

TrackR2: Dual Axis Gyro Head-Tracker

Operator's Manual: July 2008

Firmware version v1.1



Brought to you by the ImmersionRC Team, the developers behind
AeroPix.



Pre-requisites and Warnings

- The purchaser of this product takes all responsibility for following local laws and regulations.
Flying model aircraft via Video link should not be attempted without the help of a 'spotter', and even then, never in populated areas.
- **The TrackR2 is sensitive to static, shock, and moisture. Keep it dry, and handle with care! If dropped onto a hard surface, the delicate gyro mechanism will almost certainly be damaged. This will not be repaired under warranty.**

Overview

The AeroPix TrackR2 is a dual-axis gyroscopic head-tracker. It sends the wearer's head movements to a pan/tilt camera mount, mounted on an airborne/ground based model, via the buddy-box (trainer) connector on compatible R/C transmitters.

For a 'full immersion' experience, it should be used together with a head mounted display. Use with an CRT or LCD display is possible, but far from ideal. The Fat Shark RCV922 LCD headset, custom designed for FPV are ideal for this.

Specifications

- Dual-Axis gyroscopic sensor
- 500 degree/second response rate (much faster than magnetic headtrackers)
- Buddy Box (Trainer) connection to many modern (and some older) R/C transmitters
- Unique Student/Trainer mode, links two radios for safe FPVing, and compliance with developing rules & regulations in some countries (France for example).
- Single-button 'Morse code' programming menu
- User-Definable Pan/Tilt channels
- Automatic detection of student transmitter presence, and PPM polarity.
- Positive/Negative PPM modes
- Transmitter mounted zero/cal switch (leaving the head-mounted switch for 'passenger' use)
- Anti-drift algorithm to greatly reduce (or eliminate) the need to re-center during a flight.
- Power Requirements: 8.0-20v DC, 20mA (without headset power), ~400mA (with RCV922 power)

Powering the TrackR2

The TrackR2 requires a DC supply in the range 8.0v – 20v. For most suitable Futaba transmitters, the FF7/FF9, or 7C/9C, this power is obtained directly from the trainer connector.

Note that certain top-of-the-line futaba transmitters use a 2-cell Lithium battery pack (7.2v). These are not compatible with the standard TrackR2. A version to support these will be available shortly.

General Notes On Transmitter Compatibility

The TrackR2 is designed to be used with a single transmitter, or between a trainer transmitter, and a student transmitter.

For stand-alone use, the ideal transmitters are the 7 and 9 channel Futaba line. Futaba is the only manufacturer who supplies a radio with selective channel takeover, and a power supply pin on the connector.

The choice of student transmitter is much wider. Just about anything from the 4 channel Futaba transmitters, to high-end systems, should be compatible. The PPM input circuit is tolerant of a wide range of input voltages, and is buffered, and stripped of any RF interference, before being 'reprocessed'.

Take note however that unlike many buddy-box cables, the TrackR2 does not supply power to the student Tx, and therefore the student Tx must be equipped with its own power supply. The trainer-only radios from Tower-hobbies for example, come without a battery, and must be powered in order to function with the TrackR2.

The two connectors on the TrackR2 itself are radio-independent. A cable-set is required to connect to the master, and student radios. The TrackR2 ships standard with one short cable terminated with the 6-pin Futaba 'Micro' connector.

More specific notes on radio compatibility follow:

Futaba Radios

The TrackR2 was designed for use with high-end Futaba R/C transmitters, using the 6-pin 'square' trainer connector. These transmitters supply power to the TrackR2, eliminating the need for an external power source, and can also selectively merge the pan/tilt channels into the PPM stream to the model.


For Futaba transmitters (the FF9/9C series especially), the trainer switch is a momentary switch, and must be held 'on' in order for the TrackR2 to function. A high-tech solution (rubber band) is an easy way to hold this switch On during use.

A more adventurous solution involves ordering the non-momentary switch from a futaba parts supplier, and change it.



Important to note on Futaba transmitters, the trainer setup appears to be retained through a Tx power cycle, but is lost when the selected model is changed. Take care with this, the default transmitter trainer configuration may well cause the throttle to be enabled!

Connector supported for Futaba radios

Transmitter	Connector	Compatibility
Futaba 14MZ, 12Z, 9C (FF9) , FF8, Futaba 7C (FF7), and many others	 Futaba 9/9C	<p>Tx Supports Selective Channel Mixing, HeadTracker switch should be in 'Normal' mode, not 'low end'.</p> <p>PPM Output must be Negative Polarity.</p>

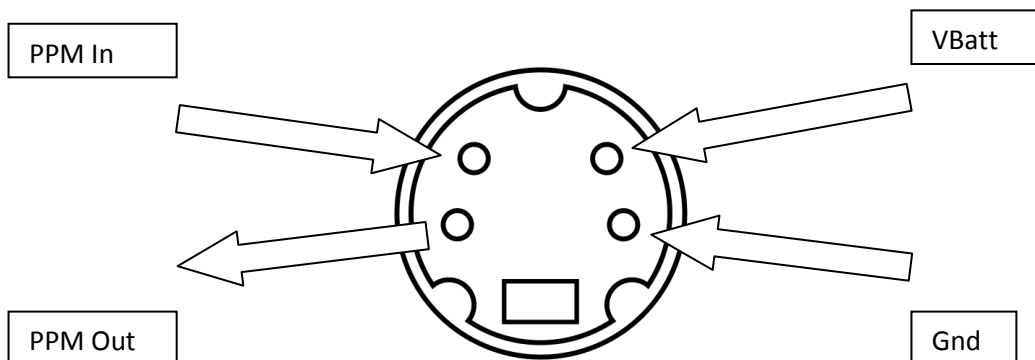
Futaba Radios successfully used with the TrackR2 include:

- 9C as the master, 9C as the student
- 9C as the master, 4 channel Futaba 'SkySport' as the student.
- 6 channel 6YG ('Skysport 6') as the only radio, TrackR2 switch in 'Low-end' mode.

Many more combinations should be supported, and will be tested and documented in the near future.

Connector Pinout

The pinout of the two connectors on the TrackR2 switchbox is shown below. Note that the pinouts are identical, but the student connector has only Gnd and PPM-In wired.



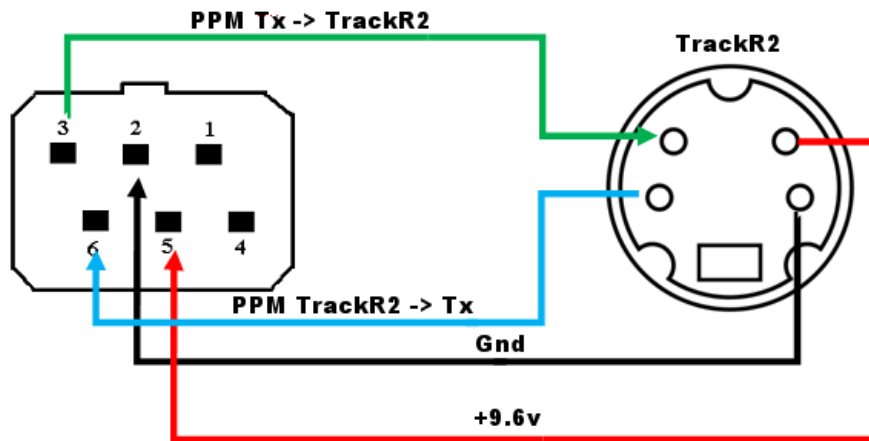
The switch on the switchbox selects between the PPM input on the student connector, and the PPM input on the trainer (master) connector (Normal selects the student PPM-In, Low-End selects the trainer PPM-In).

Wiring for supplied Futaba 6-pin Micro Connector

The wiring for the supplied cable is as follows. Note that the wire colors are almost certainly different from those shown, and can vary from batch to batch.

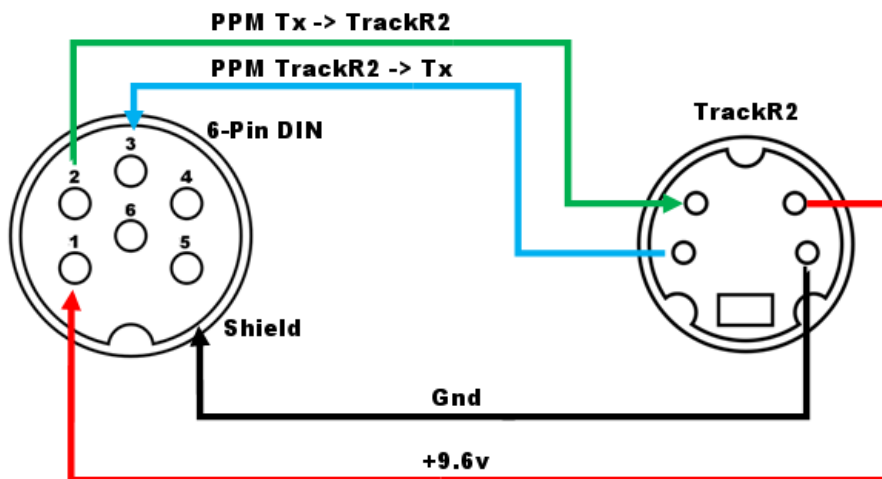
This cable may be used to link to a single 7C/9C transmitter. A second, longer cable with the same wiring, may be used to

Note that the connectors are shown as viewed from the back of the male connector.



Wiring for older 'round plug' Hitec/Futaba transmitters

Transmitters such as the older Futaba SkySport 6 may be used with the TrackR2 in 'Low-End Tx' mode. These generally use a 6-pin DIN (full-size, not mini-din), and may be wired as follows:



Suppliers of connectors:

Most of the connectors required for the transmitter side of the cable may be purchased from Endurance R/C, at the following address: <http://www.endurance-rc.com/cablesplugs.html>

The 6-pin Futaba Micro connector (not easy to find) may also be purchased from RC electronics in the UK: <http://www.rc-electronics.co.uk>

The 4-pin Mini-Din connectors may be purchased from Mouser Electronics in the US, using the following part number: 171-2604 (this is also the Manufacturer's P/N, they are made by Kobiconn).

Using the TrackR2

Mounting

The TrackR2 is designed to be mounted right side of the wearer's head, with label facing outwards, the button facing up, and the cable exiting to the bottom of the case.

A plastic mounting bracket is supplied with the TrackR2 which sits into the pocket in the RCV922 headset strap. For other LCD headsets, other techniques may be used to attach the device, Double-sided tape, or Velcro works well.

It is important to note that the module should be mounted as vertical as possible, or within a few degrees of vertical.

Calibration and Zeroing

When powering up, the TrackR2 will spend a few seconds calibrating itself, during this time it is very important not to move the device!



Moving the TrackR2 during the calibration procedure will cause drift

Once calibrated, mount the TrackR2 on your video goggles/baseball hat/scuba mask. Look in the direction that you wish to be 'neutral', and press briefly one of the zero buttons (either the button on the switchbox, or the button on the TrackR2 gyro module). A short beep indicates that the zero position has been redefined.

If, during flight, drift is observed (generally due to a change in temperature), you may hold down the button for > 3 seconds to restart the calibration procedure. During this time, remain perfectly still! The TrackR2 will beep twice when the calibration is complete.

One way to reduce temperature-change related drift is to ensure that the TrackR2 is exposed to the outside temperature for a few minutes before calibrating. If care is taken, the TrackR2 can even be used in frigid winter temperatures. VRFlyer shot a beautiful video on a clear, cold, Canadian winter's day, at -15 degrees C!.

Moving between a warm car, and the cold of mid-winter, immediately before a flight, is not recommended!. Likewise, moving between an air-conditioned car, and the mid-summer heat, is also not recommended.



It is highly recommended to let the TrackR2 adjust to operating temperatures for a few minutes before flying. Especially when there is a large temperature difference between storage, and operating temperature (summer/winter).

Single-button User Interface (UI)

The TrackR2 is equipped with a very simple single-button UI, and internal beeper for feedback.

This button is 'cloned' on the transmitter-mounted switchbox module, for ease of use without removing the need to remove a hand from the transmitter during flight.

As mentioned above, this button has several functions. A short button press will redefine the zero point.

A longer press, of > 3 seconds will force a recalibration. This should rarely be required during flight, but if, for example, there is a large temperature change between when the power-on calibration occurred, and flight, it may be required. When the button has been pressed for 2 seconds, a short beep is heard, this confirms that releasing the button immediately will initiate the Calibration.

During an in-flight recalibration, remain still! Any head movement during this time may create drift.

The final function of the button is to enter the programming mode. This mode can be entered only by holding down the button at power-on, and keeping it held down until calibration is complete.

The Programming mode is explored later in this manual.

In Flight: 'Zero Clicks'

During normal use, the TrackR2 will 'click' at the zero point of the pan and tilt axis.

This may be used for installations when visual indication of the front of the plane is not available, to know when looking straight ahead.

(It's also a great way to verify that everything is working correctly after powering up the TrackR2)

This feature may be disabled from the programming menu if desired.

Programming the TrackR2

The TrackR2 contains a non-volatile memory (EEPROM) which stores configuration settings. These settings include:

- Pan/Tilt channel assignments *
- Pan/Tilt servo reversing
- Pan/Tilt servo travel limits (left/right/up/down)
- Pan/Tilt gains
- Limit behaviour
- PPM Output Polarity
- Anti-Drift configuration

Programming these settings is accomplished using the single button, with feedback from the internal beeper, in a manner similar to that used by most ESCs (Electronic Speed Controllers).

To enter the programming menu, hold down the button while power is applied to the TrackR2, until the calibration beeps have finished.

The recommended setup procedure is as follows:

1. Set the PPM Output Polarity, to settings suitable for your transmitter (most futaba systems require negative polarity, which is the default setting)
2. Use either the servo reversing controls on the R/C Tx, or the servo reversing options in the TrackR2 menu (first two items) to ensure that the servos are rotating correctly in response to head movements.
3. Set the pan and tilt gains using the second two items in the programming menu.
4. Set the servo limits using the 5th menu item. *Note that the limits may need to be reprogrammed each time the gains are changed.*
5. Define the limits 'mode'. This defines what happens at the servo limits. Two choices are available, 'clip' and 'recal'. The former just limits the servo movement, but doesn't re-center the gyro axis.
The latter re-centers the gyros, allowing any drift to be corrected in flight without pressing the zero/calibrate button.

Once the programming menu has been activated, the module will start cycling through the menu options, in the order listed.

To change one of the items, wait for it to be 'played', and immediately after, touch the button.

The module will then 'play' the current value, as a number of beeps, and then will start from the first option, and play each option until the last.

Example, how to change the pan reverse setting:

Button pressed at startup, hold until calibration beeps end, and the menu is entered.

Dash Dot

Dash Dot Dot

Dash Dot Dot Dot

Dash Dot Dot Dot Dot **press button briefly**

Dot *this is the current setting, Reverse Off*

Dot this is the first available option, Reverse Off

Dot Dot this is the second available option, Reverse On **press button briefly**

At this point the pan reverse setting has been changed to 'Reverse On'. The module will now continue with the next item in the menu, Tilt Reverse, and walk to the end of the list.

Once the end of the list is reached, the system will exit programming mode.

For setting limits, the procedure is a little different, pressing the button following the 'Set Servo Limits' menu (Dash Dash Dot Dot) will enter limit setting mode. Move the TrackR2 until the camera is at its upper limit, and press the button, then do the same for the Right, Down, and Left limits in that order.

* Note that when using low-end transmitter, or student-trainer mode, the channels selected for pan/tilt channels should be numerically greater than any other channel used for other functions.

Beep Codes

Note that the beep codes are different from the original TrackR1, they have been re-arranged to move more commonly used settings earlier in the list.

Beep Code	Menu	Menu Choices
- .	Pan Channel	1.. 9 (default 5)
- . .	Tilt Channel	1.. 9 (default 6)
- . . .	Pan Gain	1 – Low gain 2 – Medium gain 3 – High gain * 4 – Max Gain
-	Tilt Gain	1 – Low gain 2 – Medium gain * 3 – High gain 4 – Max Gain
-	Pan Reverse	1 – Reverse Off * 2 – Reverse On
-	Tilt Reverse	1 – Reverse Off * 2 – Reverse On
- - .	Anti-Drift Gain	1 -Anti-Drift Off 4- Anti-Drift High 2- Anti-Drift Low 5- Anti-Drift Extreme 3- Anti-Drift Med *
- - . .	Set Servo Limits	Sequence is: Up, Right, Down, Left <i>Note: Menu exits after setting limits.</i>
- - . . .	Set Servo Offset	Pan/Tilt until desired zero point is reached, and press button. <i>Note: Menu exits after setting offsets.</i>
- -	Zero Ticks	1 – Off 2 – On *
- -	Limits Mode	1 – Clip * 2 – Recalibrate
- - - .	PPM Output Polarity	1 – Negative * 2 – Positive
- - - . .	Restore Defaults	Select to immediately restore all settings to defaults. <i>Cycle power for settings to take effect</i>

* Indicates default setting

To enter menu, turn off radio, hold down the button, turn on radio, wait until after the second beep, then release, wait for calibration ticks. Menu will enter automatically.

Using the TrackR2 in a student-trainer configuration

The TrackR2 may be used in a student-trainer configuration, where it allows a student to fly FPV, with headtracking, while the trainer monitors the flight watching the plane.

In the event that the student gets into any kind of trouble, the trainer re-takes control.



The TrackR2 intercepts the PPM control signal from the student radio, appends the pan/tilt channels, and feeds them to the trainer radio.

To use the TrackR2 in this configuration:

1. Ensure that the student radio is powered up before the trainer radio.
2. Ensure that the switch on the TrackR2 switchbox is in the 'Normal' position
3. Configure the trainer menu of the trainer radio so that the channels required to fly the plane are also in trainer mode (usually 'FUNC' on Futaba transmitters).
4. Remove the Crystal, or RF Module, from the Student transmitter, to ensure that it is not transmitting

Increasing Pan Servo Throw

Most standard hobby servos provide only 90 degrees of rotation.

In order to allow panning from wing-tip to wing-tip 90 degrees is too limiting, 180 degrees of servo rotation is desired.

There are several ways to achieve this:

1: Purchase a modified servo.

Servocity.com is one retailer which for a few extra dollars will sell a 180 degree servo. The HS85MG is one example of a servo that supports this.

2: Modify a servo yourself

There are several threads up on the rcgroups forums on modifying servos.

3: Purchase a digital servo, with programming adapter

Many digital servos, when correctly configured using the manufacturer's programming hardware, can achieve 180 degree rotation.

Pan and Tilt Camera Mounts

There are numerous ways to mount a camera so that it may be moved in the pan and/or tilt axis.

These range from extremely simple solutions, like a piece of double-sided tape, sticking the camera onto a single servo, to much more complex solutions, involving two (or more) servos.

A quick search of the rcgroups forum for 'pan and tilt' will uncover numerous designs. This thread is one of the better ones:

<http://www.rcgroups.com/forums/showthread.php?t=576597>

Note that ImmersionRC highly recommends using the Hitec HS85-MG as the Pan servo, and the Hitec HS56 as the Tilt servo.

The HS85 is extremely robust, and may be purchased from servocity.com pre-modded for 180 degree rotation. The HS56 uses karbonite gears, and is much less likely to strip a tooth during the occasional hard landing.

This recommendation is a result of hundreds of FPV flights, and the inevitable crashes. Pan/Tilts using the common HS55 resulted in multiple servo rebuilds, to replace broken gears. The HS56/HS85 combination has been flown for many months, many crashes, without a single broken servo, or tooth.

What is this anti-drift stuff?

Gyroscopic headtrackers all have some 'drift', which comes from several sources (see Appendix B for one source of drift). This drift, on the first generation of headtrackers, required a 're-zero' every few minutes of flight.

The Anti-Drift technology in the TrackR2 (v1.5 and later) negates the effects of all of these sources of drift, and greatly reduces the need to re-zero during the typical flight.

This technology relies on the fact that during the typical flight/drive the pilot's head faces towards the direction of travel most of the time (we do like to look where we are going when flying/driving).

Different styles of flight may require different anti-drift settings. The programming menu of the TrackR2 allows this to be configured.

For FPV debutants, a higher setting is recommended. This will increase the speed at which the camera returns to its center position (pan and tilt axis). (this mode is recommended for FPV Car use).

For slope-soaring, or other styles of flight where the pilot is looking off to one side for long periods of time, a milder setting is recommended.

Appendix A: Transmitter Configuration Notes

Note: For up-to-date information on transmitter cabling, compatibility, and programming, refer to the ImmersionRC website: <http://www.immersionrc.com>

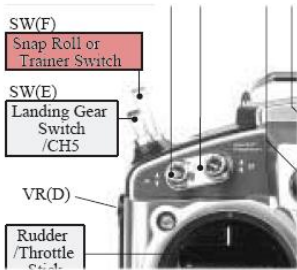
Futaba 9C/FF9

The Futaba 9C (and close relatives) are configured for head-tracking using the **TRAINER** menu. Ensure that the pan and tilt channels, configured in the TrackR2 programming menu, are enabled in the trainer menu. Note that two settings are possible, FUNC, and NORM. Either will work with the TrackR2, but FUNC allows the transmitter's mixing to function also.

This is useful to increase servo throw, using the **END POINT** menu (set upper/lower limits to +/- 140), and trim the zero position, using the **SUB TRIM** menu.

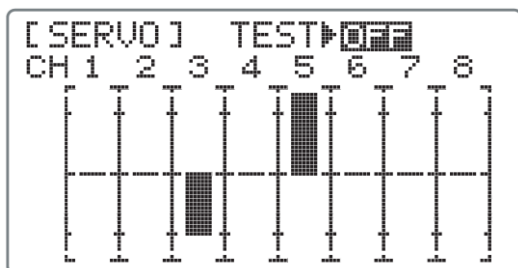
```
[ TRAINER ]  1: AIL OFF
              2: ELE OFF
  ▶ ON       3: THR OFF
              4: RUD OFF
CH1: AILE   5: GER FUNC
  ▶ FUNC    6: FLA FUNC
              7: AUX OFF
              8: AUX OFF
```

In order to enable the trainer port, the trainer switch (usually a momentary switch), must be activated. A rubber-band may be used to keep the switch active while flying



Notes: The trainer configuration 'survives' a power cycle, but when changing models, the trainer configuration is lost, and must be reconfigured.

A great way to verify the correct operation of the TrackR2 with the Futaba 9C transmitters is to enter the **SERVO** menu, the head-tracking channels should change in response to TrackR2 movement.



One last parameter which is important to setup is the mapping of the pan/tilt channels to knobs/switches on the transmitter. This seems counter-intuitive, since the headtracker overrides the pan/tilt channels.

It is important however, since it defines the position of the pan/tilt servos when the trainer switch is in the Off position (or when the TrackR2 is calibrating).

Attach a knob to the pan and tilt channels, and before the flight, turn off the trainer switch, and adjust the knobs until the camera is facing straight-ahead. There should be no difference in camera position between trainer mode on, and off, when the head tracker has just been zeroed.



Futaba 7C/FF7

The 7C is configured in a similar fashion to the 9C, but using a slightly less intuitive menu system.

To enter the **TRAINER** menu, press the Mode key for one second.

Scroll down through the menu choices using the rotary control, and when the **TRAINER** option is selected, press the control to enter the menu.

```
▶ MODEL
> D/R, EXP   B1
> E. POINT   ↵
> SUB-TRIM   ↵
```

(Basic Menu 2)

```
▶ REVERSE    ↵
> TRIM       B2
> TH-CUT     ↵
> FAIL SAFE  ↵
```

(Basic Menu 3)

```
▶ PARAMETR   ↵
> TIMER      B3
> TRAINER    ↵
```

First thing to do is define which channels are read from the headtracker. The default settings are for channels 1 thru 4, change this to channels 5 and 6 (the default channels emitted by the headtracker).

```
TRAINER > INH

CH: 1234567
MD▶ FFFF---
```

```
TRAINER >INH
```

```
CH: 1234567  
MD▶ ----FF-
```

The 'F' (as opposed to the other option, 'N') allows extra mixing within the 7C to set limits, gains, etc.

Next thing to do is enable the trainer, taking it out of 'INHibit' mode. Change the **INH** to **OFF** (yes, OFF doesn't make much sense, but the trainer switch is a momentary switch which is usually in the OFF position).

```
TRAINER >OFF
```

```
CH: 1234567  
MD▶ ----FF-
```

Once this is configured, the only remaining step is to enable trainer mode using the momentary switch (switch F for the plane version of the 7C, or switch H for the heli version)

As for the 9C, a low-budget way to keep the trainer switch in the ON position during FPV flight is to use a simple elastic band.

Unlike its big brother, the 7C doesn't provide the **SERVO** menu, so testing the headtracker will require the use of a receiver and a couple of servos on the pan/tilt channels.

Appendix B: 2-Axis vs. 3-Axis

The TrackR2 uses a 2-axis gyro. This allows us to produce a reasonably priced module, with reasonable performance, for the hobby R/C market.

The lack of third axis isn't usually a problem, but there is something to watch out for, when head-tracking without it.

So what are the three axes?. If one is tilt (looking up and down), and another is pan (looking left and right), then the third, which a 2-axis gyro doesn't see (in this application), is 'roll' (rocking the head left/right).

A 2 axis gyro is blind in the roll axis, not normally a problem, but imagine what happens when movement is sensed by one of the supported axes, followed by a movement in the 'blind' axis, and then followed by a negating movement in the same axis.

Basically... we don't end up where we started, and this looks like drift to the untrained eye.

How to avoid it? Don't roll your head while using the TrackR2 😊. Although this is easier said than done, when flying by video, and the plane is banking during a turn, the urge to straighten the horizon by rolling the head is human...

Note that the recently added Anti-Drift mode will reduce this source of drift.

Troubleshooting

1. *The servos drift slowly*

This is usually caused by movement of the gyro during the critical calibration procedure. It can also be caused by large temperature changes since the last calibration. To reduce the effects of the latter, expose the TrackR2 to the outside temperature conditions for a few minutes before calibration, and flying.

2. *The TrackR2 is silent on powerup*

Check first the power supply, if an external power source is used, is it fully charged?

3. *I hear beeps during power-up, but then the TrackR2 is silent, and ignores the button*

It could be that the TrackR2 has been accidentally programmed into one of the PPM modes which require input from the transmitter to operate.

To return the TrackR2 to PPM Out mode, enter the programming menu by holding down the button at startup, until the menu beeps are entered.

4. *The TrackR2 seems to be operating correctly (ticks when rotated), but my transmitter isn't changing the pan/tilt servo positions*

Ensure that the radio has the selected pan/tilt channels configured for student operation, and also ensure that the trainer switch is activated.

5. *I've played in the menu and now nothing works*

Best thing to do is restore defaults, using the (– – – . .) menu. Note that this also resets the PPM Polarity, so be sure to set these to the appropriate setting for your radio.

If all else fails, please contact the retailer from which you purchased the product.

As a last resort, please send a message to support@immersionrc.com

Have Fun!, and be Careful!

That concludes the TrackR2 manual. All that is left to do is enjoy this new dimension in a 200 year old hobby.

One more thing... please be careful! Flying under video control should not be performed without the help of a spotter, and never in a populated area.