Ulti Mono – Another Great Leap Backwards

Back in the days of single-channel, flying a radio-controlled model rudder-only was a source of great satisfaction... when everything worked. The big problem was reliability. That's what drove me to make a single-channel FM system with active tone filter in the late 80's. Its utter reliability did prove the point, but it was strictly a one-off. Barring operator error, today's radios are reliable, so why not combine the best of both worlds?

Cheap 2.4GHz transmitters, transmitter modules and receivers from China have made possible again to make one's own custom R/C systems. With the precious help of Australian test pilot and fresh VRCS recruit Tom Watson, I have recently completed a 2.4GHz single channel system using the RF PCB from a FlySky/Hobbyking 4-channel transmitter and the corresponding receiver (The set sells for $29.99).

The heart of the system is a simple coder which makes a standard proportional receiver and servos simulates the operation of a compound escapement or motorised servo with auxiliary motor escapement or motorised servo. I have called the coder «Ulti Mono»

Installation in the model is just like a regular proportional radio system, with a servo to actuate the rudder and if desired, another one for throttle. The model can be flown with the proportional system without any addition in the model. For single-channel pushbutton operation, a dedicated transmitter must be made, either from scratch or by modifying an existing vintage transmitter. Another possibility is to have it both ways, by adding the coder, a pushbutton and a SPDT switch in the PPM line to the RF module of the proportional transmitter to select propo or single-channel.

In the model, the rudder servo plugs to channel #1 output of the receiver, while the throttle servo, if used, plugs to channel#3 output, while channel #4 emulates the operation of a bang-bang 2P2N escapement. for the really dedicated hardcore single-channel flyers amongst us.
The present article describes the transmitter part of Ulti Mono in sufficient detail for interested modelers to be able to make their own, but mind that this is not a full step-by-step construction article. You will need a decent knowledge of electronics, or know someone who does, to construct your own Ulti Mono. You'll have to draw up and make your own PCB or populate a Veroboard and burn your own PIC microcontroller with the supplied .hex file.

The schematics are at the end of this article. The list of parts is here:

<table>
<thead>
<tr>
<th>Ref</th>
<th>Description</th>
<th>Style</th>
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<th>Price</th>
<th>Remarks</th>
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</table>

This is a CHEAP project as you can see (total cost of parts $3.63). The only expensive part of mine and Tom Watson's is the pushbutton.

It is my opinion that a good pushbutton makes all the difference in pleasant single-channel flying.

The very best pushbutton I've found is type MPS-103F, not just any MPS-103F, but the one made by Knitter Switch which definitly has superior feel and action. It can be obtained in the US from Newark (http://www.newark.com) under part # 24M4947 for $12.71 (black knob included). In the UK, Farnell (http://uk.farnell.com) offers it under part # 807989 for £5.73.

Both Tom and I made our own transmitter box out of 1/16 inch plywood. We have a good reason for not making the box of metal. The RF board we use is from a cheap FlySky/Hobbyking 2.4GHz transmitter. At switch-on, the RF board checks the airwaves before choosing the frequency on which it will operate. The check is performed via a receiving antenna etched on the PCB. The wooden box does not interfere with reception, and it is somewhat easier to make to fit one's hand. As far as I know, other RF modules do not suffer from this problem and can safely be incorporated in metal boxes such as those of vintage transmitters.

The FlySky/Hobbyking 2.4GHz RF board also works happily from a nominal 5V supply. Four 800 mAh Sanyo Eneloop NimH cells are used in both our transmitters, for well over four hours of operation on one charge. Current drain is about 170 mA for the RF and less than 1mA for the coder.

Yet another peculiarity of the FlySky/Hobbyking RF board when used with the Ulti Mono coder is that no separate bind button is required. Bind mode is simply entered by pressing the button while switching the transmitter on. This has been possible because the FlySky has no range test feature.
Jean-Marie's transmitter.
The RF module is fitted with Deans 4-pin connector, modification is not recommended because there is a great risk of damaging the RF PCB copper tracks.

Tom's transmitter, with Ulti Mono coder neatly laid out by his friend Tim

Here, both transmitters were still fitted with the 8-pin PIC 12F58. 16F630 can fit in the same socket (only the top 8 pins are used). They use a 4-cell, 800 mAh NimH battery. Do not be tempted to settle for less than the new « precharged » rechargable cells, the best ones being Sanyo Eneloop. GP Recycko is a cheaper choice. Both are available from Adorama (http://www.adorama.com - search for Eneloop or Precharged). Their prices are amongst the lowest around, and shipping is free.
Interfacing the Ulti Mono coder with RF board:

In the case of the **FlySky/Hobbyking RF board**, four wires connect to the Ulti Mono coder (See Schematic #1). They are in order:

1. VCC+5V (brown)
2. Ground (Red)
3. Bind (SW1) (Orange)
4. PPM signal (Yellow)

![The FlySky RF module in the transmitter at left, by itself at right](image)
In the case of other RF modules, either 2.4GHz but why not regular FM or even AM, which generally require a voltage higher than 5V to operate, it becomes necessary to add a 5V voltage regulator for the microcontroller.

In this case, only two wires carrying ground and the PPM signal go from the coder to the RF module (See Schematic #2). The 2.4GHz module is usually fitted with its own bind button which should be made accessible from outside the transmitter box, but not so accessible that it might be pressed inadvertently. Better to have it slightly recessed and actuate it with a pencil tip.

The reason for this precaution is that in many cases, the bind button doubles as a range test button which drastically reduces the RF power and the range to less than 100 meters. (The FlySky does not feature a range test mode).

The microcontroller used is a type Microchip PIC 16F630 which is installed in a socket to facilitate updates. This type was chosen for its timers and its EEPROM.

When programming the PIC 16F630 with the file « MonoUlti630.hex » which can be downloaded from the VRCS site, it is recommended to load the value 00h at EEPROM address 0000h and the value 86h at EEPROM address 0001h.

The 4-channel PPM sequence generated has a frame time of only 12ms. This was done to try and minimise the effect of the latency inherent in the 2.4GHz systems, caused by the supplemental coding and decoding of the PPM signal for transmitting and recovery at the receiver end.

It is entirely possible to install the Ulti Mono coder in a vintage 27MHz transmitter and use a modern 27MHz AM receiver such as the HPI RF-2 or Futaba R114H. To cover this case, another file named « MonoUlti630_FM.hex» is made available. This one generates a standard 20 ms frame.

With 2.4GHz systems, if the system features failsafe, it is entirely possible to program it for low throttle.

What do you get for all these efforts, and how does it really work ?

**Operation** is very similar to an installation with one or two motorised servos such as the trusty OS-101 and OS-101M :

- One press and hold gives right rudder,
- Two presses and hold give left rudder
- Three presses step the motor through Low->High->Medium->Low
- Four presses step the motor through the next two positions.

If 2P2N emulation is desired, the rudder servo should be connected to receiver output channel 4. Then the rudder alternately goes to right and left each time the button is pressed and returns to neutral when the button is released.

Early in the development of the software, it became apparent that a means for the modeller of adjusting and memorising the motor medium speed was highly desirable. Different models need vastly different throttle positions for the cruise part of the flight.

Early versions of the coder used a simple PIC 12F508 microcontroller which had to be reprogrammed if a change in the medium speed was needed. Not very convenient, this is where 16F630 and its EEPROM came in. The software was modified so that Medium speed could be adjusted with a particular sequence of button presses. To prevent inadvertent modification, a Data Lock feature is included.
To change the medium speed, the following procedure has to be followed:

First make sure that Data Lock is inactive.

- Press the button 5 times and hold.
  - The rudder twitches 5 times.
  - Release button.
  - The rudder twitches 3 times to confirm data lock or 2 times to confirm data unlock.

- If Locked, press 5 times and hold
  - The rudder twitches 5 times. Keep the button pressed.
  - After 5 seconds, the rudder twitches 2 times to confirm unlock
  - Release button

Now we can adjust the medium speed:

- Press the button 5 times and hold.
  - The rudder twitches 5 times.
  - Release the button for less than one second and hold.
  - After 2 seconds, the motor goes to the memorised speed and begins to change speed in small steps at 0,6s. intervals.
  - When end throttle is reached, either full or stop, the motor speed automatically begins stepping the other way.
  - At any time, briefly releasing the button will change the speed stepping direction.
  - When the desired speed is reached, release the button.
  - Medium speed is set and memorised.

Once satisfied with the adjustment, reactivate Datalock:

- Press five times and hold
  - The rudder twitches five times. Keep the button pressed.
  - After 5 seconds, the rudder twitches three times to confirm lock
  - Release button

Other features:

Two reversing jumpers or DIL switches are provided:

JP1 will reverse the rudder throw
JP2 will change the throttle cycle to Low->Medium->High->Low

There you have it, a simple hardware for reliable single-channel with brains.

In the near future, a reed emulation encoder using the same PIC 16F630 will likewise be described. It actually is simpler than Ulti Mono. I call it « Easy Reeder ». See you there...

After that, expect a version of Ulti Mono with quick-blip motor control and quick-up elevator.

My email is in the VRCS roster, just in case you may need more information or help, or want to make suggestions which will be very welcome. Happy flying!

Jean-Marie Piednoir
Proposed scheme for adding Ulti Mono to a standard proportional transmitter.