Equipment Integration Guide

FTMS · compatibility mode · packet examples · device validation

Scope: current FTMS Watch 0.1.0 source, 2026-11-08. This guide documents the receiver implementation; it is not a replacement for Bluetooth SIG specifications or a product certification.

Recommended path

Use equipment as a BLE peripheral / GATT server and the watch as a central / client. Prefer FTMS service 0x1826, advertise its UUID, and expose the sport measurement with Notify and CCCD 0x2902. Use a recognizable equipment name.

Purpose	Service	Characteristic
Treadmill	1826	2ACD
Indoor bike	1826	2AD2
Rower	1826	2AD1
Cross trainer	1826	2ACE
Cycling speed/cadence	1816	2A5B
Heart rate	180D	2A37

Connection and reporting

Watch scans, connects, discovers and subscribes, then decodes by flags. Equipment is remembered by sport for later reconnection. Remain discoverable and implement BLE identity correctly. Measurement delivery should not require an app control-point command first.

The app receives measurements only. It does not write FTMS Control Point 0x2AD9 or control motors, incline or resistance. Stop ends monitoring and connection. The website demo is not a BLE validation tool.

Wire encoding conventions

All multi-byte values are little-endian. These tables describe the app Standard mode: u8/u16/u24 are unsigned, s16 is two’s complement. Flags lead the packet. Except bit 0, set bits add fields in ascending order; unset fields consume no bytes.

More Data (bit 0) is inverted: zero includes base speed, or stroke rate and stroke count for rowers; one omits those base fields. Cross trainer flags use 3 bytes; the other sports use 2.

Packets must match their flags exactly. The current decoder rejects unknown reserved bits, truncation and trailing bytes without publishing partial values. “skip” means consumed but not currently displayed.

The energy group always contains 5 bytes: total u16, per-hour u16 and per-minute u8. The app uses total energy and treats 0xFFFF as unavailable. Heart rate zero is unavailable. Omit unsupported optional fields instead of inventing readings.

Suggested delivery behavior

Aim for about one update per second while moving. Send explicit zero speed, cadence or stroke rate on stopping; do not repeat stale positive values. Equipment readings expire after 5 seconds and may fall back to available watch data. Inactivity pauses the app timer after 5 seconds; calories do not accumulate while stationary.

Keep cumulative distance, energy and stroke count monotonic within a workout and reset clearly for a new session. Website simulation is not a sensor-accuracy test.

Packet size and splitting

Default ATT MTU 23 permits a 20-byte notification payload. Negotiate a larger MTU or use FTMS More Data packets, each with its own flags and complete fields. The app merges recent fields for the same sport; arbitrary byte-stream splitting is unsupported.

Display semantics

Valid equipment values take priority; authorized watch readings may fill gaps. Watch sensors cannot invent equipment power, resistance or stroke count. UI duration is the inactivity-filtered workout time, which may differ from equipment Elapsed Time. Missing heart-rate samples leave chart gaps.

Treadmill / 0x2ACD

Field order and app decoding (Standard mode)

Flag	Bytes	Field	Raw value / interpretation
0=0	2	Speed	u16 / 100 km/h
1	2	Average speed	u16 / 100; skip
2	3	Distance	u24 m
3	4	Inclination + ramp angle	s16 / 10 %; s16 / 10 deg (skip)
4	4	Positive + negative elevation	2 + 2; skip
5	2	Instantaneous pace	u16 s / 500 m
6	2	Average pace	u16; skip
7	5	Energy group	u16 kcal + u16 kcal/h + u8 kcal/min
8	1	Heart rate	u8 bpm
9	1	MET	u8; skip
10	2	Elapsed time	u16 seconds
11	2	Remaining time	u16; skip
12	4	Belt force + power	s16 N (skip) + s16 W

Ready-to-send example

```
8C 05 5C 03 78 14 00 19 00 0E 00 2E 01 90 01 07 94 8C 0A
```

19 bytes · 8.60 km/h; 5240 m; 2.5%; 302 kcal; 148 bpm; 2700 s

Indoor bike / 0x2AD2

Field order and app decoding (Standard mode)

Flag	Bytes	Field	Raw value / interpretation
0=0	2	Speed	u16 / 100 km/h
1	2	Average speed	u16 / 100; skip
2	2	Cadence	u16 / 2 rpm
3	2	Average cadence	u16 / 2; skip
4	3	Distance	u24 m
5	1	Resistance	u8 whole level
6	2	Power	s16 W
7	2	Average power	s16; skip
8	5	Energy group	u16 kcal + u16 kcal/h + u8 kcal/min
9	1	Heart rate	u8 bpm
10	1	MET	u8; skip
11	2	Elapsed time	u16 seconds
12	2	Remaining time	u16; skip

Ready-to-send example

```
74 0B 74 09 B0 00 B0 4F 00 0E B6 00 2E 01 90 01 07 94 8C 0A
```

20 bytes · 24.20 km/h; 88 rpm; 20400 m; level 14; 182 W; 302 kcal; 148 bpm; 2700 s

Rower / 0x2AD1

Field order and app decoding (Standard mode)

Flag	Bytes	Field	Raw value / interpretation
0=0	3	Stroke rate + count	u8 / 2 spm + u16 strokes
1	1	Average stroke rate	u8 / 2; skip
2	3	Distance	u24 m
3	2	Pace	u16 s / 500 m
4	2	Average pace	u16; skip
5	2	Power	s16 W
6	2	Average power	s16; skip
7	1	Resistance	u8 whole level
8	5	Energy group	u16 kcal + u16 kcal/h + u8 kcal/min
9	1	Heart rate	u8 bpm
10	1	MET	u8; skip
11	2	Elapsed time	u16 seconds
12	2	Remaining time	u16; skip

Ready-to-send example

```
2C 0B 38 34 03 DC 0F 00 94 00 9A 00 08 01 60 01 06 92 8C 0A
```

20 bytes · 28 spm; 820 strokes; 4060 m; 148 s/500m; 154 W; 264 kcal; 146 bpm; 2700 s

Cross trainer / 0x2ACE

Field order and app decoding (Standard mode)

Flag	Bytes	Field	Raw value / interpretation
0=0	2	Speed	u16 / 100 km/h
1	2	Average speed	u16 / 100; skip
2	3	Distance	u24 m
3	4	Step rate + average step rate	u16 spm + u16 spm (skip)
4	2	Stride count	u16 / 10 strides
5	4	Positive + negative elevation	2 + 2; skip
6	4	Inclination + ramp angle	s16 / 10 %; s16 / 10 deg (skip)
7	1	Resistance	u8 whole level
8	2	Power	s16 W
9	2	Average power	s16; skip
10	5	Energy group	u16 kcal + u16 kcal/h + u8 kcal/min
11	1	Heart rate	u8 bpm
12	1	MET	u8; skip
13	2	Elapsed time	u16 seconds
14	2	Remaining time	u16; skip
15	0	Direction	flag only; no bytes

Ready-to-send example

```
0C 29 00 34 03 D8 0E 00 7F 00 7D 00 A0 00 8E 14 07
```

17 bytes · 8.20 km/h; 3800 m; 127 spm; 160 W; 142 bpm; 1812 s

Extra energy packet: 01 04 00 00 01 58 01 06. Flags=0x000401: bit 0 omits speed; bit 10 adds 256 kcal / 344 kcal/h / 6 kcal/min.

Compatibility and other services

Legacy mode is a specific older field layout implemented by this app, not an arbitrary proprietary-protocol converter. Select it explicitly under Equipment → Connection options; the app does not guess by packet length.

Field	Standard	Legacy
Bike resistance	u8, whole level	s16, whole level
Rower/cross trainer resistance	u8, whole level	s16 / 10
Treadmill instant/average pace	u16, s / 500 m	u8; consumed, not displayed

For resistance level 14: Standard bike uses 0E; Legacy bike uses 0E 00; Legacy rower/cross trainer uses 8C 00. Flags and other field order remain unchanged. Prefer Standard for new equipment; provide captures and firmware versions for older layouts.

CSC / 0x1816 / 0x2A5B

One-byte flags: bit 0 adds cumulative wheel revolutions u32 and last wheel event time u16; bit 1 adds cumulative crank revolutions u16 and last crank event time u16. Event time uses 1/1024 s; the 16-bit clock wraps every 64 seconds.

The first packet sets a baseline. Later deltas produce rates. Wheel speed and distance require actual circumference (100–5000 mm); cadence does not. Example crank packets: 02 64 00 00 04 → 02 65 00 00 08, one turn in one second, 60 rpm.

HRS / 0x180D / 0x2A37

Heart Rate Measurement flag bit 0 selects u8 (0) or u16 (1) heart rate. Append other flagged fields in HRS order. Minimal packet 00 94 means 148 bpm. HRS alone does not supply equipment power, speed or distance.

Integration acceptance checklist

• Verify discovery, correct sport/service and continuous notifications without control writes.

• Enable optional fields individually; verify lengths, signs, scaling and units against the companion JSON vectors.

• Test stopping, resuming, power loss, range loss and re-entry. No counter jumps; reconnect restores measurements.

• Test denied Health access, absent HR and missing equipment fields. Show unavailable values or real fallback data.

• Check sessions above/below one minute, multiple same-day sessions and workouts across dates.

• Check split notifications, default MTU, rollover and malformed packets; later fields must stay aligned.

• For support, include model, firmware, service UUIDs, characteristic properties, raw HEX, interval and expected values.

Implementation boundaries

Not implemented: arbitrary vendor protocols, FTMS control commands, watch-as-peripheral data forwarding, or equipment user-profile height/weight reads. These require receiver changes and separate validation.

References and maintenance

Field tables track FTMSDecoder.swift, CSCDecoder.swift and BluetoothPacket.swift. Standards references: Bluetooth SIG FTMS 1.0 and GSS (2026-09-09). Older layouts describe this app’s compatibility behavior only.

https://www.bluetooth.com/specifications/specs/fitness-machine-service-1-0/

https://www.bluetooth.com/specifications/gss/

https://www.bluetooth.com/specifications/assigned-numbers/

Technical support: website tickets or yanshouhu8@gmail.com. Do not send complete personal health records or account passwords.