

RSA Test white paper

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Summary

RSA Test is an iPhone and iPad app, built by Stacktsy, that turns two ordinary phones or tablets into the electronic timing gates for the Repeated Sprint Ability (RSA) test: six sprints of 40 metres, each timed from a start gate to a finish gate, judged against a pass target. It runs the protocol as the International Hockey Federation (FIH) writes it for its umpires, keeps a photograph of every crossing as evidence, and prints a results sheet for the umpire and the witness to sign.

The point of the app is cost. The RSA test is defined around electronic timing gates, and a pair of gates costs between about A\$1,000 and A\$3,000 before the tripods and the annual battery and repair bills. Most umpires, clubs and schools never own a set, so the test is run with a handheld stopwatch, which carries a reaction-time error that is larger than the margin many results are decided by. RSA Test replaces the gates with the two devices a tester already has in their pockets, and measures to a couple of milliseconds.

This paper explains the test and why the FIH uses it, what timing gates cost, how two phones connect and agree on the time, how we tested the app before releasing it, and how a test is run on the day. It is written for testers, umpire managers and administrators rather than engineers.

The Repeated Sprint Ability test

Repeated sprint ability is the capacity to produce short, all-out sprints again and again with only brief recovery between them. It is the pattern of hockey, football, rugby and basketball: a burst, a jog, a burst. Tests of it have been used in sports science since the 1990s, and the simplest form, a fixed number of straight sprints with a fixed rest, is the one the FIH adopted for its umpires.

The FIH protocol places a start gate at 0 m and a finish gate at 40 m, with a start line marked 1.5 m before the start gate. The umpire stands with the front foot on the start line and, once the tester confirms that the gates are set, starts whenever they are ready. There is no starting signal and no reaction time: the clock runs from the moment the umpire breaks the start gate to the moment they break the finish gate. Six sprints are run with a maximum of 60 seconds of recovery between them, during which the umpire walks back to the start. If exactly one of the six sprints is failed, a seventh sprint is run straight after the sixth. Two failed sprints, out of six or seven, fails the test (FIH, Guidelines for Fitness of Umpires, July 2025).

The pass targets depend on the umpire's gender and panel:

Panel	Women	Men
Leading Panel, High Potential Panel, Centre Panel	6.6 s	6.2 s
International Panel	6.8 s	6.4 s

The test is paired with the Yo-Yo Intermittent Recovery Test Level 1, is reported to the FIH three times a year for the senior panels, must be witnessed by an FIH official or a national association representative, and must be video recorded and the recording kept for six months. The guidelines require the recording to show the recorded times, "either by electronic gates or handheld stopwatches".

Anyone can run the test. Clubs use it for players, schools use it for athletics squads, and strength and conditioning coaches use it as a fitness benchmark. The FIH's targets and rules are simply the best-documented version of it, and RSA Test follows them exactly. RSA Test is an independent product; it is not made by or affiliated with the FIH.

What timing costs today

Electronic timing gates are photocells: a beam across the running lane that starts or stops a clock when it is broken. They are accurate, and they are expensive. Representative retail prices in September 2026:

System	What you get	Price
Freelap Pro BT 112 pack	Two wireless transmitters and one athlete chip, phone app	A\$1,069 (Nordic Sport Australia)
Brower TCi two-gate sprint system	Two photogates, reflectors and a handheld timer	US\$1,589, about A\$2,400 (Brower Timing Systems)
Microgate Witty wireless kit	Two photocells and the Witty timer	A\$2,980 excluding GST (Event Timing Shop, Australia)

Tripods, spare batteries, a carry case and replacement of a dropped photocell come on top, and a set that is shared across a state association spends most of its life in someone's garage rather than at the test. A national association that wanted every umpire to be tested on gates would be buying dozens of sets to cover umpires across geographic differences.

The alternative the guidelines permit is a handheld stopwatch. Human reaction time at the start and again at the finish adds a random error of the order of 0.1 to 0.2 seconds, and a stopwatch tends to read short because the timer anticipates the finish. On a test where the pass mark is 6.2 seconds and an umpire's result is 6.3, that error is the difference between passing and failing, and the video the FIH asks for cannot resolve it.

Camera-based gates are the third option, and they have been validated. A 2024 study in the journal *Sensors* compared a two-phone camera timing app with photocells over 10 m and 20 m sprints and found a mean difference of 7 to 12 milliseconds, with the two phones agreeing with each other to 4 milliseconds (*Sensors*, 2024, 24(20):6719). An earlier study validated a single-phone video method against photocells over 40 m with a standard error of 7 to 15 milliseconds (Romero-Franco et al., 2017). The cameras in current phones run at 240 frames per second, which is one frame every 4 milliseconds. That is the approach RSA Test takes, with two phones rather than one so that the start and the finish are each watched from two metres away.

How two phones become timing gates

Three things have to be true for two phones to replace a pair of gates: they must agree on the time, each must know the instant the umpire crossed its line, and the finish phone must be able to subtract one from the other. RSA Test does all three without any extra hardware.

Connecting them. The finish device turns on Personal Hotspot, the setting every iPhone has for sharing its internet connection. The start device joins that hotspot the way it would join any Wi-Fi network. That is the entire setup: no pairing codes, no accessories, and no internet needed, because the two devices only talk to each other. The app finds its partner on the hotspot by itself and shows "Linked" on both screens. We tested the link across the full length of a hockey pitch and it held at every distance, so 40 metres is comfortable.

Agreeing on the time. Two phones' clocks are never quite the same, and they drift apart by a few thousandths of a second every minute. The app handles this the way two people would compare watches over a phone call: twenty times a second the finish device sends a time stamp, the start device replies with its own, and the round trip is measured. The exchanges that come back fastest are the most trustworthy, and the app keeps only those. The result is a running estimate of the difference between the two clocks that is good to about 0.2 milliseconds, and because the exchange runs continuously for the whole session, drift never gets a chance to build up.

Watching the line. Each device stands in portrait or landscape on a tripod, two to three metres to the side of its line, looking straight across it. On screen the tester sees a red line, which is the gate, and two cyan lines that mark a band from the umpire's waist to their shoulders. The camera runs at up to 240 frames per second, and the app watches only the band: when something the size of a torso moves through it, the app follows the leading edge of the body and works out, to a fraction of a frame, the instant it reached the red line. It fires on the first part of the body to cross, exactly as a single-beam photocell does, so the times are the kind umpires are used to.

The sprint time. The start device sends its crossing instant to the finish device, which converts it to its own clock and subtracts it from its own crossing. The finish device shows the time, compares it with the target, and records the result. Both devices keep the frame they fired on, with the sprint number, the gate, the time and the trigger rule burned into the picture, and the start device sends its picture across the link so the finish device holds the complete record.

Calibration. Different models of phone stamp their camera frames with slightly different delays. Once per pair of devices, both are stood on one line, facing the same way, and a few walk-throughs measure the constant difference between them. The app stores it and subtracts it from every sprint, and it is printed on the results sheet.

How we tested it

We did not build the app first and hope. Before a line of the app existed we wrote three small experimental apps and ran them on real devices, outdoors, on a hockey pitch, to answer the three questions the design depended on. The numbers below are from those runs, on an iPhone 16 Pro and an iPad Pro, on 18 September 2026.

Do the two clocks agree, and does the link hold at 40 m?

The first experiment linked the two devices and measured the difference between their clocks continuously while one was walked away. Over a direct phone-to-phone Wi-Fi link the clocks agreed to 0.2 milliseconds, but the link dropped at about 50 metres and did not carry anything until the devices were back in range. Over the iPhone's Personal Hotspot the link held for the whole length of the field, with the same agreement and no gaps. We also saw the clocks drift apart by 8 to 20 parts per million, which is a few milliseconds over a ten-minute session if the link were lost. That settled two design rules: the app uses the hotspot, and it keeps the exchange running for the whole session rather than syncing once.

Can a phone camera time a crossing?

The second experiment turned a single phone into a gate and swung a pendulum through its line, because a pendulum crosses the same line at intervals that must be identical. The early runs taught us more than they measured. An unoptimised build could only process every fifth frame. A block that hung still on the line while the app started became a permanent ghost in its picture of the background and blocked every crossing, so the background now adapts continuously. A shadow or a string ahead of the object could be taken as the leading edge, so the app now follows the largest moving block rather than the most advanced pixel. Each finding went into the code the same day with an automated test that reproduces the fault.

Do two gates agree with each other?

The pendulum could not tell us the precision of the detector, because the pendulum itself wobbles. The decisive test put both devices on the same line, facing the same way, and let both time the same crossings. The difference between their two times is the whole system's error, whatever the object does.

Measurement	Result
Clock agreement between the two devices during the run	0.18 ms
Scatter between the two gates' crossing times, per gate	1.7 ms (worst single crossing 5.5 ms)
Fixed offset between the two devices (removed by calibration)	1.8 ms
Effect of the two red lines being about 1 cm apart on the tape	±11 ms, reversing with direction; a placement error, not a timing one

A per-gate error under 2 milliseconds is well inside the target we set of 10 milliseconds per sprint, and an order of magnitude better than a stopwatch. The placement result is a useful reminder that the red line on the screen has to sit on the line on the ground, which is why the app's guide dwells on it.

What we learned outdoors

The first run with a person on a pitch, rather than a pendulum indoors, exposed a difference between a camera and a photocell: a photocell sees only its beam, but a camera also sees the ground beyond the line, and anyone walking 20 metres behind it appears in the watched band as a small moving shape. The

app now expects a person at close range, a torso-sized shape filling most of the band, and ignores anything smaller. Field testing with athletes continues, and the results of each session are kept with the source code.

How a test is run

The app is built around the day: a tester with two devices, an umpire, a witness with a third phone filming, and a marked 40 m course.

Set up. Two devices in portrait or landscape on tripods, two to three metres to the side of their lines at about waist to chest height, looking straight across. The finish device turns on Personal Hotspot and chooses Finish gate in the app; the start device joins the hotspot and chooses Start gate. Both show Linked. On each, the umpire stands on the line and the tester drags the two cyan lines to cover them from waist to shoulders, then steps out of view and taps relearn.

Details. On the finish device the tester enters the umpire's name, gender and panel, which sets the target, plus the witness, venue and date.

Each sprint. With the umpire on the start line, the tester taps Gates set. The start gate arms. The umpire goes when ready; the start gate fires and arms the finish gate; the finish gate fires and the time appears, green for a pass or red for a fail against the target. Recovery counts down from 60 seconds while the umpire walks back, and the walk back cannot trigger anything because the start gate only arms on Gates set and the finish gate only arms after the start fires.

Six, or seven. After six sprints the app calls the result. If exactly one sprint failed it asks for a seventh and calls the result after that. Two fails is a fail, and the app says so as soon as it is certain.

When something goes wrong. A false start or a gate fired by a passer-by is voided with one tap and the sprint is run again with the same number. A start with no finish is cancelled. If a gate is unusable, a stopwatch time can be typed in; it is marked as hand-timed on the results sheet so nobody mistakes it for a gate time.

Evidence. Every sprint leaves two photographs, one from each gate, with the sprint, the gate, the time and the trigger rule in the picture. The Results screen produces a one-page PDF with the umpire, panel, target, every sprint, the verdict and signature lines for the umpire and the witness, and shares the whole session folder, pictures included, for the national association's records. Nothing leaves the device unless the tester shares it; there is no account and no server.

Availability

RSA Test is free on the App Store for iPhone and iPad running iOS 17 or later; the first release was submitted for Apple's review on 19 September 2026. The app, its guide, the support page and the privacy policy live at rsa.hockey.

Platform	Where	Notes
iPhone and iPad	App Store: RSA Test	iOS 17 or later; free; two devices needed
Guide, support, privacy	rsa.hockey	Same guide as in the app

The app has no account, no advertising and no analytics. Names, times and crossing photographs stay on the finish device, and the two devices talk only to each other over the local network.

About Stacksy Pty Ltd

RSA Test is developed by [Stacksy](#), a software studio in Perth, Western Australia, that builds products for hockey and for the people who run it. It is the second of Stacksy's fitness-test apps: the [YoYo App](#) runs the Yo-Yo Intermittent Recovery Test Level 1, the other half of the FIH umpire fitness assessment, on iPhone, Apple Watch, Android and the web, and the two apps are designed to be used together on a test day. The YoYo App records the level each run started at, and any run that did not begin at level 5.1 is labelled a training run, so practice at the faster speeds is never mistaken for a test. Alongside them Stacksy makes [WhistleIQ](#), a platform for umpire and official appointments and development, and the Hockey [Shoot-out App](#), which runs penalty shoot-outs to the rules. The same approach runs through all of them: take the rule or the protocol exactly as written, build the tool around the way officials and coaches actually work on the day, and remove the cost that keeps people from doing it properly. Questions about the app or this paper: contact@stacksy.com.au.

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