FENCING

Wireless Start/Stop system

Basic Radio Specifications

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1 INTRODUCTION

The purpose of this document is to describe the radio communication equipment that should be used in fencing to start the count down.

The basic requirements are listed below:

- Several systems must be able to co-exist in the same environment/area.
- Each system must be set on a separate frequency avoiding the risk of collision between systems.
- The wireless communication range must be guaranty over 10 meters
- At least two remote controls must be connected to one scoring machine (Main and back-up)
- The radio frequency band should be compliant with local regulations (ETSI/FCC/GOST/…)
- The communication frequency (between a remote control and the scoring machine) must be selectable
- Strong robustness against perturbation from other wireless systems used in the same area (Wifi, UHF, GSM, etc..).
- The latency must be as short as possible (<100ms)
- The wireless communication must be encrypted
- The wireless communication (from the remote control to the scoring machine) must be monitored (RSSI, number of retries, battery level, frequency used, …)
- A handshake protocol must be implemented to improve the robustness of the system
- The shape of the remote control must be as small as possible and ergonomic (in particular for the push button)

2 SYSTEM OVERVIEW

The minimum basic system should be constituted of (*Figure 1)*:

- 1 scoring machine which embeds the timer with a wireless module
- 2 two Start/Stop remote controls (main / back-up) with a wireless module

Normal operation

The arbiter presses the push button on the remote control placed in one of his hands (remote Main). A wireless message is sent to the scoring machine to start the count down.

A second remote control (remote Back-up) must be used in replacement of the main in case of issue.

The remote controls are linked to only one scoring machine at the time.

The scoring machine must be able to monitor the received messages.

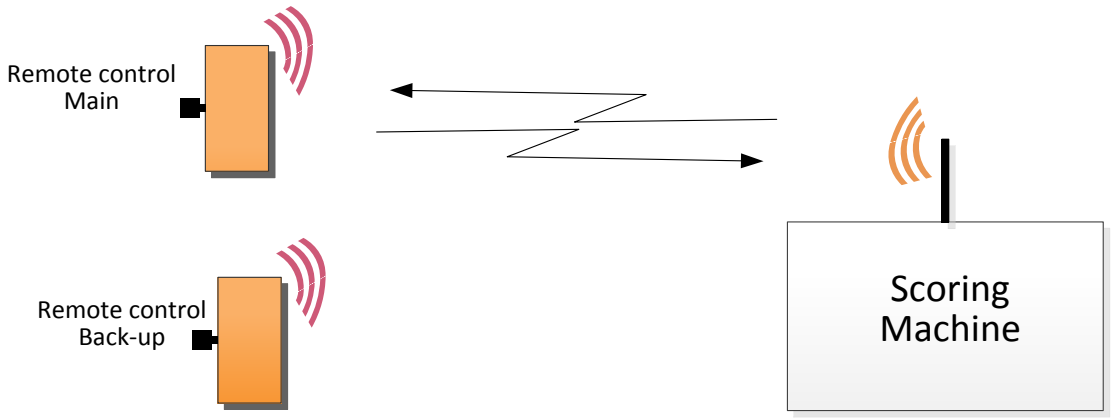

Figure 1: The 2nd retry has been acknowledged

3 WIRELESS COMMUNICATION

The timing precision used in Fencing is not so critical (1/10s), therefore the wireless technology that should be used to start the countdown must be simple and robust.

The most adapted approach is based on the principle of acknowledgement. Each wireless message should be acknowledge by the receiver to ensure that the message has been well received. If not the sender sends again the message. The number of retries should be limited; basically the number is limited to 2 retries.

However, this approach has few limitations:

- If the acknowledge message is not received in return by the remote control, it could generate unnecessary wireless traffic. Nevertheless, the arbiter could ensure that the command has been well received by the scoring machine by verifying the countdown.
- Power consumption, the fact that the remote control should have an embedded receiver implies that the current consumption will be higher and therefore will impact the battery life and the form factor of the remote control.
- The risk of collision with another wireless system exists and is not solved by the acknowledgement communication (*Figure 2)*. In addition, if two remote controls send at the same time a message, the first but also retries communications will be perturbed. Software routines must be implemented to avoid this risk (random temporization - *Figure 3*).

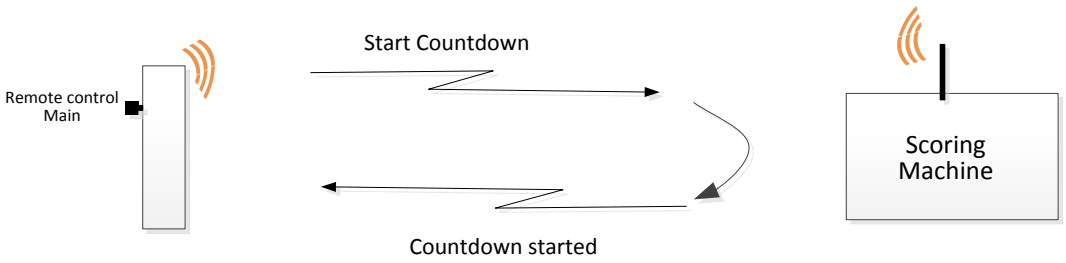

Figure 2: Message with acknowledgement

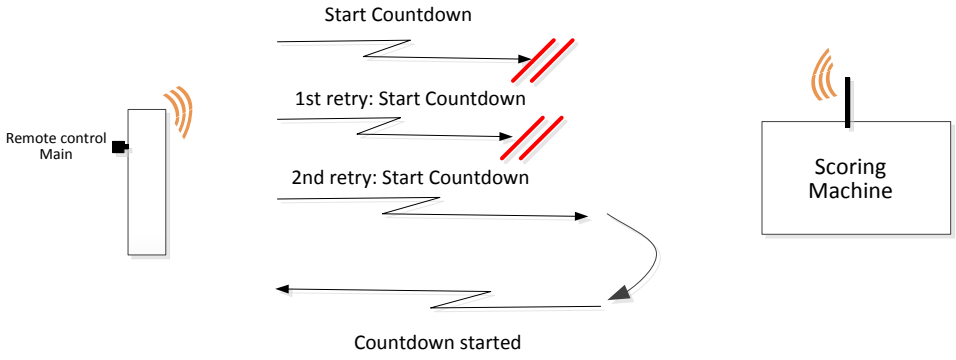

Figure 3: The 2nd retry has been acknowledged

4 COLLISIONS AND PERTUBATIONS

Basic recommendations against perturbations: Frequency selection.

- Each system (scoring machine and two remote controls) must be set on different frequencies before the start of the competition.
- To avoid crowdie frequencies, it should be necessary to change the communication frequency on each remote control as well as on the scoring machine. This selection could be done by hardware or by software (paring procedure).

Basic recommendations against collisions:

- Provide unique ID for each system (Remote and scoring machine)
- Use a random temporization before to send a new retry. The message should be acknowledge is less than 100ms
- Keep wireless message as short as possible, the risk of collision will decrease drastically.
- It is also possible to implement a LBT approach (Listen before talk) to further reduce the risk of collision with another wireless equipment.
- The implementation of LBT allows having several systems that co-exist in same area. This situation could appear if the frequency band available is too small to have all the systems on separate communication frequencies (*Figure 4)*.

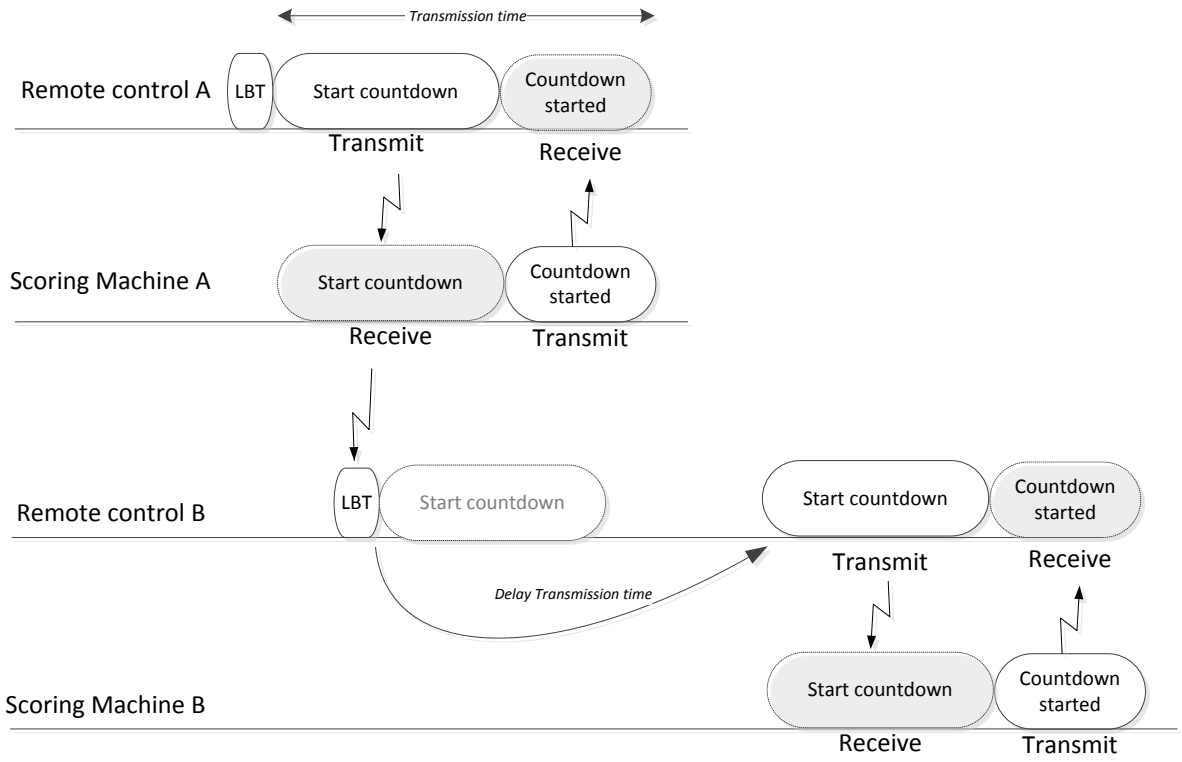

Figure 4: Listen Before Transmit

5 MAIN SPECIFICATION

Radio Communication

Frequency band:	810 -960MHz band • 863 – 870 MHz European free license band • 902 – 928 MHz Us free license band
Tx/Rx Frequency:	Selectable
Modulation type:	GFSK / 2-FSK
RF output power:	selectable
RF Sensitivity:	-110dBm @1.2kbps
RF Bit rate:	38.4kbps min
Range:	10m typ
Latency:	<100ms maximum
Security:	Encryption

Communication Protol

LBT with acknowledge

Remote control

Battery operated:	24hours min
Antenna:	Integrated
Certification:	ETSI /FCC

Scoring Machine

Supply:	External power supply
Antenna:	External / Internal (could be change according to the frequency)
Certification:	ETSI /FCC