Set-up of
FlySky FS-i6 Transmitter(Tx) and FS-iA6B Receiver(Rx) for
DF65 RC Racing Sailboat

(David Flakelar)

Background

The FlySky FS-i6 system operates under the Digital Proportional Protocol using an Automatic Frequency Hopping Digital System. It is a pulse digital system on carrier frequencies unique to a particular transmitter. You don't need to know how that works. The manufacturer claims there is no risk of interference from another transmitter.

These notes are written to help the beginner set-up the FlySky Tx/Rx system to operate with the DF65. There are also a few tips that have nothing to do with the FlySky system but may be of interest. Feedback would be much appreciated.

Why I Bought the FlySky TX/Rx System

1. It appears to be used by most of the fast sailors!
2. The marginal cost is the cost of FS-i6 system less cost saving on buying DF65 without Tx and Rx. At current Hobby Warehouse prices this represents an extra cost of (76.4-(237-179)) which is $18.
3. Minimal risk of interference from other sources.
4. Using its built-in telemetry capability, the condition of both batteries is displayed on Tx monitor. Visual and audible alarms can be set.
5. Expo (exponential) and or proportional control can be used on rudder movements
6. Winch action can be desensitised
7. Using Dual Rate alternate rudder settings can be established.

Compatibility

The FlySky Tx will only operate with a FlySky Rx of which there are several types. The Turnigy and Park Fly products appear to be FlySky re-badged?

Instruction Manual

A 27-page Instruction Manual is available from the web.

On registration with Gearbest, a slightly larger FS-i6 manual is available. Some DF65 packs come with the manual on a disc.

There are a number of videos available on YouTube. Most of these relate to control of model aircraft. Search on "FS-i6/DF65".

Switching Sequence

Having assured the user there is no risk of interference from another radio frequency source, the maker recommends that a particular switching sequence be observed, which is: Tx ON, Rx ON: Rx OFF, Tx OFF.

FlySky Product Range

The DF65 requires only a two channel Tx to control rudder and sail winch.

The FS-i6 is a 6 channel controller and the FS-i6X provides 10 channels.

The supplied Rx is the FS-iA6B with 7 ports and for neatness the three cables (battery switch, rudder and sail winch) plug-in horizontally from the end. A FS-iA6 Rx is available and has the same functionality but the seven ports are arranged vertically with exposed pins. Depends how you want to arrange cabling.

FlySky Operational Range

The physical range of the FS-i6 is dependant on the condition of batteries, orientation of both Rx and Tx antenna ie. the way the Tx is held. The Rx has two antenna and their orientation should match the manufacturer's instructions. However, range should never be a limiting factor for DF65s. The FlySky system has been shown controlling a drone out to 2.3km.

Line-of-sight transmission is important at all times.

Screen Saver
The screen brightness can be refreshed by pressing any button.

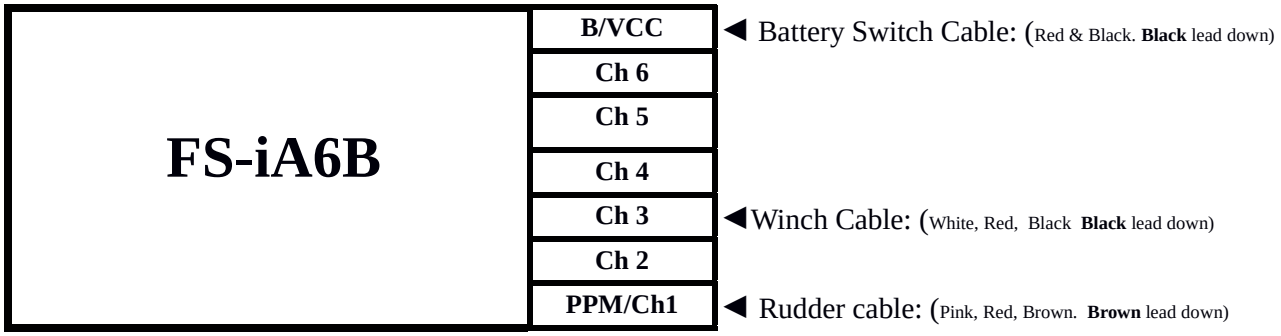
Warning
When switching on, if switches are not in their correct position, screen and audible warnings are provided.

Binding
As explained above, each Tx has a unique ID and the slave Rx must be programmed to process only those signals from the master transmitter.
The maker advises the supplied Tx/Rx combination is already "bound" but you may wish to operate two or more Rx from the one Tx. Hence the need for further "binding". To bind a second Rx you must first select a new model no. This is explained below.
Both the Instruction Manual and YouTube tutorials are clear enough as to how binding is done. Follow the sequence exactly.
With batteries loaded and Tx/Rx switched ON and before binding, a red LED on Rx will flash. This becomes steady when binding is complete.
Incidentally, the FlySky system provides for the control of up to 20 models which means you could have up to 20 DF65/95s (or aircraft) set-up independently and therefore each would require separate binding.

Binding Procedure

1. Rx should be adjacent Tx
2. Insert battery in Tx but do not switch on
3. Insert binding cable into B/VCC port on Rx
4. Insert Rx battery into any port (Ch1-Ch6). Red LED will flash indicating the Rx is not bound
5. Hold down **BIND KEY** on Tx and switch on Tx - labelled **POWER**
6. Release **BIND KEY** when binding is complete. The Red LED will remain steady
7. Switch off both devices
8. Remove the binding cable.
9. Remove Rx battery lead and insert in Rx B/VCC port
10. Switch on both devices in the correct sequence. Red LED will be steady

FS-iA6B Receiver Connections



Note that labels shown on Rx do not exactly align with ports below

Settings

FS-i6 Tx has six channels and therefore offers six controls that presumably are required to operate a quad copter. Only two are required for the DF65 – to control rudder and sail winch. These two controls are variously referred to as the gimbals, control sticks or stalks. Most sailors use the left hand stick (North-South) to control the winch and the right hand stick (East-West) to control the rudder. These can be reversed using the **Sticks** mode in **System** Menu. Additionally, the rudder control can be reversed so that it operates like a tiller. Select **Ch 1** (rudder) and **Reverse** in menu. There are four buttons on the Tx that are used to navigate through the menu and establish winch and rudder settings. The menu is arranged in a hierarchical structure. The four buttons and their function are:

OK	Press to activate the displayed screen so that setting changes can be made. To select **MENU** a long **OK** is required.
CANCEL	Short **CANCEL** to cancel any changes and exit the screen. Default screen will be the screen at the next level. Use a long **CANCEL** to save any changes to the current setting/s.
UP	Change the displayed or selected parameter upwards
DOWN	Change the displayed or selected parameter downwards

It is helpful to navigate through the menu to become familiar with the use of the buttons and the range of settings. Use a Model No. that is not in use. Alternatively, Exit the screen with a short **CANCEL** to ensure any changes made are not saved. A long **CANCEL** will save any changes.

FlySky Menu

The MENUs are selected by switching on Power and holding down **OK**. Two choices become available: **System** set up and **Functions** set-up. Toggle between these using **UP/DOWN** buttons. Exit progressively to main display at any time by Short **CANCEL**. Changes made at any point are saved by Long **CANCEL** ie. holding down **CANCEL** button.

Switch A & B and Trim Tabs

The main screen is shown in my manual on page 13. It does not show controls that will be referred to later. Switch A, labelled **SWA** (top left of Tx) is used for **Dual Rate** set-up and **SWB** is used for **Throttle curve**. There are two stick trim tabs used for fine tuning. The winch trim tab is to the right of the winch stick and the rudder trim tab is below the rudder stick. Both have an audible tone to indicate direction and mid point. Both can be used for fine tuning. The trim tab mid range position can be seen and controlled in **Display**.

Selecting Model

The example below shows the steps required to assign your DF65 A+ rig to Model 10 in FS-i6 system

	Action	Result on Screen
1	Power up Tx	**Main screen**
2	Long **OK**	**MENU** • **System (Crown icon)**

	Action	Result on Screen
		• **setup (Spanner icon)**
3	Using **UP/DOWN** buttons select "System"	System icon boxed
4	Short **OK** to select this SYSTEM MENU	**SYSTEM** **Model select** **Model name** **Type select** **etc.**
5	If necessary, use **UP/DOWN** buttons to select **Model select**	**SYSTEM** **Model select** **Model name** **Type select** **etc.**
6	If necessary, use **UP/DOWN** buttons to select required mode	**Model select** **Model 10** **Flysky 10** **Aircraft icon**
7	Short **CANCEL** to exit next screen	**SYSTEM** **Model select** **Model name** **Type select** **etc.**
8	Long **OK** to select and use **UP/DOWN** buttons to select **Model name**	**SYSTEM** **Model select** **Model name** **Type select** **etc.**
9	Short **OK** to select	
10	Using cursor, and **OK** button, type model name "DF65 A+"	**Model Name** **Model 10** **DF65 A+** **Alphabet**
11	Exit to upper level with short **CANCEL** and select "Type select"	**MENU** **Model select** **DF65 A+** **Type select**
12	Short **OK** to select Type of Aircraft	**MENU** **Model select** **Model name** **Type select**
13	Use **UP/DOWN** buttons to select	

	Action	Result on Screen
	Airplane or Glider	
14	Short **OK** to select Airplane Or Glider	**Type select** **Model 10** **DF65 A+** **Airplane or** **Glider** **Aircraft icon**
15	Long **CANCEL** to save and several short **CANCEL**s to exit to Main Menu	**Main screen**

Weather Helm Discussion

These musings are meant to provide some background to the set-up of the DF65 winch and rudder using the FlySky system.

When racing, ideally, in steady-state conditions, we want the boat to track in a straight line particularly to windward with slight weather helm. If there is too much weather helm the boat will round-up and go into irons.

There are a number of measures theoretically possible to achieve balance:

1. Constant and skilful rudder movement will provide straight line tracking however rudder movement is slow as the rudder when used provides a greater projected area. It acts a bit like a brake.
2. Mast rake by adjusting forestay and backstay tension. By this adjustment the sail's combined Centre of Effort (CE) can be moved fore and aft relative to the foil's Centre of Lateral Resistance (CLR). By this we are essentially controlling the couple between these two forces. There is plenty of reading on the internet and elsewhere about this and wont be repeated here. Generally a small amount of weather helm is safer and it is desirable to provide a bit of feedback to the helmsman otherwise the steering will feel dead. The latter does not apply to RC yachting.
   There is no known, easy way of setting up optimal mast rake except by trial-and-error. The recommended measurement from a reference point on the upper mast to a point on the deck is about all there is. This method is a guide only and not very accurate. See Soch Sails DF65 Rig Tuning Guide.
3. Changing the CLR by lifting the centreboard/keel (impossible with DF65)
4. Reduce the power of mainsail by easing main sheet (more of this later), flattening foot or ease boom vang to soften leech (ie. spill more wind from back of sail)
5. Reef main
6. Increase power of jib by moving its CE forward and thus moving the entire rig CE forward
   In an RC yacht a bit of weather helm is desirable, not for feel, but for another reason. When moving through the water the foils provide lift. This is analogous to the wing (foil) on an aircraft, particularly a glider. The downward gravitational force of the glider is balanced or counter-acted by the lift provided by the wing. One approach with DF65s might be to use the Trim tab referred to earlier and this might be a quick fix on one tack however it may have to be removed or re-applied on the other tack. There is no known way that an RC yacht can be provided with an offset rudder to provide the required minimal amount of rudder on both tacks.

The only way an RC yacht can move in a straight is by the accurate alignment of CLR and CE. However any particular setting is only good for a particular set of wind and wave conditions. And may only be good for a particular tack.
In a wind gust these balanced forces become out-of-balance. The wind force on the sails increases with the square of the wind velocity but the counteracting force from velocity of water over the foils does not increase because in the instant the gust hits the boat speed has not increased and the boat rounds up.
The second impact of a gust is to heel the boat. The underwater shape of the hull changes from one that is symmetrical (when mast is vertical) to one where the line of least resistance is for the hull to move to weather. So to counter the boat rounding-up, rudder is used to force the bow down. But as the hull heals the rudder has less effective area in the direction of travel and more and more rudder has to be used. Any rudder movement slows the boat because of Newtons First law and the greater the rudder movement the greater the impact on speed. In short, any rudder movement is slow.
The other means of countering the effect of a gust is to ease the sheets for the duration of the gust and a way of doing this is by a **`Throttle curve`** set-up using Switch B – Winch Control. It is acknowledged that the sheets can be eased with slight winch movement at any time – SWB just might just make it easier and more consistent.
Also in a gust the apparent wind moves aft and as we have suggested, the impact on heeling-over and rounding-up can be minimised by easing sheets and increasing velocity. However this is not the only possible response. Theoretically one could remain close-hauled and benefit from this velocity lift by sailing a slightly higher course. In a dinghy this is often possible by hiking harder and thus keeping the hull flat.
The recommended response to a wind gust is to slightly ease sheets although this needs to be contested.
No recommendation is made regarding taking the velocity lift and I would welcome feedback for further dissemination

Rudder Use Discussion
If during the starting sequence or when racing in a variable wind, and the boat is above close-hauled and either stationery or moving slowly, like a dinghy, it is possible that by sculling, she may be brought down to a close-hauled course. This does not violate RRS 42 Propulsion. See RRS 42.3 (d). That is, if the hull lies above close-hauled on the Port tack, by moving the rudder stick to the left and releasing so that the spring loading moves it to the centre neutral position, the scull may force the bow down to close-hauled.
This suggests the rudder **`End points`** setting may have to be greater than that required for normal steering.
It is essential to have a physical mid rudder reference point on the underside of hull so that before launching one can determine whether the rudder is physically aligned fore and aft. To establish this neutral rudder reference point, remove rudder and turn the hull upside down. Carefully align a straight edge between centre of keel and centre of rudder post opening. Using a fine permanent marker, draw a short line aft of the rudder trailing edge position. This will be a reference for a neutral rudder.
Assuming a 35 degrees rudder throw say, and using a protractor or 30/60 set square, mark the position of the trailing edge of rudder when helm is hard over - both tacks.
If there is any rudder slop, insert a short length of rigging line into the rudder post hole and trim excess later. Replace rudder and secure after carefully aligning with neutral helm marker. Ensure rudder moves freely.

Starting a Race - Discussion

There are fundamentally two ways of starting in a yacht race.

A displacement yacht will usually start coming from distance because their inherent design and weight means they cannot easily be parked and subsequently accelerated away. The primary skills are to pick the right lane, at the right end, (consistent with line bias and whether the right, or middle or left hand side of the course is likely to be favoured) and judge the speed of advance on distance so that the boat is at speed, in clear air, just behind the line when the gun goes. Simple.

The start of a dinghy race is usually fundamentally different. In say a quality Laser start, once the position on the line is determined, the boat is "parked" about one boat length back from the line and held in position by mainsail trim so the leech just catches the wind. This together with judicious sculling with the rudder the dinghy can be parked so as to not move down the line onto other boats to leeward. Weather boat keep clear!

The process is, about n seconds from the start, where n will depend on the type of boat and how well it accelerates, simultaneously quickly sheet-on, hike to keep the boat flat, and as the boat accelerates, pull-away to close hauled. This procedure is preferred to the keel boat type start because the need to judge time on distance is minimised.

It is not known which is best for the DF65? Maybe a mixture of both.

End Point Settings

Operation of the DF65 requires setting limits to (i) the number of winch rotations between fully sheeted in and fully sheeted out and (ii) the angle through which the rudder moves. This is done by using the menu to set-up the **`End points`**.

Winch (Ch 3): Use this setting to set the winch throw to about 115mm of sheet. More later.

Rudder: (Ch 1): Use this setting to set the maximum rudder throw in both directions which should be about 35 degrees or perhaps more if you intend to scull. Too much rudder movement when underway may cause the rudder to stall.

How To Set-up Winch Throw

Power-up Tx.

If necessary, select model number as described above.

Ensure that bowsies for both sheets are fully released. Better still, remove sheets from sheet clip.

Using the **`Function`** set-up menu, go to **`End points`**

Using short **OK**, index through to Ch 3 in left hand column.

This should be the sheet-in position.

Sheet Out with stick so that sheet clip is at the fwd end of hatch opening but well clear of main sheet bridle. It may be necessary to add or remove a turn or two from the winch drum. Mark this Sheet Out position of the sheet clip with a fine point marker. Sheet In and mark this position of the clip. It should be about 115mm from the Sheet Out position.

If not, use **UP/DOWN** buttons to adjust either position.

In the Sheet Out position attach sheets to clip, Sheet In and use bowsies to set both booms to their recommended positions.

Check Sheet Out position of both booms.

Use long **CANCEL** to save this setting and index out to main menu with short **CANCEL**s

Move stick to Sheet Out position and repeat above checks if necessary.

Incidentally, the winch speed can be increased by increasing its effective diameter by winding more line onto the drum during the original set-up.

Normally the sheet would be wound onto the drum in a clock-wise direction. If wound counter-clockwise, use the **`Reverse`** setting on channel 3 to reverse direction of travel.

How to Set-up Rudder Throw
Power-up Tx/Rx
If necessary, select model number as described above
Using the **Function** set-up menu go to **End points**
The default should be **Ch 1** (Rudder) in left hand column
Push rudder stalk to left and hold, rudder should follow
Using **UP/DOWN** button, fine tune rudder position so that it aligns with pre-set 35 degrees guide
Move rudder stick to right and repeat tuning in right hand column
Long **CANCEL** to register these settings and index out to main menu with short **CANCEL**s
Check to ensure you have selected the correct model.
Check rudder throw and ensure rudder is in mid ships position
Power off

Rudder Mid-Point and Weather Helm
It is not uncommon in a steady breeze for the DF65 to sail to windward perfectly balanced (ie. no rudder adjustment necessary) on one tack but to have a marked tendency to round-up on the other tack ie. weather helm. This may be due to asymmetrical sheet settings and this should be checked, particularly the position of main sheet bridle on both tacks. It may also be due to the rudder being slightly off centre. This mid-point can be reset during racing by the rudder trim tab below the stick. When used, the audible tone indicates the direction of movement and the mid position.
Alternatively when not racing the rudder mid-point can be set using Ch 1 **Subtrim** and the **UP/DOWN** buttons.

Rate
In its factory setting, rudder movements are proportional or, if you like, linear. A 50% movement of the stick to the right will result in a 50% movement of the rudder to the right, within the preset range.
There are two ways of controlling the relationship between stick movement and rudder movement. The first is **Rate, t**he other is **Expo**. They can be used alone or together. When **Rate** is used, for a given stick movement, the rudder will move through a smaller angular displacement than if there was no **Rate** used - but the relationship remains linear.
Strictly speaking it is not a "rate" which implies it is time dependant. Rather, **Rate** changes the extent of rudder movement. The default is 100. If set to 50 then a movement of 50% of the stick range will result in (0.5X50=) 25% of rudder movement. In effect, it desensitises stick movement in a linear way, but over the entire stick range. The other important consequence of the use of **Rate** is that it effectively reduces the rudder throw. If the rudder end points were set at 35 degrees say then the use of a 70% **Rate** would effectively reduce the throw to (0.7x35=) 25 degrees. So use this setting with care.
How to set-up **Rate** is explained below.

Expo (exponential) Control
Expo is the other way of controlling the relationship between stick and rudder. **Rate** and **Expo** can both be used to control rudder movement, either singularly or combined together. A second set of **Rate/Expo** settings can be use using Switch A (**SWA**)to invoke the **Sports** mode. More later.
With the use of **Expo**, the stick/rudder relationship changes to one that follows one of a theoretically infinite number of exponential curves. For example with **Expo**, a 50% stick

movement to the right (or left) might result in only a 30% rudder movement – depends on the **Expo** setting. More rudder movement leads to proportionally higher response.
The extent of **Expo** applied is a matter of personal preference.
So both **Rate** and **Expo** alter the default linear curve to one that either is less sensitive (positive expo) or, more likely, more sensitive (negative expo) around the middle range. When using **Expo**, a typical starting point might be 30%. - depends on whether **Rate** is also used.

What is Dual Rate and Why it May be Appropriate for DF65
The FlySky rudder settings allow control of the rudder throw (**End points**) and sensitivity (**Rate** and/or **Expo**). Using Switch A (**SWA**) to invoke the **Sports** mode a second set of **Rate/Expo** settings can be selected and saved but only one set of **End points** can be used.

How to Set-up Dual rate/Exp. For Alternative Rudder Control
Power-up Tx/Rx
Select model number as described above
Using the **Function** set-up menu, and short **OK**, index through to **Dual rate/expo**. Select with **OK**
Short **OK** on **Ch** and if necessary index to **Ch1** (Rudder is selected)
Throw Switch A (down) and **Sport** will be displayed
Set-up **Rate** using **Up/Down** buttons. Index to **Expo** and again using **Up/Down** buttons select an **Expo** setting.
Long **CANCEL** to save.
Experimentation on the water should give an indication of the optimal rudder settings for **Sport** mode. Depends on its intended use.

Control of Winch in a Gust – Use of Throttle curve
In the discussion above it was suggested that the most appropriate response in a gust is to ease sheets rather than use the rudder to counter the inevitable rounding-up. Of course with fine motor skills, sheets can be fractionally eased at any time however it is suggested that a desensitised winch may be appropriate. This can be set-up using **Throttle ease** and Switch B (**SWB**). The curve should be not be dissimilar to that used in the Rudder **Sports** mode. At Position 1 I have used 8%.

Model Copy
This function can be used to copy Settings on one model to another. Any settings on the target model will be over-written.
To copy, Model 3 to Model 4 say, ensure Model 3 has been selected. This becomes the source model
Select **System** menu and index to **Model copy**
Select **Target model** and long **CANCEL** to save, then several short **CANCEL**s to return to main screen
Check settings on target model

Model Reset
As the Manual says "This function will reset selected model settings to default.
The other models will be not be affected. This can be useful when a set-up is going nowhere and needs a fresh start.

Other FlySky Functions
The FlySky system provides the rich functionalty required for model aircraft and many features have no relevance to RC yacht racing. However some may be useful. Not described here are **`Model name, Model reset, Sticks mode`** (useful for changing from wheel operation to tiller operation), **`Rx battery alarms, Factory reset, Reverse stick`** operation for left handed sailors, **`Display`** (mid position and end points of all channels) and **`Sub trim`**. Refer Manual for more details.

Disclaimer
The Dual Rate features of the FlySky system have been described to highlight the available functionality. It does not follow they should be used. Moreover the suggested setting are nothing more than that. Personal preference and experience are the best guide. I'd like to draw on that experience and over time I'm sure the best techniques and settings will evolve.
I'm mindful of my experience with a compass on a Laser. When first used, I spent an inordinate amount of time watching the compass and far too little time watching the big picture ie. getting my head out of the boat.
So, any speed gain made by using say **`Throttle curve`** in gusts during the race may all be lost in one bad mark rounding.
Concentrate on the important things first.
All will become clear over time as gifted sailors develop and refine what is fast for this class and provide feedback to the plodders.

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