

Using the 9XR Pro for More than Eight Channels

Introduction

In stock form, with a module such as the FrSky DJT or OrangeRx DSMX/DSM2 installed, the Turnigy 9XR Pro transmitter can control a maximum of eight channels. This appendix describes how the number of channels can be increased to 16 or even 24 through the use of transmitter modules, receivers and other equipment.

Transmitting More than Eight Channels

The ErSky9x firmware and the Sky North-designed circuit boards of the 9XR Pro together offer two approaches for transmitting more than eight channels:

1. **One FrSky XJT module** can be installed in the external module bay, using the PXX protocol to give 16 channels. A single FrSky X-series receiver can handle all 16 channels.
2. **Two modules** can be installed, one in the external module bay and one internally. This approach can provide a maximum of 24 channels and is possible because the transmitter provides two separate signal streams: one is directed to the external module and can be programmed to use PPM, PXX or DSM2 protocols; the other goes to terminals inside the transmitter and provides a PPM signal that can be used to drive an internal “hack” (DIY) module. The two streams are configured in Model Setup menu of the firmware (page 1). Two receivers are required, one for each module.

Decoding More than Eight Channels

Traditionally, receivers have provided one port for each channel, allowing servos, speed controllers, etc. to be plugged in directly, each receiving its own PWM (pulse width modulation) signal. In most cases, however, receivers provide a maximum of eight conventional output ports.

If the radio generates more than the usual eight channels, the longer pulse stream can be transmitted using an appropriate protocol and RF module. Instead of additional servo ports, the receiver can put out the data as a serial stream of pulses containing the positioning information for all of the channels. This is then sorted out by one or more decoders that feed conventional servos or by special servos that can pick their own channel information from the stream. In the case of some helicopters and multi-rotor models, the information stream can be fed into a flight controller which does all necessary processing.

The Futaba approach to serial data transmission is called “S.BUS.” FrSky makes receivers that work with this system. The serial data stream containing 16 channels is available from the S.BUS Port on the X8R, X6R and X4R receivers, which work with the XJR module on PXX protocol. FrSky also makes S.BUS servos that can tap into the data stream directly, as well as an S.BUS converter into which regular analog or digital servos can be plugged.

Another form of serial data transmission, used by many flight controllers, is CPPM. This is simply the full PPM stream containing information for all channels. Some receivers can put out CPPM directly, while the S.BUS stream available from X-series FrSky receivers can readily be transformed into CPPM by a small and inexpensive converter unit. Some of the D-series receivers can also produce a CPPM stream directly.

The other approach is to use two receivers, one for channels 1-8 and the other for channels 9-16.

This appendix outlines these two basic methods for controlling more than eight channels with the Turnigy 9XR Pro.

Method 1: Single FrSky XJT module and S.BUS

As noted above, the FrSky XJT module can transmit up to 16 channels and any of the X-series receivers can forward the information via the S.BUS port, from where the individual pulses can be directed to conventional servos or picked up by S.BUS servos.¹

The X8R receiver has eight conventional channel outputs (CH1 to CH8), an S.BUS Port (CH1 to CH16), a Smart Port and an RSSI Output Port. The X6R and X4R receivers also provide conventional outputs in addition to an S.BUS Port covering CH1 to CH16. Thus any of these receivers may be used to control up to 16 channels.

Servos may be connected via both the regular individual ports and the S.BUS Port.

S.BUS

The S.BUS Port sends the signals for all 16 channels to servos via a special cable that has one female connector for input and multiple male pins for the servos, using conventional servo connectors. These cables, available from several manufacturers, vary in the number of servos they can support: the Futaba SBUS cable has three outlets, the FrSky cable has four and the HobbyKing cable five. Cables can be daisy-chained to support the total number of servos being used. S.BUS servos can be plugged into any set of pins and will respond only to the channel for which they are programmed; this is done by means of a Servo Channel Changer, a compact tool with OLED display that allows a servo to be assigned to any channel.



To connect conventional analog and digital servos with the S.BUS requires a Decoder that converts the serial stream to individual PWM signals. The Decoder can be plugged directly into the S-Port or into any servo connector of an S.BUS cable; the conventional servos then plug into the decoder. The Servo Channel Changer is used to assign the servos to channels. Digital servos are generally recommended due to the high frame rate involved.

The serial bus arrangement not only increases the number of channels that can be managed but also is useful for very large and/or complex models, as it reduces the number of cables routed to the extremities of the aircraft. It is also required for some flight controllers which are capable of accepting the serial signal and decoding it internally for helicopter, multicopter or FPV applications.

The S.BUS supports any combination of up to 16 S.BUS servos or conventional servos fed by decoder(s).

Examples

Suppose we have an X8R receiver with a total of eight conventional servos, speed controls, etc. connected directly to its conventional outputs and we need four more channels, for a total of 12. There are two options for the additional channels:

- 1) Four S.BUS servos connected to the S.Port via an S.BUS cable. A Servo Channel Changer is used to assign channels to each of these servos.
- 2) A Decoder plugged into the S.Port with four conventional servos plugged into the Decoder. Again, a Servo Channel Changer is necessary to assign servo channels.

To use more than 12 channels there are two more possibilities.

- 1) Connect (daisy-chain) one or more S.BUS cables into any one of the outlets from the first S.BUS cable. Then plug in up to four additional S.BUS servos.

¹ Note that to use an XJT transmitter module, the radio firmware (ersky9xr) must be updated to at least version R211, 18-Aug-2014, available at: <http://openrcforums.com/forum/viewtopic.php?f=123&t=5878>

- 2) Connect a second Decoder to either the first Decoder or an S.BUS cable and plug in up to four conventional servos.

Many combinations of conventional outputs, S.PORT devices, decoders, conventional servos, and S.BUS servos may be used to achieve the control outputs required. The following shows some possible combinations of direct servo connections to the receiver, S.BUS servos and decoders feeding conventional servos.

Method 2: Internal DHT Module plus External Module

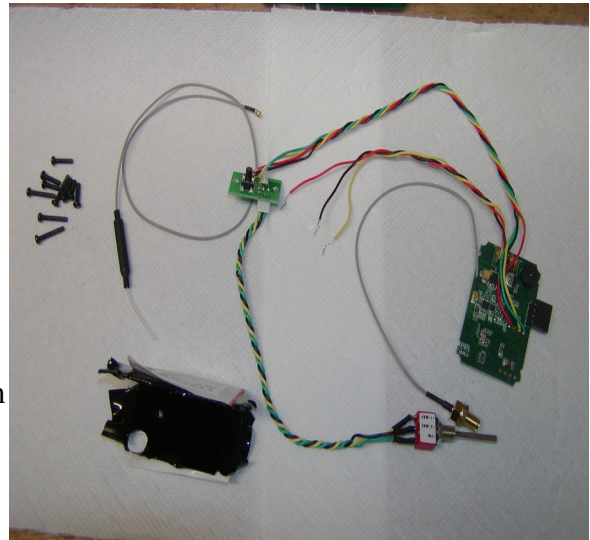
To transmit up to 16 channels using conventionally connected servos, two modules are used. Various combinations of modules and mounting systems are possible.

The approach described below uses two FrSky D-type modules: an external plug-in DJT and an internal DHT (hack) module. All components for the internal module are mounted on the rear half of the transmitter case with two cables connecting to the main part of the transmitter.

Installation of the Internal DHT module

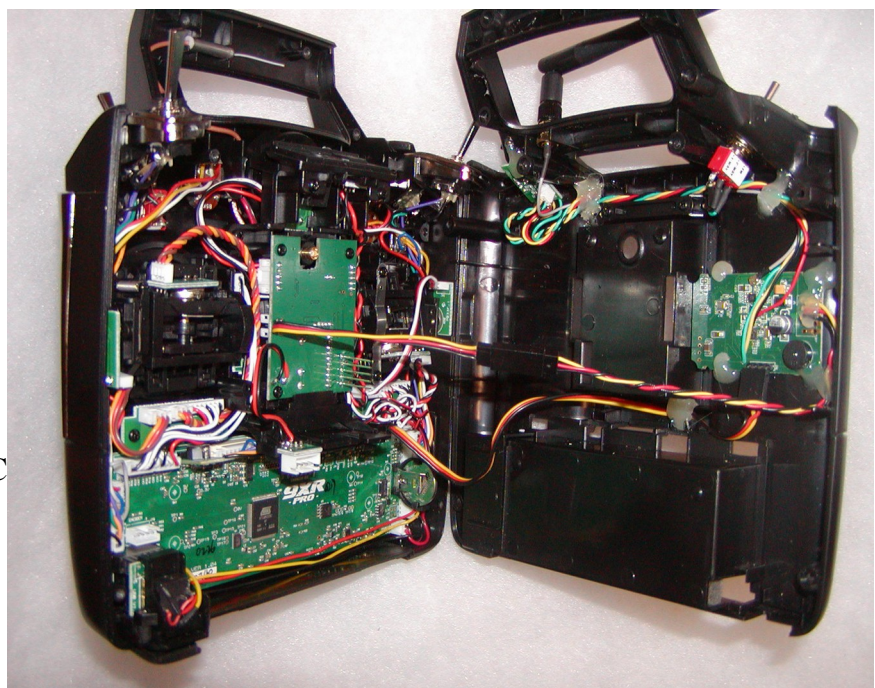
The components required are the FrSky DHT Do-It-Yourself module, a pair of servo leads and a four pin header. The dipole antenna is a 400mm receiver antenna and is an alternative to the conventional black Rubber Ducky Tx antenna supplied with the DHT module.

The FrSky DHT module requires three connections: ground, switched battery power and PPM. These are the black, red and yellow cables with the bared ends in the picture at right. For telemetry, connections to RXD, TXD and ground are required via three of the four pins on the side of the DHT PC board. The +5v pin is not connected.



Upon opening the transmitter case, two printed circuit boards are visible. The larger one is the main board that encodes the information about stick, pot and switch positions. The smaller board connects to the RF module and thus enables the logic from the main board to be converted it into a radio frequency signal for transmission.

This smaller circuit board has a three pin header for connection to the DHT module. This is referred to as the Auxiliary PPM2 Output and it provides ground, power and PPM signal. The plug needed to fit the existing socket is difficult to obtain, so it may be easier to solder a servo extension lead onto the exposed side of this PC board. The picture at right shows the completed installation.

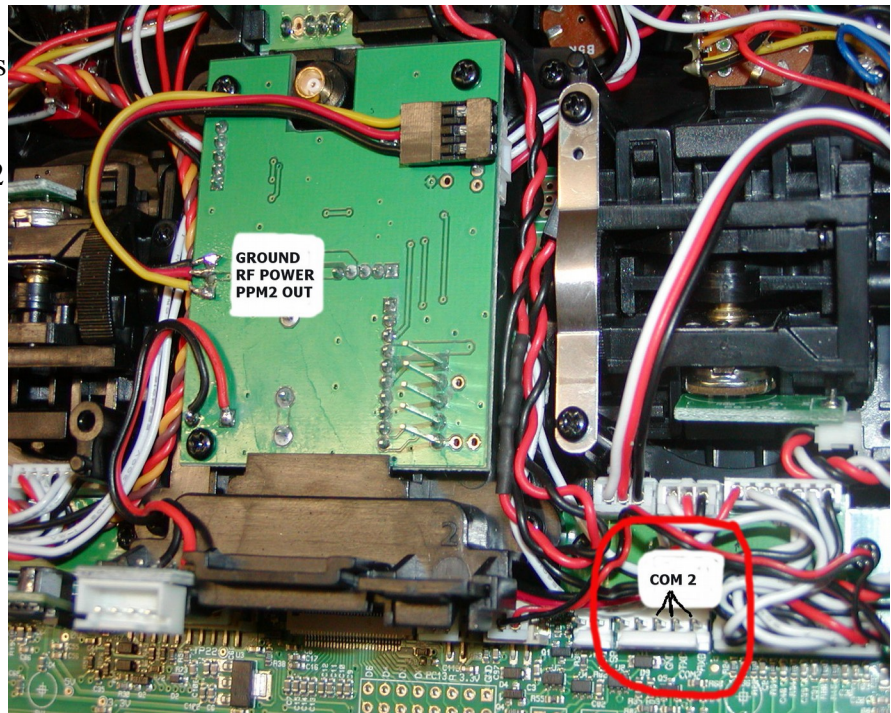


The picture below shows the connections. A servo lead socket can be fitted to the black red and yellow leads of the DHT if you have the tools, or a short servo extension lead can be used.

Telemetry Connections

Telemetry from FrSky D-series receivers is supplied to the transmitter via the Com2 connection. The pins for Com2 are labelled on the PC board: from right to left RXD, TXD and GND.

A three pin header with the sockets at 0.1 inch spacing fits the Com2 pins on the circuit board. At the other end, a four pin socket is required to fit the DHT. Alternatively the socket can be removed from a 200 mm servo extension lead and the leads soldered to the pins which protrude from the edge of the DHT circuit board.



The 9XR Pro is supplied with a red and black wire cable inside the transmitter case, attached to the back of the Futaba trainer port. This cable can be used with a cable outside the transmitter case to carry telemetry signals from the external module to the Com2 port. For the present application, however, disconnect the black/red cable and tuck it beside the gimbal.

DHT Control Panel and Switch

The DHT module includes a switch, as well as a small PC board with push-button for binding and LED to indicate status.

The switch is used to select one of three possible modes: firmware update, D-series protocol and V8 series Protocol (one way communication). If the transmitter is not to be used with the older V8 protocol receivers the switch can be removed and the module will default to the D-protocol. This supports D and V8-II type receivers.

The small printed circuit board with the push-button and LED must be accessible when binding receivers and doing reduced power range testing. The panel can be conveniently located next to the trainer ports. An alternative location is on the underside of the handle, above the screw hole. Two 5/32" (4mm) holes are required for the push-button and the LED.

Antenna

Fitting the 'Rubber Ducky' antenna that comes with the DHT is a challenge. It must not interfere with any antenna fitted to a plug-in module. The location should ideally be on the rear half of the transmitter case so that the two halves can be unplugged and separated. Note that antenna leads should never be spliced as joints in coax cable seriously affect signal strength.

The antenna requires a 1/4" hole and clearance for the hexagonal boss inside the case.

If an external module which connects to the antenna socket in the module bay is used, the existing internal antenna can be used by the DJT. This allows the transmitter to be installed in the 9XR Pro transmitter carrying case without removing the antenna.

As an alternative to the Rubber Ducky antenna, an internal antenna in the form of an FrSky receiver antenna can be used for the DHT. Some external modules can then use the connector in the module bay to enable use of the internal antenna supplied as an integral part of the 9XR Pro.

Note that this internal antenna arrangement is less efficient than using an external antenna, reducing range by about 20% according to the author's tests. Nevertheless range is still more than adequate for most purposes.

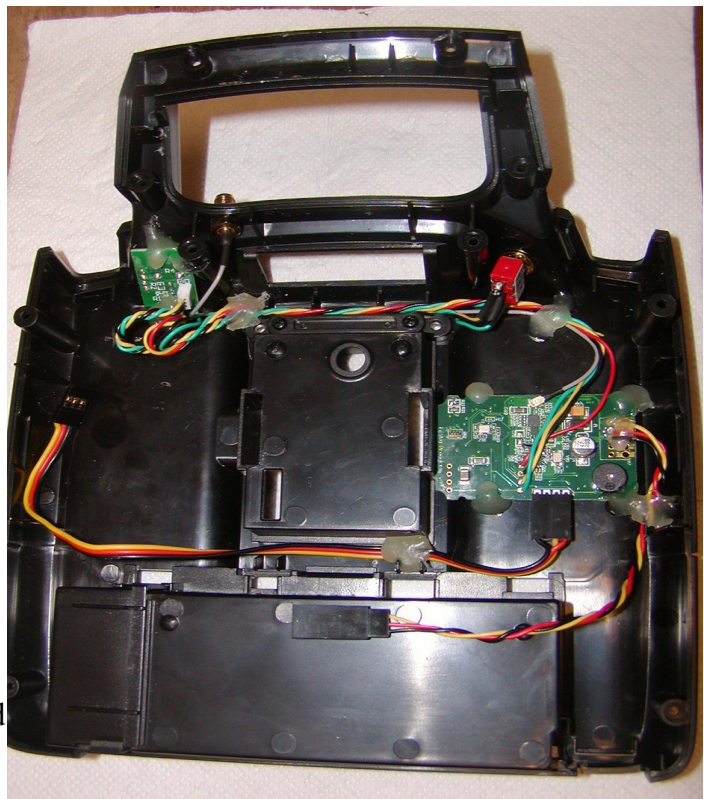


Mounting the DHT Module

The DHT circuit board is glued into position in the space under one of the gimbals, as shown in the next picture. The clearance to the moving parts is 13 mm.

The maximum thickness of the DHT module is 11mm over one of the components. The other components are about 4 or 5 mm less in thickness. The protective wrapping must be removed to ensure clearance. Keep it so that you have evidence of your compliance with national regulations and a record of the telemetry pin identities.

Note that the telemetry connections for RXD and TXD are different. RXD on the module connects with TXD on the Com2 port. TXD on the module connects with RXD on the Com2 port. At the four pin header in the above picture the red and yellow leads cross over each other to make the correct RXD and TXD connections.



Note that the cables as supplied with the DHT module are almost the correct length and need not be shortened. They fit snugly into channels in the back part of the transmitter case. The cables made from servo leads may be as long as necessary to make assembly of the two halves of the transmitter case easy but short enough to tuck away from the gimbals.

The relative positions when each module uses an internal antenna located in the handle.

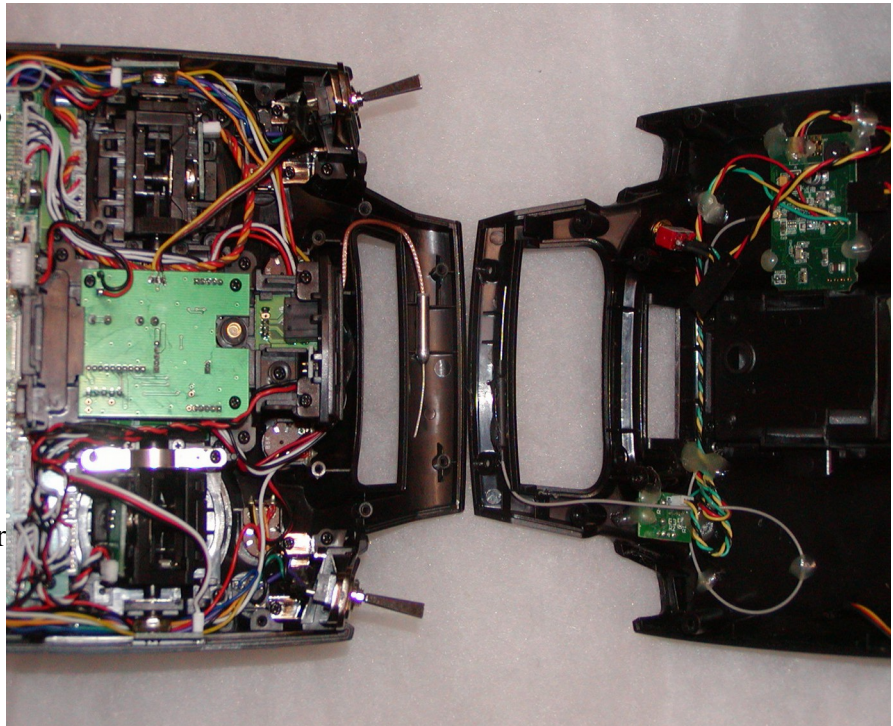
Radio Settings Related to Transmission Protocol

Transmission protocol is selected near the bottom of page 1//13 in the Model Setup pages (long right press then short right from the 'Home pages').

Proto

The options here are PPM, PXX, and DSM2 and apply to the external module. I.e., the one in the JR style module bay. The options below this line change according to the capabilities of each protocol.

The XJT module autoselects the mode of transmission depending on the type of receiver used: X series or D series. If PPM is selected in the transmitter, the over-the-air protocol can be selected amongst D8/D16/LR12 by DIP switches on the module. In PPM mode the module supports transmission of up to 12 channels.



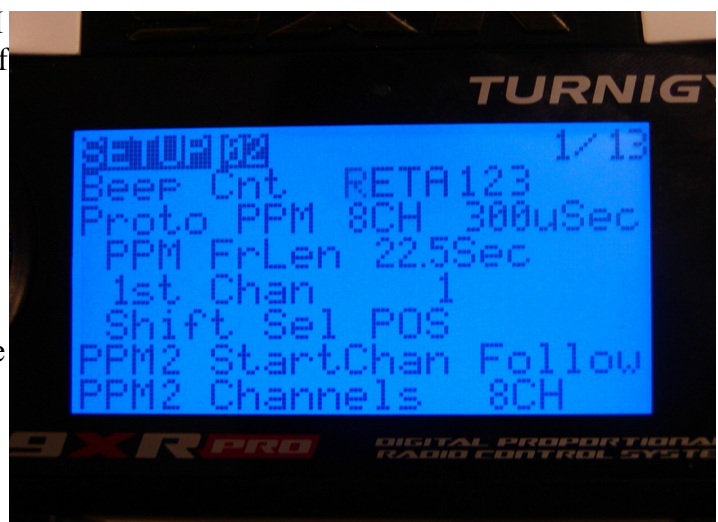
Settings For PPM Protocol

Channels

The number of channels to the right of PPM should be selected to match the capability of the external module and its receiver. The options are from 4 channels to 16 channels. For example In the case of the DJT module and a D8 series receiver this field should be set to 8CH.

Pulse Width

The 300uSec item is the width of each pulse in the PPM train. Leave it at 300uSec except when using a Spektrum DM9 module, when 350 or 400uSec will give more accurate servo centering.



PPM FrLen (Frame length):

The length of each complete frame of PPM information. Normally need not be changed from the default 22.5 mSec (milliseconds), but some DSM protocols work better at longer frame lengths.

PPM frame length should be set equal to at least the number of channels times 1.8mSec, plus an allowance for frame handling and synchronisation. For 8 channels at least 22.5 mSec is recommended. For 16 channels 35 mSec is recommended.

1st Channel

This is the channel which is first in the PPM stream and is usually left at 1. Other start numbers may be needed when using a flight controller which accepts raw PPM.

Shift Sel (Shift select)

Select signal shift POSitive or NEGative. Leave at POS if in doubt. Note that some modules, such as Orange, will accept either POS or NEG but the Spektrum DM9 requires POS.

PPM2 Start Channel

PPM 2 applies only to the internally fitted module connected to the PPM2 output on the RF board. The options are: 'Follow' or a specific channel from 1 through 17. In this case the first receiver is an 8channel unit, then the second receiver will start at channel 9.

PPM2 Channels

The options are 4 through to 16 channels in 2-channel increments. This depends on the number of channels your internal module can transmit. The DHT is capable of 8 channels.

Settings for PXX Protocol

When PXX mode is selected in the transmitter the DIP switches on the back of the XJT module are ignored. PXX supports the transmission of 16 channels. PXX protocol assumes 16 channel capability so unlike PPM and DSM2 there is no option to select the number of channels.

Rx Num

A number may be assigned to the receiver so that it will only bind with this one model memory in the transmitter

1st Chan

This is the channel which is first in the PXX stream and is usually left at 1. Other start numbers may be needed when using a flight controller which accepts raw PPM.

PPM2 Start Channel

PPM 2 applies only to the internally fitted module connected to the PPM2 output on the RF board. The options are: 'Follow' or a specific channel from 1 through 17. In this case the first Tx module is a 16 channel unit, so the internal Tx module will start at channel 17.



PPM2 Channels

The options are 4 through to 16 channels in 2-channel increments. This depends on the number of channels your internal module can transmit within a total of 24 which the radio can generate. The DHT is capable of 8 channels.

Settings for DSM2 Protocol

DSM2 protocol provides 8 channels and allows no option to select this number.

Proto Type

There are four options for the type of DSM transmission: LP4/LP5, DSM2 Only, DSM2/DSMX and 9XR-DSM.

- LP4/LP5 is used for modules taken from transmitters usually bundled with RTF models.
- DSM2Only is used for older Spektrum or Spektrum compatible transmitter modules.
- DSM2/DSMX is used for later modules which autoselect DSM2 or DSMX mode.
- 9XR-DSM is to be used for modules still under development.

Rx Num

A number may be assigned to the receiver so that it will only bind with this one model memory in the transmitter

1st Chan

This is the channel which is first in the DSM stream and is usually left at 1.

Bind

This option only appears when the 9XR-DSM type is selected. For other types of DSM2 protocol, bind mode is initiated by holding the bind button on the module while turning on the transmitter.

Range Check

This option only appears when the 9XR-DSM type is selected. For other types of DSM2 protocol, range check mode can be entered by pressing the bind button on the module.

PPM2 Start Channel

PPM 2 applies only to the internally fitted module connected to the PPM2 output on the RF board. The options are: 'Follow' or a specific channel from 1 through 17. In this case the first Tx module is a 16 channel unit, then the second Tx module will start at channel 17.

PPM2 Channels

The options are 4 through to 16 channels in 2-channel increments. This depends on the number of channels your internal module can transmit. The DHT is capable of 8 channels.

Radio Settings for Telemetry

The transmitter can only show the telemetry on the screen and log the telemetry readings from one of the receivers and any sensors connected to it. Both receivers transmit telemetry to their respective modules and the alarm settings in each module for example, will respond to low values of RSSI and beep the appropriate warnings. However only one set of telemetry data can be shown on the transmitter screen and logged. To select which set of telemetry data is shown the identity of the Com port is selected in Telemetry2 (page 11/13).

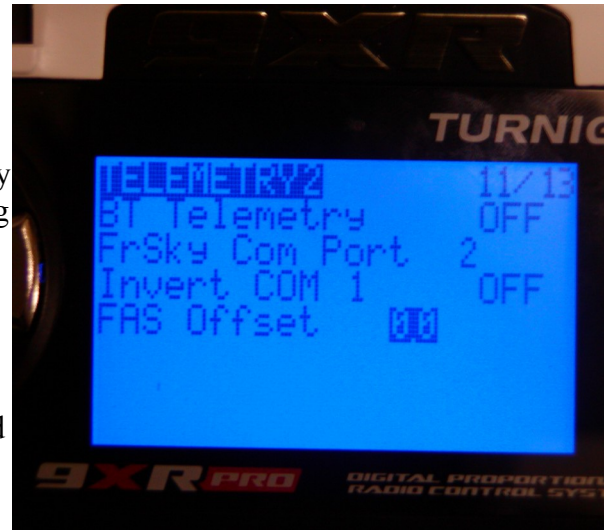
FrSky Com Port

The options here are either Com Port 1 or Com Port 2. The DHT module above was connected to Com Port 2. Therefore the receiver connected to the DHT, along with all of the telemetry associated with it, will be shown on the screen and logged. To log this data select a Log Switch and a Log Rate at the bottom of the same page 11/13.

The identity of the Com Port may be changed at any time. For example when doing a range check both modules may be set to range check mode. While walking away from the model the RSSI readings from each receiver may be compared by alternatively selecting one Com port or the other and then viewing the telemetry screen.

Invert COM 1

The options are ON and OFF. Some telemetry transmissions need to be inverted by the transmitter so that the readings can be interpreted, displayed and logged. D series FrSky telemetry is correctly set to OFF as shown.



Appendix B Hardware 12Oct2014.odt