Sailing Race Control Box

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OVERVIEW

A portable battery-powered box to provide sound and visual starting signals for sailing races. The Race Control Box provides an accurate countdown and outputs both sound and lamp control signals so that the race start is fully automated.

For a picture of the actual prototype box, click here

Purpose

At the start of a race timed signals are made to indicate a countdown to the start. The signals are both visual and audible. Visual signals use lights, or flags which are hoisted and lowered at specific times, accompanied by sound signals.

If the box is connected to starting lights and a horn, the Race Officer simply presses the "Start" button to begin the countdown, and all signals will be made correctly and at exactly the right times.

For the case where flags are used, rather than lights, the box also provides prompts, via the LCD screen, showing when a flag should be raised or lowered.

Once the race has started, it continues to run and shows the "Elapsed" Race time, which can be used to record finish times for handicap racing.

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FEATURES

The Race Control Box provides relay control for an external horn and also external lamp signalling. The main features are described briefly below, with more detail in the separate documents.

Selectable countdown sequences available

The box is pre-programmed with 12 different start sequences. This includes standard 541Go ISAF start plus others, which can include a separate pre-race attention/warning signal.
In many cases all races use the same start, so once set, this is automatically loaded the next time the box is switched on.

Multiple Flights

Also known sometimes as "rolling starts", the box can be set to start multiple flights (max. 6 flights).

Example: Fast handicap, Laser, Slow Handicap, Junior

After the initial countdown, each following flight (or recalled flight) will start after a "Flight Interval".

Status Indicators

LED indicators show the on/off status of the horn and each light. In addition, an LCD display provides countdown information and prompts - if flags are used, it indicates the action needed for each starting signal.

Recalls

 The box can handle both "Individual Recall" and "Flight/Class Recall", with lamp indications and correct sound signals. It will automatically provide an additional start for a recalled flight.

Shorten Course

Uniquely, this box also provides a "Shorten Course" option to use during the race. (2 hoots, 2 alternately flashing lights until end of race or cancelled by user)

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USER GUIDE.

Start Sequences

The box comes programmed with 12 different starts.

In a start sequence, each signal is shown in the usual manner, as a number of minutes before the start, e.g. the ISAF start sequence '541Go' will give signals at 5, 4, 1 minutes before the Go (at time zero).
An optional race warning (attention signal) is available on some start sequences. This is indicated by a dash after the number E.G '6-541Go'. This will give a race warning signal at 6 minutes before the race start.

A full list of the start sequences is given in Appendix 1.

Multiple Flights

Also sometimes called "rolling starts". When a race has more than one start for different classes of boat, each start is called a Flight.

For example, 'Fast Handicap' followed by a 'Slow Handicap'; or 'Single-handed' then 'Double-handed'. For class racing there may be a separate start for each class. For example, 'Laser'; 'RS200'; 'GP14'; 'Solo' etc.

The box can start up to 6 separate flights for a race.

Each flight will start one "Flight Interval" after the previous start.
For 541Go sequences, this is 5 minutes, for other sequences it is 3 minutes. See Appendix A for details of each sequence.

Changing the Start Sequence or Number of Flights.
1. Switch the box on.
2. The current start sequence will be shown.
3. After a few seconds the LCD will show *"(HORN TO CHANGE)"*
4. Pressing the Horn button once. The LCD will show *"(SET TO SAVE)"*
5. Press the horn button to cycle through the various start sequences,
6. Press SET when the required sequence is shown.
7. The display will hen show "*FLIGHTS=1*".
8. Press the horn button to increase the number of Flights, which will cycle 1,2 etc. up to 6, then back to 1.
9. Press SET to save. The settings will be stored and used next time the box is switched on.
10. The display will show "READY" and the chosen start sequence.

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STARTING A RACE

- **Switch the box on**.
  The box will show the current sequence and number of flights. (see also **Changing the sequence or number of flights**)
- **Press the start button.**
  A warning buzzer will bleep for 5 seconds before the first signal. The display will then show the number of seconds until the (first) start.
- As the countdown approaches each "*signal time*" the buzzer will give a 5 second warning. Then the horn will sound and the correct lamp will be triggered. (The associated relay will switch On/Off and the mimic LED on the box will also light or go out. The display will indicate which flag should be raised or lowered. The example start sequence below should make this clear!

Example starting signals and display

Example: A 6-541Go start (with one flight).

ACTION - Press the Start button: Warning beeper sounds (toggles on/off) for 5 seconds before

-6 minutes: The race warning sound signal is given, FIVE HOOTS on 0.5 seconds) and the warning light is switched on. The display shows "RACE WARNING" and starts counting down in seconds, from -360 (i.e. 6 x 60).

-5 minutes: The display shows "CLASS FLAG UP". The CLASS sound signal is given, (ONE HOOT 1.5 seconds) and the CLASS light is switched on.

-4 minutes: The display shows "PREP FLAG UP". The Preparatory sound signal is given, (ONE HOOT 1.5 seconds) and PREP light is switched on.

-1 minute: The "One Minute" sound signal is given, (ONE LONG HOOT, 2.5 seconds) and PREP light is switched off. The display shows "PREP FLAG DOWN".

0 minutes: The START sound signal is given (ONE HOOT, 1.5 seconds) and CLASS light is switched off. (All lights are now off).

Recalls

Racing rules state that a recall MUST be made as soon as possible after the start. The box will disable the Recall button after 15 seconds, which is more than enough time.

Individual Recall: Pressing the RECALL button will sound ONE HOOT and switch on the Class light.

Flight Recall: Pressing the RECALL button a second time will sound ONE HOOT and start to toggle the Class light ON/OFF at 1 second intervals.

After 15 seconds from the start, Pressing RECALL will turn the Class light off (no sound). If Recall is NOT pressed manually, the box will cancel it automatically at 60 seconds.

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A recalled flight will restart exactly one interval later.

If there are multiple flights, each flight starts one interval later, so for 541Go the 2nd flight starts 5 minutes after the 1st flight etc.

In the case of a flight recall, the flight will restart after 5 minutes. The CLASS lamp will be lit at 15 seconds after the start and the 4 minute PREP signal occur ONE minute after the previous start.

Shorten Course

During a race, it is sometimes necessary to indicate "Shorten Course". The race box can also do this once 10 minutes have elapsed.

Press the Recall Button. The box will sound 2 hoots, and start flashing the "Class" and "Prep" lights alternately.

If the signal should be cancelled for some reason before the box is switched off, press the "Recall" button again.

Manual Horn Signals

Additional signals can be made using the Horn button, which is enabled once the box startup is complete, or at any time during the race.

Postpone/Abandon

Press the Horn button as required. To postpone (2 hoots) or abandon (3 hoots).

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APPENDIX A

Starting Sequences

Sequence ID	Sequence Name	Notes	Flight Interval
1	541Go	ISAF Rule 26 Signals at 5,4,1 and Go	5 minutes
2	6-541Go	ISAF Rule 26. Race Warning at 6 minutes, then as Sequence 1	5 minutes
3	10-541Go	ISAF Rule 26. Race Warning at 10 minutes, then as Sequence 1	5 minutes
4	321Go	Signals at 3,2,1 and Go	3 minutes
5	5-321Go	Race Warning at 5 minutes, then as Sequence 4	3 minutes
6	6-321Go	Race Warning at 6 minutes, then as Sequence 4	3 minutes
7	10-321Go	Race Warning at 10 minutes, then as Sequence 4	3 minutes
8	631Go	Signals at 6,3,1 and Go	3 minutes
9	9-631Go	Race Warning at 9 minutes, then as Sequence 8	3 minutes
10	963Go	Signals at 9,6,3 and Go – NON-STANDARD **	3 minutes
11	T-321Go	TEAM RACING. Signals at 3,2,1,Go Additional Hoots at 30,20,10, then 5,4,3,2,1 seconds	3 minutes
12	T-541Go	TEAM RACING. Signals at 5,4,1,Go Additional Hoots at 30,20,10, then 5,4,3,2,1 seconds	5 minutes

Notes:

Horn signals are 1.5 seconds hoots, except the 1 minute signal which is a long hoot (2.5 seconds).

The "Race Warning" signal is 5 short hoots (of 0.5 seconds) repeating at 1 second intervals.

** Sequence 10 (963Go) is non-standard as there is no signal at -1 minute. Signals are
Race Warning at -9 minutes, Class Flag Up at -6 minutes, Prep Flag up at -3 minutes, both DOWN at the start (Go).

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APPENDIX B

Physical Design Details

This describes the mechanical layout of the prototype box.

The prototype was built in a small project box (ABS, IP66).

Mounted on the box sides:

- 1 On/Off switch. Switches power to the controller from a small PP9 battery within the box.
- 1 small piezo sounder. Gives warning beeps before an action to alert the race officer.

Mounted on the box lid:

- 4 Momentary switches for Start; Horn; Recall/Shorten; Set.
- 5 Coloured indicator LEDs (5mm) for Run; Horn; Class; Prep and Warn;
- 1 LCD display. A standard 16x2 (16 characters, 2 lines) LCD display with a backlight.

Box Internals:

- 1 PP9 Battery – for production this could be replaced with a connector to an external 12V battery, (on the Committee boat or Race Officer box etc.)
- 1 Arduino Uno microcomputer board
- 1 Seeed Studio Relay Shield v3.0. This provides 4 channels of isolated relay outputs, for interface to an external horn and 3 lights, or whatever hardware is chosen.
  NOTE: the relay board uses active HIGH on control pins 4, 5, 6 and 7 controlling relays 4,3,2,1 respectively.

Electronic Design Details

A schematic and "breadboard layout" for the box wiring are given in separate documents. Together these should allow the user to construct the box to their own physical requirements.

Arduino Microcomputer Program

The Arduino Uno board is programmed using core Arduino features and libraries. Additional open-source libraries and custom code have been written for the box. An overview of the code will be described in a future separate document.

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APPENDIX C

This shows the Protoype box that was used for development, plus the schematic and breadboard wiring diagrams.

Using these as a basis, the Race Control Box can be built to your own requirements.

The software is available for download from this site.

The Protoype Box

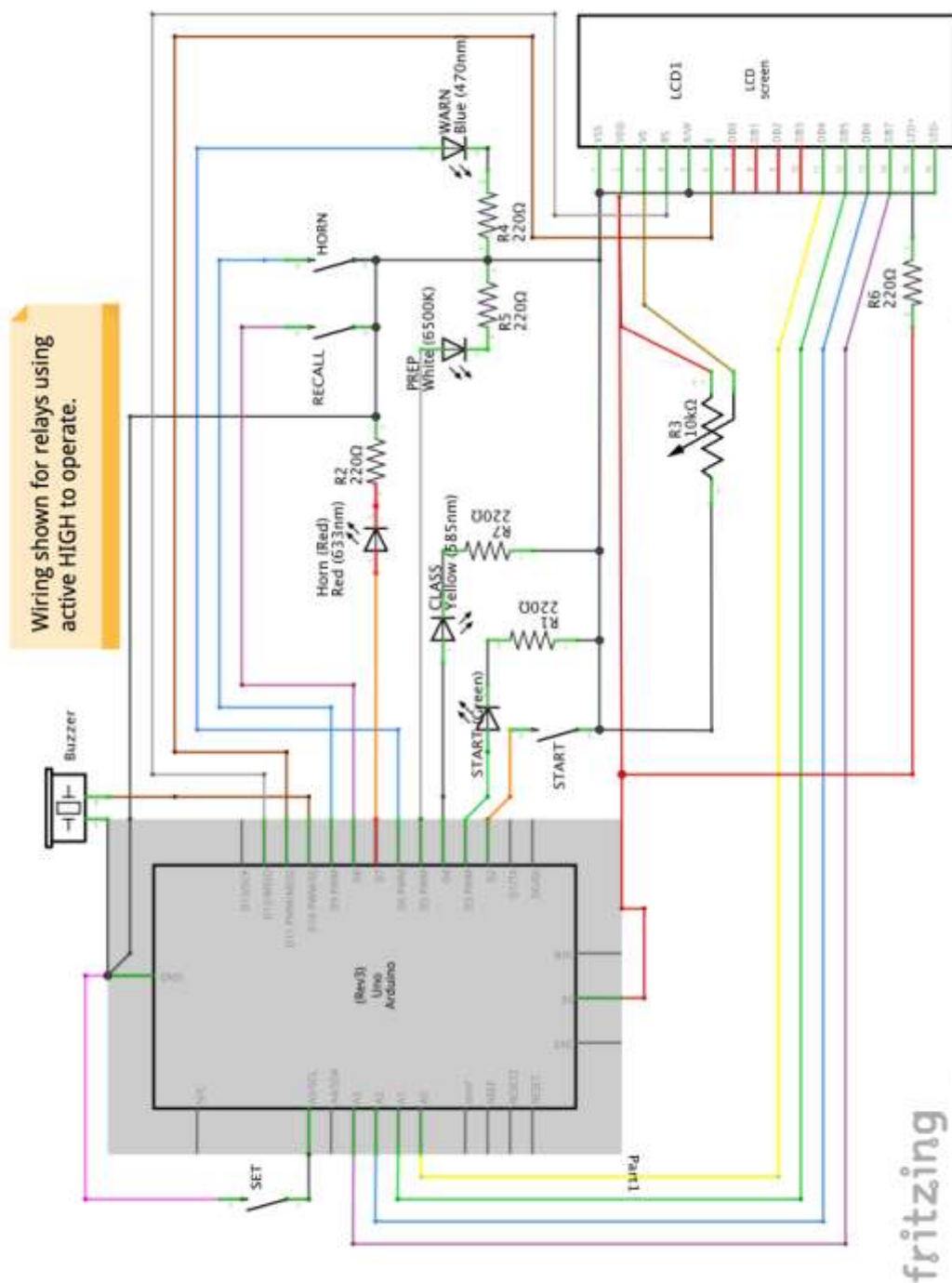Constructed in an ABS box, size 165 x 115 x 50mm.

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Schematic

If your relay shield uses Active LOW to operate the relays, or uses different pinouts, adjust the wiring to suit.

Any changes to the wiring also need changes in the code. Refer to the racebox.ino code comments and the PINOUT definitions, and set the Boolean relayActiveState to HIGH or LOW as required.

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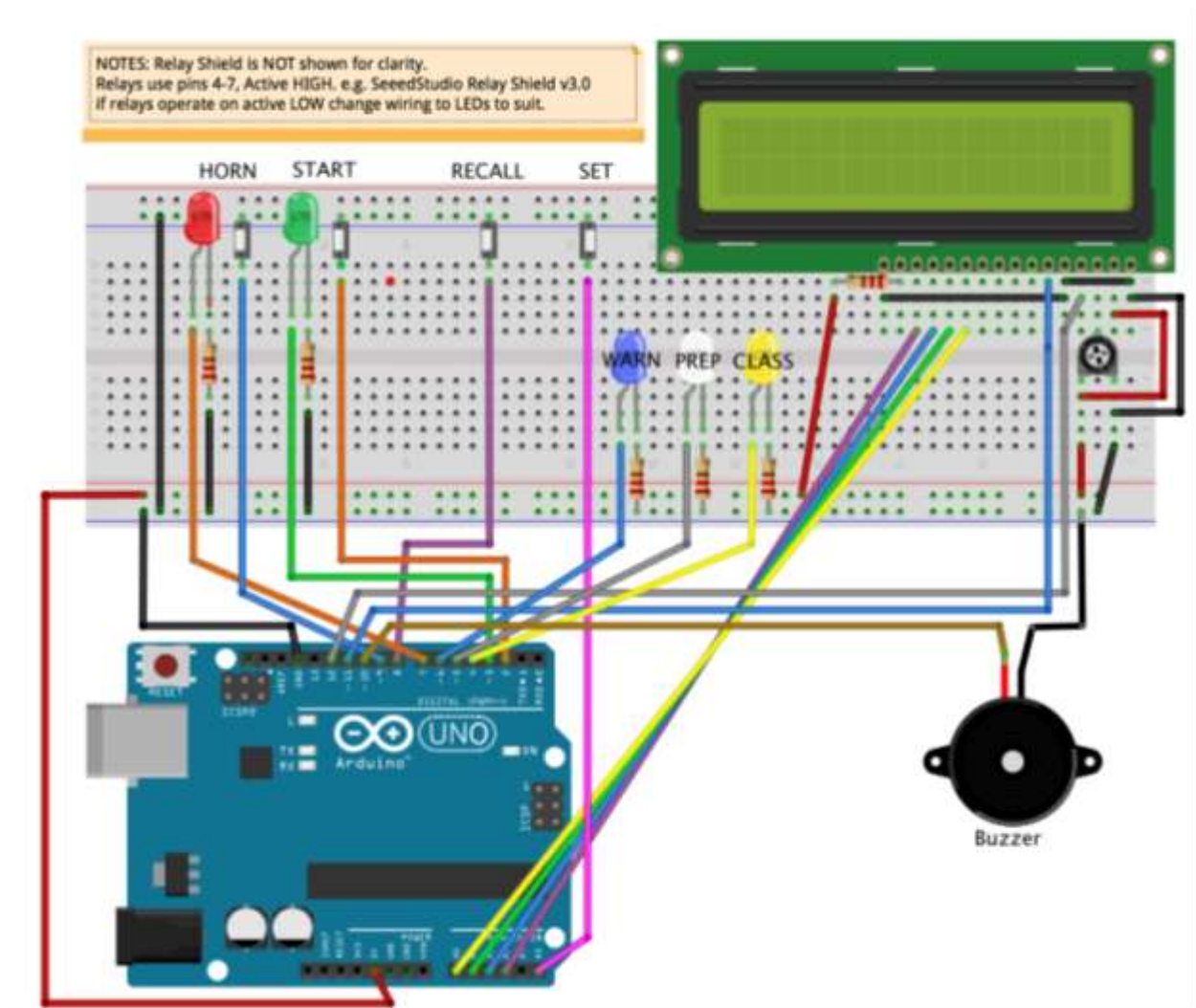
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Breadboard Wiring

Note: For clarity the Relay Shield is NOT shown (and is not necessary to demonstrate the working box). The pinouts for the Seeed Studio Relay Shield v3.0, which piggy-backs on top, are identical to the Arduino Uno.
To switch an external horn and lights, simply plug the Relay Shield on top of the Uno board and wire the connections to that – same pinout as shown below.

If your relay shield uses Active LOW to operate the relays, or uses different pinouts, adjust the wiring to suit.
Note: Code changes: Any changes to the wiring also need changes in the code. Refer to the code comments and the PINOUT definitions, and set the Boolean relayActiveState to HIGH or LOW as required.

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Parts List

This is the part list for the prototype box described above.

Vary to suit your intended use!

Item	Qty.	Description
1	1	Arduino (Genuino) Uno microcomputer. e.g. https://store.arduino.cc/arduino-uno-rev3
2	1	4 channel Relay Shield e.g. https://www.seeedstudio.com/Relay-Shield-v3.0-p-2440.html
3	1	LCD 16x2, backlit, Hitachi HD44780 compatible
4	1	ABS Box 167 x 107 x 65 mm. (or to suit your requirements/battery size) e.g. Hammond 1594ESBK
5	1	switch (metal, 16mm SPST momentary push to make) – Start
6	1	switch (black/red, SPST momentary, push to make) – Horn
7	2	switch (black, SPST momentary, push to make) – Recall and Set
8	5	coloured LEDs, 5mm
9	6	resistors, 220 Ohm 1/8th watt
10	1	10KOhm miniature potentiometer – LCD contrast (or 1K and 10K resistors)
11	1	Piezo Sounder – Buzzer
12	1	2.5mm DC connector for power
13	1	Splashproof On/Off power switch DPDT
14	2	Waterproof cable glands for power and relay connections
15	8	Misc bolts/nuts/washers for mechanical fixings