (0x0D – Digitizer)
0x09, 0x20,                    // Usage (0x20 – Stylus)
0xA1, 0x01,                    // Collection (Application)
0x85, 0x01,                    //   Report ID (1)
0x06, 0x60, 0xFF,              //   Usage Page (0xFF60)
0x0A, 0x01, 0x11,              //   Usage (0x1101 – Transducer Stim Tip
Frequency)
0x17, 0x50, 0xC3, 0x00, 0x00, //   Logical Minimum (50000)
0x27, 0xC0, 0x27, 0x09, 0x00, //   Logical Maximum (600000)
0x75, 0x20,                    //   Report Size (32)
0x95, 0x01,                    //   Report Count (1)
0xB1, 0x02,                    //   Feature (Data, Var, Abs)
```

```
0x0A, 0x02, 0x11,             //   Usage (0x1102 – Transducer Stim
Ring Frequency)
0x17, 0x50, 0xC3, 0x00, 0x00, //   Logical Minimum (50000)
0x27, 0xC0, 0x27, 0x09, 0x00, //   Logical Maximum (600000)
0x75, 0x20,                   //   Report Size (32)
0x95, 0x01,                   //   Report Count (1)
0xB1, 0x02,                   //   Feature (Data, Var, Abs)
0x0A, 0x03, 0x11,             //   Usage (0x1103 – Transducer Stim
Enable)
0x15, 0x00,                   //   Logical Minimum (0)
0x25, 0x01,                   //   Logical Maximum (1)
0x75, 0x01,                   //   Report Size (1)
0x95, 0x01,                   //   Report Count (1)
0xB1, 0x02,                   //   Feature (Data, Var, Abs)
0x75, 0x07,                   //   Report Size (7)
0x95, 0x01,                   //   Report Count (1)
0xB1, 0x03,                   //   Feature (Const, Var, Abs)
0xC0,                         // End CollectionReport Format
Pseudocode
```

Report Format

The following C types represent the format of the above report descriptor:

```
typedef enum : uint8_t {
    kTransducerStimDisabled = 0,
    kTransducerStimEnabled  = 1,
} TransducerStimEnable;

typedef struct __attribute__((packed)) {
    uint8_t report_id;
    uint32_t stim_tip_frequency;
    uint32_t stim_ring_frequency;
    TransducerStimEnable stim_enable : 1;
    uint8_t reserved : 7;
} TransducerStimFeature01;
```

7. References

- **Stylus Inking Hardware Specification** — defines the required ranges for *Transducer Stim Tip Frequency*, and *Transducer Stim Ring Frequency*.
- **Accessory USB-Triggered Bluetooth Pairing Specification** — BLE pairing delivered over the USB wired channel.
- **Accessory Proximity-Triggered Pairing Specification** — BLE pairing an accessory with Apple devices when they are in proximity to each other

8. Revision history

Version	Date	Notes
R1	2026-10-28	Release R1

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