~~~~~~ Windwhisper PRO Race Controller ~~~~~~~

Prolog.... I don't want to know the details, just tell me what buttons to push

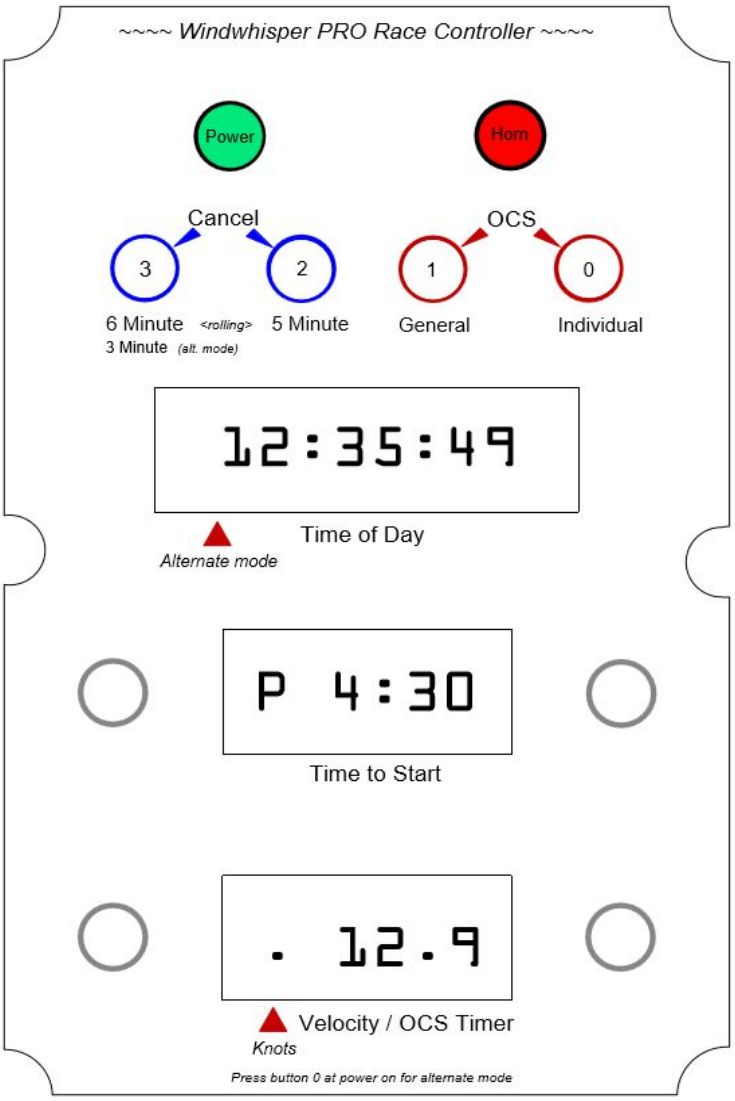


Figure front panel

Note: The controller has two modes or levels.... default and alternate. The default mode provides the four start sequences for most normal races. The alternate mode that can provide an additional sequence for each of the four buttons for a total of eight possible sequences. Additionally, an OCS (over early) function can be programmed into any sequence. The four bottom circles are place holders for a future version.

Refer to this figure in the following sections.

Normal Starts (default)...normal power up

- Turn on Power..quick momentary push. System may chirp. *Current Time of Day* display will be blank, *Time to Start* window counts down 10 seconds for system initialization, the *Velocity window* shows firmware revision

- After initialization,an opportunity to silence further spoken prompts presents it self. After the spoken prompt press button 1.

- *Current Time of Day* displays current time, *Time to Start* displays 0:0, *Velocity* . displays wind-speed and the system is ready to accept a start sequenc.

- Make sure the ship's radio is turned on and set to the competitors channel

- For this installation there are three sequences to choose from :
  - The 5 minute enters at 5:16. At 5:10 there are five alert blasts mirrored by the radio transmission with a sound on 1 second intervals. The familiar start sequence continues with no operator intervention needed. This sequence is a rolling start for multiple fleets.

  - The 6 minute repeat/postpone flag drop enters at 6:16. The sequence begins at 6:15 with the radio and local speaker announcement that the drop is eminent. At 6:05 the sequence of 5 short buzzers leads the flag volunteer into the drop. At 6:00 the horn sounds along with the accompanying radio transmission. The system rolls into the familiar 5 minute sequence.

  - The 3 minute sequence only uses the boat horn. There are no other prompts. This sequence does not roll so after the start it is ready to accept the next command. Choose Button 0.

  - A quick simple quick button push is all that is needed. The computer captures the button push. Other than power off, there is no need to hold any button down. It should be noted that it may take one or two 1 second clock intervals after a push for a sequence start.

  - While in sequence, the *Time to Start* will continuously count down

- The system updates the displays including the *Current Time of Day* every second. At the race start the, *Current Time of Day* update pauses for 30 seconds to give your score keeper time to record the start time.

- After the start, both the 5 and 6 minute sequences roll into the next 5 minute sequence (with no alert beeps) for multiple fleets. To stop the next start momentarily press either cancel button.

- Power off. All the buttons in the system are a quick press followed by and audible beep except power off. It must be held down for 3-5 seconds. There is really no reason to turn the system off. Its draws very little power and will not wear out.

- The sequences are actually programmed with a simple spread sheet making it easy to understand. It follows a traditional program and a copy (as of this writing) is appended

OCS option

- You can also use the over course side (OCS) over early feature using the two ***OCS*** buttons. At the race start an internal invisible 4 minute OCS counter starts decrementing. For 30 seconds after the start both OCS buttons become active. Reset does not clear this counter.

- X-ray Blows the horn once. At the same time a message beginning with an air horn sound coinciding with boat horn is transmitted. The message also has the words “Xray Xray Xray following the horn. The internal speaker tells the RC to raise the X flag. The PRO can then use the radio to hail the offenders. At the press of the X-ray button the anemometer display changes to the OCS time. OCS time will continue to count down until it reaches zero. It will then resort back to an anemometer.

- General recall. Blows the horn twice. At the same time a message message beginning with two air horn sounds coinciding with boat horn is transmitted. The message also has the words “General recall General recall General recall” following the air horn sound. The internal speaker tells the RC to raise the General recall flag. Unlike x-ray, the anemometer display does not change to a time but will continue displaying wind velocity.

- In both recall situations, the next start sequence under way continues. Reset will stop the start sequence but will not reset OCS counter.

- When the internal speaker OCS message is completed, the radio will have also completed its message and the PRO is free to use the transmitter to call numbers.

- If an individual recall turns into a general, the general button can be used. The system does not care (the sailors may care) how many times the recall buttons are pushed while in the 4 minute OCS window.

Alternative Sequences.. optional.. entered on power up

- Perform the normal power up except Button 0 is held down before and during power on button press. The beeper will immediately signal the reading of the switches and enter the initialization phase. The left decimal point on the *Current Time of Day* display will be turned on indicating alternative is on. After initialization, there will be the same audible announcement as the normal mode, offering the silent option and indicating the system is ready. Alternate mode lives until power down.

- After initialization all buttons offer the alternate choice of start sequence for each button. Currently there are no start sequences assigned, so this option can be ignored

Do Not Disturb.. optional.. entered on power up

Experienced race committees may find the voice prompt system coupled with the beeper intrusive. The post initialization voice prompt suggests pressing button 1 for the silent mode. This selection lives until power down.

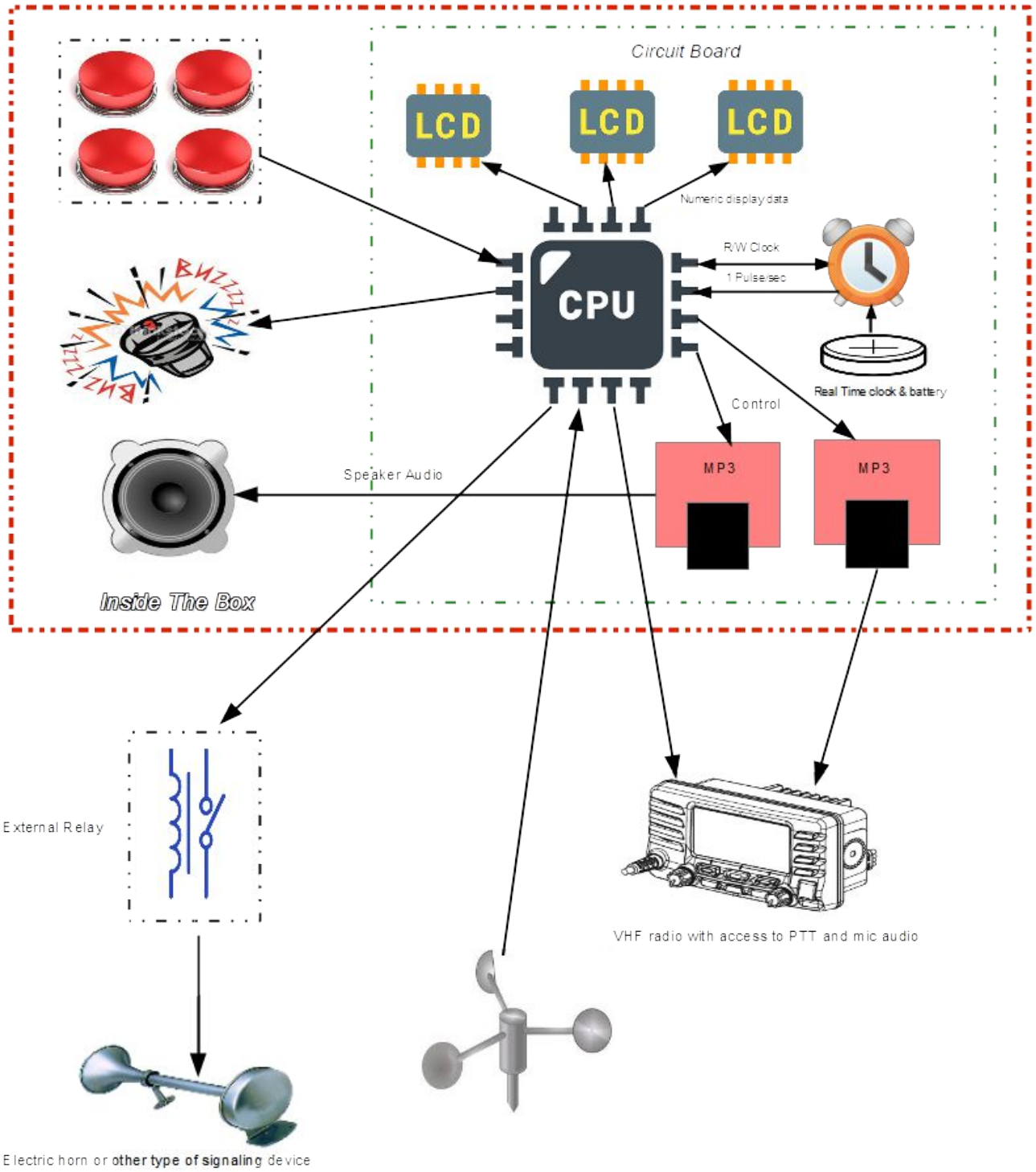
Additional notes:

- Conflicting use of the transmitter, the computer or the radio's microphone? Technically the PRO because they initiated the whole event. Hardware wise, the first user will not be interrupted. It is up to the PRO to know when the system will be transmitting. The current scripts have very few messages to the competitors and only occur during start sequences. They are short and at key times like flag drops and short timing messages leading into an event particularly the last 30 seconds before the start. Practically speaking no communication from the race committee should be happening at this time

- The timing messages will also help keep the mark set personnel current particularly if they are away at the other end of the course away.

- Early use of the system found that using the same radio channel for both the automated system and verbal communication with markset produced a confusing and chaotic situation for both the competitors and the race committee personnel. It is highly advisable to use a second channel for communication with markset.

- This concludes what you need to know to run the controller. It is recommended to read the rest of the document to more fully understand the system



Windwhisper Race Controller installation

Introduction / Overview

The design goal of the race controller is to begin with familiar existing automated audio start sequencers and add features that make it both simpler to use and at the same time add tools to enable the PRO to do their job more effectively.

The second objective is to further communicate more fully with both the RC volunteers and the competitors the timing in the start sequences using both human voice and sound effects

To accomplish this goal the design began with the familiar control concept of external horns for the competitors and the timing buzzers for the RC volunteers and then added the following features

- 6 digit Real Time Clock displayable in 12 or 24 hr format..runs on internal battery
- 4 digit display for countdown timer
- 4 digit display shareable between anemometer and OCS timer
- 3 cup anemometer mounted somewhere on the boat
- 2 internal MP3 audio players
- VHF radio interface for automatic audio transmit of MP3 timing sound bytes
- Internal audio speaker for playing RC volunteer MP3 bytes
- Internal piezoelectric buzzer for RC timing
- Displays are .7” reflective LCD for maximum visibility under all conditions
- Enclosure and all components selected for IP67 rating for maximum water resistance.
- Easily customized and work in any language.

Flexibility.... a little more detail

The system uses two common MP3 players (DFplayer). Sound byte files are generated on another device and loaded onto a microSD memory card. This is the same card commonly used in cell phones. The memory card is then inserted into DFPlayer. The project was developed on a PC and the free program Audacity was used to record the sound files. Audacity is a fully functional audio editing program and it allows merges and trimming. File length is important when using the file for timing cues. Merging allowed embedding MP3 sound effects like boat horns and whistles.

When designing the firmware, two dimensional arrays were chosen to contain the start sequences. The implementation is a simple spread sheet with three columns and a row for each event. The columns contains time left, some sort of command, some sort of command supporting argument. It became apparent that these files could be included as a separate source files when the firmware was complied. Furthermore the array format lends itself well to a spread sheet that a non programmer designing a start sequence could easily accomplish.

Details on producing sound files and spread sheet sequences are covered in another document.

Sound System.... For the more inquisitive

There are 2 separate sound systems, one for the RC volunteers and one for the competitors and mark set personnel. Both use the popular Dfplayer module. The module was chosen because of it availability, ability to run on its own and cost. It has its limitations the need for good documentation but, ... it works. It has enough output capability to drive a small speaker and also low level outputs for the radio. The sound level is firmware adjustable when the system is installed/configured.

MP3 sound files are copied into a micro SD card from an external device like a PC. The card is then inserted into the player. There lies the most serious short fall. Sound files must be loaded externally so no in device downloading is supported. Since the player is inside the waterproof enclosure, care must be

taken taken to ensure the waterproof integrity is not compromised if the box is exposed to weather.

For a speaker, an acoustical transducer is mounted to the inside bottom of the enclosure. A piezoelectric buzzer is also mounted on the bottom. Internal mounted transducers were chosen to simplify installation, and mitigate waterproof issues. Enclosure installations require a little air space underneath and preventing constriction of the bottom of the box to get a decent sound level.

The second DFplayer is interfaced to the microphone input of a vhf radio. The controller has a PTT (push to talk) relay that provides firmware control of the radio transmitter. The radio may be the ship's radio and while used primarily to send timing information to the competitors, italso helps the markset personnel. Having two DFPlayers that operate independently not only eliminates audio switching but allows two separate messages to be played simultaneously.

Sequences.... a little detail on how they work & maybe more than you want to know

The system contains a battery powered independent RTC (real time clock) much like your PC and other devices. Its job is to maintain the time of day even when the power is off. Every second, the RTC sends the main computer a signal. This signal triggers the main program to perform many tasks. The tasks include reading the RTC and displaying its time, updating and displaying the anemometer or OCS timer, decrementing and displaying the count down timer, reading the buttons, starts the half second clock and if a start sequence is active, it will execute a scheduled instruction(s).

While background tasks are hidden, everything else happens on the second and that is from where the spread sheet derived start sequence is executed. The firmware makes several commands available to the spread sheets.

Briefly the commands:

Transmitter	// turn on transmitter for **N** half seconds
Speaker_Message	// play speaker message **N**
Horn	// blow boat horn for **N** half seconds
Boat_beeper	// turn on beeper or **N** half seconds
Radio_Message	// play radio message **N**
Clock_Pause	// stop RTC clock display for **N** half seconds
Reload_Count	// reload count down counter minutes seconds
LoadOcsCount	// load count at start in case of OCS..usually 400

Notes:

- Several of the commands have half second resolution hence the reason the half second clock is started as one of the one second tasks.
- Reload_Count at the end of the spread sheet reloads the count down timer providing the rolling start. It must be the last command since it alters the count down clock, nothing under it can be executed.
- LoadOcsCount at start time loads the OCS counter The counter is decremented every second until exhausted whether or not an OCS event has occurred.

Min-Sec till start		Command		Variable		// Min-Sec till start format: min sec with implied colon
615	,	Transmitter	,	10	},	
614	,	Radio_Message	,	13	},	// "ten seconds to the postpone or repeat flag drop"
614	,	Speaker_Message	,	18	},	// "ten seconds to the postpone or repeat flag drop"
605	,	Boat_beeper	,	1	},	
604	,	Boat_beeper	,	1	},	
603	,	Boat_beeper	,	1	},	
602	,	Boat_beeper	,	1	},	
601	,	Boat_beeper	,	1	},	
601	,	Transmitter	,	4	},	
600	,	Horn	,	2	},	// blows horn for 1 sec at 6 min
600	,	Radio_Message	,	20	},	// radio mimics the air horn
511	,	Transmitter	,	12	},	
510	,	Radio_Message	,	10	},	// radio mimics the air horn 5 ½ second blasts

Snippet of start sequence

Functionality

This design has a total of six buttons. On/Off, Horn, and 4 programmed buttons. The Horn is a simple bypass that blows the horn even if the system is powered down. The power switch is a common momentarily touch on and hold down a few seconds off.

The system is really controlled by the four remaining buttons. For more options there are two modes, default or alternate, so each button can support two different sequences. The alternate mode can be entered at power up, but will resort back to default on the next power up.

Sequence start
The default mode provides four buttons for four different start sequences as defined by the respective spread sheet. While the system is in the standby mode, it will be waiting for one of these four buttons to be pushed. When in the standby mode, the *Current Time of Day* and *Velocity* displays will be updated every second. *Time to Start* will be zero.

Sequence cancel
Once a sequence is started buttons 2 and 3 become cancel or stop the sequence. A quick button depress and the sequence is stopped. The *Time to Start* display will show zero. The system then begins to look for another button press to start a new sequence.

OCS.... over course side *(over early)*
If the sequence at start time executes the command to load the OCS counter, (usually with 400, four minutes) buttons 0 and 1 become armed for 20 seconds. *(See section on Sequences).* The OCS count down starts to decrement right away but is not displayed, so OCS time begins at the race start assuming the load command was at start time. One OCS button is for general recall and the other is individual recall.

- General recall: Transmits the message containing two boat horn sounds followed by the verbal "general recall..general recall..general recall..". The boat horn also blows twice, the timing to coincide with boat horn sound in the radio message. At the same time the boat speaker will instruct the volunteer to raise general flag. After that, nothing else happens.

- Individual recall:Transmits the message containing one boat horn sound followed by the verbal "xray..xray..xray..". The boat horn also blows once, the timing coinciding with the boat horn sound in the radio message. At the same time the boat speaker will instruct the volunteer to raise individual "X" flag. The anemometer display will changed to display the remaining OCS time. This timer will be displayed and decremented every second until zero when the wind velocity display

will return.

- The start sequence may be optionally reset in either OCS case. If in the xray (individual) OCS mode, the OCS timer will to count down regardless of reset. This is important for a single or last fleet start.

Anemometer

The purchased anemometer has been modified with a hall effect switch to provide four pulses per revolution. The firmware counts the pulses and displays the average wind velocity for the immediate past five seconds. The up date is every second so the data is current and is smoothed out. Never the less, when the velocities are low and the boat is pitching, expect wide data fluctuations.

The data can be displayed in Knots, miles per hour, kilometers per hour, meters per second. The range is set at system configuration time. Knots appear to be the most popular for sailors so the left most decimal point on the *Velocity* display will indicate this range.

The speed is computed using the published specs for the cups, however the cups have been disassembled and modified. There is no guaranty or any published specs for accuracy for race controller but reasonability tests against other instruments indicate the anemometer is well in the ball park for non commercial instruments.

VHF Radio

A marine band VHF radio is used to announce to the competitors and markset. The radio must have external connections to the microphone and PTT (push to talk...turns on transmitter) circuits. Not all radios external microphones work because they may use a data stream instead of hard wires. The two radios used during the project development are the Standard Horizon (made by Yaesu) models GX-1600 and GX-1700. Both are GPS enabled with the later having an internal GPS receiver. GPS is not used by the controller. Fortunately the GX-1600 is reasonably priced from on line distributors. For good vhf communication across water, it is recommended to have a high gain antenna, preferably half wave, mounted as high as possible on the boat.

System Configuration

There are several global parameters that are available to the administrator. They are entered at startup by holding the respective button(s) down followed by a 4 digit pin. The entries are then store in flash memory and remain until changed. There is no reset to factory values. The system reserves several message slots on the sound system files to help the administrator through the process.

Hold down button to:

- Button 0 Enter alternate mode. No signin or PIN needed.
- Button 1 Radio volume: Values 0-40. Button_3 advances, Button_2 plays sample message, Button_1, stores new volume.
- Button 2 Speaker volume. Values 0-40. Button_3 advances, Button_2 plays sample message, Button_1, stores new volume.
- Button 3 Set Clock: Button_3 advances hours, Button 2_ advances minutes, Button_1 stores the clock with zero seconds. *Hint: to sync to another, set the minutes one minute ahead of the master. When the master turns over the next minute (0 sec) hit button_1.*
- Button 1&2 Play MP3 File. Left over from development. Plays MP3 files through the radio or speaker. Works with a terminal.
- Button 1&3 Set Clock Format. Button_3 will toggle between 12 and 24 hour format. Button_1 will store.
- Button 2&3 Set Anemometer scale. Button_3 cycles through the scales. 0 = meters/sec, 1 = knots, 2 = kilometers/sec, 3 = mph, Button_1 stores

Attachment notes...

The following illustration is a CSV file from the spread sheet. This is the actual file compiled into the program for the first release. The language compiler likes this format. The original spread sheet did not attach to this document very well. See the spread sheet posted elsewhere.

While overwhelming in the beginning, focus on the time the left hand column. The time is minutes and seconds with the colon omitted. Right after the comma is the command followed by a comma followed by some directive for the command. The commands are really numbers but are defined as words in the definitions to make it readable. The compiler makes the substitution at compile time

Start at 615. That is the entry point from the 6 minute button. It turns on the transmitter for 10 one half seconds (5 seconds). The time is selected to turn the radio on 1 second early and leave it on for the full duration of the message All times are ½ second resolution. That is needed for short bursts of horns and beepers.

At 614 the MP3 radio message 13 (slot 13 on memory card) is transmitted. The attached directory dump can be referenced to get the actual file name which should reflect the message

Look at 000, the start of the race. Some interesting stuff happens. The Time of day clock stops updating for 30 seconds for the score keeper. The OCS counter begins the 4 minute countdown...just in case, and the time to start is loaded with 5 minutes for the next fleet. That is where the rolling start comes from.

See the document on programming for additional information on both audio and sequence programming.

```
/*
definitions are declared globally else where. Listed here for cut and paste into
command column
#define Transmitter 1      // turn on transmitter  for N half seconds
#define Speaker_Message 2  // play speaker message N
#define Horn 3             // blow boat horn for N half seconds
#define Boat_beeper 4      // turn on beeper or N half seconds
#define Radio_Message 5    // play radio message N
#define Clock_Pause 6      // stop RTC clock display for N half seconds
//Reload_Count ..must be last command of the
#define Reload_Count 7     // reload count down counter minutes seconds (no colon)
#define LoadOcsCount 8  // load counter at start in case of OCS.. usually 400
*/
__code unsigned ScheduleONE [84] [3]  =

//Min-Sec till startCommandVariable // time till start format: minutes seconds with
implied (missing) colon
{
{615,Transmitter ,10},
{614,Radio_Message,13},// "ten seconds to the postpone or repeat flag drop"
{614,Speaker_Message,18},// "ten seconds to the postpone or repeat flag drop"
{605,Boat_beeper,1},
{604,Boat_beeper,1},
{603,Boat_beeper,1},
{602,Boat_beeper,1},
{601,Boat_beeper,1},
{601,Transmitter ,4},
{600,Horn,2},// blows horn for 1 sec at 6 min
{600,Radio_Message,20},// radio mimics the air horn
{511,Transmitter ,12},
{510,Radio_Message,10},// radio mimics the air horn  5  ½ second blasts
```

```
// 5 alert blasts ollie style
{510,Horn,1},// ½ second alerts
{509,Horn,1},
{508,Horn,1},
{507,Horn,1},
{506,Horn,1},
// 5 second warning for RC

{505,Boat_beeper,1},// ½ second beeps
{504,Boat_beeper,1},
{503,Boat_beeper,1},
{502,Boat_beeper,1},
{501,Boat_beeper,1},// 1 second message
{501,Transmitter ,4},
// class flag
{500,Radio_Message,20},// class horn 1 second
{500,Horn,2},// 1 horn second blast
// 30 seconds till prep up
{433,Transmitter ,7},
{432,Radio_Message,17},// 30 seconds to prep flag up
{432,Speaker_Message,22},// 30 seconds to prep flag up
{432,Boat_beeper,1},
{431,Boat_beeper,1},
{430,Boat_beeper,1},
// 20 seconds
{421,Boat_beeper,1},// half second  dual beep 20 sec warning
{420,Boat_beeper,1},
// 10 seconds 1 beep
{410,Boat_beeper,1},
// 5 second count down till prep
{405,Boat_beeper,1},//begin 5 sec count down
{404,Boat_beeper,1},
{403,Boat_beeper,1},
{402,Boat_beeper,1},
{401,Boat_beeper,1},
{401,Transmitter ,5},
{400,Radio_Message,20},// 1 horn second blast
{400,Horn,2},// 1 horn second blast
// 30 sec to prep flag down
{133,Transmitter ,7},
{132,Radio_Message,16},// "30 seconds to prep flag down"
{132,Speaker_Message,21},// "30 seconds to prep flag down"
{130,Boat_beeper,1},
{129,Boat_beeper,1},
{128,Boat_beeper,1},
// 20 second 2 beeps
{121,Boat_beeper,1},
{120,Boat_beeper,1},
// 10 sec 1 beep
{110,Boat_beeper,1},
// 5 sec beeper count down for prep drop
{105,Boat_beeper,1},
{104,Boat_beeper,1},
{103,Boat_beeper,1},
{102,Boat_beeper,1},
{101,Boat_beeper,1},
{101,Transmitter ,6},
{100,Radio_Message,21},// 2 second air horn
```

```
{100,Horn,2},// long (2 second) air horn
// 30 seconds till start
{33,Transmitter ,7},
{32,Boat_beeper,1},
{32,Radio_Message,18},// “30 seconds until the start”
{32,Speaker_Message,19},// “30 seconds until the class flag”
{31,Boat_beeper,1},
{30,Boat_beeper,1},
// 20 seconds till start 2 beeps
{22,Transmitter ,5},
{21,Radio_Message,15},// “20 seconds”
{21,Boat_beeper,1},
{20,Boat_beeper,1},
// 10 seconds till start 1 beep
{12,Transmitter ,5},
{11,Radio_Message,14},// “10 seconds”
{11,Boat_beeper,1},
// 5 seconds till start
{6,Transmitter ,16},
{5,Radio_Message,12},// 5 second voice count down message with horn
{5,Boat_beeper,1},
{4,Boat_beeper,1},
{3,Boat_beeper,1},
{2,Boat_beeper,1},
{1,Boat_beeper,1},
{0,Horn,2},
{0,Clock_Pause,30},// pause rtc update for scorer to copy start time
{0,LoadOcsCount,400},// start the OCS counter going
{0,Reload_Count,500},// rolling start at 5 minutes..this must be the last command
for any current second };
```

Files on micro sd card for the radio transmitter

Name	Size	Title
0001_xray+individual.mp3	109 KB	
0002_general recall.mp3	138 KB	
0003_blank file.mp3	18 KB	
0004_testing.mp3	79 KB	test message
0005_blank file.mp3	18 KB	
0006_blank file.mp3	18 KB	
0007_blank file.mp3	18 KB	
0008_blank file.mp3	18 KB	
0009_blank file.mp3	18 KB	
0010_5 air horn blasts.mp3	72 KB	
0011_5 sec count with whistles.mp3	103 KB	
0012_5 sec countdown w voice.mp3	103 KB	
0013_10 sec post or repeat drop.mp3	64 KB	
0014_10 seconds.mp3	19 KB	
0015_20 seconds.mp3	18 KB	
0016_30 sec prep down.mp3	38 KB	
0017_30 sec prep up.mp3	38 KB	
0018_30 sec till start.mp3	33 KB	
0019_30 seconds.mp3	19 KB	
0020_air-horn-1-minute.mp3	19 KB	
0021_air-horn-2 minutes.mp3	33 KB	
0022_air-horn-half sec.mp3	10 KB	
0023_air-horn-club.mp3	25 KB	