



Proven Timekeeping Systems in Orienteering

IOF IT Commission

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1 Introduction

1.1 Preface – Why do we publish this document?

IOF wants a consistent quality level at all IOF events, and always assure a minimum level of quality on timekeeping. Some events have stronger requirements than others, which influences which solutions are a possible alternative for a particular event.

The goal of the document is to help organisers and event adviser evaluate and choose a timekeeping system that has proven usage in orienteering, and within the scope of the current rules.

Solutions that are not listed in this document can be used but will require more documentation and validation before it can be approved for a particular event.

1.2 Questions and comments

Questions and comments should be sent to the IOF IT Commission - iof.itc@orienteering.org

2 Categorisation of events

We categorise IOF Events into three levels for the purpose of this document:

Events (examples)	Level	Precision
WSOC Sprint Final (optional), WOC Sprint Final (mandatory)	Level 1	0.1s precision
WOC, WSOC, World Cup, JWOC	Level 2	1s precision, electronic finish (i.e, the athlete shall not need to stop at the finish line, but run, cycle, ski across)
WRE, WMOC	Level 3	1s precision, finish punch allowed with any approved system

Timekeeping is regulated by rule §23 in all disciplines. Only a Sprint may use 0.1s precision, and only if they follow the requirements of Level 1 timekeeping.

Any race can use systems and procedures approved for a higher level, e.g a level 3 race can use proven solution for level 1 or level 2.

3 Terms and definitions

<i>IT ASEA</i>	IT Assistant Senior Event Adviser - An adviser with a particular focus on IT aspects of a major event.
<i>Start gate</i>	A start gate has a bar connected to one or more switches that trigger the start clock(s).
<i>Photocell</i>	A photocell is used to create an invisible line with light that triggers the clock when an object crosses the line.
<i>Photo finish system</i>	A photo finish system consists of a line scan camera that records the finish line at an adjustable rate (100 Hz or more), together with the necessary software. The camera must be mounted on a stable tripod or a fixed construction, aligned on the finish line. This can be used to determine the finish time exactly, and separate athletes that crosses the finish line at more or less the same time. Example: FinishLynx . Used at WOC 2003.
<i>Video finish camera</i>	A video camera recording the athletes crossing the finish line.
<i>Manual hand timing (push-button)</i>	The time is recorded by a clock printing the time triggered by a person who push a button when the athlete crosses the finish line.
<i>Transponder</i>	A transponder is a chip worn by the athlete, or fixed on the bike, that can be activated by an antenna, and be used for identification and timing.
<i>Accuracy</i>	The degree to which the result of a measurement, calculation, or specification conforms to the correct value or a standard. This is the “trueness” of the time published.
<i>Precision</i>	Refinement in a measurement, as represented by the number of digits given. This is the number of decimals used in the time published.
<i>System A</i> <i>System B</i>	Two independent timekeeping systems, a primary (system A) - and a secondary (system B), shall be used continuously throughout the competition. They must have similar accuracy.

An explanation regarding accuracy and precision

We can use a clock that prints the times in thousands, i.e 13:37:42,145 (precision 1/1000). At the world record speed at 100 m sprint that is a difference of 1 cm. It is not fair in orienteering competition to decide between athletes on the basis of a 1 cm difference, unless it is a first to finish competition. If we use a push button to mark the time when the athlete crosses the finish line, the accuracy is approximately 0.2s with a very good operator.

4 Timekeeping requirements

The current rules regulate accuracy to be at least twice the resolution of the precision, specifically with 0.1s precision, the timing must have 0.05s accuracy.

The secondary timing system (system B) must have similar accuracy as the primary system.¹

If single times are used from the secondary timing system, the timekeeper should first calculate the difference between the primary and secondary system of the three preceding athletes and correct for any systematic deviation.

4.1 Overview

	Sprint Finals	WOC, WSOC, World Cup, JWOC	WRE, WMOC
Result time precision	0.1s	1s	1s
Time recording accuracy	0.05s	0.5s	0.5s
Start system	Start gate	Start signal	Start signal or start punch
Finish system A+B	Photocell Photo finish	Photocell Transponder	Photocell Transponder Finish punch
Backup finish	Photocell Video finish Transponder Manual hand timing	Video finish Transponder Manual hand timing	Video finish Transponder Manual hand timing

4.2 Level 1

The results shall have 0.1s precision.

¹ In the unfortunate case where the primary system fails, and the secondary timing system has poorer accuracy than the primary system, and it's not possible to guarantee the correct accuracy in the result list, the race results list should be published with 1s precision.

This means that

- The exact start time must be recorded by a *start gate*.
- The finish time must be recorded by either a *photocell* or *photo finish system*.
- The recorded times must be printed on paper for backup and validation purposes.

There is not yet any *transponder*-based system that has been documented and proven for official timing at 0.1s precision in orienteering.

For backup purpose, the photocell should trigger two independent clocks.

4.3 Level 2

The results shall have 1s precision.

The athlete starts at “the beep” with an official controlling that the athlete starts at the right time (“hand on the shoulder”).

The electronic finish timing system can be based on a *photocell* set up, a *photo finish system* or a *transponder*. *Manual hand timing (push-button)* backup is recommended, in addition to the mentioned electronic systems. A common setup and good practice is to use a transponder as system A and photocells as system B, and if possible having video, and eventually a push-button and handwritten record of number bibs.

A touch free finish control is considered an electronic finish timing system, but it is not recommended from a media perspective in any high-profile event.

A transponder-based timing system must be set up and verified before each race according to the vendor’s instructions. At a minimum this basic test must be done:

1. Cross the finish line with at least 4 transponders mounted next to each other
 - a. Verify the difference
 - b. Verify that the finish line is straight
 - c. Verify that the electronic finish line is where the visible finish line is
2. Do the validation in the middle, to left and to the right of the finish lane

4.4 Level 3

The results shall have 1s precision.

The athlete shall start at the beep from the start clock, at the right time. Officials should record any false starts. Punching start is also allowed, but runners who are late for their start through their own fault shall be timed as if they had started at their original start time.

Finish time can be recorded by manual hand timing (push-button or finish punching with any of the approved punching systems).

5 Proven equipment

5.1 Timing equipment, level 1

Any equipment that is on the FIS Homologated Timing Equipment² list fulfils the criteria for orienteering.

The follow timing equipment are within the specification for 0.1s precision, and have been used successfully in orienteering:

- [Microgate REI2](#)
- [Microgate Racetime2](#)
- [Alge Timy-series](#) (Timy, Timy 2 XE, PXE, Timy3)
- [SportIdent Sprinter Station](#)
- [Emit ECB1](#)
- [Tag Heuer CP5xx](#) (Chronoprinter) - series

Some examples of professional start gates:

- [Alge STS](#)
- [Microgate Startgate](#)
- [TagHeuer HL7](#)

Photo cells;

- [Alge](#)
- [Microgate](#)
- [Tag Heuer HL2](#)

This list is not exhaustive, and other clocks and gates can be approved if they have sufficient documentation of precision and drift, and have printing capability (built-in or external)

The drift must be constant/stable during the race. If separate clocks are used on the start and in the finish, they should be of the same brand, and the combined drift during the race must be better than the accuracy requirement.

²As of February 2018 this is the latest version: <https://data.fis-ski.com/media/services/timing-and-data/timing-booklet-cross-country-nordic-combined-draft.pdf>

5.2 Timing equipment, level 2

Any clock in the list for level 1, all approved punching systems with finish punch, and any clock with a printer that has sufficient accuracy for 1s timing can be used.

5.2.1 Proven Transponder systems, level 2

- Emit Emitag with the transponder on the arm/hand with a double antenna loop for Level 2.
- Sportident Air+ is allowed with either a ground antenna loop or with a dual BS11 in gate mode for timekeeping at Level 2.

Instead of a ground loop, both touch free systems may be used with a touch free finish control, but for a high profile event the use of a finish control is discouraged.

The vendors' instructions on setup, configuration and verification must be followed. If the timekeeper has little experience with transponder timing, a test plan must be developed. There are several ways to set up transponder timing wrongly, and special attention must be paid to the materials involved in the arena construction around the antennas. Iron fences in the wrong places can seriously change the characteristics of the antennas involved in the finish line.

5.2.2 Other transponders

An organiser who plans to use any other transponder system as the official timing system need to develop a test and verification plan together with the IOF IT Commission or the IT ASEA.

Tag-Heuer / Chronolec and Mylaps Prochip are known to be within the specifications for Level 1 if used on both ankles, or fixed on the equipment, but has no known recent use in orienteering.

Transponders can be used as a supporting system at Level 1 to the official timing system to determine the unofficial results, providing identification of the runner for tv graphics etc, but the official results must be confirmed by using the official electronic timing (photocell or photo finish).

With documentation on the performance from real races, other transponder systems can be added to the list of Proven Transponder systems. The documentation should include a list of times from a photocell, the corresponding list of times from the transponder, and an analysis of the difference, together with a system component drawing, and a description of the general setup used.

6 Proven setups

These are examples of setups that is proven and has been used in many international orienteering events. The vendors will provide further details on the hardware setup, training courses and instructions on how to use their equipment.

6.1 Level 1

6.1.1 Using SportIdent

Role	Equipment	Products	Purpose
Start	Start gate	Main: SI Sprinter station Backup: A timer with a printer, e.g Tag Heuer CP540 Chronoprinter or similar	Used to determine exact start time
Finish, system A+B	Photocell (dual or with two outputs)	Main: SI Sprinter station Backup: A timer with a printer, e.g. Tag Heuer CP540 or similar	System A+B for deciding finishing time.
Finish, backup	Transponder finish	BS11 with ground loop antenna, or two BS11 in gate mode	Used for identification, and backup timing

6.1.2 Using Emit

Start	Start gate	Emit ECB1 or ETS1	Used to determine exact start time
Finish, system A+B	Photocell (dual or with two outputs)	Emit ECB1, ETS1 or RTR2	System A+B for deciding finishing time.
Finish, backup	Transponder finish	Emit ECB1 with a loop antenna	Used for identification, and backup timing

In a level 1 race, the official times must be taken from the photocell, but using a transponder for identification and backup timing is recommended.

Regardless of which technology used for system A and B, it is good practice to have a 3rd and 4th level of backup as well, by recording every finished with a push-button on a timer with a printer, alternatively using an ipad based program like Webscorer, and video preferable both from the side and the front of the finish line.

6.2 Level 2 in a high profile event (with media, TV present)

A live TV production puts higher demand on the timekeeping; results must be ready to be presented on the TV graphics at latest 500 ms after the crossing the finish line, more redundancy, less time to correct errors. Some broadcasters may even have stricter requirements. There will also be requirements on the layout of the finish area and how it looks on the picture when the runner crosses the finish line.

6.2.1 Using SportIdent

Start	Start gate (optional)	Main: SI Sprinter station Backup: A timer with a printer, e.g. Tag Heuer CP540 Chronoprinter or similar	Used to determine exact start time
Finish, system A	Transponder finish	BS11 with ground loop antenna, or two BS11 in gate mode	Used for identification, and timing
Finish, system B	Photocell	A timer with a printer, e.g. Tag Heuer CP540 or similar	Used for backup timing

6.2.2 Using Emit

Start	Start gate (optional)	Emit ECB1 or ETS1	Used to determine exact start time
Finish, system A	Transponder finish	Emit ECB1 with a double loop antenna	Used for identification, and main timing. System A.
Finish, system B	Photocell	Emit ECB1, ETS1 or RTR2	System B

6.3 Level 2 in a low profile event (little media, no TV present)

With little media present, we have more freedom in how the picture looks when the athlete crosses the finish line, and we have more time to correct any errors. (e.g a missing time, dead transponder)

Finish, system A	Transponder finish	BS11 as a finish control (i.e touch-free “finish punch”) or Emit Touch Free Pro as a finish control	Used for identification, and timing, system A
Finish, system B	Push-button / Photocell		System B Video backup is also recommended

6.4 Level 3

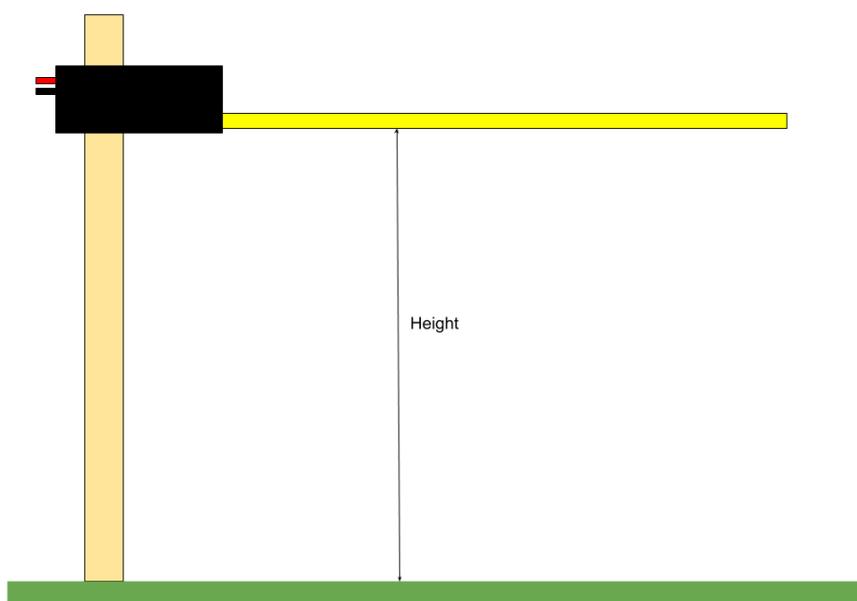
The organiser is free to use a any approved system with finish punch.

Finish, system A, variation 1	Transponder finish	BS11 as a finish control (i.e touch-free “finish punch”) or Emit Touch Free Pro as a finish control	Used for identification, and timing, system A
Finish, system A, variation 2	Finish punch	SportIdent, Emit EKT, LearnJoy, SFR control for finish punching	Used for identification, and timing, system A
Finish, system B	Push-button or video backup		

6.5 Start gate setup

The start gate mounting post must be put into the ground, snow or be firmly connected to a fixed structure.

The height above the ground of the Start Gate must be so that athletes hit the bar and won't step over it. Recommended height is between 35 and 100 cm.

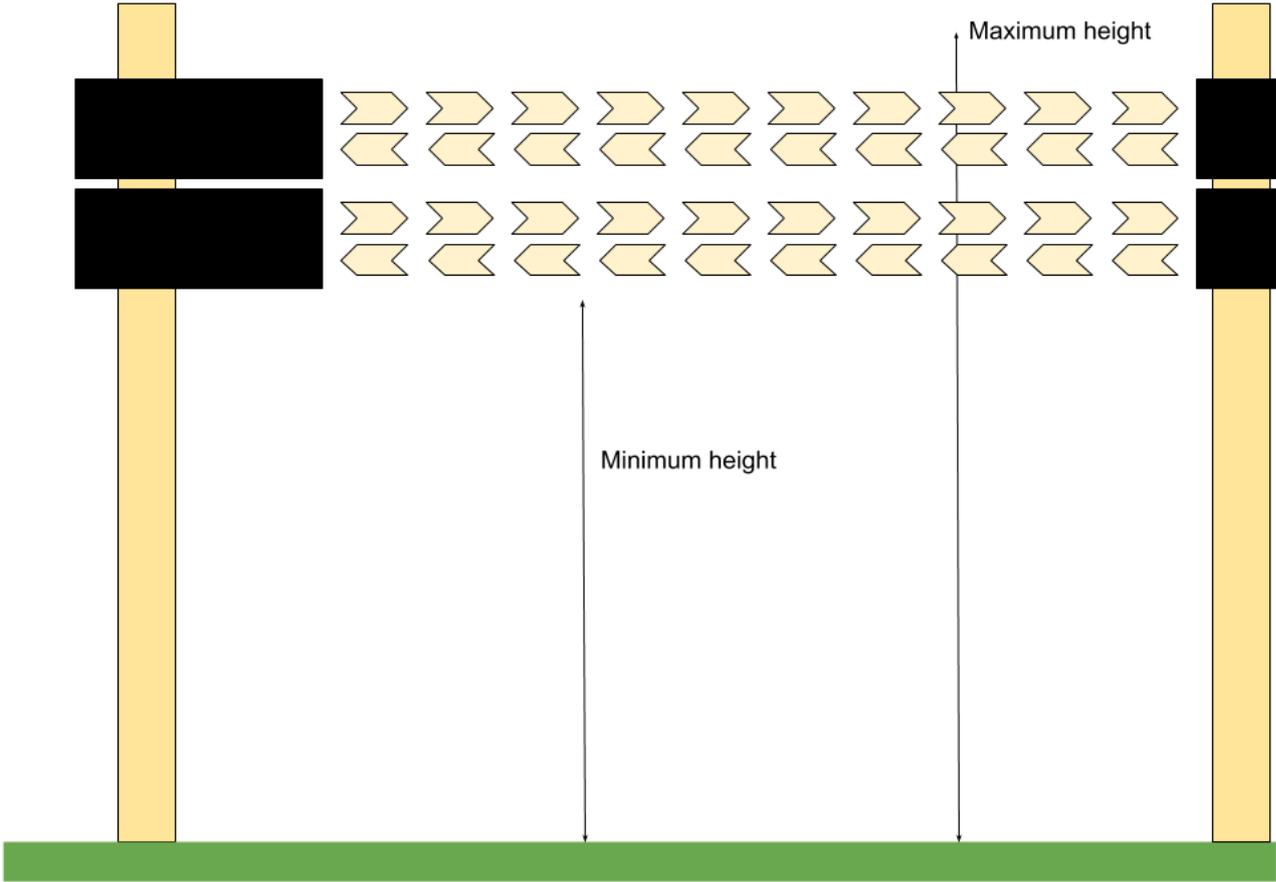


6.6 Photocell setup

The photocells must be installed so that stand stable in the snow or on the ground, and so far from the course that no athlete can struck the installation. The finish line must be as level as possible, and so that no athlete should be able to slide under or jump over the beam. The photocells must be connected to the timer by a fixed cable.

In ski-orienteeing the primary (system A) photocell must be mounted so that the measuring point is at a height of 25 cm above the snow. If two cells are used, the secondary (system B) should be mounted at most 20 cm above the primary.

In foot-orienteeing the photocell must be mounted so that the measuring point is at minimum height of 50 cm and maximum 100 cm above the ground. If two photocells are used, both must be within this limit.



7 Appendix - Discussion on Transponders

If a transponder-based system is used, it is highly critical that the system is set up *according to the manufacturer's specification*. An incorrect setup can easily invalidate the results. It is important to verify the setup on each competition day.

The accuracy of transponder timekeeping is related to where on the body the transponder is fixed to the athlete and at what angle the transponder enters the field around the antenna at the finish line.

Optimally for timekeeping, a transponder should be fixed to both ankles of the athlete. As a more affordable compromise, we accept that the transponder is fixed somewhere on the arm (or bike), so that punching and timekeeping can use the same device, and to protect the transponder from the elements of a rocky terrain. This compromise gives poorer accuracy. In order to approve a transponder for 0.1s in orienteering, we need documentation from a field test proving the accuracy.