Openloop SDK

Documentation

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Hardware Wallet SDK for Web & Node.js

Ethereum | Bitcoin | Solana | TRON | XRP

Openloop

Openloop SDK Specifications

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Architecture Overview

What is the Openloop SDK?

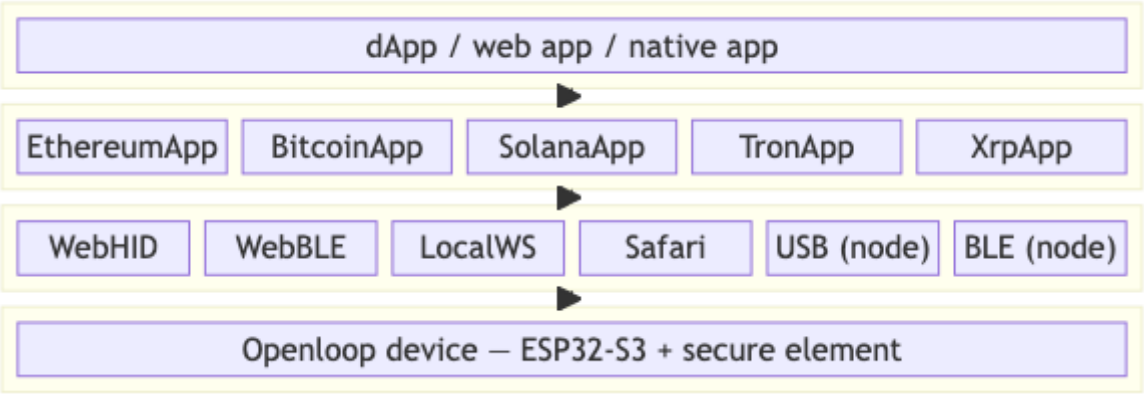
The Openloop SDK is a **multi-language library** for communicating with the Openloop hardware wallet.

Language / format	Main deliverables	Purpose
TypeScript / npm	`@openloop/sdk-core`, `@openloop/transport-*`	Web dApps, Node.js / Electron, React Native
Swift / SPM (planned)	—	Native iOS apps
Kotlin / Maven (planned)	—	Native Android
C# / NuGet (planned)	—	Native Windows

> **About licensing**: Use of the Openloop SDK requires a license agreement with Haudi Crypto, Inc. We can also customize the SDK to suit your requirements — please feel free to contact us at info@crypto.haudi.jp.

The single most important principle: private keys stay inside the device and never leave it. The SDK only sends and receives APDU (Application Protocol Data Unit) commands. All signing is performed inside the device's secure element.

Layer Structure



What each layer does

Layer	Role
dApp	User interface, transaction construction
App class	Builds chain-specific APDU commands and parses responses
ITransport	Physical communication with the device (USB / BLE / WebSocket, etc.)
Device	Private key management, signing, user approval

Security Model

What the SDK does

- Builds and sends APDU commands
- Parses responses (addresses, signatures, and so on)
- Manages transport connection and disconnection

What the SDK does not do

- Generate, hold, or operate on private keys
- Perform signing
- Manage seed phrases

Security on the device side

- Private keys are generated and stored inside the device and never leave it

- All signing is performed inside the device
- Transaction details are shown on the device's screen and the user approves them with a physical button
- If the user rejects, the device returns status word `0x6985` and no signature is produced

Supported Chains

Chain	App class	Elliptic curve	BIP44 coin_type
Ethereum (EVM)	`EthereumApp`	secp256k1	`60'`
Bitcoin	`BitcoinApp`	secp256k1	`0'` (mainnet), `1'` (testnet)
Solana	`SolanaApp`	Ed25519	`501'`
TRON	`TronApp`	secp256k1	`195'`
XRP Ledger	`XrpApp`	Ed25519 / secp256k1	`144'`

EVM-compatible chains

`EthereumApp` works not only with Ethereum but with any EVM-compatible chain. Specify the chain through the `chainId` parameter of `signPersonalMessage` and `signTypedData`.

Transport Connection Methods

The SDK offers six connection methods, covering a wide range of platforms.

Transport	Package	Use case
WebHID (USB)	`@openloop/transport-webhid`	Chrome/Edge on desktop
Web Bluetooth	`@openloop/transport-webble`	Chrome/Edge + Android
LocalWS	`@openloop/transport-local`	All browsers (via Connect)
Safari Extension	`@openloop/transport-safari`	iOS Safari
USB HID (native)	`@openloop/transport-usb`	Node.js / Electron
BLE (native)	`@openloop/transport-ble`	Node.js / Electron
WalletConnect	Built into `@openloop/sdk-core`	All browsers (remote signing)

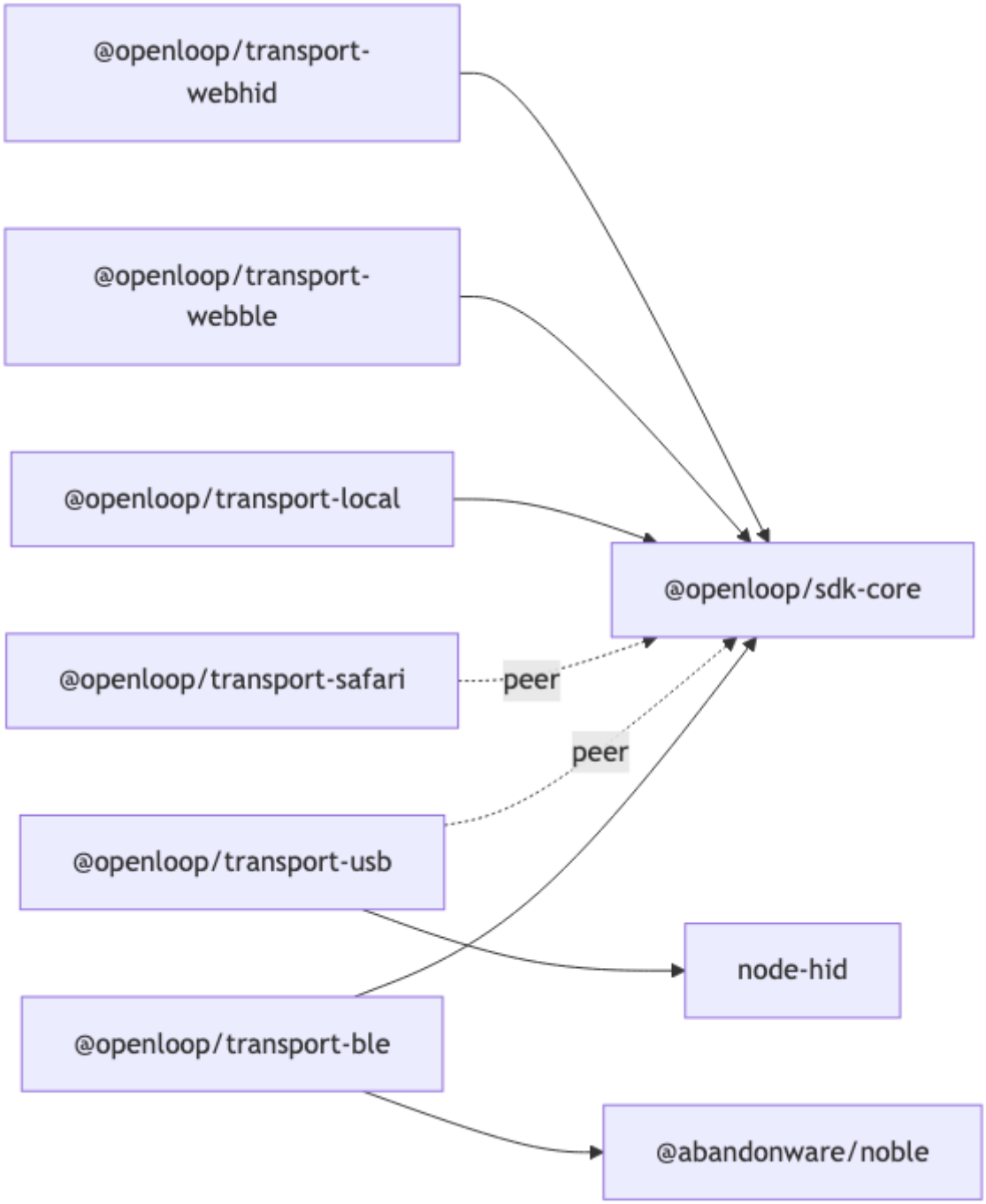
See the Transport Guide for details.

Package List

npm packages (TypeScript)

Package	Description	Dependencies
`@openloop/sdk-core`	Core library (App, Types, Errors, Constants, WcTransport)	none
`@openloop/transport-webhid`	WebHID (USB) transport	sdk-core
`@openloop/transport-webble`	Web Bluetooth transport	sdk-core
`@openloop/transport-local`	LocalWS transport	sdk-core
`@openloop/transport-safari`	Safari extension transport	sdk-core (peer)
`@openloop/transport-usb`	Native USB HID transport	sdk-core (peer), node-hid
`@openloop/transport-ble`	Native BLE transport (Node.js / Electron)	sdk-core (peer), noble

Dependency graph



`sdk-core` is a pure TypeScript package with no dependency on browser APIs or native modules. Each transport package supplies the platform-specific implementation. Swift / Kotlin / C# libraries for native apps are planned.

APDU Protocol Overview

Communication between the SDK and the device uses APDU (Application Protocol Data Unit) commands.

Command structure

```
[CLA] [INS] [P1] [P2] [Lc] [Data...]
```

Field	Size	Description
CLA	1 byte	Class byte (`0xE0`: Ledger-compatible, `0xF0`: Openloop-specific)
INS	1 byte	Instruction code
P1	1 byte	Parameter 1 (chunking control, etc.)
P2	1 byte	Parameter 2 (curve selection, etc.)
Lc	1 byte	Data length
Data	Lc bytes	Command data

Response structure

```
[Data...] [SW1] [SW2]
```

Field	Size	Description
Data	variable	Response data
SW1-SW2	2 bytes	Status word (`0x9000` = success)

CLA bytes

CLA	Purpose
`0xE0`	Ledger-compatible commands (ETH, BTC getAddress, SOL, TRON, XRP)
`0xF0`	Openloop-specific commands (chain_id-aware signing, PSBT, BTC xpub)

See Error Handling for the full list of APDU status words.

Next Steps

- Quick Start — a getting-started guide for developers
- Transport Guide — the platform support matrix
- API Reference — all type definitions and interfaces

Quick Start

This guide walks you through connecting to the hardware wallet with the Openloop SDK, retrieving an address, and signing a transaction.

Installation

Install the core package plus the transport package for the connection method you plan to use.

```
# USB connection (Chrome/Edge on desktop)
npm install @openloop/sdk-core @openloop/transport-webhid

# Bluetooth connection (Chrome/Edge + Android)
npm install @openloop/sdk-core @openloop/transport-webble

# All browsers (via Openloop Connect)
npm install @openloop/sdk-core @openloop/transport-local

# iOS Safari
npm install @openloop/sdk-core @openloop/transport-safari

# Node.js / Electron
npm install @openloop/sdk-core @openloop/transport-usb
```

The Basic Flow

The same four steps apply to every connection method.

```
1. Connect transport  →  2. Create app  →  3. Operate  →  4. Disconnect
```

```ts
import { EthereumApp, DEFAULT_ETH_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

// 1. Connect the transport (must be called inside a user gesture)
const transport = await WebHidTransport.connect()

// 2. Create the app
const eth = new EthereumApp(transport)

// 3. Operate
const { address } = await eth.getAddress(DEFAULT_ETH_PATH)
console.log('Address:', address)

// 4. Disconnect
await transport.close()
```

> **Note**: Browser security rules require `WebHidTransport.connect()` and `WebBleTransport.connect()` to be called inside a user gesture, such as a button click.

Complete Ethereum Example

```
import {
  EthereumApp,
  DEFAULT_ETH_PATH,
  type SignatureResult,
} from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

async function main() {
  // Connect
  const transport = await WebHidTransport.connect()
  const eth = new EthereumApp(transport)

  try {
    // Get the address
    const { address, publicKey } = await eth.getAddress(DEFAULT_ETH_PATH)
    console.log('Address:', address)
    console.log('Public Key:', publicKey)

    // Sign a message (EIP-191 personal_sign)
    const msgSig: SignatureResult = await eth.signPersonalMessage(
      DEFAULT_ETH_PATH,
      'Hello, Openloop!',
      1 // chainId: Ethereum Mainnet
    )
    console.log('Message Signature:', { v: msgSig.v, r: msgSig.r, s: msgSig.s })

    // Sign a transaction (pass the RLP-encoded raw tx)
    const rawTx = 'f86c...' // RLP-encoded transaction hex
    const txSig: SignatureResult = await eth.signTransaction(DEFAULT_ETH_PATH, rawTx)
    console.log('TX Signature:', { v: txSig.v, r: txSig.r, s: txSig.s })

    // Sign EIP-712 typed data
    const typedSig: SignatureResult = await eth.signTypedData(
      DEFAULT_ETH_PATH,
      'aabbccdd...', // domainSeparatorHash (32 bytes hex)
      '11223344...', // messageHash (32 bytes hex)
      1
    )
    console.log('TypedData Signature:', typedSig)
  } finally {
    await transport.close()
  }
}
```

Complete Bitcoin Example

```
import {
  BitcoinApp,
  BTC_MAINNET_PATH,
  type BtcMessageSignature,
} from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

async function main() {
  const transport = await WebHidTransport.connect()
  const btc = new BitcoinApp(transport)

  try {
    // Get the address (SegWit bech32)
    const { address, publicKey, chainCode } = await btc.getAddress(false) // mainnet
    console.log('Address:', address)  // bc1q...

    // Sign a message (BIP-137)
    const msgSig: BtcMessageSignature = await btc.signMessage(
      'Hello, Bitcoin!',
      BTC_MAINNET_PATH
    )
    console.log('Signature (base64):', msgSig.signature)

    // Sign a PSBT
    const psbtHex = '70736274ff...' // PSBT binary as hex
    const signedPsbtHex = await btc.signPsbtHex(psbtHex)
    console.log('Signed PSBT:', signedPsbtHex)

    // Sign a PSBT with explicit input paths
    const signedWithPaths = await btc.signPsbtWithPaths(psbtHex, [
      { index: 0, path: "84'/0'/0'/0/0" },
      { index: 1, path: "84'/0'/0'/0/1" },
    ])
    console.log('Signed PSBT with paths:', signedWithPaths)
  } finally {
    await transport.close()
  }
}
```

Connecting over Bluetooth

Just swap WebHID for WebBLE — the rest of the code is identical.

```
import { WebBleTransport } from '@openloop/transport-webble'

// Connect over Bluetooth (must be called inside a user gesture)
const transport = await WebBleTransport.connect()

// Everything from here on is the same as WebHID
const eth = new EthereumApp(transport)
const { address } = await eth.getAddress(DEFAULT_ETH_PATH)
```

Connecting over LocalWS (all browsers)

Connect through the Openloop Connect desktop app. This works even in Firefox and Safari.

```
import { LocalWsTransport } from '@openloop/transport-local'

// Check whether the Connect app is running
const available = await LocalWsTransport.isAvailable()
if (!available) {
  console.log('Please start Openloop Connect')
}

// Connect
const transport = new LocalWsTransport()
await transport.open()

// Everything from here on is the same
const eth = new EthereumApp(transport)
```

Using the SDK with React

```tsx
import { useState, useCallback } from 'react'
import { EthereumApp, DEFAULT_ETH_PATH, type ITransport } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

function WalletButton() {
  const [address, setAddress] = useState<string>('')
  const [transport, setTransport] = useState<ITransport | null>(null)

  const connect = useCallback(async () => {
    const t = await WebHidTransport.connect()
    setTransport(t)
    const eth = new EthereumApp(t)
    const { address } = await eth.getAddress(DEFAULT_ETH_PATH)
    setAddress(address)
  }, [])

  const disconnect = useCallback(async () => {
    await transport?.close()
    setTransport(null)
    setAddress('')
  }, [transport])

  return (
    <div>
      {address ? (
        <>
          <p>{address}</p>
          <button onClick={disconnect}>Disconnect</button>
        </>
      ) : (
        <button onClick={connect}>Connect Wallet</button>
      )}
    </div>
  )
}
```

The sample app's `useOpenloop` hook (`packages/sample-app/src/hooks/useOpenloop.ts`) is a worked example that covers switching between all transports, WalletConnect integration, and automatic reconnection.

Automatic Reconnection

WebHID and WebBLE support reconnecting automatically to a device the user has previously authorized.

```
// Reconnect automatically to a previously authorized device (no user gesture needed)
const transport = await WebHidTransport.reconnect()
if (transport) {
  // Reconnected successfully
  const eth = new EthereumApp(transport)
} else {
  // Device not found → pairing via connect() is required
}
```

Next Steps

- Transport Guide — choose the connection method that fits your environment
- Ethereum API — ethers.js / viem integration
- Bitcoin API — the PSBT protocol in detail
- Error Handling — error-handling patterns

Transport Guide

The Openloop SDK supports several connection methods (transports). Pick the transport that matches your target platform and use case — dApp or native app.

Package Structure by SDK Language

The Openloop SDK ships as a **set of TypeScript packages (npm)**. Swift / Kotlin / C# libraries for native apps are planned.

Language / format	Registry	Purpose
TypeScript / npm	npmjs.com (`@openloop/*`)	Web dApps, Node.js / Electron, React Native (including Connect Mobile)
Swift / SPM	(planned)	Native iOS apps
Kotlin / Maven	(planned)	Native Android
C# / NuGet	(planned)	Native Windows

Platform Support Matrix

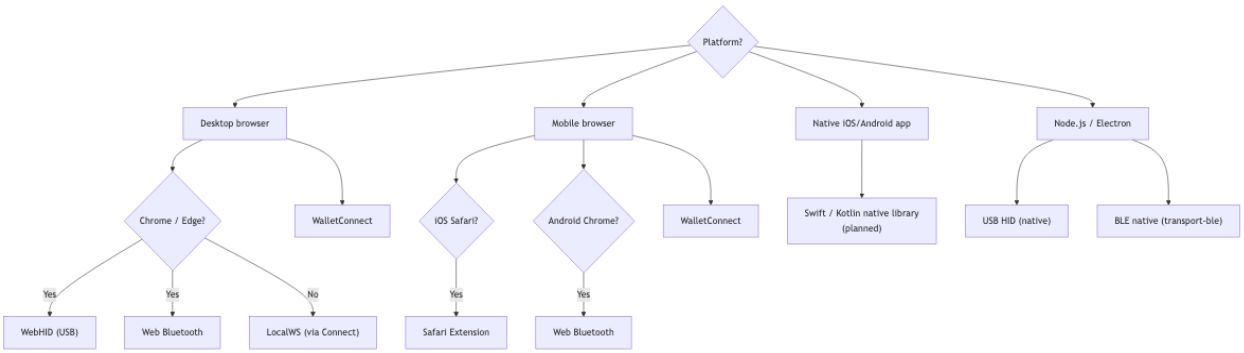
Transport	Chrome/Edge	Firefox	Safari (Desktop)	iOS Safari	Android Chrome	iOS Native	Android Native	Node.js / Electron
WebHID (USB)	✓	✗	✗	✗	✗	✗	✗	✗
Web Bluetooth	✓	✗	✗	✗	✓	✗	✗	✗
LocalWS	✓	✓	✓	✗	✓	✗	✗	✗
Safari Extension	✗	✗	✗	✓	✗	✗	✗	✗
USB HID (native)	✗	✗	✗	✗	✗	✗	✗	✓
BLE (native)	✗	✗	✗	✗	✗	✗	✗	✓
Native lib (Swift / Kotlin — planned)	✗	✗	✗	✗	✗	Planned	Planned	✗
WalletConnect	✓	✓	✓	✓	✓	△	△	✗

WalletConnect does not talk to the device directly — it is remote signing through the Openloop Connect app. Device operations such as address retrieval happen on the Connect side.

BLE (native): a noble-based BLE transport (`@openloop/transport-ble`) for Node.js / Electron. It is the BLE counterpart of USB HID (native), talking to the device directly without going through a browser.

> **Native lib (planned)**: Swift / Kotlin libraries that connect directly from native iOS / Android apps are planned. Until then, use iOS Safari (Safari Extension) or Android Chrome (Web Bluetooth) on mobile.

Selection Flowchart



Transport Details

WebHID (USB)

Package: `@openloop/transport-webhid` **Supported environments**: Chrome 89+ / Edge 89+ (desktop only)

Connects the device directly over a USB cable. This is the fastest and most stable connection method.

Static Methods

Method	Description
`isSupported(): boolean`	Whether the WebHID API is available
`connect(): Promise<WebHidTransport>`	Shows the device picker and connects (requires a user gesture)
`reconnect(): Promise<WebHidTransport | null>`	Reconnects automatically to a previously authorized device

Code Example

```
import { WebHidTransport } from '@openloop/transport-webhid'

// Check support
if (!WebHidTransport.isSupported()) {
  console.log('WebHID is not supported in this browser')
}

// First connection (inside a button click)
const transport = await WebHidTransport.connect()

// Automatic reconnection (on page load)
const transport = await WebHidTransport.reconnect()

// Detect disconnection
transport.onDisconnect(() => {
  console.log('Device disconnected')
})
```

Web Bluetooth

Package: `@openloop/transport-webble` **Supported environments**: Chrome 56+ / Edge 79+ (desktop), Android Chrome

Connects wirelessly over Bluetooth Low Energy (BLE).

Static Methods

Method	Description
`isSupported(): boolean`	Whether the Web Bluetooth API is available
`connect(): Promise<WebBleTransport>`	Shows the device picker and connects (requires a user gesture)
`reconnect(): Promise<WebBleTransport | null>`	Reconnects to a previously paired device (Chrome 100+)

Code Example

```
import { WebBleTransport } from '@openloop/transport-webble'

if (!WebBleTransport.isSupported()) {
  console.log('Web Bluetooth is not supported')
}

// First connection
const transport = await WebBleTransport.connect()

// Automatic reconnection
const transport = await WebBleTransport.reconnect()
```

Notes

- BLE may disconnect on its own while idle. The transport attempts an automatic reconnection on the next `exchange()` call.
- The MTU (Maximum Transmission Unit) is negotiated with the device, and the frame size is adjusted automatically.
- Default MTU: 155 bytes

LocalWS (All Browsers)

Package: `@openloop/transport-local` **Supported environments**: every browser that supports WebSocket **Prerequisite**: the Openloop Connect desktop app must be running

Communication goes through the WebSocket server (`ws://127.0.0.1:21320`) provided by the Openloop Connect desktop app. It works even in browsers without WebHID/WebBLE support, such as Firefox and Safari.

Static Methods

Method	Description
`isAvailable(port?, host?): Promise<boolean>`	Whether the Connect server is running

Code Example

```
import { LocalWsTransport } from '@openloop/transport-local'

// Check whether the Connect app is running
const available = await LocalWsTransport.isAvailable()

// Connect
const transport = new LocalWsTransport({
  port: 21320,    // default
  host: '127.0.0.1', // default
})
await transport.open()

// Notification when the device connection state changes
transport.onDeviceChange((connected: boolean) => {
  console.log('Device:', connected ? 'connected' : 'disconnected')
})
```

Protocol

JSON-RPC 2.0 over WebSocket:

Method	Description
`openloop_exchange`	Sends and receives APDU commands
`openloop_lock`	Acquires an exclusive lock on the device
`openloop_unlock`	Releases the exclusive lock on the device
`openloop_status`	Retrieves the device connection state

Safari Extension (iOS)

Package: `@openloop/transport-safari` **Supported environments**: iOS Safari (with the Openloop Safari Extension installed)

Reaches iOS CoreBluetooth through a Safari Web Extension and talks to the device over BLE.

Static Methods

Method	Description
`isAvailable(timeout?): Promise<boolean>`	Whether the Safari Extension is installed (3-second timeout by default)
`scan(duration?): Promise<DeviceInfo[]>`	Scans for BLE devices
`connect(deviceId?): Promise<SafariTransport>`	Connects to a device

Code Example

```
import { SafariTransport } from '@openloop/transport-safari'

// Check for the extension
const available = await SafariTransport.isAvailable()

// Scan for devices
const devices = await SafariTransport.scan(5000) // scan for 5 seconds
console.log('Found devices:', devices)

// Connect
const transport = await SafariTransport.connect(devices[0]?.deviceId)
```

USB HID (Native)

Package: `@openloop/transport-usb` **Supported environments**: Node.js / Electron **Dependency**: `node-hid`

Talks to the USB device directly, without a browser. A good fit for server-side code and desktop apps.

Static Methods

Method	Description
`discover(): UsbDeviceInfo[]`	Enumerates the connected Openloop/Ledger devices

Code Example

```
import { UsbHidTransport } from '@openloop/transport-usb'

// Detect devices
const devices = UsbHidTransport.discover()
if (devices.length === 0) {
  console.log('No device found')
}

// Connect
const transport = new UsbHidTransport({ path: devices[0].path })
await transport.open()

// Automatic retry (up to 3 times by default)
const transport = new UsbHidTransport({
  path: devices[0].path,
  maxRetries: 3,
  exchangeTimeout: 120000, // 2 minutes
})
```

BLE (Native)

Package: `@openloop/transport-ble` **Supported environments**: Node.js / Electron
Dependency: `@abandonware/noble`

Uses noble to talk to the device over BLE directly, without going through a browser. It is the BLE counterpart of USB HID (native), and a good fit for server-side code and desktop apps.

Static Methods

Method	Description
`scan(timeout?): Promise<BleDeviceInfo[]>`	Scans for BLE devices (30 seconds by default)

Code Example

```
import { BleTransport } from '@openloop/transport-ble'

// Scan for devices
const devices = await BleTransport.scan()

// Connect
const transport = new BleTransport({ deviceId: devices[0].id })
await transport.open()

// Detect disconnection
transport.onDisconnect(() => {
  console.log('Device disconnected')
})
```

Notes

- Node.js / Electron only — it does not work in a browser or in React Native
- The MTU is negotiated with the device (155 bytes by default)

WalletConnect

Package: `@openloop/sdk-core` (WcTransport is bundled with sdk-core) **Supported environments**: every browser that supports WebSocket

Communicates with a remote Openloop Connect app through the WalletConnect v2 relay. APDU commands are relayed using the custom method `openloop_exchange`.

See WalletConnect Integration for details.

Auto-Detection with the OpenloopSDK Class

The `OpenloopSDK` class auto-detects the available transports and connects for you.

```ts
import { OpenloopSDK, EthereumApp, DEFAULT_ETH_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'
import { WebBleTransport } from '@openloop/transport-webble'
import { LocalWsTransport } from '@openloop/transport-local'

// Register the transports
OpenloopSDK.registerTransport('webhid', {
  factory: () => WebHidTransport.connect(),
  name: 'WebHID (USB)',
  isAvailable: () => WebHidTransport.isSupported(),
})

OpenloopSDK.registerTransport('webble', {
  factory: () => WebBleTransport.connect(),
  name: 'Web Bluetooth',
  isAvailable: () => WebBleTransport.isSupported(),
})

OpenloopSDK.registerTransport('local', {
  factory: async () => {
    const t = new LocalWsTransport()
    await t.open()
    return t
  },
  name: 'LocalWS (Connect)',
  isAvailable: () => LocalWsTransport.isAvailable(),
})

// Check which transports are available
const transports = await OpenloopSDK.discover()
console.log(transports)
// [
//   { type: 'webhid', name: 'WebHID (USB)', available: true },
//   { type: 'webble', name: 'Web Bluetooth', available: true },
//   { type: 'local', name: 'LocalWS (Connect)', available: false },
// ]

// Connect using a specific transport
const transport = await OpenloopSDK.connect({ transport: 'webhid' })

// Or connect using the first available transport
const transport = await OpenloopSDK.connect()
```

Reconnection Patterns

```ts
// Reconnect automatically to the previous device on page load
async function autoReconnect(): Promise<ITransport | null> {
  // WebHID: look for a previously authorized device
  if (WebHidTransport.isSupported()) {
    const transport = await WebHidTransport.reconnect()
    if (transport) return transport
  }

  // WebBLE: look for a previously paired device (Chrome 100+)
  if (WebBleTransport.isSupported()) {
    const transport = await WebBleTransport.reconnect()
    if (transport) return transport
  }

  // LocalWS: connect if the Connect app is running
  if (await LocalWsTransport.isAvailable()) {
    const transport = new LocalWsTransport()
    await transport.open()
    return transport
  }

  return null
}
```

Next Steps

- Ethereum API — every method on EthereumApp
- Bitcoin API — the PSBT protocol in detail
- WalletConnect Integration — WcTransport / AppKit

Bitcoin API

The `BitcoinApp` class provides Bitcoin address retrieval, message signing (BIP-137), and PSBT (Partially Signed Bitcoin Transaction) signing.

Import

```
import {
  BitcoinApp,
  BTC_MAINNET_PATH,
  BTC_TESTNET_PATH,
  type BtcMessageSignature,
  type InputSigningPath,
} from '@openloop/sdk-core'
```

Initialization

```
const btc = new BitcoinApp(transport)
```

Methods

Method	Description
`getAddress(testnet?)`	Retrieves a SegWit address (switches between mainnet and testnet automatically)
`getAddressWithPath(path)`	Retrieves an address at an arbitrary BIP32 path
`getAccountXpub(coinType)`	Retrieves the account-level extended public key
`getMasterFingerprint()`	Retrieves the master key fingerprint (4 bytes hex)
`signMessage(message, path)`	BIP-137 message signing
`signPsbt(psbt)`	PSBT signing (binary in and out)
`signPsbtHex(psbt)`	PSBT signing (hex in and out)
`signPsbtWithPaths(psbt, inputPaths)`	PSBT signing with explicit input paths

getAddress

Retrieves a SegWit (bech32) address.

```
async getAddress(testnet?: boolean): Promise<{
  publicKey: string   // uncompressed public key (hex)
  address: string     // bech32 address ("bc1..." or "tb1...")
  chainCode: string   // chain code (hex, 32 bytes)
}>
```

Parameters

Name	Type	Default	Description
`testnet`	`boolean`	`false`	`true`: testnet path (`84'/1'/0'/0/0`)

Default Paths

Network	Path	Constant
Mainnet	`84'/0'/0'/0/0`	`BTC_MAINNET_PATH`
Testnet	`84'/1'/0'/0/0`	`BTC_TESTNET_PATH`

Example

```
// Mainnet
const { address } = await btc.getAddress()
// address: "bc1q..."

// Testnet
const { address } = await btc.getAddress(true)
// address: "tb1q..."
```

---

getAddressWithPath

Retrieves an address at an arbitrary BIP32 path. Use it for multi-account setups and for change addresses.

```
async getAddressWithPath(path: string): Promise<{
  publicKey: string
  address: string
  chainCode: string
}>
```

Example

```
// First address of the second account
const { address } = await btc.getAddressWithPath("84'/0'/1'/0/0")

// Change address
const { address } = await btc.getAddressWithPath("84'/0'/0'/1/0")

// The "m/" prefix is also accepted
const { address } = await btc.getAddressWithPath("m/84'/0'/0'/0/5")
```

---

getAccountXpub

Retrieves the account-level extended public key (`m/84'/coin'/0'`). Derive child keys from it in software to check balances and generate addresses.

```
async getAccountXpub(coinType: number): Promise<{
  publicKey: string   // compressed public key (hex, 33 bytes)
  chainCode: string   // chain code (hex, 32 bytes)
}>
```

Parameters

Name	Type	Description
`coinType`	`number`	`0` : mainnet, `1` : testnet

Example

```
const { publicKey, chainCode } = await btc.getAccountXpub(0)  // mainnet
```

---

getMasterFingerprint

Retrieves the wallet's **BIP32 master key fingerprint** — `hash160(master public key)[:4]`. It is identical to the value the device computes internally, and it is the value to place in a PSBT input's BIP32 derivation (`master_fingerprint`).

```
async getMasterFingerprint(): Promise<string>  // 8 lowercase hex characters (big-endian), e.g.
```

When to Use It

In a normal wallet integration you fetch this value once, at account import time, and embed it in the input derivations of every PSBT you build afterwards. It matters most on the **AirGap / watch-only (QR PSBT)** path: the device decides an input is its own by matching this fingerprint, so a PSBT input without the correct `master_fingerprint` is treated as belonging to another wallet and cannot be signed — there is no input-path injection there like `signPsbtWithPaths` over USB.

> Internally it fetches the public key at depth 0 (master `m`) and returns the first 4 bytes of its `hash160` . This is the same processing Sparrow / HWI perform.

Example

```
const fp = await btc.getMasterFingerprint()  // e.g. "631698e0"

// Embed it in the PSBT input's BIP32 derivation (type 0x06):
//   value = fingerprint(4B) ‖ path(4B LE × N)
```

---

signMessage

Signs a message in BIP-137 format.

```
async signMessage(
  message: string,
  path: string
): Promise<BtcMessageSignature>
```

Parameters

Name	Type	Description
`message`	`string`	UTF-8 message
`path`	`string`	BIP32 path (e.g. `"84'/0'/0'/0/0"`)

Returns: `BtcMessageSignature`

Field	Type	Description
`v`	`number`	Recovery ID (35-38: P2WPKH native SegWit)
`r`	`string`	R value (32 bytes hex)
`s`	`string`	S value (32 bytes hex)
`signature`	`string`	Base64 of the full signature (65 bytes: V || R || S)

Example

```
const sig = await btc.signMessage('Hello, Bitcoin!', BTC_MAINNET_PATH)
console.log(sig.signature) // Base64 encoded signature
```

---

signPsbt

Signs a PSBT (Partially Signed Bitcoin Transaction). The paths are detected automatically from the `BIP32_DERIVATION` fields inside the PSBT.

```
async signPsbt(psbt: Uint8Array | string): Promise<Uint8Array>
```

Parameters

Name	Type	Description
`psbt`	`Uint8Array | string`	PSBT binary data or hex string

Returns

The signed PSBT as binary data (`Uint8Array`)

---

signPsbtHex

PSBT signing with hex strings — both input and output are hex strings.

```
async signPsbtHex(psbt: string): Promise<string>
```

Example

```
const signedHex = await btc.signPsbtHex('70736274ff...')
```

---

signPsbtWithPaths

Signs a PSBT with the BIP32 path of each input given explicitly. Use it when the PSBT has no `BIP32_DERIVATION` fields, or when you want to sign only specific inputs.

```
async signPsbtWithPaths(
  psbt: string,
  inputPaths: InputSigningPath[]
): Promise<string>
```

Parameters

Name	Type	Description
`psbt`	`string`	PSBT hex string
`inputPaths`	`InputSigningPath[]`	The path for each input

`InputSigningPath`

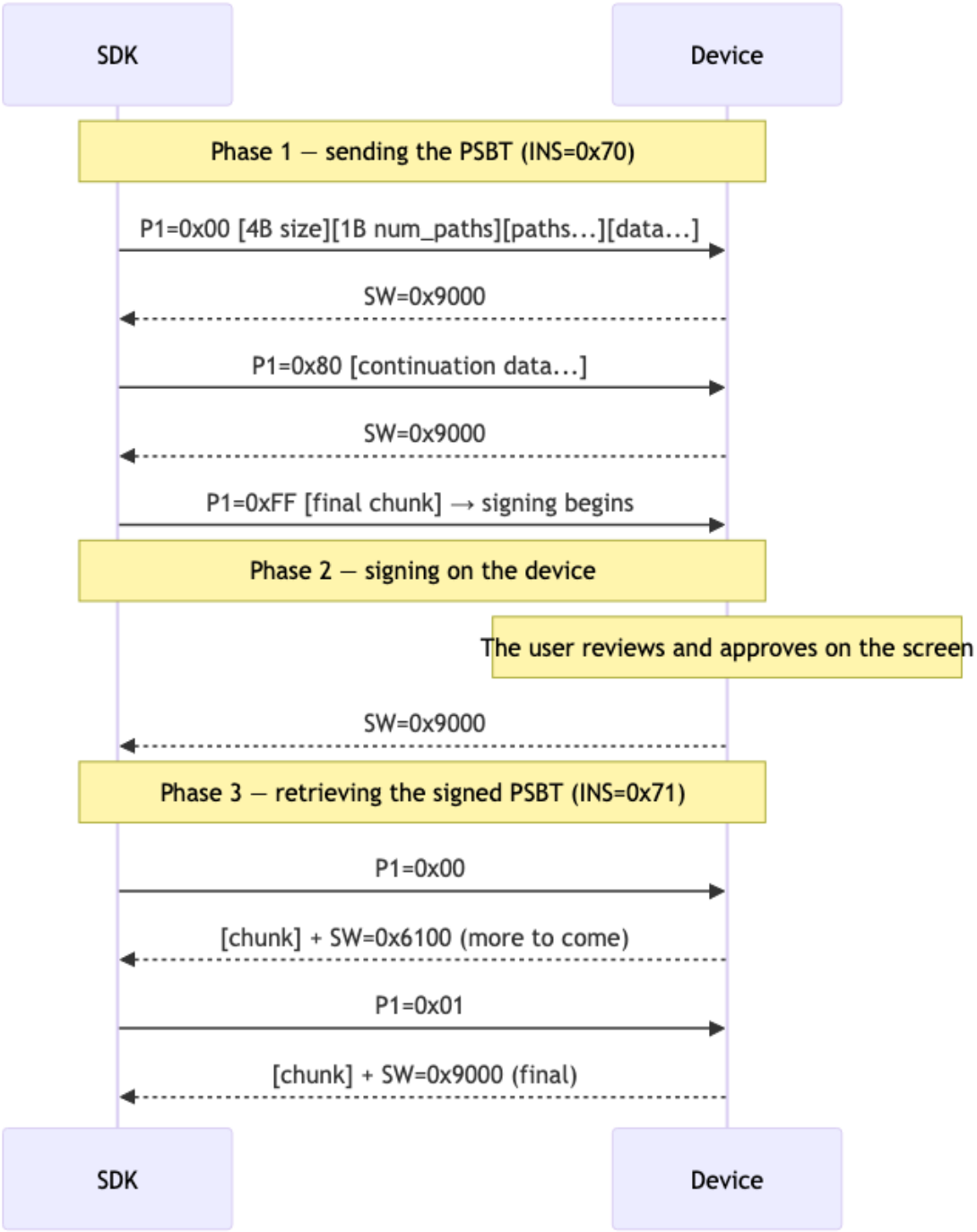
Field	Type	Description
`index`	`number`	Input index in the PSBT
`path`	`string`	BIP32 path (e.g. `"84'/0'/0'/0/5"`)

Example

```
const signedHex = await btc.signPsbtWithPaths('70736274ff...', [
  { index: 0, path: "84'/0'/0'/0/0" },
  { index: 1, path: "84'/0'/0'/0/3" },
  { index: 2, path: "84'/0'/0'/1/0" }, // change
])
```

PSBT Protocol Details

PSBT signing is a three-phase exchange with the device.


SDK
Device
Phase 1 — sending the PSBT (INS=0x70)
P1=0x00 [4B size][1B num_paths][paths...][data...]
SW=0x9000
P1=0x80 [continuation data...]
SW=0x9000
P1=0xFF [final chunk] → signing begins
Phase 2 — signing on the device
The user reviews and approves on the screen
SW=0x9000
Phase 3 — retrieving the signed PSBT (INS=0x71)
P1=0x00
[chunk] + SW=0x6100 (more to come)
P1=0x01
[chunk] + SW=0x9000 (final)
SDK
Device

Phase 1: Sending the PSBT

Chunk	P1	Data format
First	`0x00`	`[4B total_size][1B num_paths][paths...][psbt_data...]`
Continuation	`0x80`	`[psbt_data...]`
Final	`0xFF`	`[remaining_data]` → the device starts signing

- `num_paths=0`: detected automatically from `BIP32_DERIVATION` inside the PSBT
- `num_paths>0`: the path for each input is given explicitly (`[1B input_index][1B path_len][4B * path_len elements]`)

Phase 2: Signing on the Device

The user reviews the transaction details on the device screen and presses the approve button.

Phase 3: Retrieving the Signed PSBT

Response	Status word	Meaning
`[signed_psbt_chunk]`	`0x61XX`	More data follows — request the next chunk
`[signed_psbt_chunk]`	`0x9000`	Final chunk — retrieval complete

Increment the chunk index from 0 and repeat until `0x9000` comes back.

bitcoinjs-lib Integration

```
import * as bitcoin from 'bitcoinjs-lib'
import { BitcoinApp, BTC_MAINNET_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const btc = new BitcoinApp(transport)

// Get the address
const { address, publicKey } = await btc.getAddress()

// Build the PSBT
const psbt = new bitcoin.Psbt({ network: bitcoin.networks.bitcoin })
psbt.addInput({
  hash: 'txid...',
  index: 0,
  witnessUtxo: {
    script: Buffer.from('0014...', 'hex'),
    value: 50000,
  },
})
psbt.addOutput({
  address: 'bc1q...',
  value: 40000,
})

// Sign the PSBT on the device
const psbtHex = psbt.toHex()
const signedHex = await btc.signPsbtWithPaths(psbtHex, [
  { index: 0, path: BTC_MAINNET_PATH },
])

// Load the signed PSBT
const signedPsbt = bitcoin.Psbt.fromHex(signedHex)
signedPsbt.finalizeAllInputs()

// Raw transaction ready to broadcast
const rawTx = signedPsbt.extractTransaction().toHex()
```

Next Steps

- Solana API
- Error Handling — handling user rejection

Ethereum API

The `EthereumApp` class provides Ethereum address retrieval, message signing, transaction signing, EIP-712 typed data signing, and EIP-7702 authorization signing.

Import

```
import {
  EthereumApp,
  DEFAULT_ETH_PATH,
  type SignatureResult,
} from '@openloop/sdk-core'
```

Initialization

```
const eth = new EthereumApp(transport)
```

`transport` is any transport instance that implements the `ITransport` interface.

Methods

Method	Description
`getAddress(path)`	Retrieves the address and public key
`signPersonalMessage(path, message, chainId?)`	EIP-191 personal_sign
`signTransaction(path, rawTx)`	Signs an RLP-encoded transaction
`signTypedData(path, domainHash, msgHash, chainId?)`	Signs EIP-712 typed data
`signAuthorization(path, authorizationRlp)`	Signs an EIP-7702 authorization

getAddress

Retrieves the Ethereum address and public key from the device.

```
async getAddress(path: string): Promise<{
  publicKey: string  // uncompressed public key (hex, 65 bytes)
  address: string    // checksummed address ("0x...")
}>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path (e.g. `"44'/60'/0'/0/0"`)

Example

```
import { DEFAULT_ETH_PATH } from '@openloop/sdk-core'

const { address, publicKey } = await eth.getAddress(DEFAULT_ETH_PATH)
// address: "0x742d35Cc6634C0532925a3b844Bc9e7595f2bD18"
// publicKey: "04a1b2c3d4..."
```

Default Path

`DEFAULT_ETH_PATH = "44'/60'/0'/0/0"`

---

signPersonalMessage

Signs a message with EIP-191 personal_sign. It uses the Openloop-specific extended protocol that is aware of the chain ID.

```
async signPersonalMessage(
  path: string,
  message: string,
  chainId?: number
): Promise<SignatureResult>
```

Parameters

Name	Type	Default	Description
`path`	`string`	—	BIP44 path
`message`	`string`	—	The message — a UTF-8 string or `0x`-prefixed hex
`chainId`	`number`	`1`	EVM chain ID

Returns: `SignatureResult`

Field	Type	Description
`v`	`number`	Recovery ID (27 or 28)
`r`	`string`	R value (32 bytes hex, no `0x`)
`s`	`string`	S value (32 bytes hex, no `0x`)

Example

```
const sig = await eth.signPersonalMessage(
  DEFAULT_ETH_PATH,
  'Hello, Openloop!',
  1
)
// sig.v = 27
// sig.r = "a1b2c3..."
// sig.s = "d4e5f6..."
```

> **Note**: Long messages are split into chunks automatically before they are sent to the device — 150 bytes for the first chunk, then 255 bytes each.

---

signTransaction

Signs an RLP-encoded Ethereum transaction.

```
async signTransaction(
  path: string,
  rawTx: string
): Promise<SignatureResult>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`rawTx`	`string`	RLP-encoded transaction (hex, with or without the `0x` prefix)

Example

```
const sig = await eth.signTransaction(
  DEFAULT_ETH_PATH,
  'f86c0a8502540be400825208...'
)
```

---

signTypedData

Signs EIP-712 typed data. Pass the pre-hashed domainSeparator and message.

```
async signTypedData(
  path: string,
  domainSeparatorHash: string,
  messageHash: string,
  chainId?: number
): Promise<SignatureResult>
```

Parameters

Name	Type	Default	Description
`path`	`string`	—	BIP44 path
`domainSeparatorHash`	`string`	—	EIP-712 domain separator hash (32 bytes hex)
`messageHash`	`string`	—	EIP-712 message hash (32 bytes hex)
`chainId`	`number`	`1`	EVM chain ID

Example

```
const sig = await eth.signTypedData(
  DEFAULT_ETH_PATH,
  'aabbccddee...', // domainSeparatorHash
  '1122334455...', // messageHash
  1
)
```

---

signAuthorization

Signs an EIP-7702 authorization — Set Code for an EOA.

```
async signAuthorization(
  path: string,
  authorizationRlp: string
): Promise<SignatureResult>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`authorizationRlp`	`string`	Hex of `RLP([chain_id, address, nonce])`

Example

```
const sig = await eth.signAuthorization(
  DEFAULT_ETH_PATH,
  'c3010a...' // RLP([1, "0x...", 0])
)
```

ethers.js Integration

```
import { ethers } from 'ethers'
import { EthereumApp, DEFAULT_ETH_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const eth = new EthereumApp(transport)

// Get the address
const { address } = await eth.getAddress(DEFAULT_ETH_PATH)

// Provider (connection to an Ethereum node)
const provider = new ethers.JsonRpcProvider('https://eth.llamarpc.com')

// Build the transaction
const tx = {
  to: '0xd8dA6BF26964aF9D7eEd9e03E53415D37aA96045',
  value: ethers.parseEther('0.01'),
  gasLimit: 21000n,
  gasPrice: (await provider.getFeeData()).gasPrice,
  nonce: await provider.getTransactionCount(address),
  chainId: 1n,
}

// RLP-encode and sign
const unsignedTx = ethers.Transaction.from(tx).unsignedSerialized
const sig = await eth.signTransaction(DEFAULT_ETH_PATH, unsignedTx)

// Assemble the signed transaction
const signedTx = ethers.Transaction.from({
  ...tx,
  signature: {
    v: sig.v,
    r: '0x' + sig.r,
    s: '0x' + sig.s,
  },
})

// Broadcast
const txResponse = await provider.broadcastTransaction(signedTx.serialized)
```

viem Integration

```
import { createPublicClient, http, parseEther } from 'viem'
import { mainnet } from 'viem/chains'
import { EthereumApp, DEFAULT_ETH_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const eth = new EthereumApp(transport)

const { address } = await eth.getAddress(DEFAULT_ETH_PATH)

// personal_sign
const sig = await eth.signPersonalMessage(
  DEFAULT_ETH_PATH,
  'Hello from viem!',
  1
)

// Convert to viem's signature format
const signature = `0x${sig.r}${sig.s}${sig.v.toString(16)}` as `0x${string}`
```

Next Steps

- Bitcoin API — PSBT signing
- Error Handling — handling user rejection and similar cases

XRP API

The `XrpApp` class provides XRP Ledger address retrieval and transaction signing. It supports both the Ed25519 (default) and secp256k1 elliptic curves.

Key Differences from Ethereum

Aspect	Ethereum	XRP
Address format	`0x...` (hex)	`r...` (Base58Check)
Default curve	secp256k1	Ed25519
Ed25519 public key	—	Carries a `0xED` prefix
Signature format	v/r/s	raw bytes (Ed25519: 64B, secp256k1: DER)
BIP44 path	`44'/60'/...`	`44'/144'/...` (Ed25519: fully hardened)

Import

```
import {
  XrpApp,
  DEFAULT_XRP_PATH,
  type XrpSignatureResult,
  type XrpCurve,
} from '@openloop/sdk-core'
```

Initialization

```
const xrp = new XrpApp(transport)
```

Methods

Method	Description
`getAddress(path, curve?)`	Get the XRP address and the public key
`signTransaction(path, txBlob, curve?)`	Sign a serialized transaction

---

getAddress

Get the XRP Ledger address from the device.

```
async getAddress(
  path: string,
  curve?: XrpCurve
): Promise<{
  publicKey: string  // Public key (hex, Ed25519: 33B with 0xED prefix, secp256k1: 33B compresse
  address: string    // XRP address ("r...")
}>
```

Parameters

Name	Type	Default	Description
`path`	`string`	—	BIP44 path
`curve`	`XrpCurve`	`'ed25519'`	`'ed25519'` or `'secp256k1'`

`XrpCurve` Type

```
type XrpCurve = 'ed25519' | 'secp256k1'
```

Default Path

`DEFAULT_XRP_PATH = "44'/144'/0'/0'/0'"` (Ed25519: every element hardened)

Example

```
// Ed25519 (the default)
const { address, publicKey } = await xrp.getAddress(DEFAULT_XRP_PATH)
// address: "rHb9CJAWyB4rj91VRWn96DkukG4bwdtyTh"
// publicKey: "ed01a2b3c4..." (0xED prefix)

// secp256k1
const { address, publicKey } = await xrp.getAddress(
  "44'/144'/0'/0/0",  // secp256k1 also accepts a non-hardened path
  'secp256k1'
)
```

Curve Selection and P2 Values

Curve	P2 value	Description
`'ed25519'`	`0x80`	Ed25519 (default, recommended)
`'secp256k1'`	`0x40`	secp256k1 (Ethereum-compatible)

---

signTransaction

Sign a serialized XRP transaction.

```
async signTransaction(
  path: string,
  txBlob: string,
  curve?: XrpCurve
): Promise<XrpSignatureResult>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`txBlob`	`string`	Serialized transaction (hex, with or without `0x`)
`curve`	`XrpCurve`	Curve (defaults to `'ed25519'`). Following the Ledger-compatible specification, it is sent in P2 as a curveMask (secp256k1=0x40 / ed25519=0x80). Match the curve you used with `getAddress`

Returns: `XrpSignatureResult`

Field	Type	Description
`signature`	`string`	Signature as hex (Ed25519: 64 bytes, secp256k1: variable-length DER encoding)

Example

```
// Ed25519 (the default when omitted)
const { signature } = await xrp.signTransaction(
  DEFAULT_XRP_PATH,
  '120000228...' // serialized transaction blob
)

// secp256k1 (pass the same value you used with getAddress if you chose 'secp256k1')
const { signature: sig2 } = await xrp.signTransaction(
  DEFAULT_XRP_PATH,
  '120000228...',
  'secp256k1'
)
```

xrpl.js Integration

```
import { Client, Wallet, encode, decode } from 'xrpl'
import { XrpApp, DEFAULT_XRP_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const xrp = new XrpApp(transport)

// Get the address
const { address, publicKey } = await xrp.getAddress(DEFAULT_XRP_PATH)

// Connect to the XRP Ledger
const client = new Client('wss://xrplcluster.com/')
await client.connect()

// Build the transaction
const prepared = await client.autofill({
  TransactionType: 'Payment',
  Account: address,
  Amount: '1000000', // 1 XRP = 1,000,000 drops
  Destination: 'rPT1Sjq2YGrBMTttX4GZHjKu9dyfzbpAYe',
})

// Serialize and sign on the device
const txBlob = encode(prepared)
const { signature } = await xrp.signTransaction(DEFAULT_XRP_PATH, txBlob)

// Add the signature to the transaction
const signedTx = {
  ...prepared,
  TxnSignature: signature.toUpperCase(),
  SigningPubKey: publicKey.toUpperCase(),
}

// Broadcast
const result = await client.submitAndWait(encode(signedTx))
console.log('TX Result:', result.result.meta.TransactionResult)

await client.disconnect()
```

Next Steps

- WalletConnect Integration
- Error Handling

Solana API

The `SolanaApp` class provides Solana address retrieval, transaction signing, and off-chain message signing. It uses an APDU protocol compatible with the Ledger Solana app.

Import

```
import {
  SolanaApp,
  DEFAULT_SOL_PATH,
} from '@openloop/sdk-core'
```

Initialization

```
const sol = new SolanaApp(transport)
```

Methods

Method	Description
`getAddress(path)`	Get the Ed25519 public key and the Base58 address
`signTransaction(path, txBytes)`	Sign a transaction
`signOffchainMessage(path, messageBytes)`	Sign an off-chain message

---

getAddress

Get the Solana address — the Base58 encoding of the Ed25519 public key — from the device.

```
async getAddress(path: string): Promise<{
  publicKey: string  // Ed25519 public key (hex, 32 bytes)
  address: string    // Base58 address
}>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path (e.g. `"44'/501'/0'/0'"`)

Default Path

`DEFAULT_SOL_PATH = "44'/501'/0'/0'"`

> **Note**: Solana uses Ed25519, so every element of the path is hardened.

Example

```
const { address, publicKey } = await sol.getAddress(DEFAULT_SOL_PATH)
// address: "7xKXtg2CW87d97TXJSDpbD5jBkheTqA83TZRuJosgAsU"
```

---

signTransaction

Produce an Ed25519 signature over the binary data of a Solana transaction.

```
async signTransaction(
  path: string,
  txBytes: Uint8Array
): Promise<string>  // 64-byte Ed25519 signature (hex)
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`txBytes`	`Uint8Array`	Serialized transaction (raw binary)

Returns

A 64-byte Ed25519 signature as a hex string.

Example

```
const signatureHex = await sol.signTransaction(
  DEFAULT_SOL_PATH,
  transactionBytes
)
```

> **Note**: Large transactions are automatically split and sent using the Ledger P2 chunking protocol.

---

signOffchainMessage

Sign an off-chain message, such as Sign-In With Solana.

```
async signOffchainMessage(
  path: string,
  messageBytes: Uint8Array
): Promise<string>  // 64-byte Ed25519 signature (hex)
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`messageBytes`	`Uint8Array`	Raw bytes of the message

Example

```
const message = new TextEncoder().encode('Hello, Solana!')
const signatureHex = await sol.signOffchainMessage(DEFAULT_SOL_PATH, message)
```

@solana/web3.js Integration

```
import {
  Connection,
  PublicKey,
  SystemProgram,
  Transaction,
} from '@solana/web3.js'
import { SolanaApp, DEFAULT_SOL_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const sol = new SolanaApp(transport)

// Get the address
const { address } = await sol.getAddress(DEFAULT_SOL_PATH)
const publicKey = new PublicKey(address)

// Build the transaction
const connection = new Connection('https://api.mainnet-beta.solana.com')
const recentBlockhash = (await connection.getLatestBlockhash()).blockhash

const tx = new Transaction()
tx.add(
  SystemProgram.transfer({
    fromPubkey: publicKey,
    toPubkey: new PublicKey('...'),
    lamports: 1000000, // 0.001 SOL
  })
)
tx.recentBlockhash = recentBlockhash
tx.feePayer = publicKey

// Sign on the device
const txBytes = tx.serializeMessage()
const signatureHex = await sol.signTransaction(DEFAULT_SOL_PATH, txBytes)

// Add the signature to the transaction
const signatureBytes = Uint8Array.from(
  signatureHex.match(/.{2}/g)!.map(b => parseInt(b, 16))
)
tx.addSignature(publicKey, Buffer.from(signatureBytes))

// Broadcast
const txId = await connection.sendRawTransaction(tx.serialize())
console.log('TX:', txId)
```

Next Steps

- TRON API
- XRP API

TRON API

The `TronApp` class provides TRON address retrieval, transaction signing, and message signing. It uses the same INS codes as Ethereum, but `coin_type=195'` in the BIP44 path puts the firmware into TRON mode.

Key Differences from Ethereum

Aspect	Ethereum	TRON
Address format	`0x...` (hex)	`T...` (Base58Check)
TX hash	Keccak-256	SHA-256
Signature response	V(1) + R(32) + S(32)	R(32) + S(32) + V(1)
V value	27 or 28	0 or 1 (recovery ID)

Import

```
import {
  TronApp,
  DEFAULT_TRON_PATH,
  type SignatureResult,
} from '@openloop/sdk-core'
```

Initialization

```
const tron = new TronApp(transport)
```

Methods

Method	Description
`getAddress(path)`	Get the TRON address (`T...`) and the public key
`signTransaction(path, rawDataHex)`	Sign the raw_data of a transaction
`signMessage(path, message)`	Sign a message

---

getAddress

Get the TRON address — Base58Check format, `T...` — from the device.

```
async getAddress(path: string): Promise<{
  publicKey: string  // Uncompressed public key (hex, 65 bytes)
  address: string    // Base58Check address ("T...")
}>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path (e.g. `"44'/195'/0'/0/0"`)

Default Path

`DEFAULT_TRON_PATH = "44'/195'/0'/0/0"`

Example

```
const { address } = await tron.getAddress(DEFAULT_TRON_PATH)
// address: "TLsV62...txnV1Fm"
```

---

signTransaction

Sign the `raw_data` of a TRON transaction.

```
async signTransaction(
  path: string,
  rawDataHex: string
): Promise<SignatureResult>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`rawDataHex`	`string`	Hex of the protobuf-encoded `raw_data` (with or without `0x`)

Returns: `SignatureResult`

Field	Type	Description
`v`	`number`	Recovery ID (0 or 1)
`r`	`string`	R value (32 bytes hex)
`s`	`string`	S value (32 bytes hex)

Example

```
const sig = await tron.signTransaction(
  DEFAULT_TRON_PATH,
  'a1b2c3d4...' // raw_data hex
)
```

---

signMessage

Sign a TRON message. The firmware reads `coin_type=195'` from the BIP44 path and applies the TRON message format.

```
async signMessage(
  path: string,
  message: string
): Promise<SignatureResult>
```

Parameters

Name	Type	Description
`path`	`string`	BIP44 path
`message`	`string`	UTF-8 message string

Example

```
const sig = await tron.signMessage(DEFAULT_TRON_PATH, 'Hello, TRON!')
```

TronWeb Integration

```
import TronWeb from 'tronweb'
import { TronApp, DEFAULT_TRON_PATH } from '@openloop/sdk-core'
import { WebHidTransport } from '@openloop/transport-webhid'

const transport = await WebHidTransport.connect()
const tron = new TronApp(transport)

// Get the address
const { address } = await tron.getAddress(DEFAULT_TRON_PATH)

// Build the transaction with TronWeb
const tronWeb = new TronWeb({ fullHost: 'https://api.trongrid.io' })

const transaction = await tronWeb.transactionBuilder.sendTrx(
  'TLsV62...', // Recipient
  1000000,     // 1 TRX = 1,000,000 SUN
  address
)

// Convert raw_data to hex and sign on the device
const rawDataHex = Buffer.from(
  JSON.stringify(transaction.raw_data)
).toString('hex')

const sig = await tron.signTransaction(DEFAULT_TRON_PATH, rawDataHex)

// Add the signature to the transaction
const signedTx = {
  ...transaction,
  signature: [`${sig.r}${sig.s}0${sig.v}`],
}

// Broadcast
const result = await tronWeb.trx.sendRawTransaction(signedTx)
```

Next Steps

- XRP API
- Error Handling

WalletConnect Integration

The Openloop SDK supports remote device access over WalletConnect v2 in two ways.

The Two Approaches

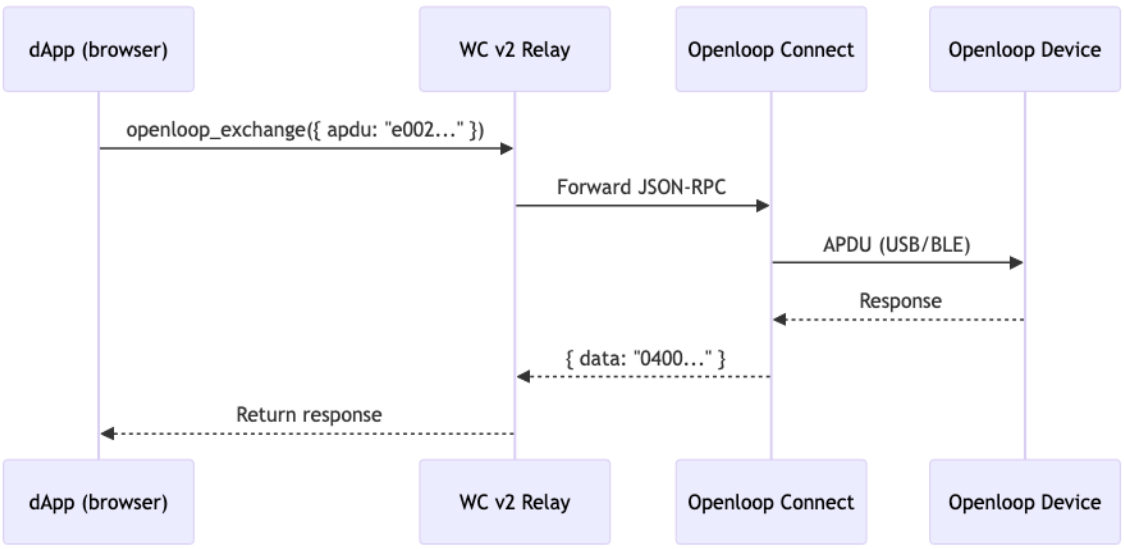
Approach	Level	Description
WcTransport	Low-level	Relays APDU commands through the WalletConnect relay
AppKit	High-level	Standard multi-chain WC connection via Reown AppKit

---

WcTransport (APDU Relay)

`WcTransport` implements `ITransport` and sends APDU commands to a remote Openloop Connect app through the WalletConnect v2 relay.

How It Works



Hex-encoded APDUs are sent and received over the custom JSON-RPC method `openloop_exchange`.

Setup

```
import { WcTransport, EthereumApp, DEFAULT_ETH_PATH } from '@openloop/sdk-core'
import SignClient from '@walletconnect/sign-client'

// Initialize the WalletConnect SignClient
const client = await SignClient.init({
  projectId: 'your-project-id',
})

// Pair and establish a session
const { uri, approval } = await client.connect({
  requiredNamespaces: {
    eip155: {
      methods: ['openloop_exchange', 'openloop_lock', 'openloop_unlock'],
      chains: ['eip155:1'],
      events: [],
    },
  },
})

// Show the URI as a QR code → the user scans it with Openloop Connect
console.log('Pairing URI:', uri)

// Wait for session approval
const session = await approval()

// Create the WcTransport
const transport = new WcTransport({
  client,
  session: { topic: session.topic },
  chainId: 'eip155:1', // optional (default: 'eip155:1')
})

await transport.open()

// The regular App classes work as-is
const eth = new EthereumApp(transport)
const { address } = await eth.getAddress(DEFAULT_ETH_PATH)
```

WcTransport Type Definitions

```
interface WcTransportOptions {
  client: IWcSignClient   // WalletConnect SignClient instance
  session: WcSession       // Active session { topic: string }
  chainId?: string         // Chain ID (default: "eip155:1")
}

interface IWcSignClient {
  request<T>(params: {
    topic: string
    chainId: string
    request: { method: string; params: unknown }
  }): Promise<T>
}

interface WcSession {
  topic: string
}
```

Supported Methods

Method	Description
`openloop_exchange`	Send and receive APDU commands
`openloop_lock`	Acquire the exclusive device lock
`openloop_unlock`	Release the exclusive device lock

Key Features

- Signing works even in environments with no direct access to the device
- Implements the `ITransport` interface, so every App class works as-is
- Device locking (`lock` / `unlock`) also works over the relay

AppKit (High-Level WC)

With Reown AppKit you sign using WalletConnect's standard methods — `eth_signTransaction`, `personal_sign`, and so on. This approach never handles APDUs directly; Openloop Connect drives the device internally.

Supported Chains and Methods

EVM (eip155)

Chains: - `eip155:1` — Ethereum Mainnet - `eip155:11155111` — Sepolia Testnet

Methods: | Method | Description | |———|——| | `eth_sendTransaction` | Send a transaction | | `eth_signTransaction` | Sign a transaction | | `eth_sign` | Sign data | | `personal_sign` | Sign an EIP-191 message | | `eth_signTypedData` | Sign EIP-712 typed data | | `eth_signTypedData_v3` | EIP-712 v3 | | `eth_signTypedData_v4` | EIP-712 v4 | | `wallet_getCapabilities` | Get the wallet's capabilities |

Bitcoin (bip122)

Chains: - `bip122:000000000019d6689c085ae165831e93` — Bitcoin Mainnet - `bip122:000000000933ea01ad0ee984209779ba` — Bitcoin Testnet3

Methods: | Method | Description | |———|——| | `signPsbt` | Sign a PSBT | | `getAccountAddresses` | Get the account addresses | | `signMessage` | Sign a message | | `sendTransfer` | Send a transfer |

Solana

Chains: - `solana:5eykt4UsFv8P8NJdTREpY1vzqKqZKvdp` — Mainnet Beta - `solana:EtWTRABZaYq6iMfeYKouRu166VU2xqa1` — Devnet

Methods: | Method | Description | |———|——| | `solana_signTransaction` | Sign a transaction | | `solana_signAllTransactions` | Sign multiple transactions | | `solana_signAndSendTransaction` | Sign and send | | `solana_signMessage` | Sign a message |

TRON

Chains: - `tron:0x2b6653dc` — TRON Mainnet - `tron:0x94a9059e` — TRON Shasta Testnet

Methods: | Method | Description | |———|——| | `tron_signTransaction` | Sign a transaction | | `tron_signMessage` | Sign a message |

AppKit Configuration Example

```
import { createAppKit } from '@reown/appkit/react'
import { WagmiAdapter } from '@reown/appkit-adapter-wagmi'
import { SolanaAdapter } from '@reown/appkit-adapter-solana'
import { BitcoinAdapter } from '@reown/appkit-adapter-bitcoin'
import { TronAdapter } from '@reown/appkit-adapter-tron'
import { mainnet, sepolia } from '@reown/appkit/networks'

const projectId = 'your-walletconnect-project-id'

// Create the adapters
const wagmiAdapter = new WagmiAdapter({ projectId, networks: [mainnet, sepolia] })
const solanaAdapter = new SolanaAdapter()
const bitcoinAdapter = new BitcoinAdapter()
const tronAdapter = new TronAdapter()

// Create the AppKit instance
const modal = createAppKit({
  projectId,
  adapters: [wagmiAdapter, solanaAdapter, bitcoinAdapter, tronAdapter],
  networks: [mainnet, sepolia],
  metadata: {
    name: 'My dApp',
    description: 'My dApp with Openloop',
    url: 'https://my-dapp.com',
    icons: ['https://my-dapp.com/icon.png'],
  },
  customWallets: [
    {
      id: 'openloop-connect',
      name: 'Openloop Connect',
      homepage: 'https://crypto.haudi.jp/openloop/',
      mobile_link: 'openloop://',
      desktop_link: 'openloop://',
      image_url: 'https://crypto.haudi.jp/openloop/images/logo/openloop-icon.png',
    },
  ],
})
```

Choosing Between WcTransport and AppKit

Criterion	WcTransport	AppKit
APDU-level control	✓ Full control	✗ Abstracted away
Ease of adoption	Somewhat involved	Easy
UI components	None (build your own)	Modal included
Multi-chain	Manual switching	Automatic switching
EIP-7702	✓ Supported	✗ Not supported
Supported wallets	Openloop Connect only	Every WC-compatible wallet

Recommendation: - Integrating with the Openloop device is the main goal → **WcTransport** - You want to support multiple wallets → **AppKit**

Limitations

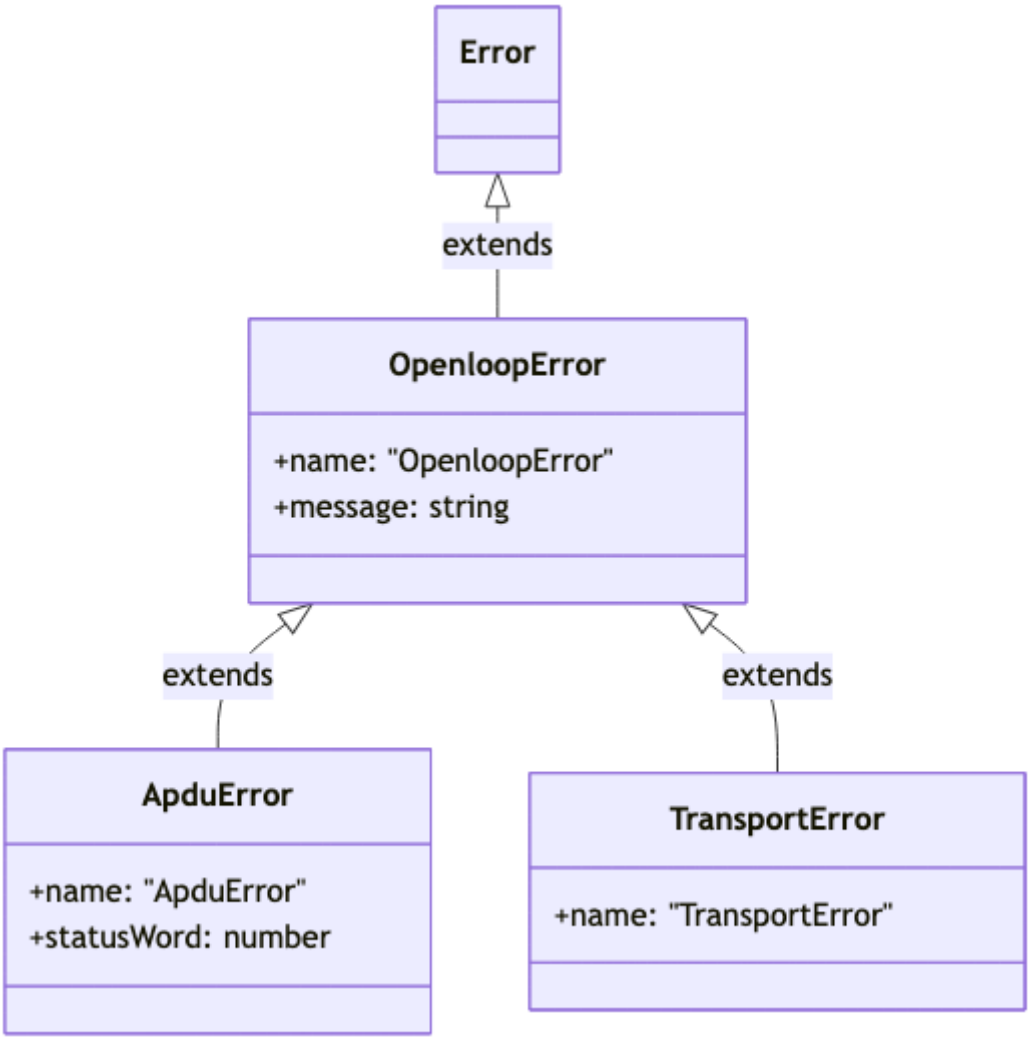
- WalletConnect always goes through a remote Openloop Connect app, so the device must be connected to that app
- EIP-7702 authorization is supported only over WcTransport — AppKit does not support it
- XRP is not currently supported over WalletConnect
- The `exchange` timeout of `WcTransport` depends on the constraints of the WalletConnect relay

Next Steps

- Error Handling
- API Reference

Error Handling Guide

Error Class Hierarchy



Import

```
import { OpenloopError, ApduError, TransportError } from '@openloop/sdk-core'
```

ApduError

Thrown when the device returns an error status word — anything other than `0x9000`.

```
class ApduError extends OpenloopError {
  readonly statusWord: number  // e.g. 0x6985
}
```

APDU Status Word Table

Status word	Constant name	Description	Common cause
`0x9000`	—	Success	—
`0x6985`	User rejected	The user rejected on the device	The user pressed the reject button
`0x6a80`	Invalid data	Invalid data	A malformed BIP44 path or transaction
`0x6a82`	App not found	App not found	The matching app is not open on the device
`0x6d00`	Instruction not supported	Instruction not supported	The device firmware version is too old
`0x6e00`	CLA not supported	CLA not supported	Invalid class byte
`0x6f00`	Internal error	Internal error	An unexpected error inside the device
`0x61XX`	More data	More data available	Intermediate response while fetching a PSBT (not an error)

Example

```
import { ApduError } from '@openloop/sdk-core'

try {
  const sig = await eth.signPersonalMessage(DEFAULT_ETH_PATH, 'Hello')
} catch (err) {
  if (err instanceof ApduError) {
    if (err.statusWord === 0x6985) {
      console.log('The user rejected the signing request on the device')
    } else {
      console.log(`APDU error: 0x${err.statusWord.toString(16)}`)
    }
  }
}
```

TransportError

Thrown when a communication error occurs in the transport layer — USB, BLE, WebSocket, and so on.

```
class TransportError extends OpenloopError {
  // message carries the error details
}
```

Common TransportErrors

Message	Cause	What to do
`WalletConnect transport not connected`	WcTransport is not connected	Call `open()` before using it
`Transport type "..." not registered`	The transport is not registered with OpenloopSDK	Register it with `registerTransport()`
`No available transport found`	No transport is available	Check the registered transports and the environment
`Device disconnected`	The device was disconnected	Try reconnecting
`Exchange timeout`	The APDU response timed out	Check the state of the device — it may be waiting for approval

Error Handling Patterns

The Basic Pattern

```
import { OpenloopError, ApduError, TransportError } from '@openloop/sdk-core'

try {
  const { address } = await eth.getAddress(DEFAULT_ETH_PATH)
} catch (err) {
  if (err instanceof ApduError) {
    // Error response from the device
    switch (err.statusWord) {
      case 0x6985:
        showMessage('Rejected on the device')
        break
      case 0x6a80:
        showMessage('Invalid data')
        break
      default:
        showMessage(`Device error: ${err.message}`)
    }
  } else if (err instanceof TransportError) {
    // Communication error
    showMessage('Lost the connection to the device. Please reconnect.')
  } else if (err instanceof OpenloopError) {
    // Any other SDK error
    showMessage(`Error: ${err.message}`)
  } else {
    // Unexpected error
    throw err
  }
}
```

Retry Pattern With Reconnect

```
async function withRetry<T>(
  fn: () => Promise<T>,
  reconnect: () => Promise<void>,
  maxRetries: number = 1
): Promise<T> {
  for (let i = 0; i <= maxRetries; i++) {
    try {
      return await fn()
    } catch (err) {
      if (err instanceof TransportError && i < maxRetries) {
        await reconnect()
        continue
      }
      throw err
    }
  }
  throw new Error('Unreachable')
}

// Usage example
const { address } = await withRetry(
  () => eth.getAddress(DEFAULT_ETH_PATH),
  async () => {
    transport = await WebHidTransport.reconnect()
    eth = new EthereumApp(transport!)
  }
)
```

Detecting a User Rejection

```
function isUserRejected(err: unknown): boolean {
  return err instanceof ApduError && err.statusWord === 0x6985
}

try {
  const sig = await eth.signTransaction(DEFAULT_ETH_PATH, rawTx)
} catch (err) {
  if (isUserRejected(err)) {
    // A deliberate user action — no error display needed
    return
  }
  // Show every other error
  showError(err)
}
```

Next Steps

- API Reference — every type definition

API Reference

A complete list of type definitions, interfaces, classes, and constants. Unless stated otherwise, everything here is exported from `@openloop/sdk-core`.

Contents

Interfaces

ITransport

The interface that abstracts communication with the device. Every transport implements it.

```
interface ITransport {
  open(): Promise<void>
  close(): Promise<void>
  isConnected(): boolean
  exchange(apdu: Uint8Array): Promise<Uint8Array>
  lock(): Promise<void>
  unlock(): Promise<void>
}
```

Method	Description
`open()`	Open the connection to the device
`close()`	Close the connection
`isConnected()`	Whether a connection is active
`exchange(apdu)`	Send an APDU command and receive the response
`lock()`	Acquire exclusive access to the device (for multi-step operations)
`unlock()`	Release exclusive access

TransportStatus

```
interface TransportStatus {
  connected: boolean
  deviceName?: string
  deviceId?: string
}
```

TransportEvent

```
type TransportEventType = 'connected' | 'disconnected' | 'error'

interface TransportEvent {
  type: TransportEventType
  error?: Error
}

type TransportEventHandler = (event: TransportEvent) => void
```

TransportInfo

The transport information returned by `OpenloopSDK.discover()`.

```
interface TransportInfo {
  type: string        // Registered name (e.g. 'webhid')
  name: string        // Display name (e.g. 'WebHID (USB)')
  available: boolean  // Whether it is available
}
```

TransportFactory

```
type TransportFactory = () => Promise<ITransport>
```

SignatureResult

The ECDSA signature result for Ethereum / TRON.

```
interface SignatureResult {
  v: number    // Recovery ID
  r: string    // R value (32 bytes hex, no 0x prefix)
  s: string    // S value (32 bytes hex, no 0x prefix)
}
```

BtcMessageSignature

The Bitcoin BIP-137 message signature result.

```
interface BtcMessageSignature {
  v: number       // Recovery ID (35–38: P2WPKH native SegWit)
  r: string       // R value (32 bytes hex)
  s: string       // S value (32 bytes hex)
  signature: string // Base64 of the full signature (V || R || S, 65 bytes)
}
```

InputSigningPath

The per-input BIP32 path for a Bitcoin PSBT.

```
interface InputSigningPath {
  index: number   // Input index within the PSBT
  path: string    // BIP32 path (e.g. "84'/1'/0'/0/5")
}
```

DeviceInfo

```
interface DeviceInfo {
  connected: boolean
  path?: string
  vendorId?: number
  productId?: number
}
```

XrpSignatureResult

The XRP signature result.

```
interface XrpSignatureResult {
  signature: string  // Signature hex (Ed25519: 64B, secp256k1: DER, variable length)
}
```

XrpCurve

```
type XrpCurve = 'ed25519' | 'secp256k1'
```

WcSession

```
interface WcSession {
  topic: string
}
```

IWcSignClient

```
interface IWcSignClient {
  request<T>(params: {
    topic: string
    chainId: string
    request: { method: string; params: unknown }
  }): Promise<T>
}
```

WcTransportOptions

```
interface WcTransportOptions {
  client: IWcSignClient
  session: WcSession
  chainId?: string  // Default: "eip155:1"
}
```

App Classes

EthereumApp

```
class EthereumApp {
  constructor(transport: ITransport)

  getAddress(path: string): Promise<{ publicKey: string; address: string }>

  signPersonalMessage(path: string, message: string, chainId?: number): Promise<SignatureResult>

  signTransaction(path: string, rawTx: string): Promise<SignatureResult>

  signTypedData(
    path: string, domainSeparatorHash: string, messageHash: string, chainId?: number
  ): Promise<SignatureResult>

  signAuthorization(path: string, authorizationRlp: string): Promise<SignatureResult>
}
```

BitcoinApp

```
class BitcoinApp {
  constructor(transport: ITransport)

  getAddress(testnet?: boolean): Promise<{ publicKey: string; address: string; chainCode: string

  getAddressWithPath(path: string): Promise<{ publicKey: string; address: string; chainCode: str

  getAccountXpub(coinType: number): Promise<{ publicKey: string; chainCode: string }>

  getMasterFingerprint(): Promise<string>  // hash160(master pubkey)[:4], 8-char hex (e.g. "6316

  signMessage(message: string, path: string): Promise<BtcMessageSignature>

  signPsbt(psbt: Uint8Array | string): Promise<Uint8Array>

  signPsbtHex(psbt: string): Promise<string>

  signPsbtWithPaths(psbt: string, inputPaths: InputSigningPath[]): Promise<string>
}
```

SolanaApp

```
class SolanaApp {
  constructor(transport: ITransport)

  getAddress(path: string): Promise<{ publicKey: string; address: string }>

  signTransaction(path: string, txBytes: Uint8Array): Promise<string>

  signOffchainMessage(path: string, messageBytes: Uint8Array): Promise<string>
}
```

TronApp

```
class TronApp {
  constructor(transport: ITransport)

  getAddress(path: string): Promise<{ publicKey: string; address: string }>

  signTransaction(path: string, rawDataHex: string): Promise<SignatureResult>

  signMessage(path: string, message: string): Promise<SignatureResult>
}
```

XrpApp

```
class XrpApp {
  constructor(transport: ITransport)

  getAddress(path: string, curve?: XrpCurve): Promise<{ publicKey: string; address: string }>

  signTransaction(path: string, txBlob: string): Promise<XrpSignatureResult>
}
```

OpenloopApp

The class for utility commands specific to the Openloop firmware. It provides the Openloop-specific commands exposed under CLA=0xF0 (CLA_OPENLOOP).

```
class OpenloopApp {
  constructor(transport: ITransport)

  /**
   * Sends GET_DEVICE_INFO (F0 A0) and retrieves identity, state, and feature information.
   *
   * Return value:
   *   - Returns null for older Openloop firmware (earlier than v0.91.13) and for
   *     devices that do not support the command
   *   - Throws on transport-layer errors
   */
  getDeviceInfo(): Promise<OpenloopDeviceInfo | null>
}
```

OpenloopDeviceInfo

```
interface OpenloopDeviceInfo {
  modelId: number              // Hardware SKU ID (e.g. 0x0001 = Openloop V1)
  hwRevision: number           // PCB revision
  mainFwVersion: { major: number; minor: number; patch: number }
  recoveryFwVersion: { major: number; minor: number; patch: number }
  state: number                // 16-bit state bitmask (raw value)
  stateBits: OpenloopDeviceState  // Decoded view of state
  features: number             // 16-bit feature bitmask (implementation detail, subject to char
}
```

Field	Type	Description
`modelId`	`number`	Hardware SKU ID. Increments with every new SKU
`hwRevision`	`number`	PCB revision number
`mainFwVersion`	`{major,minor,patch}`	Version of the main firmware currently running
`recoveryFwVersion`	`{major,minor,patch}`	Version of the recovery (factory) partition. All zeros when it cannot be read
`state`	`number`	16-bit bitmask representing the current state (raw value)
`stateBits`	`OpenloopDeviceState`	`state` decoded into an object
`features`	`number`	16-bit bitmask representing the hardware features (raw value). **The bit layout is an implementation detail of the firmware and may change between versions.** Host apps should only store and forward the raw value

OpenloopDeviceState

The `state` field decoded into a human-readable object.

```ts
interface OpenloopDeviceState {
  walletProvisioned: boolean
  language: number            // 0=English, 1=Japanese, 2-7=reserved
  usbEnabled: boolean
  usbVidCompat: boolean       // false=Native (0x303A), true=Compatible (0x2C97)
  bleEnabled: boolean
  blePaired: boolean
  fidoEnabled: boolean
  pivEnabled: boolean
}
```

state bitmask layout (finalized in FW v0.91.14+):

bit	Name	Meaning
0	`WALLET_PROVISIONED`	A wallet has been created
1-3	`LANG` (3 bit)	Language index (0=EN, 1=JA, …)
4	`USB_ENABLED`	USB communication on
5	`USB_VID_COMPAT`	USB VID = compatible mode (0x2C97). Native (0x303A) when 0
6	`BLE_ENABLED`	BLE communication on
7	`BLE_PAIRED`	A paired BLE device exists
8	`FIDO_ENABLED`	FIDO / passkey feature on
9	`PIV_ENABLED`	PIV / PKCS#11 feature on
10-15	reserved	Reserved for future expansion, currently 0

More bits may be added in the future. To read a bit that `stateBits` does not expose, mask the raw `state` value directly.

Example

```
import { OpenloopApp, formatOpenloopState } from '@openloop/sdk-core'

const app = new OpenloopApp(transport)
const info = await app.getDeviceInfo()

if (info === null) {
  console.log('GET_DEVICE_INFO not supported (old firmware)')
} else {
  console.log(`Model: 0x${info.modelId.toString(16).padStart(4, '0')}`)
  console.log(`FW: ${info.mainFwVersion.major}.${info.mainFwVersion.minor}.${info.mainFwVersion.
  console.log(`State: ${formatOpenloopState(info.stateBits)}`)
  if (!info.stateBits.walletProvisioned) {
    // Branch for when no wallet has been created yet
  }
}
```

Signature Verification

The `@openloop/sdk-core/verify` subpath. Utilities that verify a signature returned by the device against a reference implementation (viem / @noble). Transport-independent — USB, BLE, AirGap, and WalletConnect all work. It is not part of the base `@openloop/sdk-core` (viem is never forced on you); it ships as a subpath instead.

```
import { verifyPersonalSign } from '@openloop/sdk-core/verify'

const result = verifyPersonalSign(message, sig, address)
// result: { recovered: string; expected?: string; ok: boolean }
```

Function	Chain	Verifies
`verifyPersonalSign(message, sig, expected?)`	EVM	EIP-191 personal_sign
`verifyTypedDataJson(typedDataJson, sig, expected?)`	EVM	EIP-712 (full JSON)
`verifyTypedDataHashes(domainHash, msgHash, sig, expected?)`	EVM	EIP-712 (pre-hashed)
`verifyTransaction(unsignedTxHex, sig, expected?)`	EVM	legacy / EIP-2718 typed tx (takes `{v,r,s}`)
`verifySignedTransaction(signedTxHex, expected?)`	EVM	Recovers the signer from a signed serialized tx (the return value of WalletConnect `eth_signTransaction`)
`verifyAuth7702(authRlpHex, sig, expected?)`	EVM	EIP-7702 authorization
`verifyBtcMessage(message, sig, identity)`	BTC	BIP-137 message (`identity` = pubkey hex or BTC address)
`verifyBtcPsbt(signedPsbtHex)`	BTC	Signed PSBT (BIP-143 P2WPKH; the pubkey comes from the PSBT)
`verifySolMessage(message, sigHex, pubkeyHex)`	SOL	ed25519 off-chain message
`verifySolTransaction(txHex, sigHex, pubkeyHex)`	SOL	ed25519 transaction
`verifyTronMessage(message, sig, identity)`	TRON	keccak256 TRON prefix (`identity` = pubkey hex or TRON address)
`verifyTronTransaction(rawDataHex, sig, identity)`	TRON	sha256(raw_data) (`identity` = pubkey hex or TRON address)
`verifyXrpTransaction(txBlobHex, curve, result, pubkeyHex)`	XRP	ed25519 / secp256k1 (for-signing blob + explicit pubkey)
`verifyXrpSignedTx(signedTxHex)`	XRP	Self-contained verification from a signed tx blob (extracts SigningPubKey / TxnSignature; no pubkey needed)

Every one of them returns a `VerifyResult`: `{ recovered: string; expected?: string; ok: boolean }`. Pass `expected` and the check goes one step further, reporting whether the recovered signer matches (`ok`).

> **About `identity` (pubkey or address)**: for BTC / TRON the shape of `identity` decides automatically whether to compare the public key recovered from the signature directly, or to derive a chain address from the recovered key and compare that. On routes where no public key is available — WalletConnect, for example — you can **match by address**. `verifySignedTransaction` (EVM) and `verifyXrpSignedTx` (XRP) recover the signer / public key from the signed data itself, so there is no pubkey to pass in from outside.

Error Classes

```
class OpenloopError extends Error {
  name: 'OpenloopError'
}

class ApduError extends OpenloopError {
  name: 'ApduError'
  readonly statusWord: number
  constructor(statusWord: number)
}

class TransportError extends OpenloopError {
  name: 'TransportError'
  constructor(message: string)
}
```

OpenloopSDK Class

The class that manages transport registration, discovery, and connection. Every method is static.

```
class OpenloopSDK {
  static registerTransport(type: string, config: {
    factory: TransportFactory
    name: string
    isAvailable: () => boolean | Promise<boolean>
  }): void

  static discover(): Promise<TransportInfo[]>

  static connect(opts?: { transport?: string }): Promise<ITransport>

  static getRegisteredTransports(): string[]

  static clearTransports(): void
}
```

WcTransport Class

```
class WcTransport implements ITransport {
  constructor(options: WcTransportOptions)
  open(): Promise<void>
  close(): Promise<void>
  isConnected(): boolean
  lock(): Promise<void>
  unlock(): Promise<void>
  exchange(apdu: Uint8Array): Promise<Uint8Array>
}
```

Constants

USB Identifiers

```
const OPENLOOP_VENDOR_ID  = 0x303a   // Espressif VID
const OPENLOOP_PRODUCT_ID = 0x8341   // Openloop PID
const LEDGER_VENDOR_ID    = 0x2c97   // Ledger SAS VID
const LEDGER_PRODUCT_ID   = 0x1011   // Nano S compatible
```

BIP44 Default Paths

```
const DEFAULT_ETH_PATH  = "44'/60'/0'/0/0"
const BTC_MAINNET_PATH  = "84'/0'/0'/0/0"
const BTC_TESTNET_PATH  = "84'/1'/0'/0/0"
const DEFAULT_SOL_PATH  = "44'/501'/0'/0'"
const DEFAULT_TRON_PATH = "44'/195'/0'/0/0"
const DEFAULT_XRP_PATH  = "44'/144'/0'/0'/0'"
```

BLE Constants

```
const BLE_SERVICE_UUID      = '13d63400-2c97-0004-0000-4c6564676572'
const BLE_NOTIFY_UUID       = '13d63400-2c97-0004-0001-4c6564676572'
const BLE_WRITE_UUID        = '13d63400-2c97-0004-0002-4c6564676572'
const BLE_DEVICE_NAME_PREFIX = 'Openloop'
const BLE_DEFAULT_MTU       = 155
```

WalletConnect Constants

```
const WALLETCONNECT_PROJECT_ID = 'b3d610140c2d0d39f50150a030c7c985'
```

WalletConnect Supported Chains (CAIP-2)

```
const SUPPORTED_EVM_CHAINS = [
  'eip155:1',         // Ethereum Mainnet
  'eip155:11155111',  // Sepolia Testnet
] as const

const SUPPORTED_BIP122_CHAINS = [
  'bip122:000000000019d6689c085ae165831e93', // Bitcoin Mainnet
  'bip122:000000000933ea01ad0ee984209779ba', // Bitcoin Testnet3
] as const

const SUPPORTED_SOLANA_CHAINS = [
  'solana:5eykt4UsFv8P8NJdTREpY1vzqKqZKvdp', // Mainnet Beta
  'solana:EtWTRABZaYq6iMfeYKouRu166VU2xqa1',  // Devnet
] as const

const SUPPORTED_TRON_CHAINS = [
  'tron:0x2b6653dc',  // TRON Mainnet
  'tron:0x94a9059e',  // TRON Shasta Testnet
] as const
```

WalletConnect Supported Methods

```
const SUPPORTED_EVM_METHODS = [
  'eth_sendTransaction', 'eth_signTransaction', 'eth_sign',
  'personal_sign', 'eth_signTypedData', 'eth_signTypedData_v3',
  'eth_signTypedData_v4', 'wallet_getCapabilities',
] as const

const SUPPORTED_BIP122_METHODS = [
  'signPsbt', 'getAccountAddresses', 'signMessage', 'sendTransfer',
] as const

const SUPPORTED_SOLANA_METHODS = [
  'solana_signTransaction', 'solana_signAllTransactions',
  'solana_signAndSendTransaction', 'solana_signMessage',
] as const

const SUPPORTED_TRON_METHODS = [
  'tron_signTransaction', 'tron_signMessage',
] as const

const SUPPORTED_EVENTS = ['chainChanged', 'accountsChanged'] as const
```

APDU Instruction Set

```
const APDU = {
  // Class bytes
  CLA_ETHEREUM: 0xe0,         // Ledger-compatible
  CLA_OPENLOOP: 0xf0,         // Openloop-specific

  // Shared INS (routed automatically by coin_type)
  INS_GET_PUBLIC_KEY: 0x02,    // Get the address / public key
  INS_SIGN_TX: 0x04,           // Sign a transaction
  INS_SIGN_MESSAGE: 0x08,     // Sign a message
  INS_SIGN_EIP712: 0x0c,      // EIP-712 typed data
  INS_SIGN_AUTHORIZATION: 0x34, // EIP-7702

  // Bitcoin PSBT (Openloop-specific)
  INS_BTC_SIGN_PSBT: 0x70,          // Send the PSBT
  INS_BTC_GET_SIGNED_PSBT: 0x71,    // Get the signed PSBT
  INS_BTC_GET_WALLET_PUBLIC_KEY: 0x40, // Get the BTC public key / address
  INS_BTC_GET_ACCOUNT_XPUB: 0x72,   // Get the account xpub
  INS_BTC_SIGN_MESSAGE: 0x73,       // Sign a BTC message

  // Solana (Ledger Solana compatible)
  INS_SOL_GET_PUBKEY: 0x05,         // Get the Ed25519 public key
  INS_SOL_SIGN_MESSAGE: 0x06,       // Sign a transaction / message
  INS_SOL_SIGN_OFFCHAIN_MSG: 0x07,  // Sign an off-chain message
} as const
```

Utility Functions

```
// Build an APDU command
function buildApdu(cla: number, ins: number, p1: number, p2: number, data?: Uint8Array): Uint8Ar

// Convert a BIP32 path to a buffer
function pathToBuffer(path: string): Uint8Array

// Convert a BIP32 path to an array of elements
function pathToElements(path: string): number[]

// Concatenate Uint8Arrays
function concat(...arrays: Uint8Array[]): Uint8Array

// Convert a hex string to a Uint8Array (with or without the 0x prefix)
function hexToBytes(hex: string): Uint8Array

// Convert a Uint8Array to a hex string (no 0x prefix)
function bytesToHex(bytes: Uint8Array): string

// Base58 encode / decode
function base58Encode(bytes: Uint8Array): string
function base58Decode(str: string): Uint8Array

// Format an OpenloopDeviceState into a single-line log string
// e.g. "wallet=N lang=0 USB(native) ble=off FIDO PIV"
function formatOpenloopState(s: OpenloopDeviceState): string
```