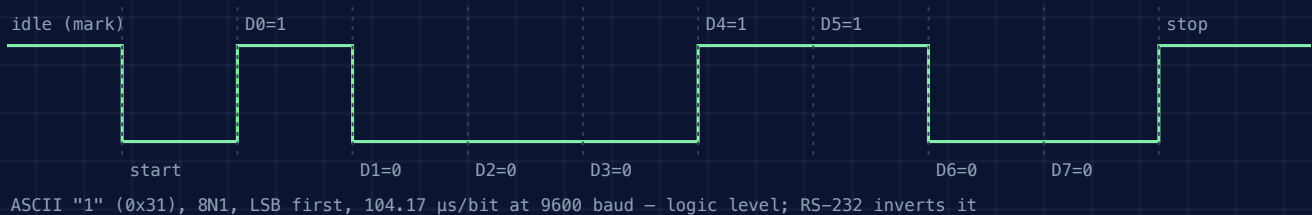


NordicRaceTrace Timing System

Operation, procedures and hardware reference for the iOS timing app, the nordicracetrace.com website, and the Summit SRT-1000 hardware timer link over a DX-CP26 RS-232/Bluetooth Low Energy adapter.

App NordicRaceTrace for iOS 2.5.0 · **Web** nordicracetrace.com / live.nordicracetrace.com
Timer Summit Systems SRT-1000 · 9 inputs · 1 ms internal resolution · ± 2 ppm (0–40 °C)
Link DX-SMART DX-CP26 · BLE GATT 0xFFE0 / 0xFFE1 / 0xFFE2 · RS-232 9600 8N1
Wire DB9 null-modem, 3-conductor · 2→3 · 3→2 · 5→5 · no handshaking
Record1 92 1 b 7 0:55:19.8%_{FF} · 29 bytes · ≈ 30.2 ms at 9600 baud



About this manual

This is the technical reference for NordicRaceTrace: the iOS timing app, the website and live-results server behind it, and the optional hardware timer link. It is written for the person who wants to know *exactly* what the system does — the timer at the finish line who needs to defend a result, the coach who wants to understand why two phones disagree by a tenth, and the hardware-minded reader who wants pinouts, byte counts and state machines rather than reassurance.

Parts I–III cover the system and how to run a race in each timing mode. Part IV is the hardware integration in depth: the Summit SRT-1000, the DX-CP26 adapter, the cabling, the serial protocol as it was actually captured off the wire, the Bluetooth transport, and the clock arithmetic that turns a hardware impulse into an official time. Part V collects reference material, and the book closes with a glossary of timing terms and an index.

Typographic conventions

Start Race	A control or label in the app or on the website, as it appears on screen.
<code>POST</code> <code>Ctrl</code> + <code>2</code>	A physical key on the Summit timer or the DX-CP26 adapter.
<code>0xFFE1</code> , <code>parseRecordLine()</code>	A literal value, identifier, UUID, or a name in the app's source code.
<code>1 92 1 b 7 0:55:19.8</code>	Bytes as they appear on the serial line. <code>\r</code> marks the CR LF terminator (0x0D 0x0A).
§16.3, p. 92	A cross-reference to a numbered section and the page it begins on.
T_0 , t_{rec}	Quantities in formulas. All times are milliseconds unless a unit is given.

NOTE

Supplementary information that clarifies a point or saves you a step.

TIP

A practice that experienced operators use.

CAUTION

Something that can cost you a time, a record or an hour of debugging if ignored.

WARNING

An action that destroys data, or a failure that produces a *plausible but wrong* result.

DESIGN NOTE

Why the system is built the way it is. Skippable, but it usually explains a behavior that would otherwise look like a bug.

Scope and status

This revision describes NordicRaceTrace for iOS **2.5.0** and the website as deployed in October 2026. Hardware timer support is labeled **Beta** in the app. It has been developed and verified against a single model of timer — the Summit Systems SRT-1000 — through a DX-SMART DX-CP26 adapter. Behavior described in Part IV was established by capturing and decoding the timer's real output, and where the manufacturers' documentation disagrees with the hardware, this manual says so and follows the hardware.

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PART I

The System

What NordicRaceTrace is made of, what it needs, and the arithmetic every timing mode is built on. Read Chapter 3 before trusting any number the system produces: every other chapter assumes it.

CHAPTER 1

System Overview

NordicRaceTrace is a timing system for Nordic skiing built around a phone. An iPhone or iPad records times at a start, a finish or anywhere on the course; a server publishes them live; a website reconciles, archives and shares them; and an optional hardware timer can feed the phone impulses stamped by a crystal-controlled clock instead of a thumb.

1.1 Components

The system has four parts. Only the first is required to time a race; each of the others adds a capability and a dependency.

Table 1-1. System components

COMPONENT	RUNS ON	ROLE
NordicRaceTrace app	iPhone / iPad, iOS 15.1 or later	Records every time. Holds the authoritative copy of a timing session on the device, works with no network, and computes results locally.
Live server	<code>live.nordicracetrace.com</code> (HTTPS, Node.js/Express, SQLite)	Receives times from one or more phones while Share Live is on, merges devices, serves live results and the reconcile worksheet.
Website	<code>nordicracetrace.com</code>	Coach accounts, team rosters and start lists, the start-list converter, the public results archive, time-trial history and personal bests, team splits.
Hardware timer link 	Summit SRT-1000 + DX-CP26 RS-232/BLE adapter	Feeds the phone hardware-stamped impulses and bib entries in real time over Bluetooth Low Energy. Race Timing only.

1.2 Architecture and data flow

Data flows one way at race time — from the point of capture toward the server — and comes back only as merged, published results. [Figure 1-1, p. 11](#) shows every path a time can take.

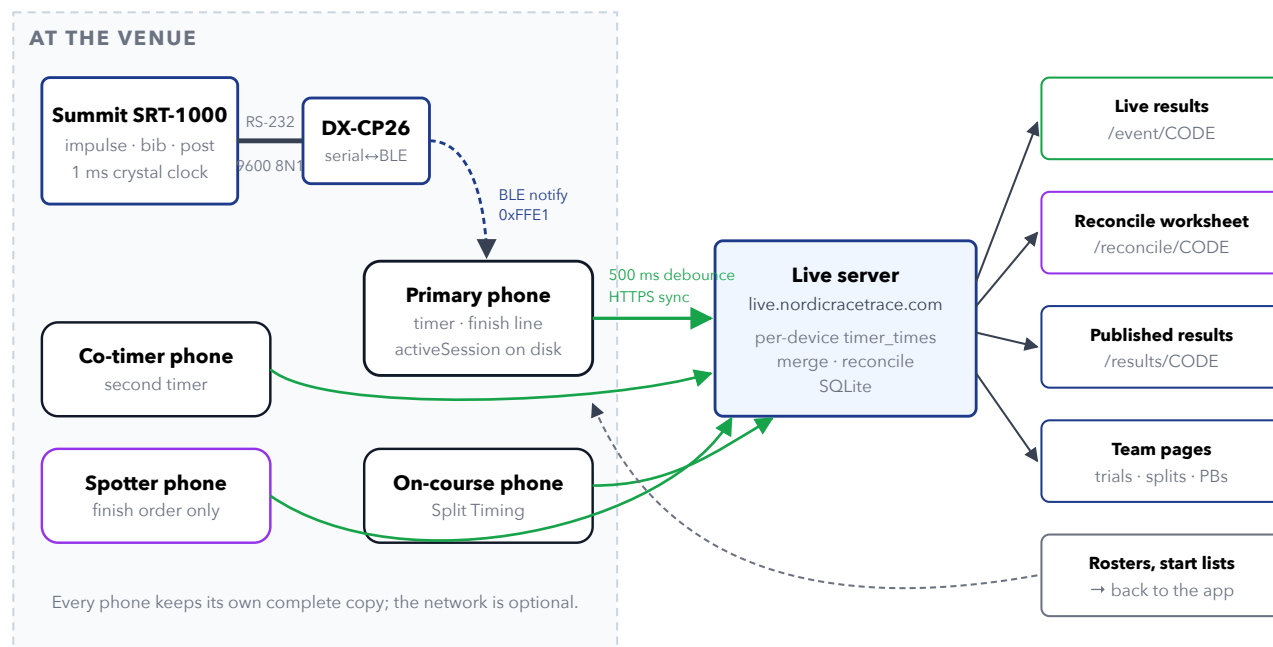


Figure 1-1. System architecture. Solid green arrows carry times; the dashed return path carries rosters and start lists to the app before a race.

Three properties of this design matter more than any feature:

1. **The phone is the system of record during a race.** Every time is written to the phone's own storage the instant it is taken. The server holds a copy for sharing and merging; it is never the only place a time exists. A dead network costs you the live page, never a result.
2. **Each device's data stays separate on the server.** Two phones timing the same race write to separate per-device rows. Nothing one phone sends can overwrite another phone's times; disagreements are resolved by a person on the reconcile worksheet, not by whichever device synced last.
3. **A hardware time is computed entirely in the hardware's clock.** When a Summit is attached, finish minus start is taken between two readings of the Summit's own crystal; the phone's clock and the Bluetooth latency never enter the subtraction ([Chapter 18, p. 58](#)).

1.3 The timing modes at a glance

The app has three timing modes, chosen in **Settings → Timing Mode** or from the mode switcher on the Timer screen before a race starts. They differ in where you stand, what the clock means, and what the output is.

Table 1-2. Timing modes compared

	SPLIT TIMING	RACE TIMING	TEAM TIME TRIAL
Where	Anywhere on course	The finish line	The finish line (practice)
Start event	None needed	Start Race on the phone, or from the Summit	Start on the phone
Identity	Bib numbers	Bib numbers	Athlete names (bibs optional)

Primary output	Time behind the leader at your point; gaining/losing places	Elapsed race times, ranked	Elapsed times saved to the team page and PB history
Start formats	Mass, 15/20/30 s interval, custom	Mass, 15/20/30 s interval, custom, pursuit	Mass, interval, custom
Hardware timer	—	Supported (Beta)	—
Co-timers	—	Yes, merged on the reconcile worksheet	Yes, each phone saves its own trial
Chapter	Chapter 7, p. 28	Chapter 8, p. 29	Chapter 9, p. 32

1.4 Free and Pro features

NordicRaceTrace is free to download and time with. A Pro subscription (annual, with a seven-day free trial, purchased through the App Store) unlocks the coach and team workflow. The paywall is presented at the moment you open a Pro feature.

Table 1-3. What requires Pro

FREE	PRO
Timing a race on the number pad; starting a race; recording splits and finishes	Importing start lists — from NordicRaceTrace.com, a CSV file, a photo, or by typing
In-app results; Save to Events	Creating new Events from the Events tab (+ Event)
The Live tab (following other organizers' live results)	Team Time Trials using a team roster
Settings, Restore Purchases, the in-app guide	Share Live: public live results and co-timer pairing

CHAPTER 2

Requirements, Installation and Accounts

2.1 Supported devices

Table 2-1. Device requirements

Operating system	iOS / iPadOS 15.1 or later.
Devices	Any iPhone or iPad that runs iOS 15.1. iPad gets a two-pane layout with the number pad or name tiles beside the results. The iPad mini (744 pt short side) is laid out as an iPad.
Bluetooth	Bluetooth Low Energy 4.0 or later — every supported device has it. Needed only for a hardware timer.
Network	Optional. Needed for Share Live, co-timers, roster sync, website start lists, photo import and publishing. Timing itself never needs it.
App version for hardware timers	2.5.0 or later. Bluetooth support is a compiled native module; it cannot be added to an older build over the air. Older versions report "Bluetooth is not available in this build of the app".

2.2 Permissions the app requests

iOS asks for each permission the first time the feature that needs it is used. None is required for basic timing.

Table 2-2. iOS permission prompts

PERMISSION	ASKED WHEN	TEXT SHOWN BY IOS
Bluetooth	First scan for a hardware timer	"NordicRaceTrace connects to a Summit race timer over Bluetooth so finish times arrive automatically instead of being tapped in by hand."
Camera	Take a Photo start-list import	"Take a photo of a printed start list and NordicRaceTrace will read the racers from it."
Photo Library	Choosing an existing photo of a start list	"Choose a photo of a start list and NordicRaceTrace will read the racers from it."
Files	CSV import, PDF/CSV export	System document picker; no blanket access is requested.

2.3 Coach accounts, teams and roles

A **coach account** is created by signing in with Google or Apple, either on nordicracetrace.com or in the app under **Settings** → **Coach Account**. The same identity works in both places. A coach account is needed for anything that touches a team: rosters, Team Time Trials from a roster, website start lists, publishing splits to a team page, and the training log.

- **Team.** A named group with a roster of athletes (name, gender, graduation year). A coach can belong to several teams.
- **Owner.** The coach who created the team, or to whom ownership was transferred with **Make owner**. Only the owner can delete time-trial results and manage other coaches.

- **Coach.** Invited to a team. Can view and edit rosters, build and edit shared start lists, and run trials.
- **Club.** Each coach account has exactly one club (a 1:1 relationship), used for the club's timed-races page. There is no multi-club selection.

2.4 Preparing the phone for a race

These steps take two minutes and remove the most common causes of a bad result. They are repeated in the printable checklist in [Appendix B, p. 74](#).

- 1 **Turn off automatic time.** iOS Settings → General → Date & Time → Set Automatically = Off, for the duration of the race. See §3.9, p. 18 for why. Turn it back on afterwards.
- 2 **Charge.** A phone at a cold finish line loses charge quickly; lithium cells deliver noticeably less below 0 °C. Keep the phone in an inside pocket until needed and carry a battery pack. The screen stays awake for as long as a race is running, which costs power.
- 3 **Sound.** If you want the FIS start-sequence beeps, turn **Sound Effects** on in Settings. The audio plays even with the ring/silent switch on silent.
- 4 **Notifications.** Enable a Focus mode (Do Not Disturb) so a banner never covers the number pad at the moment a finisher arrives.
- 5 **Gloves.** Touch-screen gloves, or a stylus on a lanyard. A missed tap is a missed time.

CHAPTER 3

The Timing Model

Every result NordicRaceTrace produces is the output of a short chain of arithmetic: a timestamp, minus a race start, minus an athlete's scheduled start, truncated to a display precision, then ranked. This chapter defines each link in that chain precisely. The hardware timer replaces the first link with a better one; the rest is identical.

3.1 Timestamps

When you record a time on the phone, the app reads the device system clock — `Date.now()`, milliseconds since 1970-01-01T00:00:00Z — and stores that number. It stores nothing else about the instant. A timing session is therefore a set of absolute timestamps keyed by entry:

```
times = { "7": [1759329319812], "47": [1759329323504, 1759330103991], "?1": [1759329329617] }
methods = { "7": "posted", "47": "bib_impulse", "?1": "impulse" }
status = { "12": "DNF" }
```

- **Entry ID.** The key. A bib number for bib-based timing; for Team Time Trial without bibs, the athlete's position in the start order; for a time not yet assigned to anyone, an **unknown** key `?1`, `?2`, ... in capture order.
- **Lap array.** Each entry holds an array. The first element is lap 1 (or the finish), the second lap 2, and so on — recording the same bib again appends a lap.
- **Method.** How the time was captured (Table 3-3, p. 18). It is a confidence label, not decoration.
- **Status.** DNS, DNF or DSQ, kept separately so that marking a status never destroys the timing data underneath it.

DESIGN NOTE

Absolute timestamps make every other quantity recomputable. The race start, the interval and each athlete's start can all be corrected after the fact and every result recomputed, because nothing derived was ever stored in place of the raw instant. The saved form of a race carries its *race context* — start time, clock mode and offset, first bib, interval, and methods — for exactly this reason.

3.2 The race start and the three clock modes

In Race Timing and Team Time Trial, results are measured from a single **race start**, R , an absolute timestamp. You establish it in the **Pre-Start** sheet by choosing a clock mode, entering a clock value $h:m:s$, and pressing **Start Race**. At the press, the app computes a clock offset c and sets

$$R = t_{\text{press}} - c$$

Table 3-1. Clock modes in the Pre-Start sheet

MODE	MEANING OF THE VALUE YOU ENTER	OFFSET C	USE IT WHEN
Since Start	How long the race has already been running at the moment you press. <code>00:00:00</code> = the start is now.	$+(h \cdot 3600 + m \cdot 60 + s) \cdot 1000$	You start the phone on the gun (enter 0), or you arrive late and know the race clock (enter it).
Until Start	How long until the start. The race clock counts down through zero.	$-(h \cdot 3600 + m \cdot 60 + s) \cdot 1000$	You want a countdown, or you will start the race from the Summit on a countdown (§18.3, p. 58).
Time of Day	The time of day the race clock should read at the moment you press. Pre-filled from the first start time in the start list.	<code>t_press - today(h:m:s)</code>	The start list is published in clock times (11:30:00, 11:30:30, ...).

Two consequences are easy to miss. First, in **Time of Day** mode the phone's own wall clock does not have to be right: the race clock is *set* to the value you enter at the instant you press, exactly as a Summit is synched with **Ctrl** + **5**. Second, in every mode, elapsed times are ultimately measured from the press, so a late press makes every elapsed time short by the same amount. Starting from the hardware timer removes that error (§18.3, p. 58).

3.3 Athlete start times

Each athlete's start S is derived from R by the first rule that applies:

Table 3-2. Rules for an athlete's start time, in priority order

#	CONDITION	START TIME S
1	Time of Day mode and the athlete has a clock start time (e.g. <code>11:30:30</code>)	$R + (\text{athlete_tod} - \text{tod}(R))$ — the difference between the athlete's start and the race clock's reading at R
2	The athlete has an explicit start offset (<code>startTimeMs</code>) from an imported list or a pursuit	$R + \text{startTimeMs}$
3	Interval start (15, 20 or 30 s)	$R + \max(0, \text{bib} - \text{firstBib}) \times \text{interval}$; <code>firstBib</code> is the lowest bib in the start list, or the bib entered in Pre-Start
4	Mass start (interval 0)	R

CAUTION

An interval of 0 means mass start. Several historical bugs came from code treating 0 as "not set" and substituting a default interval; the app now tests for an absent value explicitly. If a mass-start race shows athletes with staggered or negative times, check that the interval really is 0 in the race context.

The app refuses a time for an athlete who has not yet started: tapping a bib before S shows **Athlete Not Started** with the seconds remaining. Tapping the same bib twice within **5 seconds** shows **Duplicate Entry**; a genuine next lap is accepted after that.

3.4 Elapsed time

For an entry with timestamp t on lap k , Race Timing and Team Time Trial compute

```
elapsed_k = t_k - S
```

and the lap time is the difference between consecutive elapsed values. When a race has no recorded start (only possible for data saved by very old versions), the app re-bases on the earliest time in the lap: the leader reads 0:00 and every gap behind is still exact.

3.5 Split Timing arithmetic

Split Timing never needs to know when the race started. A coach standing on the course cares about *gaps*, and the gap between two athletes at a point does not depend on the race start at all. The app computes a **corrected time** for each pass,

```
corrected = t - startOffset
startOffset = startTimeMs      (imported start list)
              = (bib - 1) × interval (interval start, no list)
              = 0              (mass start)
```

sorts by it, and reports each athlete's **time behind** the leader: `corrected - corrected_leader`. The absolute value of `corrected` is meaningless — it is a wall-clock instant shifted by a nominal offset — but every difference between two of them is an exact time gap, which is what the coach shouts. Because there is no race start, Split Timing has no Start button, no Pre-Start and no Stop; the session begins with the first time you record.

NOTE

Split Timing's default offset assumes bibs start at 1 and are in start order. If your first bib is 101, or the order is not the bib order, load a start list with start times; the gaps will otherwise be off by a constant per athlete.

3.6 Precision and truncation

Times are stored to the millisecond and **displayed truncated** to tenths of a second, which is the timing convention: 5:40.39 is 5:40.3, never 5:40.4. Truncation, not rounding, is what the printed tape of a hardware timer does too, so a phone result and a tape line agree digit for digit.

When a Summit is attached and set to hundredths, the app detects it from the timer's own output — every record carries two decimals — and displays hundredths for that race (§20.7, p. 65). There is no setting.

WARNING

A one-millisecond error is not harmless under truncation. If a reference is 1 ms late, 34:17.100 becomes 34:17.099 and displays as 34:17.0 — a whole tenth an official will query. For that reason, any hardware-derived reference value is snapped to the display precision before use (§18.5, p. 60).

3.7 Ranking and ties

Results use **standard competition ranking** ("1224" ranking), keyed on the *displayed* time:

- Two athletes whose times display identically share a place, and the next place is skipped: two at 5:40.3 are 11th and 11th, and the next athlete is 13th.

- The comparison is on the displayed string, not raw milliseconds. 340 312 ms and 340 349 ms both read 5:40.3, and 5:40.3 is the official time of each; ranking on milliseconds nobody timed to would break a genuine tie.
- Entries without a time — DNS, DNF, DSQ, or still on course — take no place and do not consume one, so a DNF between two finishers cannot push the second down.
- On the website, an impossible (negative) elapsed time never ranks. It stays editable on the reconcile worksheet and appears unranked at the bottom of the public results.

The app, the CSV and PDF exports and the website all apply the same rule, so places agree everywhere.

3.8 Recording methods and confidence

Every time carries the method that produced it. The method decides how much the time can be trusted and how it is shown in **Recently Timed** and on the reconcile worksheet.

Table 3-3. Recording methods, in descending order of confidence

METHOD	ICON	PRODUCED BY	WHAT THE TIME MEANS
posted		Post + Impulse in the app, or a Summit P record	Athlete confirmed <i>before</i> the crossing; time stamped at the Impulse. Highest confidence: nothing to review.
impulse		Impulse with no bib, or a Summit S record	Accurate crossing time, athlete unknown. Stored under ?n until assigned.
impulse_unknown		? in Team Time Trial Accurate mode	An impulse the operator deliberately left unassigned. Still a real time, still assignable later; shown as Unknown rather than Assign bibs .
bib_impulse	#	Bib typed then the timer button (Race Timing), or a Summit b record	Athlete known; time is when the operator <i>finished typing</i> , not when the athlete crossed. Biased late by reaction and typing time.
bibpress / numpad	—	Tapping a name tile or bib, or number pad in Split Timing	Athlete known; time is the tap.
spotter_order		A spotter device	Not a time at all: a finishing position (1, 2, 3, ...) used to identify impulses (§10.3, p. 34).

3.9 Dependence on the phone's system clock

Because phone timestamps are read from the system clock, a change to that clock during a race moves every time recorded after the change by the size of the change. iOS can change it without warning when **Set Automatically** is on and the phone resynchronizes with the network. The correction is usually small but has been observed at several seconds, and the same failure is documented by other phone-based timing products.

The app cannot read the **Set Automatically** switch (iOS exposes no API for it), so the Pre-Start **preflight** carries a row you tick by hand. The app *does* watch for the clock moving while a race runs and records each event with the race:

Table 3-4. Clock events the app records during a race

KIND	DETECTED AS
jump	A 1-second watchdog compares the wall clock against where it should be. A discrepancy greater than ± 4 s while the app is continuously in the foreground is a clock change, not time passing. (The 4 s margin keeps a JavaScript thread stalled by a busy finish from raising a false alarm.)
backward	On returning to the foreground, the wall clock reads <i>earlier</i> than when the app left by more than 10 s. Certain: nobody is away for negative time.

back-ground	On returning, the app was away for more than 10 s. Ambiguous by nature — a long absence and a forward clock change look identical without a clock that runs through suspension — so it is reported with that caveat.
--------------------	--

Recorded clock events are shown while the race is running, travel with the saved race, and appear as a banner on the reconcile worksheet ("the phone clock moved back by about 4 seconds at 10:42:07 — times after this are shifted by that much"). The app does not attempt to correct the times; it makes sure nobody is unaware that they might need correcting.

NOTE

A hardware timer is immune to all of this. Its times are taken from its own crystal and subtracted from each other; the phone's clock is used only to display a running clock.

PART II

The App

A reference to every screen, every way of getting athletes into the app, and every setting. Procedures for actually running a race are in Part III.

CHAPTER 4

Screen Reference

The app is organized as five tabs along the bottom of the screen, plus a small number of full-screen editors opened from them. The Timer tab is where races happen; the other four exist to feed it and to keep what it produces.

Table 4-1. Tabs

TAB	PURPOSE
Timer	The live timing surface: race controls, number pad or name tiles, Recently Timed, and the entry points for start lists, Share Live and the hardware timer.
Results	The current session ranked, per lap, with editing, insights and export (CSV, PDF).
Events	Saved races and start lists on this phone, newest first. Includes a built-in <i>Sample Race</i> with 65 athletes for practice.
Live	An in-app browser for other organizers' live results (Bullitt Timing, Zone4, FIS live timing, RaceResult), with pinch-zoom forced on.
Settings	Coach account, timing defaults, feedback, highlighting, subscription and data management (Chapter 6, p. 26).

4.1 The Timer screen

The Timer screen changes shape with the timing mode and with the race state, but always has the same three regions: a **top bar** of tools, a **race bar** with the clock and race controls, and an **entry surface** (number pad or name tiles) above **Recently Timed**.

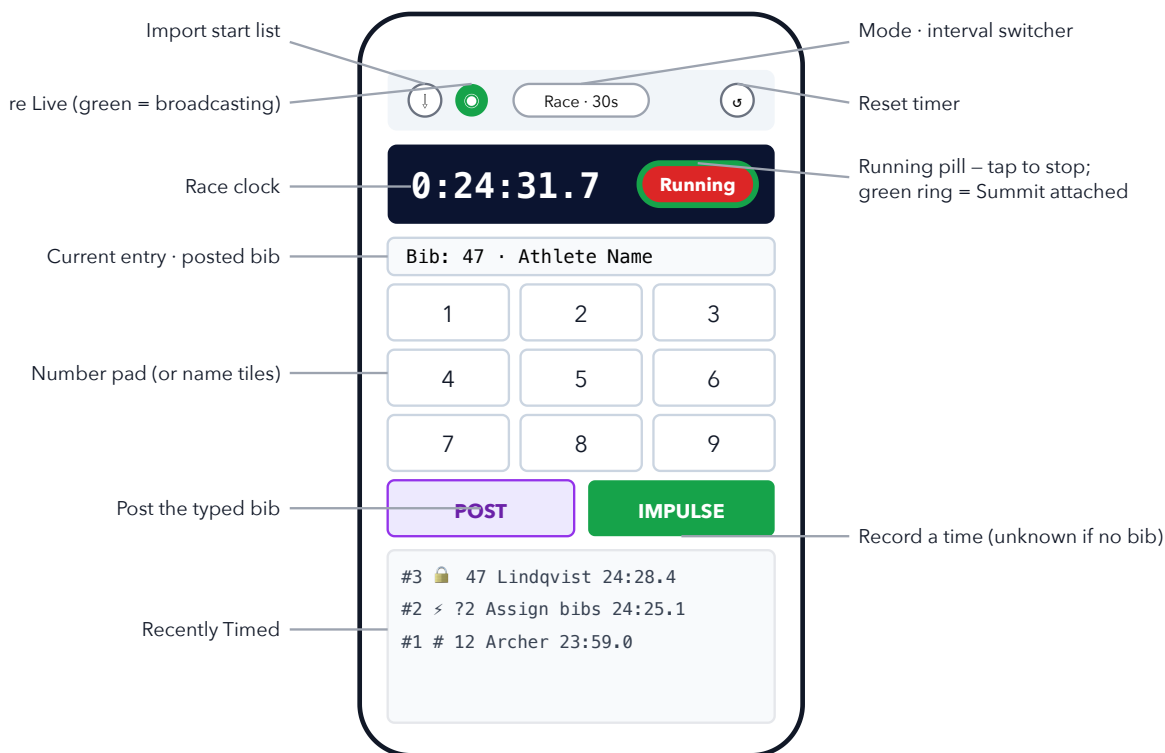


Figure 4-1. Anatomy of the Timer screen in Race Timing on an iPhone (schematic; exact layout varies by device, mode and entry mode).

4.1.1 Top bar

- **Import** (download icon) — opens the start-list sources ([Chapter 5, p. 24](#)). Pro.
- **Share Live** (radio icon) — publishes the race and pairs co-timers. Green while broadcasting; carries an amber or red triangle when syncs are failing (§10.4, p. 34). Pro.
- **Mode and interval switcher** — Split / Race / Team Time Trial and the start interval. Changing mode clears the active session, so the app asks first.
- **Reset** — ends a session without a race being "stopped"; offers **Keep Start List** (or **Keep Custom Start Times**) and **Reset Everything**, then offers to save.

4.1.2 Race bar

Before a race: the first bib, the interval and **Start Race**, which opens the Pre-Start sheet (§8.2, p. 29). During a race: the running clock in large type and a red **Running** pill. Tapping the pill is how you stop the race. A **green ring** around the pill means a hardware timer is attached and feeding.

4.1.3 Entry surface

Two entry modes, toggled from the race bar or set in Settings:

- **Number Pad** — type a bib; the athlete's name appears beside the number as you type if a start list is loaded. The timer button records it. In Race Timing the pad adds **POST** and **IMPULSE** (§8.5, p. 30).

- **Bib Press** — a grid of tiles, one per athlete, showing the bib with the name under it (or the name alone in Team Time Trial without bibs). One tap records. Requires a start list. An optional confirmation step (**Bib Press Confirmation**) guards against mis-taps.

Long-press any athlete (tile or row) to set **DNS**, **DNF** or **DSQ**; long-press again to clear it. A status never deletes timing data.

4.1.4 Recently Timed

The most recent captures, newest first (Team Time Trial: oldest first, scrolled to the latest). Each row shows a position number (#5), the method icon from [Table 3-3, p. 18](#), the bib or ?n, the name, and the time. Unassigned impulses read **Assign bibs** in orange; impulses deliberately set aside read **Unknown** in grey. Tap a row to assign, edit or delete it. Above the list, a count of timers shows how many devices are contributing when Share Live is on.

4.2 The Results screen

Results are recomputed from raw timestamps every time the screen renders, so any edit — a bib reassignment, a start time correction — takes effect everywhere at once.

- **Lap selector** for multi-lap sessions; lap times and cumulative times.
- **Tap a result** for the action sheet: **Edit Time**, **Assign Bib Number** (for an unknown), **Swap Bib**, **Edit Athlete Info**, **Delete Time** and **View Key Insights**.
- **Insights** (Split Timing especially): places gained or lost between passes, "now ahead of" a named athlete, and up to five highlighted athletes followed in a dedicated panel.
- **Start-list view** of the loaded athletes and their scheduled starts.
- **Export** to CSV or PDF ([§11.1, p. 36](#)), and a share link when the race is published.

4.3 The Events screen

Everything saved on this phone: finished races (*results*) and prepared start lists (*events*), newest first. Opening a saved result loads it read-only into the Results screen; tapping a start-list event offers **Time a Race** or **Take Splits** with that list. A result that was published shows **View on Web**. **+ Event** creates an event from scratch (Pro). Saved results carry their full race context, so they render identically however long afterwards they are opened.

4.4 Other screens

Table 4-2. Full-screen editors

SCREEN	OPENED FROM / PURPOSE
Start List Import	Import → team roster, CSV, manual input, saved lists.
Start List Creator / Editor	Typing a list from scratch; editing names, bibs, teams, start times.
Team Trial Setup	The three-door chooser for Team Time Trial (§9.1, p. 32).
Team Start List	Build a trial from a roster: order, bibs, gender filter, guests, start intervals.
Field Mapping	Shown after a CSV or photo import to confirm which column is which.
Hardware Timer sheet	Mid-race status of the Summit link (§19.4.1, p. 63).

CHAPTER 5

Start Lists and Rosters

A start list maps entry IDs to athletes: name, team, category, class, gender and, optionally, a start time. Nothing about timing requires one — every mode works on bare bib numbers — but a list gives you names in results, Bib Press tiles, the "not started yet" guard, and per-athlete start times for staggered and pursuit starts.

5.1 Sources

Tap the **Import** (download) icon on the Timer screen. The sources are:

Table 5-1. Start-list sources

SOURCE	NETWORK	NOTES
NordicRaceTrace.com	Required	Public race start lists browsable by season and event (including pre-made Bullitt Timing lists for Eastern Cup and EISA races), plus, when signed in, lists you saved yourself.
CSV File	None	Parsed on the phone. Headers matched automatically (Table 5-2, p. 24), then confirmed on the Field Mapping screen.
Take a Photo	Required	Photograph a printed list. The image is resized on the phone to 1568 px (JPEG q 0.8, typically a few hundred KB) and read by the website's converter. Server reachability is checked <i>before</i> the camera opens.
Team Time Trial Roster	Sign-in	Routes to the Team Time Trial chooser (§9.1, p. 32).
Manual Input	None	Type or paste names and bibs.
From My Events / My Start Lists	Varies	Reuse a list saved on the phone, or one saved to your website account.
Remove Current Start List	—	Removes the list; times already recorded are kept.

5.2 CSV format

The importer is deliberately forgiving: a header row is required, column order is free, and headers are matched by substring, case-insensitively. A missing column is simply left blank.

Table 5-2. CSV header matching

FIELD	HEADER CONTAINS	VALUE
Bib	bib, id, number	Integer. Required for bib timing.
Name	name, athlete, participant; or separate first / last	First and last are joined.
Team	team, club, affiliation	Used for team highlighting.
Category	category, age	Free text.
Class	class, division, group, bracket	Free text.

Gender	<code>gender</code> , <code>sex</code>	M / F
Start time	<code>start</code> , <code>time</code>	HH:MM:SS time of day (e.g. 14:00:00) or an offset. Stored per athlete as milliseconds after the <i>earliest</i> start in the file.

```
Bib,First,Last,Club,Class,Gender,Start
1,Astrid,Lindqvist,QRSC,U18,F,11:30:00
2,Maya,Archer,Colby,U18,F,11:30:30
3,Ingrid,Nilsson,QRSC,U18,F,11:31:00
```

A start column switches the race to **custom start times**: every athlete's start comes from the list (rule 2 or 1 of [Table 3-2, p. 16](#)) and the uniform interval is ignored. Waves, pursuits and tandem starts are all just start lists with the right times in them.

5.3 The website start-list converter

At nordicracetrace.com, the converter turns a PDF or HTML start list (or a URL to one) into structured rows you can map, preview and send to the app. Layout heuristics handle the common timing vendors' formats; when they recover fewer than three rows the converter falls back to an AI parser, which is particularly good at Scandinavian lists (it keeps å, ä, ö, æ, ø and recognizes *Startnr*, *Namn/Navn*, *Klubb*, *Klass/Klasse*). CSV and RaceResult API sources never go through the AI path. Photo import in the app uses the same endpoint.

5.4 Team rosters and website start lists

A **roster** is a team's athletes on the website: name, gender and graduation year, each with a stable athlete ID. Signing in on the app makes the roster available; nothing is retyped.

A **Time Trial Start List** is built on the team page: drag (or ↑/↓) to order, filter by **All / Men / Women**, assign bibs, set a date (defaulting to today), add guests, and save. Each saved row carries the athlete's **roster ID**, so the app resolves athletes by identity and never by guessing from a name. Lists shared with a team are visible and editable by any accepted coach; only the creator or the team owner can delete one.

5.5 Guests

A **guest** is someone who races a trial without being on the roster — a visiting national-team athlete, a parent, a prospective recruit. Add one in the start-list builder in the app or on the website. A guest is a full member of *that one trial* and nothing else: their result is saved under their own name and ranked normally, but they are excluded from personal-best tracking and are not linked to an athlete history.

NOTE

Personal-best tracking skips guests on purpose. Keyed on an empty athlete ID, every guest from every session of a recurring event would collapse into one "athlete", and the fastest guest ever would hold everyone's PB badge.

CHAPTER 6

Settings Reference

Table 6-1. Settings

SETTING	VALUES	EFFECT
Coach Account	Google / Apple sign-in	Connects the app to your teams: rosters, website start lists, team publishing, training logs. Shown at the top.
Timing Mode	Split · Race · Team Time Trial	See Table 1-2, p. 11 . Switching clears the active session.
Entry Mode	Number Pad · Bib Press	Number Pad is restored at every launch for Split and Race; Team Time Trial always uses tiles and remembers Simple/Accurate.
Default Interval	0 · 15 · 20 · 30 s	Start interval when no start times are loaded. 0 = mass start. Default 30 s.
Bib Press Confirmation	On · Off	A confirm step after each tile tap.
Sound Effects	Click · Beep · None	Confirmation sound on each capture, and the FIS start-sequence audio.
Haptic Feedback	Light · Medium · Heavy · None	Vibration on each capture.
Last Timed Athlete	display option	How the most recent capture is presented above the pad.
Team Highlighting	team names	Your teams' athletes are colour-coded in results and live pages.
Athlete Highlighting	up to 5 athletes	Followed individually in the insights panel.
Athlete Training Logs	link	Opens the website training log for your team.
Subscription	—	Status, Manage in App Store , Restore Purchases .
Data Management	—	Clear All Data (destructive, confirmed) and Delete Account .
Learn More & Get Help	—	User Guide, Restart Welcome Tour , website, privacy policy, terms.

NOTE

The hardware timer has no entry in Settings. It is configured where it is used — the **Pre-Start** sheet of Race Timing — and is remembered once paired ([§17.2, p. 55](#)).

PART III

Running a Race

Step-by-step procedures for each timing mode, for sharing a race live and timing it on more than one phone, and for getting a finished race reconciled, published and archived.

CHAPTER 7

Split Timing

Split Timing is for a coach on the course: at a climb, a lap lane or a feed zone, recording athletes as they pass and reading off who is gaining and by how much. It needs no start list, no start and no stop.

7.1 Before the race

- 1 Select **Split Timing** (Settings or the Timer screen switcher).
- 2 Set the interval to the race's start format: **0** for a mass start, or 15, 20 or 30 s. Split Timing assumes bib 1 starts first and bibs go in order at that interval (§3.5, p. 17).
- 3 For anything else — a first bib other than 1, a pursuit, waves, a seeded order — load a start list *with start times*. Each athlete's own start then replaces the interval assumption.
- 4 Optional: add your team under **Team Highlighting** and pick up to five athletes under **Athlete Highlighting** so they stand out.

7.2 Recording splits

- 1 As an athlete passes, type the bib and tap the timer button — or tap their tile in Bib Press. The time is the instant of the tap.
- 2 Missed the bib? Tap without one. The time is kept as an unknown (?1 , ?2 ...) and can be assigned from Results later.
- 3 Recording the same bib again adds the next lap. Taps of the same bib within 5 s are rejected as duplicates.
- 4 Read the result: Results ranks by corrected time and shows each athlete's **time behind** the leader at your point. From the second pass on, insights show places **gained or lost** since the previous pass and who an athlete has just moved ahead of.

TIP

Two coaches at two points on the same loop, each in Split Timing, give you a gap-at-point comparison per lap with no coordination beyond agreeing on the start format.

7.3 Saving and publishing splits

Split Timing has no Stop. To finish, tap **Reset**, choose whether to keep the start list, and then **Save**. If you are signed in, **Save & Publish to Team** also publishes the session to your team page under **Splits** (the picker appears only if you belong to more than one team). Published splits are reachable by link and listed on the coach-authenticated team dashboard; they do not appear in the public race-results archive.

CHAPTER 8

Race Timing

Race Timing records finish times against a race start, for a mass start or an interval-start field. It is the mode that supports co-timers, spotters, the reconcile worksheet and the hardware timer.

NOTE

NordicRaceTrace is well suited to club races, school meets, time trials and backup timing. For a sanctioned event that requires certified equipment, use a professional timing service — and consider running NordicRaceTrace alongside it as backup.

8.1 Setting up

- 1 Select **Race Timing**.
- 2 Load a start list if you have one ([Chapter 5, p. 24](#)). With start times in it, the race uses custom start times; without, set the interval (0 for mass start).
- 3 Decide whether to turn on **Share Live** now ([Chapter 10, p. 34](#)). It must be on *before* the start if a second phone will co-time, and it is what makes the reconcile worksheet available afterwards.
- 4 If a hardware timer will be used, connect it now in Pre-Start ([Chapter 19, p. 62](#)).

8.2 The Pre-Start sheet

Start Race opens Pre-Start, which collects everything needed to define *R* ([§3.2, p. 15](#)) and checks the race is ready. From top to bottom:

Table 8-1. Pre-Start sheet contents

SECTION	CONTENTS
PREFLIGHT	Four rows. <i>Race name</i> (optional). <i>Athletes loaded</i> (count, or "No start list — you can still time by bib"). <i>Share Live</i> on or off. <i>Phone clock set manually</i> — a row you tap to tick, because the app cannot read iOS's Set Automatically switch.
First starter	The first bib (or, timing by name, the first athlete, their start and the interval, with how many start alongside them in a wave).
Clock mode	Since Start · Until Start · Time of Day , and an <i>h:m:s</i> value. Time of Day is pre-selected and pre-filled when the start list carries clock times.
Hardware timer	A single quiet row, BETA , expanding to scan, connect and see the timer clock (Chapter 19, p. 62).
Cancel · Start Race	Pinned below the scrolling content so they are always reachable.

8.3 Starting the race

Choose the clock mode that matches how you know the start:

- **On the gun:** Since Start `00:00:00` ; press **Start Race** as the gun fires (or as the first interval starter goes).
- **On a countdown:** Until Start, e.g. `00:00:15` ; press 15 s before the start. The race clock runs negative, then through zero.
- **Late:** Since Start with the race clock reading as you press.
- **Clock-time start list:** Time of Day, pre-filled with the first start; press as the race clock should read that time.
- **From the Summit:** leave Pre-Start open and press **IMPULSE** on the timer (§18.3, p. 58). This is the only exact start.

The screen then stays awake for as long as the race runs.

8.4 The FIS start sequence

With an interval start or custom start times and Sound on, the app sounds the FIS individual-start sequence for whoever starts next, so it keeps up through an entire interval field without help. Its phases, in time remaining to that athlete's start:

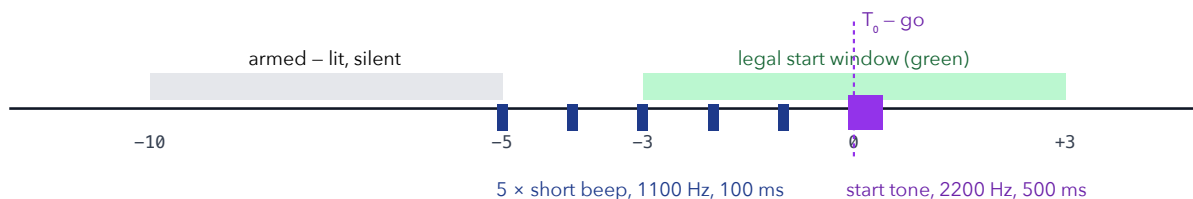


Figure 8-1. The FIS individual-start sequence as the app plays it. Tone frequencies follow the ALGE/TAG Heuer convention (count-down 1000-1200 Hz, start 2000-2400 Hz).

A mass start has a single start, which the Pre-Start countdown covers instead. The audio plays even with the phone on silent.

8.5 Recording finishes: number pad, Impulse and Post

Race Timing offers three ways to capture a finish, with different accuracy and workload.

Table 8-2. Finish capture techniques

TECHNIQUE	OPERATOR ACTION	RESULT
Bib then time	Type the bib, tap the timer button	<code>bib_impulse</code> . Athlete certain; time biased late by typing time. Fine for a sparse finish.
Impulse alone	Tap IMPULSE as the athlete crosses; assign later	<code>impulse</code> under <code>?n</code> . Accurate time; identity filled in afterwards. Best for a pack.
Post + Impulse	Type the bib and tap POST as the athlete approaches; tap IMPULSE at the line	<code>posted</code> . Accurate time <i>and</i> certain identity. Best whenever you can see who is coming.

A posted bib is shown above the pad until the impulse consumes it; **Clear posted bib** cancels it. Unknown impulses are assigned from Recently Timed or Results: tap the row, **Assign Bib Number**. Two athletes crossing together can be assigned to one time.

TIP

Post + Impulse is the same workflow the Summit timer's **POST** key implements, and it produces the same, highest-confidence record type (§16.2, p. 52).

8.6 DNS, DNF and DSQ

Long-press an athlete on the Timer screen to set a status; long-press again to clear it. Statuses are marks, not deletions: the times underneath are kept and reappear if the status is removed. On the website they are equally reversible and exclude the athlete from standings and lap rankings.

8.7 Stopping the race

Tap the red **Running** pill. The **Stop Race?** dialog offers:

- **Save & Stop** (bold, the default) — archives the race to Events, flushes the last sync, marks the live event complete and disconnects it, then shows **Review & Publish Results** with the reconcile link (or, without Share Live, **Publish to Web**).
- **Discard & Reset** — opens a second dialog that states exactly what will be lost ("This deletes 23 times for 21 athletes for good. There is no undo.") with **Keep Timing**, **Save Instead** and **Delete Everything**.
- **Hardware Timer...** — present only when a Summit is connected; opens its status sheet without stopping anything.

DESIGN NOTE

Each race stands alone. Stopping disconnects the live event so the next race starts a fresh one; otherwise the next race's first sync would replace the previous race's times on the server.

8.8 Crash and force-quit recovery

The entire session — times, methods, statuses, start list, race start, clock mode and offset, interval, first bib, live-event pairing, and the hardware timer's calibration and provenance — is written to the phone's storage (the `activeSession` snapshot) on every change. Writes are atomic (temporary file and rename), so a crash mid-write leaves the previous complete snapshot intact. On relaunch the app restores the session before anything can overwrite it, and the race clock resumes at the correct elapsed time, because it is computed from the stored race start, not counted.

CHAPTER 9

Team Time Trial

Team Time Trial is Race Timing tuned for practice: athletes come from your roster, are identified by name, and results go straight to the team page and its personal-best history.

9.1 The three doors

Choosing Team Time Trial while signed in loads your roster (or asks which team, if you have several) and offers three doors:

Table 9-1. Team Time Trial entry points

DOOR	WHAT IT DOES
Build start list	Pick athletes from the roster, drag into expected finish order, choose bibs or none, filter by gender, add guests, set interval or wave starts.
Load start list	Lists saved on the website appear inline, filtered to those dated within ± 7 calendar days (undated lists always shown). Loading keeps the website's order <i>and</i> its bibs. Anyone who cannot be matched to the roster is named, not just counted.
Join another timer	Pair this phone with a trial another phone is already running (§9.4, p. 33).

9.2 Simple and Accurate modes

Table 9-2. Team Time Trial capture modes

MODE	OPERATOR ACTION	USE WHEN
Simple	Tap the athlete's name as they cross. The tap is the time.	Athletes arrive one at a time.
Accurate	Tap the full-width Impulse bar at every crossing; then tap names to attach them to the oldest pending impulse. Tiles are dimmed and inert while nothing is pending. ? sets the oldest pending impulse aside as Unknown .	A pack finishes faster than names can be found — a mass-start track trial, a sprint finish.

The contract in Accurate mode is strict: **the Impulse bar is the only thing that creates a time; a name tile only assigns one**. A late tap on a name can never stamp a fresh, late time. The choice of Simple or Accurate is remembered between launches.

9.3 Running the trial

- 1 Open a door and finish the start list. Order matters: it is the tile order and, for interval starts, the start order.
- 2 **Start** opens the same Pre-Start sheet as Race Timing. For interval starts the countdown panel shows who has gone, who is going, and the time to the next start.
- 3 Capture finishes in Simple or Accurate mode. Assign any unknowns by tapping them: without bibs, the assign sheet lists the roster as checkboxes (searchable above eight athletes), marking anyone who already has a time.

- 4 Tap **Running** → **Save**. The trial is archived to Events first, then offered to the team page, where you can rename it. Discard asks twice.

9.4 Two phones

A second phone joins with the Co-timer Code (Share Live → **Join as Co-timer**, or the **Join another timer** door). It receives the trial itself — names, order and start times — and the race start. Each phone keeps and uploads **its own** times; the phones do not display each other's. If both save, the team page shows two trials (the second auto-re-named "Name (2)"), and the coach deletes the one not wanted. Team Time Trial deliberately has no merge step.

CAUTION

Each phone stamps times with its own clock against the host's race start, so any difference between the two phones' clocks appears as a constant offset on the joiner's times — typically around a tenth of a second. Compare phones' times with each other only with that in mind (§18.7, p. 60).

9.5 Recurring events and personal bests

On the website, a **recurring event** ("Weekly 5K Time Trial") groups sessions of the same trial. Each shows *All-Time Standings* (best time per athlete across all sessions), *Per-Date Results* and *Personal Bests*. A session's name and date can be edited — including one occurrence of a series — without disturbing the rest. Historical results can be imported from CSV.

CHAPTER 10

Share Live, Co-timers and Spotters

Share Live publishes a race to the web while it is running and lets other phones time it with you. It is the path to the reconcile worksheet, where several independent records of a race are turned into one result.

10.1 Starting a broadcast

- 1 Tap the radio icon → **Start Live Sharing**. Enter an event name and the timing points you will cover.
- 2 The app creates a server event and shows two codes: the **Results Code**, behind the public page `live.nordicracetrace.com/event/CODE`, and the private **Co-timer Code**.
- 3 Share the public link with anyone. Share the Co-timer Code only with people you trust: it lets them write times into your race.

10.2 Co-timers

On another phone: radio icon → **Join as Co-timer**, enter the Co-timer Code and a name (shown on the merge page, up to 10 characters), and choose the role **Timer** or **Spotter**. A joined phone adopts the host's race start and settings and polls the server every 3 s for changes, following the host if the race is restarted — but only until it has recorded a time, after which its clock is never re-based underneath existing times.

Every phone uploads its whole set of times for the race, per device. The server stores each device's times separately, so no phone can overwrite another. The live page shows the merged view; the reconcile worksheet shows them side by side.

10.3 Spotters

A **spotter** records finishing *order* and nothing else: they type bibs as athletes cross, building the sequence 1, 2, 3, ... A spotter is never the primary device and its data never reaches live results directly. On the reconcile worksheet its order is shown beside the primary's impulses, and:

- impulses the primary captured with no bib are ranked by time and matched to the spotter's order by position, appearing as **Suggested** rows to accept;
- a bib the primary confirmed (Post or bib+impulse) at rank N but the spotter recorded at rank $M \neq N$ is flagged as a **Conflict**.

A timer capturing Impulse-only plus a spotter calling bibs is the phone equivalent of a finish beam with a bib recorder — and it is often more accurate than one person trying to do both.

10.4 Sync and its status

Every change schedules a sync 500 ms later (later changes reset the timer), so a burst of finishers goes up as one request. Sync failures are never silent:

Table 10-1.Share Live button states

APPEARANCE	MEANING
Grey radio icon	Not broadcasting.
Green	Broadcasting; the last sync succeeded.
Green with amber triangle	The last sync attempt failed.
Green with red triangle	Three or more consecutive failures. Tap to see how long since anything got through.

The same badge appears on the Results screen. Times are safe on the phone throughout and go up when the connection returns.

CHAPTER 11

Results, Reconciliation and Publishing

11.1 Exporting from the app

CSV exports carry the same places as the screen, ties included:

Position,EntryID,Name,Team,Category,Class,ElapsedTime,TimeBehind	Race Timing / TT
Position,EntryID,Name,Team,Category,Class,TimeBehind	Split Timing
EntryID,Name,Team,Category,Class,StartTime	start list view

Files are named `<race-name>-results-<YYYY-MM-DD>.csv`. **PDF** export produces a formatted result sheet with a race name you choose. Both go out through the iOS share sheet.

11.2 The reconcile worksheet

After a Share Live race, nordicracetrace.com/reconcile/CODE (protected by the timer code) is where results become official. It is deliberately plain and dense — hairline-ruled cells, monospace numerics, plain-text statuses — and prints cleanly.

11.2.1 Summary bar

Athletes (distinct bibs with times; start-list total beneath), **Timers** (named devices; ⚡ marks the phone carrying a hardware timer; the pseudo-device for hand entries is not counted), **OK**, and • **Live** while the page refreshes every 15 s.

11.2.2 Row status

For each athlete the server compares every device's time and computes the spread:

Table 11-1.Reconcile row statuses

STATUS	RULE
OK	All devices agree within 500 ms and none is missing. Published automatically.
Warn	Spread between 500 ms and 1000 ms. Review.
Conflict	Spread over 1000 ms, or primary and spotter disagree on order.
Suggested	A spotter position matched an unidentified impulse.
Unknown	An impulse with no bib.
Missing	On the start list with no time.

11.2.3 Editing

- **Inline cells** like a spreadsheet: Bib, Name, Start, Class and Gender.
- **Opened row:** hand-enter a time (HH:MM:SS.d, **Set Time**), **Accept** one device's time over another's, **Swap Bib** (asking which start time to keep and whether name, club and class move with the time — a swap usually means the wrong athlete was recorded), team, and DNS/DNF/DSQ.

- **Protected edits:** any row you change is never overwritten by a later sync from a phone.
- **Save Progress** snapshots the worksheet; **Raw Data** shows every captured impulse read-only and can reset to it (snapshotting first); **Finalize** locks results; **Unlock** reopens them.

Races with a hardware timer gain tape provenance, a completeness proof and clock alignment on this page ([Chapter 20, p. 64](#)). Races where a phone's clock moved carry a banner saying when and by how much (§3.9, p. 18).

11.3 Publishing and the results archive

Published Race Timing results live at nordicracetrace.com/results/CODE and in the public archive. A race timed *without* Share Live can still be published after the fact: **Publish to Web** in the post-save prompt creates the server event, uploads the start list and times, completes and publishes it in one step, and the saved race in Events then offers **View on Web**. Team Time Trials go to the team page; Split sessions to the team's Splits list.

PART IV

Hardware Timer Integration

The Summit SRT-1000 to iPhone link, from the copper up: parts, pinouts, the serial protocol as captured off the wire, the Bluetooth transport, the clock model, and the procedures and diagnostics for using it at a race.

- Status: **Beta**, Race Timing only, app 2.5.0 or later.
- Verified on one SRT-1000 through one DX-CP26, in use at races since September 30, 2026.

CHAPTER 12

Hardware Overview and Bill of Materials

A hand-held hardware timer stamps each impulse against a temperature-stable crystal with millisecond resolution and keeps every record in its own memory. NordicRaceTrace listens to the timer's serial output through a small Bluetooth adapter and turns each record into a time in the race, without anyone typing it in.

12.1 Why add hardware

A phone records the instant a thumb lands on glass. That instant lags the athlete's crossing by a human reaction time of roughly 150–250 ms, with a standard deviation of 50–100 ms, plus 20–80 ms of touch-to-application latency ([Chapter 22, p. 69](#)). A finish beam or plunger on a hardware timer removes the human from the timestamp, and a **POST**ed bib removes the human from the identity: the result is a time that is right to the resolution of the timer, attached to an athlete who was confirmed before they crossed.

Just as important for a scored race, the timer is an **independent, printable record**. Every hardware time in NordicRaceTrace carries the timer's own record number and clock reading, so a result can be checked line by line against the Summit's tape.

12.2 Bill of materials

Table 12-1. Bill of materials for one timer-to-phone link

#	ITEM	QTY	SPECIFICATION AND NOTES
1	Summit Systems SRT-1000 race timer	1	9-channel hand-held timer, 4×16 LCD, 1 ms internal resolution, 10 000-record memory. AA batteries (2 or 4). Chapter 13, p. 41 .
2	DX-SMART DX-CP26 Bluetooth to RS-232/RJ45 wireless adapter	1	BLE serial bridge, internal rechargeable lithium battery, USB charging, external antenna, DB9 and RJ45 interfaces. Sold singly or as a two-unit "for Device" pair; one adapter per Summit is all that is needed (§14.6, p. 47). Chapter 14, p. 45 .
3	RS-232 (RJ45 → DB9 male) adapter	1	Supplied in the DX-CP26 kit. Presents the adapter's serial port as a DB9 <i>male</i> , wired as DTE (pin 2 RXD, 3 TXD, 5 GND).
4	DB9 female–female null-modem cable, 3-conductor	1	Pins 2↔3, 3↔2, 5↔5, nothing else connected ("no handshaking"). The Summit "RS232 Cable to PC" accessory is exactly this cable; any generic 3-wire F/F null modem with that wiring also works. Meter a new cable before trusting it (§15.4, p. 49).
5	Glue-stick antenna	1	Supplied with the DX-CP26; screws onto the ANT connector. Fit it: range without it is much shorter.
6	USB charging cable	1	Supplied with the DX-CP26. Charge before every race day.
7	iPhone or iPad running NordicRaceTrace 2.5.0+	1	One phone per adapter. The phone with the timer attached is the primary timer for the race.
8	Finish input (optional)	—	Plunger (push-button), photocell or other contact closure on channel 1. Without one, the timer's IMPULSE key is the finish input.

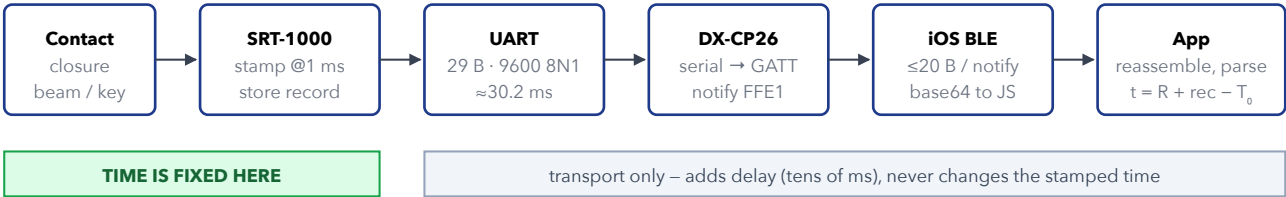
9	Start input (optional)	—	Start wand or gun contact on the start channel. See §13.5, p. 43 for its current status.
10	Spares	—	Fresh AA cells (lithium AA in deep cold), a USB power bank for the adapter, a second null-modem cable.

CAUTION

Do not substitute a "full handshaking" null-modem cable, a straight-through DB9 extension, or a gender changer. A gender changer swaps genders and crosses nothing; a full-handshake cable ties pins together that the Summit uses for its RS-485 timer network. §15.3, p. 49 explains both.

12.3 The signal chain

Figure 12-1, p. 40 traces one finish from the beam to a result. Every stage before the phone is deterministic and stamped by the timer; every stage after it is transport, which delays the record but never changes its time.



The record carries the timer's own clock reading (H:MM:SS.t). Latency after the timer affects only how soon the time appears on the phone and the readout of the live timer clock – not the result. The one exception is a race started from the phone rather than the box, where the phone must estimate where the timer's clock stood at the start.

Figure 12-1. Signal chain for one finish impulse. Stages left of the green bar determine the time; stages to its right only carry it.

CHAPTER 13

Summit SRT-1000 Reference

The SRT-1000 is a hand-held, battery-powered race timer from Summit Systems of Salt Lake City. Specifications in this chapter are from the Summit manual unless marked as observed; behavior observed on the development unit takes precedence where the two disagree.

13.1 Specifications

Table 13-1. SRT-1000 specifications (manufacturer)

Inputs	9 channels. Jacks: ch 1 & 5, ch 2 & 6, ch 3 & 7, ch 4 & 8 (the upper channel of each pair reached with a double plunger), ch 9.
Internal resolution	1 ms (0.001 s), always. Displayed and reported resolution selectable: 0.1, 0.01 or 0.001 s.
Accuracy	± 2 ppm (± 0.16 s/day) from 0 to 40 °C; ± 7.5 ppm (± 0.66 s/day) from -40 to 85 °C.
Storage	10 000 events with up to 6-digit bibs, or 4 000 events with 16-character entries. 50 000 optional.
Display	4×16 character LCD. Operates to -20 °C; the rest of the unit to -40 °C.
Operating temperature	-20 to 70 °C (display-limited). FIS cross-country minimum is -20 °C.
Power	2 or 4 AA cells. Up to 150 h on two, 300 h on four, at room temperature. Low-battery warning at 20 % remaining. Optional AC adapter (does not charge cells).
Serial	RS-232 to a computer; RS-485 network between timers (up to 4 000 ft / 1.2 km); auxiliary RS-232 with TX, RX, CTS, RTS (bar-code scanner).
Wireless option	900 MHz, 7 networks, up to 7 mi line of sight (not used by NordicRaceTrace).
Size, mass	19×10 cm (7.5×4 in); 370 g (13 oz) with batteries, 312 g (11 oz) without.

Translate the accuracy figure into race terms: at 2 ppm, the timer's clock drifts by $2 \times 10^{-6} \times 3\,600\text{ s} = 7.2\text{ ms per hour}$ against true time. Because a result is the *difference* of two readings of the same clock taken minutes apart, the error in an athlete's elapsed time is 2 ppm of that elapsed time — 0.24 ms over a 2-minute sprint, 7.2 ms over an hour — far below the 100 ms display unit. Even at the cold extreme (7.5 ppm), an hour costs 27 ms.

13.2 Keypad and display

Table 13-2. SRT-1000 keys relevant to NordicRaceTrace

KEY	FUNCTION ON THE TIMER	EFFECT IN NORDICRACETRACE
On	Red key, centre of the top row. Power on.	—
Ctrl + Del	Power off: answer <code>yes</code> , then 1 2 3 Enter .	The link drops; the app reconnects when the timer returns.
0 – 9	Type a bib (up to 6 digits).	Nothing until Enter, Post+Impulse.
Enter	Commit the typed entry with the current time.	<code>b</code> record → time with method <code>bib_impulse</code> . With nothing typed: a stray, discarded.

POST	Designate the typed bib as a posting bib for the next impulse.	No record by itself. The next impulse emits a single P record.
IMPULSE	A software switch closure on the selected channel, as a plunger would make.	S record (no bib) → unknown ?n ; P if a bib was posted; Y during a countdown (starts the race from Pre-Start).
Ch	Select the channel that keypad entries and IMPULSE belong to (channels 1–4).	Channel is carried in every record; the app treats channel 1–8 as finish, 0 as start.
B (Block Inputs)	Cycles: block keys → block switches → block both → unblock.	Blocked inputs produce no records. Block switches while plugging accessories.
Bksp	Delete the last typed character.	—
Ctrl + *	Toggle default / bib-entry display mode.	—

The LCD shows, top to bottom: the channel and current time (with a **<**, **=** or **>** sign comparing the count of bibs entered against switch closures), the last external input, the last entry typed, and the entry in progress.

13.3 The Ctrl menu

Table 13-3. Ctrl functions

KEYS	NAME	DESCRIPTION AND RELEVANCE
Ctrl + 0	Totals	Impulse counts per channel and bibs entered. Useful to cross-check the app's count.
Ctrl + 1	History	Times and bibs per channel, on the display.
Ctrl + 2	Reprint	Re-sends stored records out of the serial port. This is the recovery mechanism for anything the phone missed (Chapter 20, p. 64).
Ctrl + 3	Results	Preliminary results matching bibs to impulses per channel. Not used.
Ctrl + 4	Event	Event/heat numbering within one session. Not used; NordicRaceTrace races stand alone.
Ctrl + 5	Synch	Set the timer's clock. Prompts for a time (which may be negative); the next Enter or switch closure applies it (§13.6, p. 43).
Ctrl + 6	Config	Reconfigure. Resets the timer and destroys all stored data.
Ctrl + 8	retx	Retransmit. Not relied on; use Reprint.
Ctrl + 9	Version	Firmware version and checksum.

WARNING

Ctrl + **6** (Config) erases every stored record, which also erases your ability to recover anything with Reprint. Never enter it on race day after the first impulse. If you only need to change the clock, use **Ctrl** + **5**.

13.4 Configuration for NordicRaceTrace

The factory defaults are correct. If a timer has been reconfigured, walk **Ctrl** + **6** *before* race day (answering "no" skips each section) and confirm:

Table 13-4. Required SRT-1000 configuration

PARAMETER	REQUIRED	WHY
Baud rate (Super Expert)	9600	Must match the DX-CP26 (three blue blinks).

Emulation mode	None (native)	The app parses Summit native records only; Tag Heuer 505/605 emulation produces a different format.
Bib entry length	6 (10 000 records)	Bibs must be purely numeric; 16-character user strings will not parse. Changing it requires a reset.
Time resolution	0.1 s, or 0.01 s for sprints	The app follows whatever the timer prints. Set it <i>before</i> the first impulse of the race.
Only timing device / wired to computer	Yes / Yes	Single timer, serial output.
Start impulse zeroes timer	No	A ch 9 impulse re-zeroing the clock mid-race would break To.
24-hour clock	Either	The app reads H:MM:SS; a time-of-day race past midnight is not supported.
Token delay	500 (default)	Irrelevant: output is event-driven, not polled.

13.5 Channels

Every record carries the channel it arrived on. NordicRaceTrace maps them as follows:

Table 13-5. Channel mapping

CHANNEL	TYPICAL INPUT	TREATMENT
1	Finish beam or plunger; keypad default	Finish.
2–8	Second finish plunger, intermediates	Finish (all non-start channels are finishes today). Verified on channel 2.
0	Start wand, or a gun wired to the start input	Start. Never a finish. While Pre-Start is open, starts the race. During a race: in the web timer (<code>/timer</code>), an impulse within the start window of a one-athlete slot becomes that athlete's actual start; in the phone app , collected and shown on the tape only.

NOTE

The Summit manual numbers the dedicated start input channel 9; the serial records seen so far report start-wand impulses as channel 0, and the app keys on 0. A start wand has not yet been used with the integration, so treat wand starts as unverified and keep the published schedule authoritative.

DESIGN NOTE

How wand starts are applied (web timer): an impulse within ± 3 s of an athlete's scheduled slot is taken as their real start; otherwise the schedule stands. Only **one-athlete slots** use the wand — wave and mass starts keep the gun or published time, because a wand cannot say which of several athletes went through it. The window narrows automatically on intervals under about 6 s so that no impulse can be claimed by two slots ($\text{window} = \min(3000, \lfloor \text{gap}/2 \rfloor - 1) \text{ ms}$). The scheduled start is never overwritten: the server keeps both, and uses a start set by hand on the reconcile page first, then the wand start, then the schedule. A start timer that cannot be wired to the timing shed can be Reprinted into the race afterwards. The phone app collects wand impulses but does not yet apply them.

13.6 Synching the Summit's clock

Correctness does not depend on the Summit's clock reading anything in particular. Results are computed in the timer's own clock relative to To ([Chapter 18, p. 58](#)). Synching is for humans: it makes the tape and the app show the same numbers, so they can be compared without arithmetic. For any race that matters, synch:

Table 13-6. Recommended Summit synch by race type

RACE	SUMMIT (CTRL + 5)	APP PRE-START
Zero-start	0:00:00.0 , triggered at the start	Since Start 00:00:00
Countdown on both	-0:00:15.0	Until Start 00:00:15
Time of day	Wall-clock time	Time of Day

CAUTION

Enter a synch time in full **h:mm:ss.t** . An incomplete entry registers as the smallest possible time: **3:00** is three *minutes*, not three hours.

13.7 Batteries and cold

- Put fresh cells in the **lower** compartment for every race; never remove the **upper** compartment's cells during a race.
- When changing cells, insert the two new ones in the empty positions before removing the two old ones, so the timer never loses power and memory.
- Rechargeable (NiMH) cells perform poorly in cold. Lithium primary AA cells are the best choice below freezing.

CHAPTER 14

DX-CP26 Bluetooth Serial Adapter Reference

The DX-CP26 from Shenzhen DX-SMART Technology is a transparent bridge between an RS-232 (or RJ45 console) serial port and a Bluetooth Low Energy GATT service. It knows nothing about timing: bytes in on the wire come out as BLE notifications, and bytes written over BLE go out on the wire.

14.1 Specifications

Table 14-1. DX-CP26 specifications

Interfaces	RJ45 (8P8C) serial port on the body; RS-232 DB9 male via the supplied RJ45→DB9 adapter; USB for power and charging; external antenna connector (ANT).
Serial default	9600 bps, 8 data bits, no parity, 1 stop bit (8N1). Software flow control supported.
Selectable rates	2400, 4800, 9600, 19200, 38400, 57600, 115200 bps (Table 14-4, p. 46).
Bluetooth	Bluetooth Low Energy peripheral. Advertised name RS232\485 (shown by iOS as "RS232/485" or similar).
GATT	Service 0xFFE0 ; characteristic 0xFFE1 notify/write; 0xFFE2 write.
PIN	1234 — used only by classic pairing on laptops; BLE connections from the app need no PIN.
Supply	Internal rechargeable lithium battery; USB supply/charging. VCC range 4.5–6 V.
Range	Not specified by the manufacturer's manual. Seller listings quote about 90 m to a phone; plan on 10–20 m in practice, line of sight, antenna fitted.
Dimensions	Body 60.0 × 27.8 × 16.4 mm; antenna end 26.6 × 15.3 mm (excluding antenna).
Environment	"Normal temperature" indoor/outdoor; not for damp or wet environments.

14.2 Controls and indicators

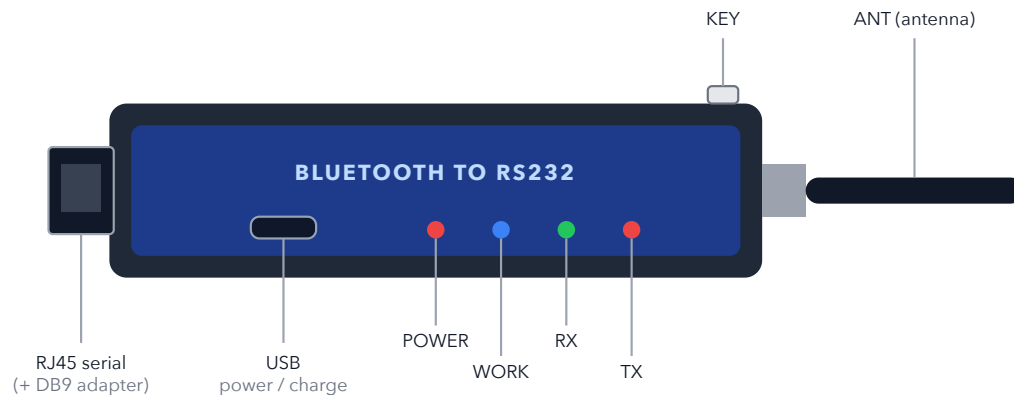


Figure 14-1. DX-CP26 controls and indicators (schematic; LED order and positions vary between production runs – read the leg-end printed on the case).

Table 14-2. DX-CP26 indicators

LED	COLOUR	MEANING
WORK	Blue	Blinking: advertising, not connected; the <i>number of blinks per group encodes the baud rate</i> . Solid: a BLE central (the phone) is connected.
TX	Red	Flashes when the adapter sends data over Bluetooth — i.e. when bytes arrive from the timer. The single best "is the timer talking?" indicator.
RX	Green	Flashes when the adapter receives data over Bluetooth. The app never writes, so this stays dark.
POWER	Red	A charging light, not a power light. On while charging; goes out when fully charged. Dark on a working, charged adapter is normal.

14.3 The KEY button

Table 14-3. KEY button actions

PRESS	ACTION
Long press, ~1 s	Power on. The adapter does not advertise at all while off — a powered-off adapter is indistinguishable from a broken one.
Long press, ~3 s	Power off.
Short press while connected	Disconnect the BLE link.
Two presses in quick succession	Advance the baud rate to the next value in the cycle. The new rate is shown by the blink count.

WARNING

Never press KEY twice quickly. It silently changes the baud rate, after which the timer's output arrives as high-bit garbage with no line endings and nothing parses. To disconnect, use the app, not KEY. If it happens: count the blinks and double-press until you see three (§21.3, p. 66).

Table 14-4. WORK LED blink count and baud rate

BLINKS	BAUD	BIT TIME	ONE 29-BYTE RECORD	NOTE
1	2 400	416.7 µs	120.8 ms	
2	4 800	208.3 µs	60.4 ms	
3	9 600	104.2 µs	30.2 ms	Required — matches the Summit default
4	19 200	52.1 µs	15.1 ms	
5	38 400	26.0 µs	7.6 ms	
6	57 600	17.4 µs	5.0 ms	
7	115 200	8.7 µs	2.5 ms	

Record time = 29 bytes × 10 bits (start + 8 data + stop) ÷ baud.

14.4 GATT profile

Table 14-5. DX-CP26 GATT layout as used by NordicRaceTrace

ATTRIBUTE	128-BIT UUID	PROPERTIES	USE
Service	0000ffe0-0000-1000-8000-00805f9b34fb	primary	Serial bridge
Characteristic	0000ffe1-0000-1000-8000-00805f9b34fb	notify, write	Serial → BLE data. The app subscribes here.
Characteristic	0000ffe2-0000-1000-8000-00805f9b34fb	write	BLE → serial. Never written by the app.

The 16-bit IDs expand on the Bluetooth Base UUID, `0000xxxx-0000-1000-8000-00805F9B34FB`. The `0xFFE0/0xFFE1` pair is a common convention among inexpensive BLE serial modules (HM-10 and its relatives), which is why generic tools such as nRF Connect and LightBlue can talk to the adapter.

14.5 Vendor and third-party tools

- **DX-SMART** (App Store, by Shenzhen DX-SMART): connects and shows received data as text. It is the *reference implementation*: if DX-SMART receives data and NordicRaceTrace does not, the fault is in the app, not the hardware.
- **nRF Connect, LightBlue**: generic BLE explorers; subscribe to `0xFFE1` to watch raw notifications in hex.
- The vendor's manual documents parameter changes (including renaming) only in its *Android* app: connect, **Query**, edit, **Set**.

CAUTION

A BLE peripheral accepts one central at a time, and a connected adapter stops advertising. After using DX-SMART or another tool, **force-quit it** or NordicRaceTrace will not find the adapter.

NOTE

Every DX-CP26 advertises the same name. With several adapters at one venue, pair each phone with its adapter while only that adapter is powered on; the app thereafter remembers it by identifier. If you rename adapters, keep "RS232" in the new name (for example RS232 T1): the app's scan filter looks for it, or for the `0xFFE0` service.

14.6 Package variants

The vendor ships the DX-CP26 in three kits. The manual's packing lists:

Table 14-6. DX-CP26 kit contents (vendor manual)

CP26 FOR PHONE/LAPTOP	CP26 FOR PC	CP26 FOR DEVICE
1 × adapter, manual, antenna, USB cable, RJ45 adapter, RS-232 adapter	As left, plus a CP11 USB "master" dongle for desktop PCs	2 × each: adapter, manual, antenna, USB cable, RJ45 adapter, RS-232 adapter

The adapter is sold both singly and as the two-unit "for Device" pair, which is intended as a pre-matched master/slave set replacing a cable between two serial devices. NordicRaceTrace needs **one adapter per Summit**: it acts as a BLE peripheral and the phone connects to it directly, so a single unit is enough for a one-timer setup. If you have a pair, the second unit is a spare or serves a second timer; keep it **switched off** while a phone is pairing, so the two units do not connect to each other first.

CHAPTER 15

Cabling, Pinouts and Signal Levels

The link is three wires: transmit, receive and ground. Getting those three right — and connecting nothing else — is the whole of the cabling job.

15.1 RS-232 in one page

RS-232 (TIA-232) is single-ended, asynchronous serial signalling referenced to a common ground. Logic levels are inverted and bipolar: a **mark** (logic 1, and the idle state) is -3 to -15 V; a **space** (logic 0) is $+3$ to $+15$ V; ± 3 V is undefined. A character is framed as one start bit (space), data bits least-significant first, an optional parity bit, and one or more stop bits (mark). At **8N1** each byte costs 10 bit-times; at 9600 baud that is 1.0417 ms per byte and a ceiling of 960 bytes/s.

A port is either **DTE** (data terminal equipment, e.g. a PC: transmits on pin 3, receives on pin 2 of a DB9) or **DCE** (data circuit-terminating equipment, e.g. a modem: the reverse). DTE to DCE uses a straight-through cable. **DTE to DTE needs a null modem**, which crosses transmit and receive.

Table 15-1. Standard DB9 pin functions (EIA-574), DTE view

PIN	SIGNAL	DIRECTION (DTE)	PIN	SIGNAL	DIRECTION (DTE)
1	DCD — data carrier detect	in	6	DSR — data set ready	in
2	RXD — receive data	in	7	RTS — request to send	out
3	TXD — transmit data	out	8	CTS — clear to send	in
4	DTR — data terminal ready	out	9	RI — ring indicator	in
5	GND — signal ground	—			

15.2 Connector pinouts

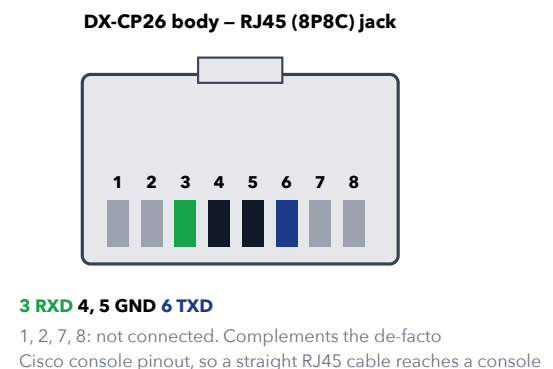
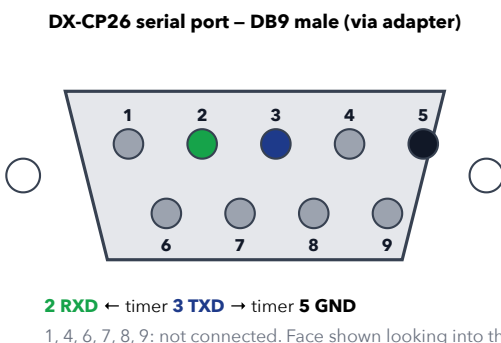


Figure 15-1. DX-CP26 serial pinouts, from the vendor manual (Figures 3 and 4). The DB9 face is the supplied RJ45→DB9 male adapter.

The Summit's serial connectors are documented only through its cable accessories:

Table 15-2. Summit cable accessories (manufacturer)

CABLE	CONNECTORS	WIRING
RS-232 cable to PC	DB9 female ↔ female	2–3, 3–2, 5–5 (null modem). Up to 100 ft.
RS-485 cable to other timers	DB9 male ↔ female	1–1, 4–4, 5–5, 6–6, 7–7, 8–8, 9–9. Up to 4 000 ft.

From this the timer's PC port is a **DB9 male behaving as DTE** (it transmits on pin 3: the null modem delivers that to a PC's pin 2). The RS-485 network uses pins 1, 4, 6, 7, 8 and 9, plus ground on 5 — the same pins a handshaking RS-232 cable would use.

15.3 The null-modem cable

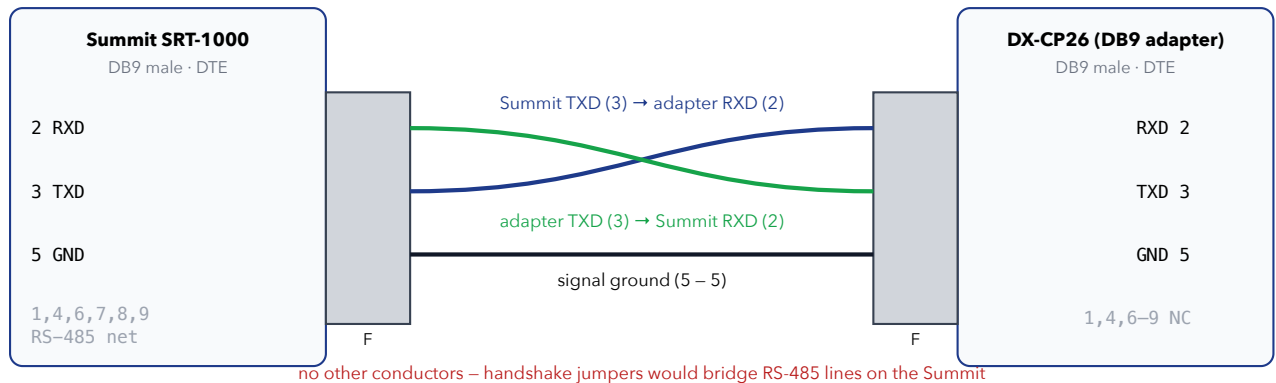


Figure 15-2. The correct cable: a 3-conductor DB9 female-female null modem.

Both ends are DTE, so the cable must cross 2 and 3. Commercial null-modem cables come in two families:

Table 15-3. Null-modem cable types

TYPE	WIRING	USE WITH THE SUMMIT
3-wire / "no handshaking"	2–3, 3–2, 5–5 only	CORRECT
Loop-back handshaking	As above, plus 7–8 and 4–1+6 jumpered <i>within each hood</i>	DO NOT USE — ties RS-485 network pins together inside the plug
Full handshaking	As above, plus 7↔8, 8↔7, 4↔1+6, 1+6↔4 crossed between ends	DO NOT USE — drives the Summit's RS-485 lines from the adapter side
Gender changer (F–F coupler)	1–1 ... 9–9	DOES NOT WORK — transmit meets transmit; silence

Buy cables that publish their pinout and say "3-wire" or "no handshaking"; reject any that say "full handshaking" or publish no pinout at all.

15.4 Verifying a cable with a meter

Check every new cable before trusting it at a race. With a continuity meter, female–female:

- ☐ End A pin 2 ↔ end B pin 3: continuity.
- ☐ End A pin 3 ↔ end B pin 2: continuity.

- ☐ End A pin 5 ↔ end B pin 5: continuity.
- ☐ End A pin 2 ↔ end B pin 2, and 3 ↔ 3: **open** (otherwise it is straight-through).
- ☐ Pins 1, 4, 6, 7, 8, 9 at each end: **open** to every other pin at both ends (no hood jumpers).
- ☐ Shell to shell: continuity is fine (shield); shell to pin 5: either is acceptable.

15.5 Which Summit port

Use the **right-hand port at the top of the timer, as you face the keypad**. That is the port that carries the serial data on the development unit.

CAUTION

The Summit manual describes the *left* connector as the computer (RS-232) port and the right as the RS-485 network port, and the two may not be wired the same way on every Summit. If the right-hand port produces nothing — the adapter's TX light stays dark and the app's **bytes received** stays at zero when you press **Enter** — move the cable to the **left** port before suspecting anything else.

15.6 Assembly

- 1 Block the timer's switch inputs (**B**, twice) so plugging in cannot inject an impulse.
- 2 Plug the RS-232 (DB9 male) adapter into the DX-CP26's RJ45 jack, fit the antenna, and connect the null-modem cable between the adapter and the Summit's right-hand top port (§15.5, p. 50).
- 3 Unblock the inputs.
- 4 Strap the adapter to the timer or its lanyard so the cable cannot be pulled: a connector working loose mid-race is a dropout (recoverable, but avoidable).
- 5 Power the adapter on with a ~1 s press of KEY. The blue WORK LED blinks — count three.

CHAPTER 16

The Summit Serial Protocol

The SRT-1000's native output is plain ASCII, one record per line, pushed on every event. This chapter specifies it as observed on the wire. It was established by capturing the timer's output while pressing known key sequences, and is validated against a 51-record capture reproduced in full in [Appendix A, p. 72](#).

WARNING

Do not code to older descriptions of this format that show fixed columns, binary fields or CRC suffixes (e.g. `yNNNN CCC HH:MM:SS.zhtq GRRRRR`). The real native output has no CRCs, no binary and no reliable columns.

16.1 Record format

```

1 92 1 b 7      0:55:19.8%Lf
├── timer:      timer clock, H:MM:SS.t (sign, 1–3 decimals)
├── bib:        digits; present on P and b only
├── type:       P | S | b | Y
├── channel:    input channel, 0–9
├── record:     record number, +1 per event, all types
└── timer:     device number on the RS-485 network

```

Table 16-1. Record fields

FIELD	SYNTAX	SEMANTICS
Timer ID	[0–9]+	The device number configured on the timer. 1 on a single-timer setup.
Record no.	[0–9]+	Increments by exactly 1 per stored event, across all types and channels. Restarts at 1 after a reset. The basis of gap detection and Reprint deduplication.
Channel	[0–9]+	Input channel (§13.5, p. 43). Keypad entries carry the channel selected with Ch .
Type	P S b Y	Case-sensitive single letter (Table 16-2, p. 52).
Bib	[0–9]{1,6}	Present on P and on b when something was typed. Absent otherwise — the field is omitted, not blank-filled.
Time	–?H+:MM:SS.f{1,3}	The timer's own running clock at the event — elapsed since its synch, not necessarily time of day. Negative while counting down to a synched start. Decimal places follow the configured resolution.
Terminator	0D 0A	CR LF

16.1.1 Grammar

```

record    = timer SP+ recno SP+ channel SP+ type [ SP+ bib ] SP+ time CR LF
timer     = 1*DIGIT
recno     = 1*DIGIT
channel   = 1*DIGIT
type      = "P" / "S" / "b" / "Y"                ; case-sensitive
bib       = 1*6DIGIT
time      = [ "-" ] 1*DIGIT ":" %x30-35 DIGIT ":" %x30-35 DIGIT "." 1*3DIGIT
SP        = %x20

```

16.2 Record types

Table 16-2. Record types, in descending order of confidence

TYPE	PRODUCED BY	BIB	THE TIME IS...	APP ACTION
P	bib, POST , then IMPULSE or a switch closure	yes	the impulse — a true hardware crossing time, with an identity confirmed beforehand	Finish for that bib, method <code>posted</code>
S	IMPULSE or a switch closure with nothing posted, clock ≥ 0	no	a true hardware crossing time	Unknown finisher ?n, method <code>impulse</code>
b	bib then Enter	yes	when Enter was pressed	Finish for that bib, method <code>bib_impulse</code> #
b	Enter with nothing typed	no	meaningless — a stray keypress	Discarded (recorded as a discarded line)
Y	IMPULSE committing a pending synch / during a countdown	no	the synch instant; clock typically negative	Starts the race if Pre-Start is open; otherwise discarded. Never a finish.

```

1 103 2 P 9      1:01:31.5    bib 9 posted, impulse at 1:01:31.5 on channel 2
1 69 1 S        0:47:10.4    bare impulse
1 68 1 b 7      0:47:04.5    bib 7 entered
1 84 1 b        0:48:44.6    Enter with nothing typed
1 1 1 Y        -0:00:15.0    synch committed fifteen seconds before the start

```

16.2.1 What **POST** really does

POST captures no time. It designates certainty about the *next* athlete: the operator confirms who is coming before they cross, so the next impulse is unambiguously theirs. Bib, Post and Impulse are **one event producing one record**, emitted when the impulse fires and stamped with the impulse time. In a controlled test on a freshly reset timer, POST was pressed at about 0:00:10 and IMPULSE at about 0:00:30; the only record was `1 2 1 P 40 0:00:30.0`.

16.2.2 The Y record

Y does not appear in any Summit documentation available to us. It was found when starting a race from the box did nothing: the timer emitted `1 1 1 Y -0:00:15.0` — record 1, channel 1, a negative clock — and the app, which then knew only P, S and b, dropped it. The conservative reading, which the app implements, is "this record is about the start": it may start a race and is never filed as a finish, because inventing a finish time from an unexplained record type would put a wrong time in a result.

16.3 Tokenizing: never by column

All 51 captured records are exactly 29 bytes long (27 characters plus CR LF), with the time right-aligned at a fixed position. It is tempting to slice fields by column. **Do not.** The bib field does not sit at a stable offset — in the same capture, bib 7 in record 92 landed one character to the right of bib 8 in record 91 — the record number widens from two digits to three at 100, and the **Y** line uses yet another spacing:

```
1..91.2.b.8.....0:51:36.6
1..92.1.b..7.....0:55:19.8    ← bib shifted one column
1.100.2.S.....1:01:08.7      ← record number now 3 digits
1....1..1.Y.....-0:00:15.0    ← different spacing again
```

Column slicing works on the first sample and silently corrupts bibs at a race. The rule, validated against every captured record:

```
tokens = line.trim().split(/\s+/)
if tokens.length == 6: timer, recno, channel, type, bib, time = tokens    ; P, or b with a bib
if tokens.length == 5: timer, recno, channel, type, time = tokens        ; S, Y, or b with no bib
otherwise: not a record
then decide by tokens[3], never by the count
```

A blank **b** has five tokens like an **S**, and a **P** has six like a **b**, but they mean entirely different things. The token count tells you only whether a bib is present.

16.4 Validation

A line becomes a record only if every field validates; anything else is silently skipped (the adapter can emit a partial line on connect, and a race is no place to throw an exception). In order:

1. 5 or 6 whitespace-separated tokens;
2. timer, record number and channel all `^\d+$`;
3. `type ∈ {P, S, b, Y}`;
4. time matches `^(-?)(\d+):([0-5]\d):([0-5]\d)\.(\d{1,3})$`;
5. bib, if present, `^\d+$`.

The time converts to signed milliseconds as `h·3 600 000 + m·60 000 + s·1 000 + frac`, where the fraction is right-padded to three digits (`.1` → 100, `.15` → 150, `.157` → 157). The number of decimals is kept separately: it drives display precision and how `To` is rounded.

A line that is *shaped* like a record but carries an unknown type letter is counted by letter and reported in the diagnostics panel as `unrecognised types: X ×1 – dropped`. The **Y** letter vanished silently once; the next unknown letter will name itself.

16.5 Timing on the wire

Table 16-3. Serial timing at 9600 8N1

Bit time	$1 / 9600 \text{ s} = 104.17 \mu\text{s}$
----------	---

Byte time (10 bits)	1.0417 ms
Record time (29 bytes)	30.21 ms — the full record must arrive before its CR LF can be seen
Maximum record rate	960 B/s ÷ 29 B ≈ 33 records/s
Reprint of the 51-record capture	1 479 bytes ≥ 1.54 s
Reprint of a full 10 000-record memory	290 000 bytes ≥ 302 s (about 5 minutes), assuming the timer transmits at line rate

Output is **event-driven**: a record is pushed on each keypress or impulse and the line is silent otherwise. There is no polling, no token passing and nothing for the phone to transmit. (The manual's "token delay" refers to computer polling on an RS-485 network and does not apply.)

16.6 From record to result

Each record delivered by the stream is processed in this exact order. The first rule that matches decides its fate.

Table 16-4. Record processing pipeline

#	TEST	ACTION
1	Always	Move the timer-clock anchor forward to this record (never backward: a Reprint must not drag the live readout into the past).
2	Race not running, Pre-Start open, record is Y, S or channel 0	Start the race from this record; exact calibration (§18.3, p. 58).
3	Race not running	Ignore.
4	Channel 0	Keep as a start impulse; account the line as discarded.
5	b without a bib	Discard (stray Enter).
6	Y	Discard (a start, never a finish).
7	To unknown	Try to calibrate from this record (§18.4, p. 59); if refused, skip it — a later live record will calibrate.
8	Time < T ₀	Discard: stamped before the race began (synch trigger, tests, a false start).
9	Record number already held, or tombstoned	Skip (a Reprint replaying what the app has, or a line the operator removed).
10	P / b with a bib	Store a finish for the bib at $R + (\tau - T_0)$ with its provenance.
11	S	Store an unknown finisher ?n at $R + (\tau - T_0)$ with its provenance.

Discarded lines are reported to the server so that the reconcile worksheet can account for every record number without mistaking them for losses (§20.5, p. 65).

CHAPTER 17

BLE Transport and Connection Management

17.1 Stack

The app talks to the adapter through `react-native-ble-plx` as a BLE *central*. This is native code compiled into the app — which is why version 2.5.0 is the minimum, and why the feature cannot run in the iOS Simulator or Expo Go. All protocol logic (decoding, reassembly, parsing, gap tracking) is plain JavaScript with no dependency on the BLE library, and is covered by an automated test suite run against the real capture, including feeding it in 20-byte chunks and one byte at a time.

17.2 Discovery and pairing

- 1 Race Timing → **Start Race** to open Pre-Start; expand the **Hardware timer** row.
- 2 Power the adapter on (KEY ~1 s; three blue blinks). Tap **Scan for timer**.
- 3 The scan runs for 12 s and lists only plausible adapters: a name matching `RS[\s_]*(232|485)` (case-insensitive), or an advertised service UUID beginning `0000ffe0`. Each row shows the RSSI in dBm.
- 4 Tap the adapter. The header reads **Timer connected · RS232\485** and the blue LED goes solid.

The device identifier and name are remembered on the phone. Thereafter the app connects automatically whenever Bluetooth is on and it is in Race Timing — the pairing is a one-time chore. **Forget this timer** (or, when not connected, **Forget saved timer & start over**) clears it.

NOTE

iOS never exposes a peripheral's MAC address; it assigns each app its own opaque UUID for the device. A remembered identifier can therefore go stale (for example after a reset of network settings), and auto-connect will then retry a device that no longer answers to that name. Forget and scan again.

17.3 Connection sequence

```
connectToDevice(id, { requestMTU: 185 })
discoverAllServicesAndCharacteristics()
persist { id, name }
monitorCharacteristicForService(FFE0, FFE1, onNotify)      ; subscribe (CCCD notify)
onDeviceDisconnected(id, onDrop)
state ← CONNECTED, backoff ← 1 s
```

A subscription error is never swallowed. It is reported as **Timer error** with the reason, because a failed subscription would otherwise leave the screen saying "connected" while nothing could ever arrive — indistinguishable from a dead timer.

17.4 Link states

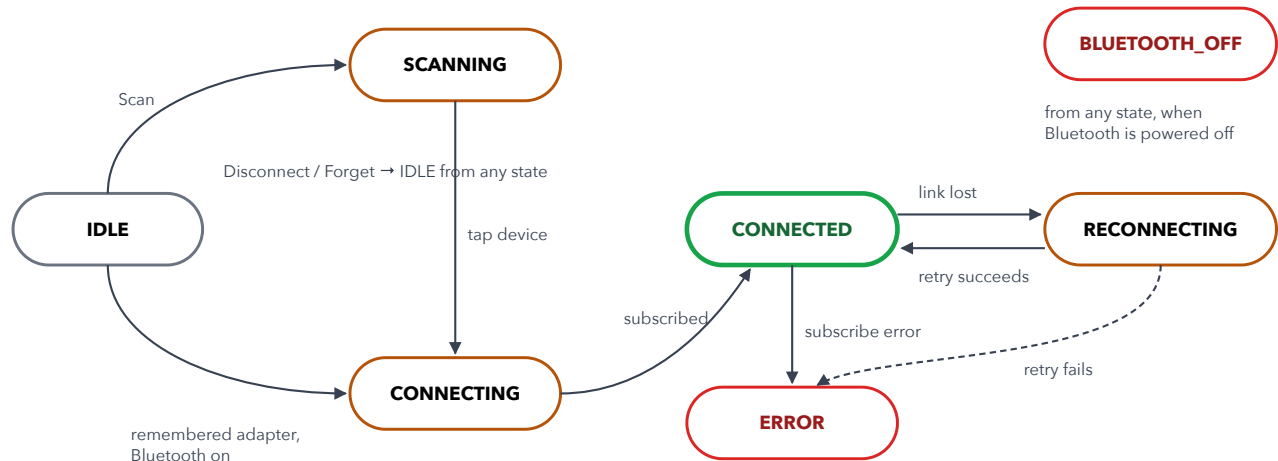


Figure 17-1. Link state machine. RECONNECTING retries the remembered adapter with exponential backoff (1, 2, 4, 8, then every 15 s); a manual Reconnect resets the backoff.

17.4.1 Automatic reconnection

When the link drops unexpectedly, the app tears down the dead subscription, clears the device reference (without which no reconnect path could ever fire), enters **RECONNECTING** and retries the remembered adapter after 1 s, then 2, 4, 8 and every 15 s thereafter. The 15 s cap keeps a timer that has been switched off from draining the phone. A retry never interrupts a scan the operator started. **Reconnect** in the Hardware Timer sheet tries immediately and resets the backoff to 1 s.

While the link is down, **nothing is lost**: the phone keeps timing with taps, the Summit keeps every record in its own memory, and a Reprint after reconnecting pulls back everything missed ([Chapter 20, p. 64](#)).

17.5 Notifications, chunking and reassembly

The adapter forwards serial bytes as GATT notifications on `0xFFE1` carrying at most about 20 bytes each — the payload of the default 23-byte ATT MTU. (The app requests an MTU of 185; the adapter's notification size is what it is.) A 29-byte record therefore always spans at least two notifications, and record boundaries fall anywhere within them.

notify #1	"1 92 1 b 7 0:"	20 bytes: head of record 92
notify #2	"55:19.8\r\n1 93 1 b 4"	tail of 92, head of 93 – split mid-bib
notify #3	"7 0:55:23.5\r\n1 "	tail of 93, head of 94

Each notification's value reaches JavaScript as base64; the app decodes it with a small built-in decoder (neither `Buffer` nor `atob` exists in a bare React Native runtime). The stream then:

1. appends the bytes to a buffer, counting total bytes, line endings and non-printable bytes for diagnostics;
2. splits the buffer on `\r\n`, `\n` or `\r`;
3. **keeps the last fragment** as the start of the next record;

4. parses every complete line, flags it `replayed` if its record number was seen before, and updates the lowest and highest record numbers seen.

CAUTION

A Reprint does not arrive "in bulk". Because notifications are smaller than a record, a Reprint is delivered as a long run of one- and two-record batches, indistinguishable by size from live traffic. Nothing in the app infers anything from batch size.

17.6 Latency

Table 17-1. Impulse-to-screen latency components (typical)

COMPONENT	MAGNITUDE
Serial transmission of the record	30.2 ms (fixed, 9600 baud)
Adapter buffering	Not specified by the vendor; small
BLE connection interval (iOS)	Typically 15–30 ms per event, more under radio contention
iOS → JavaScript delivery and parsing	A few ms; more when the JS thread is busy

The total is typically tens of milliseconds. **It does not affect hardware results**, which are computed from the timer's own stamps. It affects only (a) how soon the time appears, (b) the live timer-clock readout, and (c) an estimated calibration when the race was started from the phone (§18.4, p. 59).

CHAPTER 18

Clock Model, Calibration and T_0

Two clocks are in play: the Summit's crystal, which stamps hardware records, and the phone's system clock, which stamps taps and runs the race clock. This chapter defines how they are tied together, and proves that a hardware result depends only on the first.

18.1 Definitions

Table 18-1. Symbols

SYMBOL	MEANING
τ	A timer-clock reading: the time field of a record, in signed ms.
R	The race start in phone time (unix ms) — §3.2, p. 15.
c	The Pre-Start clock offset: the race-clock reading at the press (Since Start +, Until Start –).
T_0	The timer's clock reading at the instant the race clock reads zero.
o_a	Athlete a 's start offset after R (interval, list or 0) — Table 3-2, p. 16.

18.2 Mapping a record into the race

A record with timer reading τ is stored as the phone-time timestamp

$$t = R + (\tau - T_0)$$

and the athlete's elapsed time is then, from §3.4, p. 16,

$$\text{elapsed} = t - S_a = [R + (\tau - T_0)] - [R + o_a] = \tau - T_0 - o_a$$

R cancels. The phone's clock — its accuracy, any jump in it, the Bluetooth delay — does not appear in a hardware result. Only two readings of the Summit's crystal (τ and T_0) and the athlete's scheduled offset do.

DESIGN NOTE

An earlier design reasoned that a calibration error between the clocks was "common-mode" and therefore harmless. That is only half true: a common error cancels in the *gaps* between athletes, but it lands in full on every athlete's *absolute* elapsed time — which is the official result. This is why T_0 is pinned to a timer stamp wherever possible, and why the test suite asserts that shifting T_0 and a finish together leaves elapsed unchanged.

18.3 Exact calibration: starting the race from the box

With Pre-Start open and the timer connected, a **Y**, an **S**, or any channel-0 record presses **Start Race** for you. The record that started the race was stamped by the Summit, so the app knows exactly where the race clock's zero sits in timer time:

$$T_0 = \text{snap}(\tau_{\text{trigger}} - c)$$

One formula covers every clock mode:

Table 18-2. T_0 from the trigger record – worked examples

SETUP	TRIGGER T	C	T_0	EFFECT
Summit synched to -0:00:15.0 ; Until Start 00:00:15; IMPULSE at $T-15$ s	-15 000	-15 000	0	Race zero = timer 0:00:00.0 . Both clocks count down together; tape and app read identically.
Until Start 10:00, IMPULSE as the Summit reads -0:10:00.0	-600 000	-600 000	0	As above.
Since Start 00:00:00, gun on channel 0, Summit running since a morning synch	3 723 400 (1:02:03.4)	0	3 723 400	Correct results; the tape reads 1:02:03.4 more than the app.
Since Start 00:00:30 (race al- ready running 30 s), IMPULSE	τ	+30 000	$\tau - 30 000$	Timer zero placed 30 s before the press.

The press *defines* the start. In Until Start mode, pressing IMPULSE n seconds late puts race zero n seconds later than intended, exactly as pressing the phone's button late would. What the box removes is every source of error between the press and the number: no reaction time on a second device, no Bluetooth latency, no estimate.

Only Y , S and channel 0 can start a race. A blank Enter cannot — during Pre-Start the operator is often typing bibs into the timer, and an empty Enter is too cheap a keystroke to start a race with — and P cannot, because it names an athlete. Outside Pre-Start, nothing on the timer can start a race.

18.4 Estimated calibration: starting from the phone

If the race is started with the phone's button, the timer has no record of the start. T_0 is then inferred from the first finish record that arrives, by assuming it is happening *now*:

$$T_0 = \text{snap}(\tau_{\text{record}} - (\text{now} - R))$$

The error in that assumption is the record's transport latency (§17.6, p. 57), typically tens of milliseconds, and it is applied identically to every athlete: gaps stay exact, but every absolute elapsed time is shifted by the same small amount, which can move a truncated tenth. The Hardware timer panel says which calibration is in force: **Clocks locked from the timer** or **Clocks aligned from the first impulse**.

A record is used for calibration only if it is **live**. Two independent tests guard this:

1. **Against the timer's own clock**, when known: the record must be no more than 30 s behind where the timer's clock is estimated to be now. A replayed record is minutes old.
2. **To must not be negative**. T_0 is the timer's reading when the race clock read zero, which is ≥ 0 in every real workflow (the timer was zeroed at the gun, or was already running). A replayed record makes $\tau - (\text{now} - R)$ negative — proof the anchor is wrong. This is the test that protects the very first record of a race, when no timer-clock estimate exists yet.

If either test fails, T_0 stays unknown and the record is skipped; the next live record calibrates. Refusing to calibrate leaves times unwritten, which is far better than a uniformly wrong race that looks entirely plausible.

WARNING

Case study — the 6:39.9 race. A mid-race reset followed by a Reprint once calibrated T_0 from a replayed record that was 6 min 39.9 s old. Every hardware time in the race was inflated by exactly 6:39.9: correctly formatted, correctly ordered, uniformly wrong. Two faults combined — T_0 was not persisted across the reset, and replays were detected by batch size. Both are fixed (T_0 is now part of the saved session; liveness is judged by the two tests above), and the reconcile worksheet's clock-alignment check caught it unaided ("clocks differ by up to 417.9 s across the race"). Starting from the box makes the whole class of error impossible.

18.5 Snapping to the display precision

Every Summit record is a whole number of display units: tenths normally, hundredths when switched for a sprint. T_0 is therefore a whole number of the same unit, and any finer component in it is noise — from `Date.now()` in the estimated path, or from a time-of-day offset. That noise is not harmless under truncation (§3.6, p. 17): a T_0 1 ms high turns 34:17.100 into 34:17.099, displayed 34:17.0. So:

```
unit = 100 ms (1 decimal) | 10 ms (2 decimals) | 1 ms (3 decimals)
snap(x) = round(x / unit) × unit
```

The unit follows the timer's own record. Snapping to a tenth in a hundredths race would discard up to five hundredths — the same bug one decimal place down, where it matters more.

18.6 The live timer clock and offset check

There is no serial command to ask the Summit what time it is. The app learns the timer's clock only from records: each one sets an **anchor** { τ , local instant of arrival}, and the Hardware timer panel extrapolates from the anchor at 5 Hz, labelled **synced** or **synced 12s ago**. The anchor only ever moves forward, so a Reprint replaying old records cannot drag the readout backwards. The readout runs negative during a countdown, because that is when the operator is watching it.

From the anchor the panel also *measures* how far the timer's clock is from the race clock:

```
offset =  $\tau_{\text{anchor}}$  - (arrival_anchor - R)
```

and states it in words — **Timer clock matches the race clock** (within 100 ms) or **Timer clock is 0:01:02.3 ahead of the race clock**. This is an observation, independent of T_0 ; it should equal T_0 to within transport latency. A disagreement means T_0 is wrong and every hardware time is out by the difference. The panel also shows the mapping in human-checkable form, e.g. `Timer 0:00:00.0 = 10:03:17.4`, for comparison against the tape.

18.7 Phones, skew and the hardware

For completeness, the clock relationships between all devices in a race:

Table 18-3. Clock relationships

PAIR	RELATIONSHIP AND CONSEQUENCE
Summit ↔ results	Exact: elapsed = $\tau - T_0 - o$. Crystal error ± 2 ppm of the elapsed time.
Summit ↔ phone race clock	Offset measured continuously; display only.

Primary phone ↔ co-timer phone	A co-timer adopts the host's <i>R</i> verbatim but stamps taps with its own clock, so the difference between the two phones' clocks becomes a constant offset on all its times (observed ≈ 0.1 s). Reconcile thresholds (500 / 1000 ms) are wide enough not to flag it.
Phone ↔ true time	Irrelevant to results unless the clock is <i>changed</i> during the race (§3.9, p. 18).

CHAPTER 19

Procedure: Timing a Race with the Summit

19.1 The day before

- ☐ Charge the DX-CP26 until the red POWER (charging) light goes out.
- ☐ Fresh cells in the Summit's lower compartment; lithium AA if it will be below freezing.
- ☐ Confirm the Summit configuration (§13.4, p. 42): 9600 baud, native format, numeric bibs.
- ☐ Meter any cable you have not used before (§15.4, p. 49).
- ☐ Bench test end to end: timer → cable → adapter → phone. Confirm records appear in the app's diagnostics.
- ☐ Phone on app 2.5.0 or later, signed in, start list loaded, Share Live planned.

19.2 At the venue

- 1 Assemble the link (§15.6, p. 50) and power the adapter: three blue blinks.
- 2 Phone: Race Timing, start list loaded, Share Live on if wanted. Turn off **Set Automatically**.
- 3 Open Pre-Start (**Start Race**) and expand **Hardware timer**. It connects automatically to a remembered adapter, or scan and tap it. The blue LED goes solid.
- 4 Test with **Enter**, not **IMPULSE**. With Pre-Start open, IMPULSE starts the race. An empty Enter produces a record the app ignores: the TX LED flashes, **bytes received** rises by 29, and the timer clock appears.
- 5 Check the panel: no baud warning, no unrecognised types, a sensible timer clock.
- 6 Close Pre-Start if the start is not imminent; reopen it before the start.

CAUTION

Records stamped before a **Ctrl** + **5** re-synch may carry clock readings that are *later* than the new race start (for example, tests at 0:55:12.0 before synching to -0:00:15.0). They are ignored when they happen, but a later full Reprint replays them, and their times pass the "before the race" test. After any Reprint, check the reconcile worksheet for times attributed to tape lines numbered *below* the line that started the race, and delete them.

19.3 Starting

Recommended — countdown start from the box:

- 1 Summit: **Ctrl** + **5**, enter -0:00:15.0 (in full). The timer now waits for a trigger.
- 2 App Pre-Start: **Until Start**, 00:00:15. Leave the sheet open.
- 3 At fifteen seconds to the start, press **IMPULSE**. The Summit commits the synch and emits **Y**; the app starts with To = 0 and reports **Clocks locked from the timer**.
- 4 Both clocks count down and pass zero together; the tape and the app now read the same numbers.

Alternatives: zero start — Summit synched to 0:00:00.0, Since Start 00:00:00, IMPULSE (or a gun on the start input) at the start. Phone start — the green button; calibration is then estimated from the first finish (§18.4, p. 59).

19.4 During the race

- A **green ring** around the **Running** pill confirms the timer is attached and feeding.
- Timer workflow, best first: **bib** · **POST** · **impulse** (**P** , nothing to review) → **impulse alone** (**S** , assign on the phone or later) → **bib** · **Enter** (**b** , identity without an accurate time).
- The phone remains fully usable. Taps on the phone are recorded alongside hardware times and marked as taps.
- If the link drops or records go missing, a banner appears under the race bar (**Table 19-1, p. 63**). It leads with what is still safe and can be dismissed; a *new* problem brings it back.

Table 19-1. Hardware link banners

BANNER	TEXT AND ACTION
Bluetooth is off	"Turn Bluetooth on — the timer is still recording and nothing is lost."
Timer disconnected	"Still timing on the phone. The timer keeps its own record — press Reprint once reconnected."
N times missed	"Press Reprint on the timer to pull them back in."

19.4.1 The Hardware Timer sheet

Mid-race, tap **Running** → **Hardware Timer...** (or tap a banner). The sheet is read-mostly: status, live timer clock, calibration, offset check, bytes received, the last raw line, missed record numbers with a Reprint prompt, **Re-import N removed lines**, and **Reconnect**. Scanning and forgetting are deliberately absent: nothing on this sheet can disrupt a working link.

19.5 After the finish

- 1 Before stopping, check for missed records. If any, press **Ctrl** + **2** (Reprint) and watch the count clear.
- 2 **Running** → **Save & Stop**.
- 3 Open the reconcile worksheet. Confirm: nothing lost since the start record, clock alignment within ± 1 unit, no outliers.
- 4 Print the Summit tape (or use its History) and spot-check provenance lines against it.
- 5 Finalize and publish.

CHAPTER 20

Reprint, Gaps and Tape Provenance

20.1 Gap detection

Because record numbers increase by exactly one per event, any number between the lowest and highest delivered that was never delivered is a record the phone missed:

```
missing = { n : lowest ≤ n ≤ highest, n ∉ delivered }
```

Discarded lines (stray Enter, Y, channel 0, pre-race) are *delivered*, so they never count as gaps.

20.2 Reprint

Ctrl + **2** makes the Summit re-send its stored records. It is proven: a full Reprint on the development unit returned all 51 stored records, gapless. (The **Ctrl** + **8** "retx" function is not relied upon.) Replayed records are delivered to the app flagged as replays, and each is checked against what the app **holds**:

- a line the app already has a time for is skipped — no duplicates;
- a line the app never received is added — gaps fill;
- a line the operator **deleted or hand-corrected** stays out (it is *tombstoned*).

DESIGN NOTE

"Already have it?" is answered from the stored times themselves, not from a list of record numbers seen on the wire. The difference is that deleting a time must free its tape line, and provenance left behind by an old deletion must not claim a line forever. Deriving the answer from the data, rather than relying on every edit path to tidy up, makes it correct whatever state is on disk.

20.3 Tombstones and discards

Table 20-1. Lines the app holds back

KIND	WHAT IT IS	EFFECT OF REPRINT
Tombstoned	A real time the operator deleted, or replaced by hand-editing.	Kept out. Re-import N removed lines clears tombstones; the next Reprint brings them back.
Discarded	A line that was never a time: stray Enter, Y, channel 0, pre-race.	Discarded again.

Both are reported to the server and worded differently on the reconcile worksheet. Re-import is offered mid-race because it only ever adds times back — never the dangerous direction.

20.4 Provenance

Every hardware time carries a provenance record kept parallel to the time itself:

```
{ recordNo: 18, timerClock: "0:34:35.8", channel: 1, type: "P" }
```

Phone taps carry none, so "did this come from the timer?" is a lookup, not a guess. On the reconcile worksheet each hardware time shows `<#18 0:34:35.8` beneath it (hover for type and channel); a phone tap shows `📱 tap`. Races without hardware show nothing. Reconciling against the printed tape is therefore line-by-line matching, not trust in a conversion. Hand-entering a time on the worksheet accepts the timer's clock reading by default and echoes the resulting elapsed time as you type.

20.5 The completeness proof

The worksheet accounts for every record number from the start of the race to the last received, and separates three different facts:

- **Lost** — never received. Reprint recovers them.
- **Deleted** — received, then removed by the operator.
- **Never a time** — stray Enter, `Y`, channel 0, pre-race.

When the race was started from the box, the proof is anchored to the record that started it, so a finisher lost *before* the first received finish is still detected; the worksheet can then state that nothing has been lost since the start.

20.6 Clock alignment

For every hardware time the worksheet compares the result the app computed with what the tape line implies, and reports the **median** difference with named outliers ("tape #5 (bib 9) by 417.9 s"). The median is used rather than the mean or max–min, which one bad row destroys. A clean race reads within one display unit with no outliers; anything else points straight at the line to examine.

20.7 Hundredths

Switch the Summit to 0.01 s resolution for a sprint and the app displays hundredths for that race automatically, provided **every** hardware record in it has two decimals. Unanimity is required so that one tenths record from before the switch cannot mislabel a race. Set the resolution *before* the first impulse.

CHAPTER 21

Diagnostics and Troubleshooting

21.1 Reading the diagnostics

The expanded Hardware timer panel shows the raw facts needed to localize a fault:

Table 21-1. Diagnostic readouts

READOUT	MEANING
bytes received	Raw bytes off the BLE subscription, before parsing. Zero while the timer is clearly sending ⇒ the problem is below the parser.
Last raw line	The most recent chunk, escaped (<code>\r\n</code> visible). Paste it verbatim when asking for help.
unrecognised types: X ×n – dropped	Well-formed lines with an unknown type letter. If the box ever does something inexplicable, read this line first.
Baud rate mismatch	Bytes arriving that cannot be text (§21.3, p. 66).
N records missed	Gap list (§20.1, p. 64); Reprint.
Calibration, offset	Which To is in force and whether the measured offset agrees with it.

21.2 Garbage versus silence

TIP

Garbage means data arriving at the wrong baud. Silence means no data arriving at all. They are different problems with different fixes: the first is almost always a double-press of KEY; the second is power, cable, port or pairing.

21.3 Automatic baud-mismatch detection

The stream classifies its own health:

```

if bytes == 0:           NO_DATA
elif records_parsed > 0: OK
elif bytes < 16:         UNKNOWN           ; too little to judge
elif nonprintable/bytes > 0.10
  or line_endings == 0:   BAUD_MISMATCH
else:                     UNKNOWN

```

Correctly clocked Summit output is printable ASCII punctuated by CR LF every 29 bytes. Sampled at the wrong rate, the same signal decodes as bytes with the high bit set and no line endings at all. The rule was tuned against real wrong-baud bytes captured from the hardware. The fix: disconnect in the app, watch the WORK LED, double-press KEY until it blinks three times, reconnect.

21.4 Symptom table

Table 21-2. Troubleshooting

SYMPTOM	LIKELY CAUSE	REMEDY
Adapter not found in scan	Adapter off (it does not advertise when off); another app holds it; Bluetooth permission denied	KEY ~1 s, blue blinks. Force-quit DX-SMART / nRF Connect. iOS Settings → NordicRaceTrace → Bluetooth.
Auto-connect keeps retrying, never connects	Stale remembered identifier; adapter off	Forget saved timer & start over , then scan.
"Timer connected", bytes stay 0, TX LED dark on keypress	Wrong Summit port; wrong cable (straight, gender changer); inputs blocked	Try the Summit's left port; meter the cable; press B until unblocked.
Bytes rise, nothing parses, "Baud rate mismatch"	KEY double-pressed; Summit baud changed	Three blinks; Summit at 9600.
Bytes rise, "unrecognised types"	A record type the app does not know; emulation mode on	Native mode; report the raw line.
Timer error: Notifications failed	BLE subscription failed	Reconnect; if persistent, fully reload the app.
Race does not start from the box	Pre-Start closed; pressed Enter (not a trigger); link not connected	Keep Pre-Start open; use IMPULSE.
Hardware times not appearing after a phone start	No live record yet to calibrate from; first record refused as a replay	The next live impulse calibrates. Prefer starting from the box.
Every hardware time off by the same large amount	Wrong To (calibrated from a stale record)	Check the offset line against To; reconcile alignment shows it. Correct by hand; start from the box next time.
"N missed" will not clear after Reprint	Lines tombstoned, or Reprint not reaching the phone	Re-import removed lines if intended; watch bytes rise during Reprint.
Bib wrong on a hardware time	Typed bib wrong on the timer	Swap bib on the phone or reconcile worksheet; the tape line stays linked.
Red POWER LED dark	Normal — charged	None.
Everything looked right and nothing works	App or iOS Bluetooth state	Fully reload the app; toggle Bluetooth. This has fixed "won't connect" repeatedly.

21.5 Isolating a fault

- 1 **Adapter alive?** Blue blinking, three per group.
- 2 **Timer talking?** Press Enter: the adapter's TX LED flashes. If not: port, cable, block state.
- 3 **Reference app receives?** Connect with DX-SMART; press Enter; a text line appears. If yes, hardware is good.
- 4 **NordicRaceTrace receives?** Force-quit DX-SMART, connect in the app, press Enter: bytes received +29.
- 5 **Parses?** No baud or unknown-type warning; timer clock appears.

Change one thing at a time and confirm before the next. Stacked changes make a connection fault unattributable.

PART V

Reference

Accuracy, data and storage internals, known limitations, the captured protocol data, printable checklists and a quick-reference card.

CHAPTER 22

Accuracy and Error Budget

Precision is how finely a time is written down; accuracy is how close it is to the truth. A phone writes times to the millisecond and is accurate to a few tenths. This chapter quantifies where the error comes from, so you can choose the capture method a race deserves.

22.1 Error sources

Table 22-1. Error budget per captured time

SOURCE	MAGNITUDE	CHARACTER
Human perception and reaction (phone tap)	150–250 ms, σ 50–100 ms	Dominant. Biased late; varies tap to tap and with fatigue, cold and crowding.
Touch-to-handler latency (phone)	~20–80 ms	Biased late; jitters, worst when the finish is busiest.
Typing a bib before the tap (bib_impulse)	0.5–3 s	Late by however long typing took. Use Post + Impulse instead.
Cross-device clock skew (co-timers)	~100 ms	Constant per device; affects agreement between phones, not each phone's internal consistency.
Phone system clock change mid-race	0 or seconds	Rare, a step; detected and flagged (§3.9, p. 18).
Date.now() resolution	1 ms	Negligible.
Hardware contact closure → stamp	≤1 ms resolution	Summit internal; plus the sensor's own response.
Summit crystal	±2 ppm (±7.2 ms/h)	Negligible over a race.
Estimated calibration (phone start + hardware)	tens of ms	Constant across athletes. Zero when started from the box.
Display truncation	0–99 ms (tenths)	By convention; identical for every athlete.

22.2 Methods ranked by accuracy

1. **Summit, finish beam/plunger + POST** — hardware time, confirmed identity.
2. **Summit, IMPULSE key** — still a human press, but stamped at the press with no touch latency, on a crystal.
3. **Phone, Impulse or Post + Impulse** — one human reaction, no typing.
4. **Phone, bib then tap** — reaction plus typing.

Clock synchronization between phones makes two inaccurate measurements agree; it does not make either accurate. The only large improvement available is removing the human from the timestamp, which is what the hardware link does.

TIP

Run the Summit alongside phone timers at a race and read the median difference off the reconcile worksheet. Because the tape is ground truth, that number is your phone timers' reaction bias, measured.

CHAPTER 23

Data, Storage and Sync Internals

23.1 On-device storage

Table 23-1. Principal storage keys on the phone

KEY	CONTENTS
activeSession	The live session snapshot: times, methods, statuses, start list, race start, clock mode/offset, interval, first bib, timing mode, Team Time Trial state, live-event pairing, hardware-timer To, calibration, start record, provenance, tombstones and discards, clock events. Written on every change; removed when a session is reset.
events	Index of saved events and results.
event_<id>	A saved event or result, including its race context.
settings	Preferences (Chapter 6, p. 26).
teamTimingMode	Team Time Trial Simple/Accurate choice.
submitTimerDeviceId / ...Name	The remembered DX-CP26.

Storage is iOS-backed key/value files written atomically; restore runs before any write is permitted, so an empty initial state can never overwrite a saved session.

23.2 Sync model

- **Upload:** each device posts its complete set of times for the race (with methods, statuses and, for hardware times, provenance and discards) to the live server, 500 ms after the last change. The server replaces that device's rows only.
- **Roles:** the first timer is the primary device; spotters are never primary and their order data never reaches live results directly.
- **Joined devices** poll the event every 3 s for the race start and settings.
- **Reconcile page** refreshes every 15 s while the event is live; edits made there are protected from later syncs.
- **Finish:** stopping flushes the pending sync, marks the event complete and disconnects the device from it.

23.3 Public URLs

Table 23-2. Web endpoints a timer will use

URL	CONTENT
live.nordicracetrace.com/event/CODE	Live results during a race.
nordicracetrace.com/reconcile/CODE	Reconcile worksheet (timer code required).
nordicracetrace.com/results/CODE	Published final results.
nordicracetrace.com/teams	Coach dashboard: rosters, start lists, trials, splits.
nordicracetrace.com/get-started	User guide.

CHAPTER 24

Known Limitations

Stated plainly, so that nobody discovers them at a start line.

Table 24-1. Known limitations (October 2026)

AREA	LIMITATION
Phone clock	Phone-tapped times shift if the system clock changes mid-race. Detected and flagged, not corrected. Turn off Set Automatically.
Co-timer skew	Each phone's clock offset appears as a constant on its times (≈ 0.1 s observed). Not measured or corrected.
Start wand (phone app)	In the phone app, channel-0 impulses are collected and shown but do not replace published start times. The web timer applies them to one-athlete slots. Neither has yet been used with a real wand.
Hardware models	Summit SRT-1000 native format only; one timer per phone; Race Timing only.
Y record	Undocumented by the manufacturer; interpreted conservatively.
Pre-synch records	Records stamped before a re-synch can survive the pre-race filter on a full Reprint (§19.2, p. 62).
Re-synch, then phone start	If the Summit is re-synched (Ctrl + 5) to a <i>lower</i> clock after the app has already received records from it, and the race is then started from the phone rather than from the box, the app can treat every live record as a replay and record no hardware times. Not expected in practice: start the race from the box as recommended (§19.3, p. 62), or restart the app after re-synching. The web timer is not affected.
Time of Day	Races spanning midnight are not supported.
Offline co-timing	Joining and merging need a network. Recording does not.
Posted bib	A bib posted in the app but not yet impulsed is not preserved across a crash.
Split Timing	Without a start list, assumes bib 1 starts first and bibs go in order.

APPENDIX A

Captured Summit Session

The complete 51-record session used to establish and test the protocol, captured from a Summit SRT-1000 through a DX-CP26 at 9600 8N1: 1 479 bytes, records 68–118, gapless. Type counts: S 22, b 21 (15 with a bib, 6 stray), P 8. Channel 2 was selected from record 91 onward.

A.1 Hex dump of the first three records

```
0000 31 20 20 36 38 20 31 20 62 20 37 20 20 20 20 20 1 68 1 b 7
0010 20 20 30 3A 34 37 3A 30 34 2E 35 0D 0A 31 20 20 0:47:04.5..1
0020 36 39 20 31 20 53 20 20 20 20 20 20 20 20 30 69 1 S 0
0030 3A 34 37 3A 31 30 2E 34 0D 0A 31 20 20 37 30 20 :47:10.4..1 70
0040 31 20 62 20 31 20 20 20 20 20 20 20 30 3A 34 37 1 b 1 0:47
0050 3A 32 34 2E 33 0D 0A :24.3..
```

Offsets in hex. Each record is 27 printable bytes followed by 0D 0A ; the second record begins at offset 0x1D (29).

A.2 All records

Table A-1. The 51 captured records

RAW LINE (SPACES SHOWN AS RECEIVED)	REC	CH	TYPE	BIB	TIME	KIND
1 68 1 b 7 0:47:04.5	68	1	b	7	0:47:04.5	bib entry
1 69 1 S 0:47:10.4	69	1	S		0:47:10.4	impulse
1 70 1 b 1 0:47:24.3	70	1	b	1	0:47:24.3	bib entry
1 71 1 b 7 0:47:34.9	71	1	b	7	0:47:34.9	bib entry
1 72 1 S 0:47:42.9	72	1	S		0:47:42.9	impulse
1 73 1 S 0:47:52.8	73	1	S		0:47:52.8	impulse
1 74 1 S 0:48:00.0	74	1	S		0:48:00.0	impulse
1 75 1 S 0:48:10.8	75	1	S		0:48:10.8	impulse
1 76 1 b 7 0:48:21.4	76	1	b	7	0:48:21.4	bib entry
1 77 1 S 0:48:24.5	77	1	S		0:48:24.5	impulse
1 78 1 S 0:48:25.7	78	1	S		0:48:25.7	impulse
1 79 1 S 0:48:26.1	79	1	S		0:48:26.1	impulse
1 80 1 S 0:48:26.3	80	1	S		0:48:26.3	impulse
1 81 1 S 0:48:26.4	81	1	S		0:48:26.4	impulse
1 82 1 S 0:48:33.5	82	1	S		0:48:33.5	impulse
1 83 1 S 0:48:42.3	83	1	S		0:48:42.3	impulse
1 84 1 b 0:48:44.6	84	1	b		0:48:44.6	stray Enter
1 85 1 b 8 0:48:51.4	85	1	b	8	0:48:51.4	bib entry
1 86 1 b 7 0:51:08.6	86	1	b	7	0:51:08.6	bib entry
1 87 1 b 47 0:51:10.8	87	1	b	47	0:51:10.8	bib entry
1 88 1 b 120 0:51:18.6	88	1	b	120	0:51:18.6	bib entry

1 89 1 S	0:51:20.0	89 1 S	0:51:20.0	impulse
1 90 1 S	0:51:21.6	90 1 S	0:51:21.6	impulse
1 91 2 b 8	0:51:36.6	91 2 b 8	0:51:36.6	bib entry
1 92 1 b 7	0:55:19.8	92 1 b 7	0:55:19.8	bib entry
1 93 1 b 47	0:55:23.5	93 1 b 47	0:55:23.5	bib entry
1 94 1 b 120	0:55:27.3	94 1 b 120	0:55:27.3	bib entry
1 95 1 S	0:55:29.6	95 1 S	0:55:29.6	impulse
1 96 1 S	0:55:30.0	96 1 S	0:55:30.0	impulse
1 97 2 b 8	0:55:37.8	97 2 b 8	0:55:37.8	bib entry
1 98 2 b	1:01:00.6	98 2 b	1:01:00.6	stray Enter
1 99 2 b 5	1:01:06.6	99 2 b 5	1:01:06.6	bib entry
1 100 2 S	1:01:08.7	100 2 S	1:01:08.7	impulse
1 101 2 b 6	1:01:19.7	101 2 b 6	1:01:19.7	bib entry
1 102 2 S	1:01:23.1	102 2 S	1:01:23.1	impulse
1 103 2 P 9	1:01:31.5	103 2 P 9	1:01:31.5	posted
1 104 2 b	1:01:43.5	104 2 b	1:01:43.5	stray Enter
1 105 2 b	1:04:54.0	105 2 b	1:04:54.0	stray Enter
1 106 2 P 9	1:04:58.2	106 2 P 9	1:04:58.2	posted
1 107 2 P 20	1:06:35.2	107 2 P 20	1:06:35.2	posted
1 108 2 b	1:06:45.9	108 2 b	1:06:45.9	stray Enter
1 109 2 P 21	1:06:51.9	109 2 P 21	1:06:51.9	posted
1 110 2 S	1:06:56.9	110 2 S	1:06:56.9	impulse
1 111 2 S	1:07:06.4	111 2 S	1:07:06.4	impulse
1 112 2 P 20	1:07:27.0	112 2 P 20	1:07:27.0	posted
1 113 2 P 21	1:07:36.2	113 2 P 21	1:07:36.2	posted
1 114 2 b	1:07:43.3	114 2 b	1:07:43.3	stray Enter
1 115 2 S	1:07:49.5	115 2 S	1:07:49.5	impulse
1 116 2 S	1:07:54.6	116 2 S	1:07:54.6	impulse
1 117 2 P 30	1:15:40.3	117 2 P 30	1:15:40.3	posted
1 118 2 P 31	1:16:00.8	118 2 P 31	1:16:00.8	posted

APPENDIX B

Printable Checklists

B.1 Every race – phone

- ☐ App updated; signed in if using team features
- ☐ Phone charged; battery pack
- ☐ Set Automatically **off**
- ☐ Focus / Do Not Disturb on
- ☐ Timing mode and interval correct
- ☐ Start list loaded and checked (first bib, start times)
- ☐ Share Live on (if co-timers, live results or reconcile wanted)
- ☐ Co-timers joined and showing the race
- ☐ Sound on for FIS beeps (interval starts)
- ☐ Pre-Start preflight all ticked
- ☐ Start: clock mode chosen; press on time
- ☐ Finish: Post + Impulse wherever possible
- ☐ Assign every unknown before stopping
- ☐ Save & Stop → reconcile → Finalize → publish
- ☐ Set Automatically back **on**

B.2 Every race – hardware timer

- ☐ DX-CP26 charged (red light out)
- ☐ Fresh AA in the Summit's lower compartment
- ☐ Summit: 9600 baud, native, numeric bibs, resolution set
- ☐ Cable: 3-wire null modem, metered
- ☐ Antenna fitted; adapter strapped to timer
- ☐ Inputs blocked while plugging; unblocked after
- ☐ Adapter on; three blue blinks
- ☐ Connected in Pre-Start; blue solid
- ☐ Tested with **Enter** — bytes +29, timer clock shown
- ☐ No baud or unknown-type warnings
- ☐ **Ctrl** + **5** synch armed; Until Start matches
- ☐ Start from the box: "Clocks locked from the timer"
- ☐ Green ring on Running throughout
- ☐ Before stopping: no missed records (Reprint)
- ☐ Reconcile: nothing lost, alignment clean
- ☐ Tape kept with the results

APPENDIX C

Quick Reference

C.1 Summit SRT-1000

On	Power on
Ctrl + Del , yes, 1 2 3 Enter	Power off
bib POST ... IMPULSE	P — best finish record
IMPULSE	S — unknown finisher; in Pre-Start: start
bib Enter	b — bib at keypress time
Ctrl + 2	Reprint (recovery)
Ctrl + 5	Synch (full h:mm:ss.t)
Ctrl + 6	Config — erases memory
B	Block keys / switches / both / none

C.2 DX-CP26

KEY 1 s / 3 s	On / off
KEY ×2 quickly	Changes baud — avoid
Blue blinking ×3	Advertising, 9600
Blue solid	Connected
Red TX flash	Data from the timer
Red POWER	Charging (off = full)
BLE	FFE0 / notify FFE1

C.3 Formulas

```
R      = t_press - c
S_a    = R + o_a
elapsed = t - S_a
split  = t - o_a      (rank, gaps only)
o_a    = startTimeMs | max(0, bib-firstBib) · I
      | 0

t_hw   = R + (τ - T_0)
elapsed = τ - T_0 - o_a
T_0 box = snap(τ_trigger - c)
T_0 est = snap(τ - (now - R)),
      τ ≥ τ_now - 30 s, T_0 ≥ 0
snap(x) = round(x/u) · u, u = 100|10|1 ms

record = 29 B · 30.2 ms @ 9600 8N1
```

C.4 Cable

```
Summit DB9 -F| 2 — 3 |F- adapter DB9 (male,
DTE)
      3 — 2
      5 — 5
      nothing else
```

C.5 Reconcile

OK ≤ 500 ms spread · Warn ≤ 1000 ms · Conflict > 1000 ms or order mismatch.

Glossary of Timing Terms

8N1

Serial framing of 8 data bits, no parity, 1 stop bit — 10 bit-times per byte including the start bit.

Accurate mode

Team Time Trial capture in which an Impulse bar creates every time and name tiles only assign them.

Anchor (timer clock)

The most recent known pairing of a timer-clock reading with the phone instant it arrived; the basis of the live timer-clock readout.

Backup timing

An independent second record of a race, used to recover or verify the primary. NordicRaceTrace is often run as backup to a professional system.

Baud rate

Symbols per second on a serial line; for RS-232, bits per second. The Summit link runs at 9600.

Bib

The number worn by an athlete, and the identity a timing record is attached to.

Bib Press

Entry mode in which each athlete has a tile; one tap records.

BLE

Bluetooth Low Energy: the low-power Bluetooth variant used between the DX-CP26 and the phone.

Calibration (T_0)

Establishing where the timer's clock stood when the race clock read zero. *Exact* when the race is started from the timer; *estimated* otherwise.

Channel

A numbered timer input. Each record states the channel it arrived on: start, finish or an intermediate.

Characteristic

A BLE data value within a GATT service. The adapter streams serial data through characteristic 0xFFE1.

Clock mode

How the Pre-Start value is interpreted: Since Start, Until Start, or Time of Day.

Co-timer

A second phone timing the same race, whose times are kept separately and merged on the reconcile worksheet.

Competition ranking

"1224" ranking: tied athletes share a place and the following place is skipped.

Completeness proof

Accounting for every timer record number from the start of a race as received, deleted, or never a time.

Contact closure

A switch closing across a timer input — a plunger press or a beam break. See Impulse.

Countdown

A race clock running negative toward the start (Until Start; a negative Summit synch).

CR LF

Carriage return, line feed (0x0D 0x0A): the end of every Summit record.

DCE / DTE

Data circuit-terminating / data terminal equipment: the two sides of an RS-232 link. DTE transmits on DB9 pin 3. Two DTEs need a null modem.

DB9

The 9-pin D-subminiature connector (strictly DE-9) used for RS-232.

Debounce

Ignoring a repeat of the same input within a short window: 5 s for the same bib on the phone; a hold-off on a timer input.

DNF

Did Not Finish.

DNS

Did Not Start.

Drift

The rate at which a clock gains or loses against true time, usually in ppm.

DSQ

Disqualified.

Elapsed time

Finish time minus the athlete's own start time: the race result.

Finish beam

A photocell (electric eye) across the finish that closes a contact when broken.

FIS start sequence

The standard individual-start countdown: silent arming at T−10, five beeps from T−5, a start tone at T−0, and a legal start window from T−3 to T+3.

GATT

Generic Attribute Profile: how a BLE device exposes services and characteristics.

Guest

An athlete in a time trial who is not on the team roster; saved under their own name for that trial only.

Hand time

A time taken by a person pressing a button rather than by a sensor.

Hold-off

A timer setting that ignores further impulses on a channel for a short time after one.

Impulse

In timing, a switch closure — the event that marks a crossing. Also the button that produces one.

Interval start

Athletes start individually at a fixed spacing, typically 15 or 30 s.

Lap

One circuit of a multi-lap course; recording a bib again records its next lap.

Mass start

All athletes start together; interval 0.

MTU

Maximum transmission unit of a BLE link; with the default 23-byte ATT MTU a notification carries 20 bytes.

Net time

Elapsed time from the athlete's own start — the result in an interval or wave start.

Notification

A BLE message pushed from peripheral to central without being requested.

Null modem

A cable crossing transmit and receive, for connecting two DTE devices.

Plunger

A hand-held push button on a cable, plugged into a timer input. Also "button".

Post

To designate the next athlete to cross before they do, so the next impulse is certainly theirs.

ppm

Parts per million: clock accuracy. 1 ppm is 3.6 ms per hour.

Pre-Start

The sheet in which the race clock is configured and the race started.

Preflight

The checklist at the top of Pre-Start.

Provenance

A hardware time's origin on the tape: record number, timer clock, channel and type.

Pursuit start

Athletes start separated by their deficits from an earlier race.

Race clock

The clock shown on the Timer screen, zero at the race start.

Race context

Everything needed to recompute a saved race's results from its raw timestamps.

Reaction time

The delay between seeing a crossing and pressing; the dominant error in hand timing.

Reconcile

To combine independent records of a race into one result, resolving disagreements.

Record number

The timer's sequence number for each stored event; increases by one per event.

Reprint

The Summit function that re-sends stored records; NordicRaceTrace's recovery mechanism.

Resolution

The smallest time step a timer records or displays.

RS-232

Single-ended bipolar serial signalling between two devices.

RS-485

Differential multi-drop serial signalling; used by Summit to network timers.

RSSI

Received signal strength, in dBm; closer to zero is stronger.

Spotter

A device recording finishing order only, used to identify unsigned impulses.

Split

A time taken at an intermediate point on the course.

Start list

The athletes in a race, with bibs and, optionally, start times.

Start wand

A hinged gate at the start that closes a contact when the athlete pushes through.

Start window

The period around a scheduled start in which leaving is legal (FIS: T-3 to T+3 s).

Synch

Setting a timer's clock to a chosen value, applied at the next trigger.

T₀

The timer's clock reading at the instant the race clock reads zero.

Tape

The timer's printed (or stored) record of events — the ground truth for hardware times.

Tie

Equal displayed times; tied athletes share a place.

Time behind

An athlete's gap to the leader at a point.

Time of day

A clock reading in hours of the day, as opposed to elapsed time from a start.

Tombstone

A marker keeping a deleted hardware time from being re-imported by a Reprint.

Truncation

Dropping digits beyond the display precision without rounding: 5:40.39 → 5:40.3.

Unknown finisher

A captured time with no athlete yet attached, keyed ?n.

Wave start

Groups of athletes start together at intervals.

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Page numbers refer to the first mention of a term in each section. Terms set in `code` style in the text — record types, UUIDs, identifiers — are indexed under their descriptive names.

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