TARANIS X9D	INTRODUCTION MANUAL

16 Channel digital telemetry radio system | FrSky Electronic Co. Ltd

Contents

INTRODUCTION

Thank you for purchasing the FrSky®, TARANIS X9D, digital telemetry radio system. In order for you to make the best use of your system and to fly safely, please read this manual carefully. If you have any difficulties while using your system, please consult the manual, your hobby dealer, or the FrSky Service.

Due to unforeseen changes in production procedures, the information contained in this manual is subject to change without notice.

Support and Service: It is recommended to have your FrSky equipment serviced annually during your hobby's "off season" to ensure safe operation.

FCC Statement

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

 - Reorient or relocate the receiving antenna.

 - Increase the separation between the equipment and receiver.

 - Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

 - Consult the dealer or an experienced radio/TV technician for help.

RF warning statement:

The device has been evaluated to meet general RF exposure requirement.
 The device can be used in portable exposure condition without restriction.

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CE

The product may be used freely in these countries: Germany, UK, Italy, Spain, Belgium, Netherlands, Portugal, Greece, Ireland, Denmark, Luxembourg, Austria, Finland, Sweden, Norway and Iceland.

France: the law permits the emission band 2400 to 2483.5 MHz with the limitation of transmission power of 100 mW (reduced to 10 mW between 2454 and 2483.5 MHz for outdoor flying).

FCC CE 2200

Meaning of Special Markings

Pay special attention to safety where indicated by the following marks:

⚠ **DANGER -** Procedures which may lead to dangerous conditions and cause death/serious injury if not carried out properly.

⚠ **WARNING -** Procedures which may lead to a dangerous condition or cause death or serious injury to the user if not carried out properly or procedures where the probability of superficial injury or physical damage is high.

⚠ **CAUTION -** Procedures where the possibility of serious injury to the user is small, but there is a danger of injury, or physical damage, if not carried out properly.

ⓘ = Mandatory ⊘ = Prohibited

⚠ **Warning:** Always keep electrical components away from small children.

FLYING SAFETY

⚠ **Warning:**

To ensure the safety of yourself and others, please observe the following precautions:

ⓘ **Have regular maintenance performed**. Although your TARANIS X9D protects the model memories with non-volatile EEPROM memory (which does not require periodic replacement) and not a battery, it still should have regular check-ups for wear and tear. We recommend sending your system to the FrSky Service annually during your non-flying-season for a complete check-up and service.

Battery

ⓘ **Charge the batteries!** Always recharge the transmitter and receiver batteries for at least 8 hours before each flying session. A low battery will soon die, causing loss of control and a crash. When you begin your flying session, reset your transmitter's built-in timer, and during the session pay attention to the duration of usage.

ⓘ **Stop flying long before your batteries become low on charge. Do not rely on your radio's low battery warning systems, intended only as a precaution, to tell you when to recharge. Always check your transmitter and receiver batteries prior to each flight.**

Where to Fly

We recommend that you fly at a recognized model airplane flying field. You can find model clubs and fields by asking your nearest hobby dealer or in the US by contacting the Academy of Model Aeronautics.

You can also contact the national Academy of Model Aeronautics (AMA), which has more than 2,500 chartered clubs across the country. Through any one of them, instructor training programs and insured newcomer training are available. Contact the AMA at the address or toll-free phone number below.
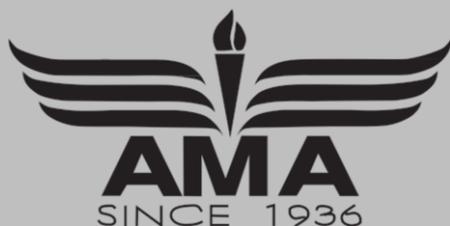
Academy of Model Aeronautics
5161 East Memorial Drive
Muncie, IN 47302
Tele: (800) 435-9262
Fax: (765) 289-4248
Or via the Internet at
http:\\www.modelaircraft.org

ⓘ **Always pay particular attention to the flying field's rules**, as well as the presence and location of spectators, the wind direction, and any obstacles on the field. Be very careful flying in areas near power lines, tall buildings, or communication facilities as there may be radio interference in their vicinity.

At the flying field

ⓘ To prevent possible damage to your radio gear, turn the power switches on and off in the proper sequence:

1. Pull throttle stick to idle position, or otherwise disarm your motor/engine.
2. Turn on the transmitter power and allow your transmitter to reach its home screen.
3. Confirm the proper model memory has been selected.
4. Turn on your receiver power.
5. Test all controls. If a servo operates abnormally, don't attempt to fly until you determine the cause of the problem. (For PCM systems only: Test to ensure that the Failsafe settings are correct by waiting at least 2 minutes after adjusting then, turning the transmitter off and confirming the proper surface/throttle movements. Turn the transmitter back on.)
6. Start your engine.
7. Complete a full range check.
8. After flying, bring your throttle stick to idle position, engage any kill switches or otherwise disarm your motor/engine.
9. Turn off receiver power.

If you do not turn on your system in this order, you may damage your servos or control surfaces, flood your engine, or in the case of electric-powered or gasoline-powered models, the engine may unexpectedly turn on and cause a severe injury.

ⓘ **While you are getting ready to fly, if you place your transmitter on the ground, be sure that the wind won't tip it over.** If it is knocked over, the throttle stick may be accidentally moved, causing the engine to speed up. Also, damage to your transmitter may occur.

ⓘ In order to maintain complete control of your aircraft it is important that it remains visible at all times. Flying behind large objects such as buildings, grain bins, etc. is not suggested. Doing so may result in the reduction of the quality of the radio frequency link to the model.

🚫 Do not grasp the transmitter's antenna during flight. Doing so may degrade the quality of the radio frequency transmission.

🚫 As with all radio frequency transmissions, the strongest area of signal transmission is from the sides of the transmitter's antenna. As such, the antenna should not be pointed directly at the model. If your flying style creates this situation, easily move the antenna to correct this situation

ⓘ **Before taxiing, be sure to extend the transmitter antenna to its full length.**

A collapsed antenna will reduce your flying range and cause a loss of control. It is a good idea to avoid pointing the transmitter antenna directly at the model, since the signal is weakest in that direction.

ⓘ **Don't fly in the rain!** Water or moisture may enter the transmitter through the antenna or stick openings and cause erratic operation or loss of control. If you must fly in wet weather during a contest, be sure to cover your transmitter with a plastic bag or waterproof barrier. Never fly if lightning is expected.

Nickel–metal hydride Battery Safety and Handling instructions

IMPORTANT! The Nickel–metal hydride battery (NiMH) batteries included in the TARANIS X9D transmitter are not to be confused with Lithium-Polymer (LiPo) batteries, or any other type of rechargeable battery (including NiCd's and LiFe's). NiMH batteries require special charging criteria different than other rechargeable batteries. Use only the **FrSky** transmitter charger included with this set for, or other chargers approved by FrSky to charge the NiMH batteries in the TARANIS X9D transmitter.

It is important to understand the operating characteristics of Nickel–metal hydride battery (NiMH) batteries. Always read the specifications printed on the label of your NiMH battery and charger prior to use. Failure to follow the proceeding precautions can quickly result in severe, permanent damage to the batteries and its surroundings and possibly result in a **FIRE!**

IMPORTANT PRECAUTIONS

- 🚫 Do not attempt to disassemble NiMH packs or cells.
- 🚫 Do not allow NiMH cells to come in contact with moisture or water at any time.
- ⓘ Always provide adequate ventilation around NiMH batteries during charge, discharge, while in use, and during storage.
- 🚫 Do not leave a NiMH battery unattended at any time while being charged or discharged.
- 🚫 Do not attempt to charge NiMH batteries with a charger that is NOT designed for NiMH batteries, as permanent damage to the battery and charger could result.
- ⓘ Always charge NiMH batteries in a fireproof location. Do not charge or discharge NiMH batteries on carpet, a cluttered workbench, near paper, plastic, vinyl, leather or wood, or inside an R/C model or full-sized automobile! Monitor the charge area with a smoke or fire alarm.
- 🚫 Do not charge NiMH batteries at currents greater than the "1C" rating of the battery ("C" equals the rated capacity of the battery).
- 🚫 Do not allow NiMH cells to overheat at any time! Cells which reach greater than 140 degrees Fahrenheit (60°C) should be placed in a fireproof location.
- ⓘ NiMH cells will not charge fully when too cold or show full charge.
- ⓘ It is normal for the batteries to become warm during charging, but if the charger or battery becomes excessively hot disconnect the battery from the charger immediately!! Always inspect a battery which has previously overheated for potential damage, and do not re-use if you suspect it has been damaged in any way.
- 🚫 Do not use a NiMH battery if you suspect physical damage has occurred to the pack. Carefully inspect the battery for even the smallest of dents, cracks, splits, punctures or damage to the wiring and connectors. DO NOT allow the battery's internal electrolyte to get into eyes or on skin—wash affected areas immediately if they come in contact with the electrolyte. If in doubt, place the battery in a fire-proof location for at least 30 minutes.
- 🚫 Do not store batteries near an open flame or heater.
- 🚫 Do not discharge NiMH batteries at currents which exceed the discharge current rating of the battery.
- ⓘ Always store NiMH cells/packs in a secure location away from children.

Secure Digital (SD) Memory Card Handling Instructions
(SD card is not included with this set)

- 🚫 Never remove the SD card or turn off power while entering data.
- 🚫 Never store the SD card where it may be subject to strong static electricity or magnetic fields.
- 🚫 Do not expose the SD card to direct sunlight, excessive humidity or corrosive environments.
- ⓘ Do not expose the SD card to dirt, moisture, water or fluids of any kind.
- 🚫 Be certain to insert the SD card in the correct direction.
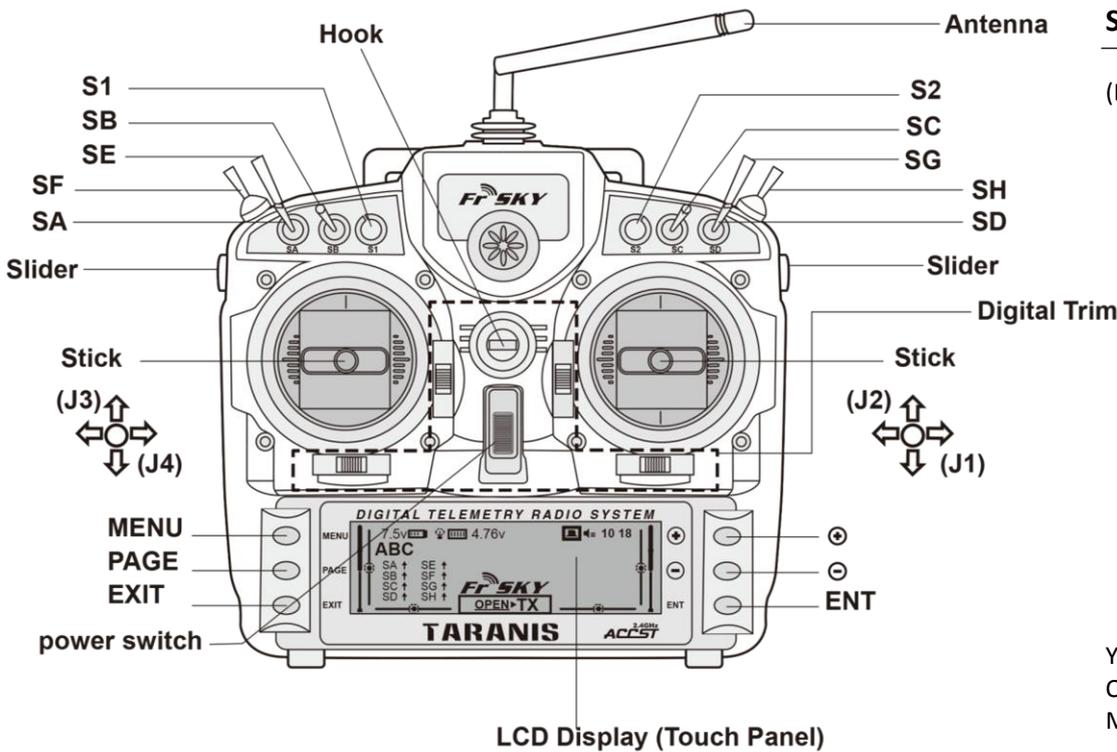
Switch Reallocation

(Default settings)
- SA: 3 positions, Alternate; Short Lever
- SB: 3 positions, Alternate; Long Lever
- SC: 3 positions, Alternate; Long Lever
- SD: 3 positions, Alternate; Short Lever
- SE: 2 positions, Alternate; Long Lever
- SF: 3 positions, Alternate; Long Lever
- SG: 2 positions; Momentary; Long lever
- SH: 3 positions, Alternate; Long Lever

You can choose the Switch and the ON/OFF position in the menu of Mixer.

Cautions on handling antenna

⚠ WARNING

🚫 Do not touch the antenna during operation.
*There is the danger of erroneous operation causing a crash.

🚫 Do not carry the transmitter by the antenna.
*There is the danger that the antenna wire will break and operation will become impossible.

🚫 Do not pull the antenna forcefully.
*There is the danger that the antenna wire will break and operation will become impossible.
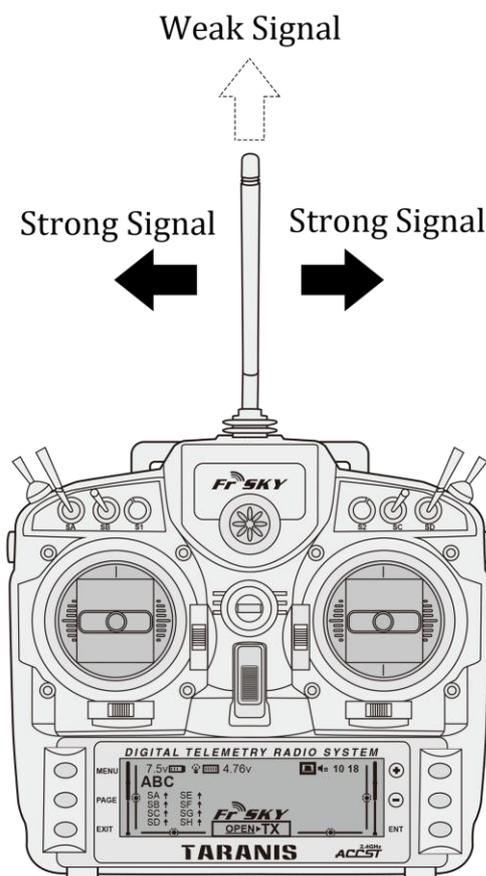
Rotating Antenna

The antenna can be rotated 180 degrees and angled 90 degrees. Forcing the antenna further than this can cause damage to the antenna. The antenna is not removable.

Angle adjustment of the antenna

The antenna rotation and angle can be adjusted. The antenna features week radio signal in the forward direction and strong radio signal directions. Adjust the antenna angle to match your flying style.

FEATURES

- ACCST system

The TARANIS X9D transmitter adopted the newly developed bidirectional communication system "ACCST" (Advanced Continuous Channel Shifting Technology). Data from the receiver side can be checked in your transmitter side.

- PXX protocol

PXX protocol is used to produce super low latency between the transmitter and RF module (approx. 1/3 of current systems). Also, PXX protocol brings Receiver Match.

- Three selectable modes
    - D8 (8 channels telemetry)
      PPM protocol, 8 signal channels with telemetry, normal flight
    - D16 (16 channels full duplex telemetry)
      PXX protocol, 16 signal channels with telemetry, normal flight
    - LR12 (12 channels non-telemetry for long range, up to triple range of current system)
      PXX protocol, 12 signal channels without telemetry, long-range flight

- S.PORT (Smart Port)

By using the S.PORT system, multiple sensors, and other devices can be easily installed with a single line of cables.

- Receiver Match

Receiver Match otters that each transmitter program for a particular flight model is bound to one and only one receiver, which prevents a user from flying his model while the transmitter is still programmed for it.

- LCD

TARANIS X9D has a big monochrome Backlight LCD Bottom screen (View area 212 x 64).

- Inbuilt telemetry display

TARANIS X9D has FrSky telemetry display inbuilt, you don't need and other add-on or 3rd party device to modify your radio to get telemetry and display.

- Custom Sound

TARANIS X9D can playback WAV (Waveform Audio Format) files on a SD-Card. You can set custom the sound of your own.

- Secure Data (SD)

Model data, music files, voice files and picture files can be stored on optional SD card. The SD card is also used when updating the software/features of the TARANIS X9D.

- Audio speech output

The TARANIS X9D can "speak out" the values, alarms, settings, etc. with the sound you want.

- High capacity Nickel–metal hydride Battery

The high capacity Nickel–metal hydride Battery gives you extended flight time.

- Stick

Each axis is supported by dual ball bearings. This allows for finer and more precise operation, the new potentiometers also offer a very long lifespan.

- Replaceable switches

You can replace 8 of the toggle switches on the right and left shoulder, with optional switches (two position, three position, and momentary etc.).

Contents and Technical Specifications

(Specifications and ratings are subject to change without notice.)

Your TARANIS X9D kit may include the following components:

- TARANIS X9D Transmitter
- 6 cell Nickel–metal hydride Battery & AC adaptor
- Neck strap

- Transmitter case
- X8R S.PORT telemetry receiver (optional)

The set contents depend on the type of set.

Transmitter TARANIS X9D

- Operating system: 2-stick, 16 signal channels, ACCST 2.4GHz full telemetry
- ACCST system
- Transmitting frequency: 2.4 GHz band
- System: D16, D8 LR12, switchable
- Power supply: DC 7.2V 6 cell Nickel–metal hydride battery

- Current drain: 260 mA maximum (RF power on and back light on)
- Operating temperature: -10°C - 45 °C
- Operating humidity: 45%-80%
- Operating barometric pressure: 860MBar-1060Mbar

Note: The battery in the TARANIS X9D is not connected to the battery connector at initial. Please connect the battery before use.

Receiver (Optional)

- FrSky X8R telemetry receiver
- Receiving frequency: 2.4 GHz duplex telemetry system
- Power requirement: DC 3V - 10V

- Current drain: 100 mA
- Size: 46.3 x 26.8 x 13.6 mm (L x W x H)
- Weight: 14g

The following additional accessories are available from your dealer. Refer to FrSky website for more information:

- Transmitter battery pack - the transmitter Nickel–metal hydride battery pack may be easily exchanged with a fresh one to provide enough capacity for extended flying sessions.
- Trainer cord - the optional training cord may be used to help a beginning pilot learn to fly easily by placing the instructor on a separate transmitter. Note that the TARANIS X9D transmitter may be connected to another TARANIS X9D system, as well as to any other models of FrSky transmitters.
- Neckstrap - a neckstrap may be connected to your TARANIS X9D system to make it easier to handle and improve your flying precision since your hands won't need to support the transmitter's weight.
- Decoder - an FrSky CPPM/SBUS decoder to convert the CPPM/SBUS signal for conventional servos.
- Converter – an FrSky converter to convert the SBUS signal into CPPM.
- Receivers - various models of FrSky receivers may be purchased for use in other models. (Receivers for 2.4GHz types are available.)
- Servos - there are various kinds of servos. Please choose from the servos of FrSky what suited the model and the purpose of using you

Battery

⚠ Warning

- ⓘ Be careful to not drop the battery.
- ⊘ Never take out the battery from the TARANIS X9D transmitter while the voltage warning is blinking.
  - ✴ Internal settings and memories can be destroyed.
  - ✴ Do not use the transmitter if a "Backup Error" warning occurs. Send it to the FrSky to be checked.

- ⊘ Don't pull battery wiring.
  - ✴ When it short-circuits, there is danger of explosion ignition.
- ⊘ The standard charger is for 6S NiMH battery only.

SD Card (sold separately)

The SD card can store various files, such as model data, music, sound files and pictures. Any SD card on the market can be used with the TARANIS X9D. The card is locked when it is pushed in all the way in. To remove the card, push in on the card again, it will pop up allowing you to remove it.

> ⚠ **Warning**
>
> - ⓘ Be sure to turn off the power to the transmitter before inserting or removing the SD card.
> - ⃠ As the SD card is a precision device, do not use excessive force when inserting.
> - ⓘ If model data generated by a new software version transmitter is copied to an old software version transmitter, the transmitter may operate erroneously. Copy the model data after updating the copy destination transmitter to the new software version.

Read data from a PC

Saving music and image files edited by a PC into the SD card, you can use those files on your TARANIS X9D transmitter. Equipment for reading and writing SD cards are available at most electronics stores.

Stored data

The life of the SD card is limited due to the use of Flash memory. If you have a problem saving or reading data such as picture data after a long period of use you may need to purchase a new SD card.

- We are not responsible for, and cannot compensate for any failure to the data stored in the memory card for any reason. Be sure to keep a backup of your models and data in your SD card.
- No necessity for backup; TARANIS X9D transmitters and SD cards are using non-volatile memory devices so that the data stored in those will not be destroyed even without a backup battery. The clock for the transmitter depends on the Lithium battery.

System Type

System mode setting, Receiver bind.

System Type Selection

The TARANIS X9D is for 2.4GHz only. The system can be changed from among 3 choices: D16, D8, LR12. Select the system matched to the type of receiver you are using.

- ★ Even if it changes a System Type, other model data is not reset
- ★ After change should operate a model and should fully check a direction and a motion

Receiver Binding

The receiver will only be controlled (without being affected by other transmitters) by the transmitter it is bind to. When using a receiver other than one purchased as a set, binding is necessary.

Binding Method (TARANIS X9D ↔ FrSky Receiver)

1. Set the transmitter to **BIND** Mode.
2. Power the receiver while holding **F/S** button.
3. When the **GREEN** LED **On** and the **RED** LED **Blinks**, the receiver is bound to the transmitter.
4. Set the transmitter to **NORMAL** Mode, repower the receiver to Link. If the **GREEN** Led **On** and the **RED** Led is **OFF**, the receiver is linked to the transmitter.

★ Do not perform the binding operation when the drive motor is connected or the engine is running
★ When you use two X8R in one time, please be sure to set one of the receivers in non-telemetry mode.
★ Since the transmitter cannot recognize individually the telemetry data from the two sets of receivers, it is impossible to receive telemetry data correctly

UPDATING

Your FrSky TARANIS X9D transmitter programming can be updated easily and at no cost online. When functions are added or improved, the update file can be downloaded from our website. Copy the update files to the SD card and then use the following procedure to update the program. Check our web site for the FAQ regarding updating for more information.

Updating procedure

- Note: If the battery fully discharges during program updating, updating will fail. When the remaining battery capacity is 50% or less, always recharge the battery before updating
- Note: The model data in the transmitter can be used unchanged after updating, but to be safe, back up the model data before updating.

    1. Insert the SD card containing the update file into the card slot.
    2. Use tweezers to switch the slide switch (update switch) at the side of the card slot in the up direction.
    3. Turn on the transmitter power. An update screen is displayed. Rotary key or the arbitrary direct keys are pressed
    4. When updating is complete, the screen shown below appears
    5. Turn off the power switch. After the monitor LED goes off, switch the update switch in the down direction

If a problem occurs, an error message will appear and the update will not be complete.

After the updating above has been completed, turn on the power and then check the system program version at the system menu information screen.

Firmware

DISCLAIMER: The content below is still subject to change before the radio is available on the shelves.

FrSky have chosen OpenTx as the operating system for their new TARANIS X9D radio.

This page is intended to describe the OpenTx firmware installed on the TARANIS X9D, and offer some explanations about the philosophy of the firmware and how to set up models. We'll start with an overview of menu contents, and then go into more details about how to set up models. The TARANIS X9D version of OpenTx has all of the features from the 9x version, includes the additions of the sky9x version (audio/speech, SD card for model/audio files/logs storage, USB access to card and settings/model memory), sees the UI adapted to the larger screen and different button layout, and finally adds support for the TARANIS X9D' extra hardware capabilities.

Software overview

Now might be the time to put the battery on charge, so that after reading this section you can directly have a go at putting what you learned in practice.

Button navigation

The TARANIS X9D has 6 input keys: a standard set of +/-/ENTER/EXIT, plus 2 contextual MENU and PAGE keys. On the main views, the PAGE key will switch between the different views described in the next section. A LONG press of the PAGE key will bring up the telemetry display. A SHORT press of the MENU key will call the model menu, while a LONG press will call the radio settings menu. In those 2 menus, a SHORT press of the PAGE key goes to the next page, while a LONG press goes back to the previous one. EXIT goes back to the main views. On the STICKS and MIXER model menu pages, a long press of the MENU key will bring up a channel signal monitor to allow quickly looking at the result of a change in settings.

The navigation in a menu is simple: The +/- keys will navigate up/down between editable fields, or lines of fields depending on the screen. ENTER will enter the line of fields when applicable, and then edit mode. In edit mode, +/- will change the value, ENTER or EXIT will validate the input and return to navigation. EXIT always goes back to the previous navigation level.

In edit mode, we have four 2-key shortcuts available: +/- together: Invert value -/ENTER: Set value to 100 EXIT/PAGE: Set value to -100 MENU/PAGE: Set value to 0

Another handy feature is the auto selection of physical inputs in the relevant fields. Instead of choosing a source or switch with the + and - keys, just move the pot or flick the switch you want, and it will be recognised. For switches the position is also auto-selected, and the +/- double key combination will allow selecting the opposite position in a pinch.

Main views

We have 3 main views showing the same basic information in the top part and different inputs/outputs on the lower part. On the main views a long press of the ENTER key brings up a menu where you can reset the timers, telemetry data (min/max), all of those, or bring up a statistics view (throttle graph, timers). As mentioned above, a short press of the PAGE key switches views. The new title bar includes radio battery voltage, receiver signal strength (for FrSky receivers), main on-board voltage (can be receiver battery, flight battery, or anything else depending on sensors the "Voltage" parameter in the telemetry settings), status icons (SD present, USB connected, trainer port mode, logging in progress), audio volume and time. The other "always present" items are model name, flight mode, and trim/pot positions. The logo is of course customisable - if you have a microSD card in your radio, you'll be able to load your model's photo.

- The first view lists the physical switch states in the bottom left zone, and the 2 timers (when enabled) on the right.

- The second shows the gimbal and switches positions, and is handy to check that all the physical controls respond as intended.

- The third shows again the physical switches on the left, and the states of the 32 custom (logic) switches on the right.

- The last view is a servo channel monitor showing the servo outputs for all 32 channels (+/- change page). If channel names are defined on the SERVOS page, they will show up here instead of the numbers for convenience.

Telemetry

A LONG press of the PAGE key from any of the main views brings up the telemetry views. The PAGE and +/- keys will then cycle between the power status screen (voltage, current, power or A1/A2 if not set, cell voltages from an FLVS-01 sensor if connected), the min/max and GPS coordinates screen, and if defined from one to three customs screens that can hold up to 12 items each, configured in the telemetry setup menu.

Radio general settings

A LONG press of the MENU key brings up the mostly self-explanatory radio setup menu:

- Date/Time: To be set, they serve as info but also to give a correct timestamp to files and logs saved by the radio.
- Battery range: range of the graphical radio battery meter on the main views. To be set accordingly with the battery type you use (2s LiPo here).
- Alarms -> Sound off: if "Sound Mode" is "Quiet", the radio will not even sound warnings like a low battery. This alarm will remind you of that when turning the radio on.
- Throttle reverse: Ensures correct operation of throttle-based timers and functions for people who like having full throttle with the stick down.
- Backlight -> Mode: If set to Stks, Keys or Both, the backlight will turn on when a stick is moved and/or a key is pressed, for the duration set below.
- Backlight -> Alarm: Backlight will flash when an alarm sounds if it's not already on at that time.
- Splash screen: On TARANIS X9D the splash will always be shown as the EEPROM takes some time to load. Setting this on will just show it for longer.
- Country code: Must match your geographical location to keep RF transmission parameters within regulatory requirements.
  America: 2.404-2.479 GHz
  Europe: 2.404-2.450 GHz
- Default channel order: Defines the order of the 4 default mixers that are inserted on channels 1-4 when creating a new model. Set this to your preference. They can of course always be moved later, this is just a time-saving option.
- Mode: This is your stick mode, e.g. Mode 1 for throttle and aileron on the right stick, Mode 2 for throttle and rudder on the left stick.
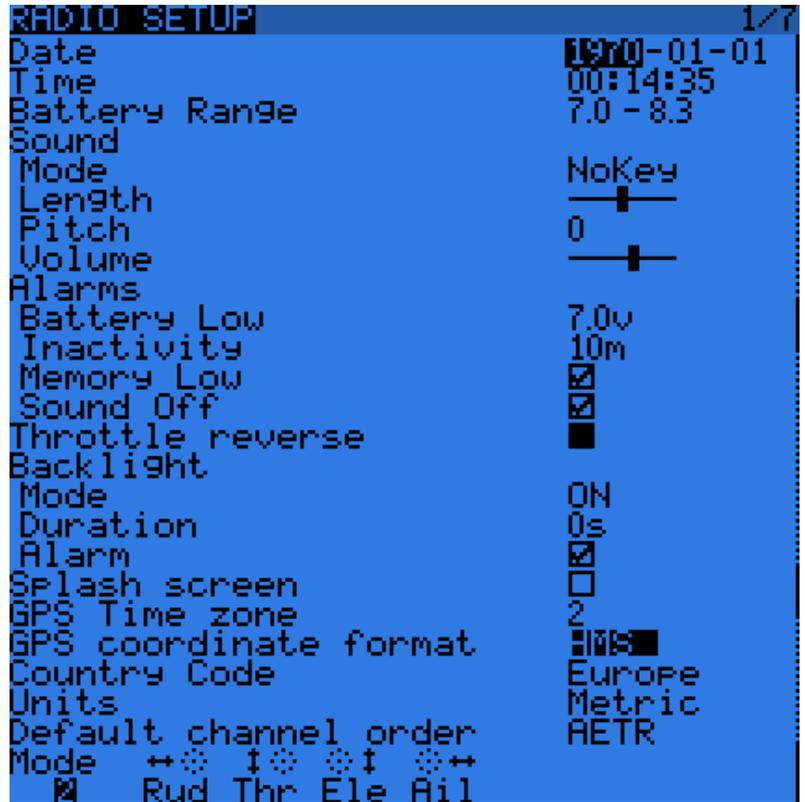
Other pages reachable by pressing the PAGE key include an SD card browser where you can copy/rename/delete files and preview sounds, a version info page, trainer setup, key/stick/pot diagnostics, and stick/pot calibration.

Model menus

A SHORT press of the MENU key from the main views brings up the model selection screen. There models can be selected, deleted, backed up and restored to/from SD card using the menu brought up by a LONG press on the ENTER key. They can also be copied or moved (one SHORT press on ENTER key highlights the line, +/- create and place a copy of the model on the desired slot, while two SHORT presses create a dotted outline where +/- simply move the current model to another slot.)
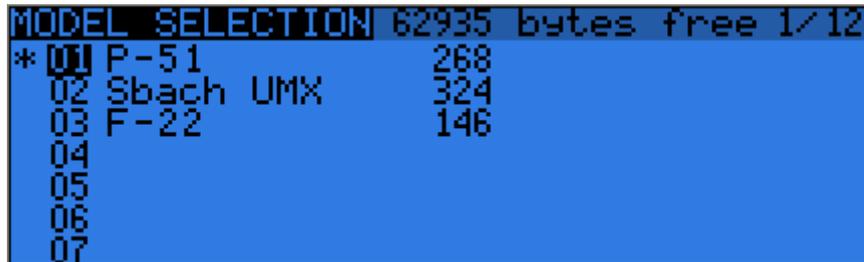
```
MODEL SELECTION 62935 bytes free 1/12
*01 P-51                 268
 02 Sbach UMX            324
 03 F-22                 146
 04
 05
 06
 07
```

Model setup

A SHORT press of the PAGE key brings up the basic model setup page:

```
MODEL SETUP                      2/13
Model Name       ████████████
Model Image      ---
Timer 1          OFF   00:00
Persistent       □
Minute call      □
Countdown        □
Timer 2          OFF   00:00
Persistent       □
Minute call      □
Countdown        □
Extended Limits  □
Extended Trims   □   [Reset]
Trim Step        Exponential
Throttle reverse □
Throttle Source  Thr
Throttle Trim    □
Throttle Warning ☑
Switch Warning   ☑  A↑B↑C↑D↑E↑F↑G↑
Center Beep      RETA12LR
Internal RF
Mode             X16
Channels Range   CH1-8
Receiver No.     01 [Bind] [Range]
Failsafe mode    Hold
External RF
Module           XJT  X16
Channels Range   CH17-32
Receiver No.     01 [Bind] [Range]
Failsafe mode    Hold
Trainer Mode     Master
```

● Model image: There you can select a 64x32px, 16-grayscale .bmp file located in the BMP folder of the SD card as your model logo.

● Timers: Persistent, if ticked, means the value is stored in memory when the radio is powered off or model is changed, and will be reloaded next time the model is used. Minute call will beep / say the time every full minute, while countdown will also give announcements several more times during the last minute. ABS counts up all the time, THs runs whenever the throttle stick isn't at idle, THt starts the timer the first time throttle is advanced, TH% counts up as a percentage of the full stick range.

● Extended limits: allow setting servo movement limits up to 125% instead of 100%.

● Extended trims: allows trims to cover the full stick range instead of +/-25%. The "Reset" item will reset all trims (for all flight modes).

● Trim step sets the precision of trim clicks. Exponential means very fine steps close to the trim centre, but larger one the farther you get from centre.

● Throttle source: defines what triggers the THx functions of the timers. It's common to set it to the throttle channel instead of the stick, so that throttle cut or other modifiers are taken into account.

● Throttle trim: IC engine mode, where trim only affects the idle part of the throw without touching the full throttle point.

● Switch warning: Defines whether the radio requests the switches to be in predefined positions on power on/model change. To set them, arrange your switches the way you like, and LONG press ENTER.

● Centre beep: Makes a beep when the active control(s) pass the centre point.

● Internal RF:

   ○ Mode: Transmission mode of the internal RF module (OFF, X16, D8, LR12).
   ○ Channel Range: Choice of which of the radio's internal servo channels are actually transmitted over the air.
   ○ Receiver No.: defines the behaviours of the receiver match function. This number is sent to the receiver, which will only respond to the number it was bound to. By default this is the number of the model's slot when it is created. It can however be changed manually, and will not change if a model is moved or copied. If manual setting, a move or copy operation results in 2 or more models on the radio having the same number, a warning popup will show up. It is then up to the user to determine if this is the desired behaviour or not.
   Bind and range check fields get activated by a press of the ENTER key. The internal module will beep every few seconds to confirm. Range check will display a popup with the RSSI value to evaluate how reception quality is behaving.
   ○ Failsafe mode: allows choosing between simply holding the last received positions, turning off pulses (like old PPM MHz receivers), or moving the servos to custom predefined positions. For custom positions a SET field will call the failsafe settings page, where the position can be defined separately for each servo channel. Select the desired servo channel,

press ENTER to get in edit mode, move the control to the desired position, and LONG press ENTER to save. Receiver power should be cycled after switching to hold mode.

- External RF:
  - Module type: PPM for generic modules, XJT (same operation modes as above), DJT (D8 mode only), DSM (for "hack" mod with a modul**e** taken out of a DX4e or DX5 Spektrum radio).
  - Channel range: same as for internal module.
  - Receiver no, Bind, Range check (when module type is XJT or DSM): Same as above.
  - PPM Frame (when module type is PPM): Allows setting the frame length, pulse length, and polarity of the PPM frame. The frame length is automatically adjusted to a safe value when the number of transmitted servo channels is changed. Advanced users can still adjust it afterwards if necessary.
  - Failsafe mode: When module type is XJT, same as above.
- Trainer mode: Master or slave, this setting defines which way the trainer port works. An icon is shown in the main view when the cable is inserted showing which mode is in use.

Helicopter setup

A SHORT press of the PAGE key will bring up the helicopter CCPM head mixer page. This page allows setting a swashplate type, and limiting the control autority through the Swash Ring setting.

The inputs of this mixer are the Ail and Ele sticks, plus the virtual servo channel selected in "Collective source". This channel would see entries added on the MIXER page for one or more pitch curves. The outputs of the CCPM mixer are CYC1, CYC2 and CYC3, which need to be assigned on the MIXER page to the servo channels you will connect your servos to. Note that the settings made here have no effect unless you are using those CYC1, CYC2 and CYC3 sources. A multirotor or flybarless helicopter which uses onboard computers/mixers will NOT use them.

Flight modes

Next up is the flight modes screen.

8 flight modes plus the default one are available for use. Each of them can be named, has a selectable activation switch (physical or logical), a trim selection array (R, E, T, A when shown mean the mode has its own trim setting for that control, but each can be changed to a number from 0 to 9 and thus use the same value as the specified mode), and slow up/down parameters for

smooth transitions between modes. The priority of the flight modes is such as the first FM of 1-8 that has its switch ON is the active one. When none has its switch ON, the default FM0 is active.

Sticks

The next screen allows setting one or more input formatting rules to each stick axis. This is the first step of the control chain - where you define the amount of control authority you want on each stick.

As many lines as required can be assigned to each stick (LONG press ENTER brings up a popup menu), and again the first one that has its switch on (starting from the top) will be the active one. This is commonly used to create dual, triple,... rates. A name can be defined for each entry, as well as the rate and exponential ratio. A curve (built-in or custom) can also be used instead of the "simple" exponential function. The Modes line allows to choose in which mode(s) (highlighted numbers) that line can be active. If the current mode is not selected, turning on the switch will not activate that formatting line. The Side parameter limits the effect of that formatting line to only one side of the stick.

Mixer

The next page is where the actions on the controls will be mapped to servos. OpenTx does not have any predefined mixing functions that relate only to a particular model type or situation; it rather gives you a blank canvas you can build upon. The key to configuring a model on OpenTx is not to think about "activating the delta mix" like on certain radios, but rather to think about what you want your control on the model to do in response to an input on the radio's controls. The mixer is where all that "logic" gets entered.

The various channels are outputs, for example CH1 being the servo plug #1 on your receiver (with the default protocol settings). A channel without a mixer line will just centre a servo that would be connected to it. Each mixer line connects one input to the channel it's on. Inputs can be:

- The 4 stick axes
- The 4 pots and sliders
- The heli mixer outputs (CYC1-3)
- A fixed value (MAX)
- The 8 physical switches
- The 32 custom (logical) switches

- The trainer port input channels (PPM1-8)
- Each of the radio's 32 channels, which allow using channels as a virtual functions for clarity (mix several inputs into one reuseable function, that can then be assigned to one or more channels). Note that the settings of the SERVOS page are NOT taken into account there.

All inputs work on a -100% to +100% basis. Sticks, pots, channels, CYC sources, trainer inputs will vary proportionally within this range. 3-position switches will return -100%, 0% or +100%. 2-position switches (and logic ones) will return -100% or +100%. MAX is always +100%.

If you want the servo connected to the #2 plug of your receiver to be controlled by the elevator stick, you will simply create a mixer entry on CH2 with Ele as source. Easy enough!

There can be as many lines as needed on each channel, and the operation between each line can be selected. To create a new line, you would LONG press the ENTER key, and select insert before/after. By default all the lines on a same channel are added together, but a line can also multiply those before it, or replace them. For clarity, each line that is currently active and contributing to the channel's output will have its source displayed in **bold**. This can be very handy when many are present and to check switch functions.

For each mixer line, several parameters are available:

- A name can be entered for convenience
- The weight (in %) of the input can be set. This sets how much of the input control has to be mixed in. A negative value inverts the response.
- An offset on the input value can be added.
- A trim can be used, for sticks this is by default the trim assiciated to the stick, but can be chosen to be one of the other trims (for cross-trimming for example) or disabled altogether. For other inputs the trim defaults to OFF, but can of course be set to one if required.
- Either a differential setting can be set (resuces response by the specified percentage on one side of the throw) or a curve (built-in or custom) can be assigned. When a custom curve is selected, a press of the MENU key will bring you to the curve editor.
- The modes the mixer line is active in can be selected (see D/Rs).
- A switch (physical or virtual) can be used to activate the mixer line.
- A sound warning (1, 2 or 3 beeps) can be set to play when the line is active.
- The Multpx setting defines how the current mixer line interacts with the others on the same channels. "Add" will simply add its output to them, "Multip" will multiply the result of the lines above it, and "Replac" will replace anything that was done before it with its output. The combination of these operation allows creating complex mathematical operations.
- Response of the output can be delayed and/or slowed down compared to the input change. Slow could for example be used to slow retracts that are actuated by a normal proportional servo. The time is how many seconds the output will take to cover the -100 to +100% range.

As a little example, if you wanted to add some compensation on the elevator channel when you increase throttle, you would go through a simple path:

- What's the control surface I want this to act on? Elevator, which is connected to CH2.
- When do I want it to move? When I move the throttle stick.

Servos

The SERVOS page is the interface between the setup "logic" and the real world with servos, linkages and control surfaces. Up to now, we have set up what we want our different controls to do, now is the time to adapt that to the mechanical characteristics of the model.

For each channel, we can define:

- A name, which will be shown on the mixer screen when the cursor is on a line belonging to that channel, on the channel monitor and on the failsafe settings page.
- An offset or subtrim.
- Low and high limits. These are "hard" limits, i.e. they will never be overridden, so as long as they are set so that your servo never forces, it really never will. They also serve as gain or "end point settings", so reducing limit will reduce throw rather than induce clipping.

- Servo reverse.
- Center adjustment. This is similar to subtrim, with the difference that an adjustment done here will shift the entire servo throw (including limits), and won't be visible on the channel monitor.
- Subtrim Behaviour: When set to default, adjusting subtrim will only shift the center of the servo throw. Given a -100% to +100% order from the mixer, the servo will still move exactly between the lower and upper limits, without clipping or dead band. This introduces a different stick to servo movement relation for both sides of the stick. Depending on the situation it can be either convenient or probematic, so the = setting changes subtrim effect to rather shift the servo throw "symmetrically". A full throw order from the mixer can now be clipped by the limit that is on the same side as the subtrim, while on the other side the servo will not reach the limit anymore. That way on both sides of the stick a given stick movement always results in the same servo movement. Typically using the default mode allows for faster setup of servos that are driven by a single control input, while = is required to keep correct response of control surfaces using differential and/or mixing several inputs together. The = mode typically requires reducing D/R so that a margin is left between full "control" throw and the defined limits.

The last line after CH32 is the "Trims to Offsets" function. It is used to take the trims of the currently selected flight mode, transfer their content to the subtrims, reset them, and adjust all other flight modes' trims. If you're close to running out of trim, instead of having to adjust every value one after the other, all it takes is to LONG press ENTER on this line and everything is done magically. Beware that you should still check if it would not be wiser to correct the problem mechanically, especially with large values, as depending on the subtrim behaviour setting it might lead to either unsufficient and assymetric throws, or clipping/dead band.

Curves

Custom curves can be used either in input formatting or mixers. There are 16 of them available, and they can be of several types (3, 5, 9, 17pt, both with fixed or user-definable x coordinates). 3pt would be a 3-point curve with fixed x, 9pt' is a 9-point curve with user-defined x coordinates. These curves are available in addition to the "built-in" curves:

- x>0, x<0: If input is positive resp. negative, return input, otherwise 0.
- |x|: Return the absolute value of the input.
- f>0, f<0: If input is positive resp. negative, return 100%, otherwise 0.
- |f|: If input is negarive, return -100%. If input is positive, return +100%.

Global variables

Global variables are values that can be substituted to the usual number on every Weight, Offset, Differential or Expo setting. Their main use is to group the adjustment of several parameters that should have the same value. For example, aileron differential on a glider with 4 surfaces responding to the aileron function. When trying to find the sweet spot for the differential value, instead of having to repeatedly edit the differential value in 4 mixers, all 4 can be set to use a global variable (e.g. GV1 resp. -GV1, selected by a LONG press of the ENTER key on the Differential field). Then adjusting GV1 on this page is all it takes for all differentials to be updated. Global variables are also flight mode specific, so instead of having to create separate mixer lines with different values depending on the flight mode one can simply use a global variable with different values for each flight mode. This can significantly help simplifying the mixer screen by avoiding many duplicate entries. Global variables can also be adjusted in flight thanks to the Adjust GVx Custom Function that will be described later, and help adjusting those parameters that are easier to tweak in flight like D/R ratios, expos or again differential. The Global variables screen allows setting a name for each of the 5 available variables for conveniency, and seeing/setting the value each of them will have in each of the 9 flight modes.

	FP0	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8
GV1	0	0	0	0	0	0	0	0	0
GV2	0	0	0	0	0	0	0	0	0
GV3	0	0	0	0	0	0	0	0	0
GV4	0	0	0	0	0	0	0	0	0
GV5	0	0	0	0	0	0	0	0	0

Custom switches

These are logic switches that are used to compare values and combine various conditions.

The first "operation" column lists a few arithmetical, logical and differential operations. In arithmetical ones a and b represent variables, x represents a constant. Variables can be every source, i.e. all those available in mixers, plus the 5 global variables and all telemetry values. In logical operations the available sources are all physical and other custom switches. Differential functions compare the variation of a variable since last match to another value.

CUSTOM SWITCHES		AND Switch		10/12	
CS1 a<x	Vfas	10.2v	▆▆▆	---	---
CS2 ---	---	0	---	---	---
CS3 ---	---	0	---	---	---
CS4 ---	---	0	---	---	---
CS5 ---	---	0	---	---	---
CS6 ---	---	0	---	---	---
CS7 ---	---	0	---	---	---

- a~x: active when variable a is approximately equal to constant x (hysteresis added, as comparing a stick's value for example would pretty much never trigger an exact match)
- a<x, a>x: Active when variable a is smaller resp. greater than constant x
- |a|<x, |a|>x: Active when the absolute value of variable a is smaller resp. greater than constant x
- a<b,a>b,a=b: See above, but with 2 variables
- AND, OR, XOR: Logical and, or, exclusive or between 2 binary inputs
- d>x, |d|>x: Active when the selected variable, repectively its absolute value has changed by more than x since last time. For example, d>x Alt 10 would trigger once every time Altitude goes up by 10m. |d|>x Alt 10 would trigger once everytime Altitude goes up OR down by 10m.

Custom switches offer 3 more parameters: An extra AND condition (if selected, must be on for the custom switch to become active), a Duration parameter (the minimum time a custom switch will be active for even if its conditions become false instantly), and a delay parameter (that affects both activation and deactivation).

Custom Functions

This is the place where switches can be used to trigger special functions such as trainer mode, soundtrack playback, speech of variables etc.

CUSTOM FUNCTIONS				11/12
CF1	SF↓	SafetyCH3	-100	☑
CF2	CS1	Play Track	batlow	10
CF3	---			
CF4	---			
CF5	---			
CF6	---			
CF7	---			

The first column selects the trigger, which can be any switch (physical or custom) or ON (always on). A LONG press of the ENTER key will switch to "toggle" mode (ending with t), i.e. the selected input will be turned on when the selected switch is activated, and will remain on until it is deactivated and reactivated again. Scrolling through the list you will also find a few more options: One (triggers just once when loading a model or turning the radio on), SHdownS (short press of the momentary switch), SHdownL (long press of the momentary switch).

The available functions are:

- Safety CHx: When active, the output of CHx is forced to the selected value. A checkbox is there to enable the function, which you would typically do after ensuring the value is set correctly and the switch is off if your model is powered.
- Trainer, TrainerXXX: Enables trainer mode globally, and for individual functions. Unless a custom function is set for an individual function, turning the one set for Trainer automatically activates all 4 sticks.
- Instant trim: When activating the selected switch the current stick positions will be added to their respective trims.
- Play Sound: Play a simple tone from the available list
- Reset: Resets the selected items (Timer 1, Timer 2, telemetry values, or all of those)
- Vario: Turns on variometer sounds (see Telemetry setup)
- Play track: Plays a sound file from the SD card, with repeats at the specified interval
- Play value: Speaks the current value of the selected parameter, with repeats at the specified interval
- SD Logs: Logs the telemetry values to SD card at the specified interval
- Volume: Adjusts sound volume using the selected source
- Backlight: Turns backlight on
- BgMusic, BgMusic || (pause): Plays a selected soundtrack from the SD card. The BgMusic Pause item pauses the track and resumes it once inactive again, while switching BgMusic off stops the track completely.
- Adjust GVx: When active, sets the relevant global variable to the value of the specified source. The adjustment source can be one of 4 groups cycled through using a LONG press of the MENU key:
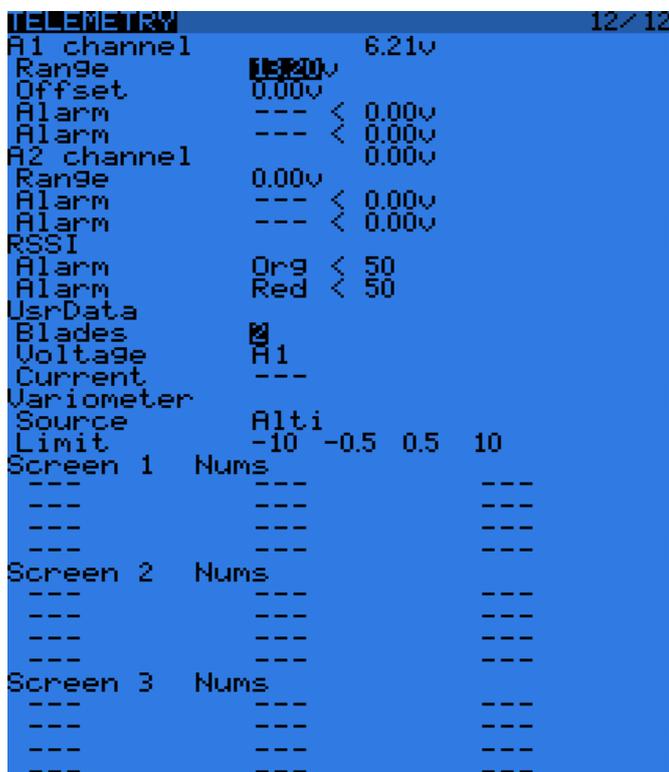
  A fixed value
  A proportional control, or a channel with for example specified curve/weight/offset to limit the adjustment range
  Another GVAR
  +1/-1, to increment/decrement the GVAR with each activation.

Telemetry

This page groups all the basic telemetry-related settings.

- A1 and A2 are the 2 analog ports available on D8R receivers. X8R receivers only have A1, which measures the receiver's power supply. Range sets the maximum measureable voltage, i.e. 3.3V / (divider ratio). For example with the receivers' internal sensor (1:4), this would be 13.2V. For the FBVS-01 sensor with the default ratio of 1:6, this would be 19.8V. The number next to "Ax channel" will show the currently measured value, and can be used to confirm or correct the Range setting. Offset and custom units (A, m/s, m, %...) can be used in addition to help scaling the input to accomodate 3rd-party analog sensors.
- Blades: Number of blades for the RPM sensor.
- Voltage/current: Allows choosing the input for the power calculation and MAH count features. These should match the input you've connected the corresponding sensors to.
- Variometer source: sensor type that is installed in your model. Limit sets respectively the maximum expected sink rate, low and high dead band (no sound), and maximum climb rate.

Following those basic parameters are the selection lists for the 3 custom telemetry screens that can be seen by LONG pressing the PAGE key on the main views. Each screen can either show numerical parameters (9 in the main screen area and 3 in the bottom bar), or 4 bargraphs with configurable upper/lower limits.

Screen 1 **Nums**
 Cell   Cels   Vfas
 Curr   Cnsp   Powr
 Alt   GAlt   AccX
 Batt   Tx   Rx
Screen 2   Nums
 ---   ---   ---

Cell	0.00	Cels	0.0	Vfas	0.0
Curr	0.5	Cnsp	7	Powr	0
Alt	0.0	GAlt	50	AccX	0.00
Batt	7.4	Tx	75	Rx	75

Each field can be one of the various available parameters, of course the corresponding sensors and/or hub must be installed in the model:

- Tmr1,2: Both timers
- Tx,RX: RSSI of the radio and receiver in D8 mode. In X16 mode, they are both identical and return the RSSI of the receiver.
- A1,2: Analog ports on D8 receivers (only A1 available on X8 receivers, with receiver voltage).
- Alt: Barometric altitude sensor.
- Rpm: Engine speed, number of blades is adjusted in the settings above.
- Fuel: Fuel level.
- T1,T2: Temperature sensors 1 and 2.
- Spd, Dist, GAlt: GPS speed, distance from starting point and GPS altitude.
- Cell: Lowest cell on FLVS-01.

- Cels: Sum of all cells on FLVS-01
- Vfas: FAS-40/100 voltage measurement
- Curr: Current, source configured in the settings above (FAS or analog)
- Cnsp: mAH used totalizer (needs current source configured correctly)
- Powr: Power, voltage and current sources configured above
- AccX,Y,Z: Acceleration values from TAS-01
- Hdg: GPS heading
- Vspd: Vertical speed (either calculated by the radio or reported by the sensor, depending on the sensor type chosen above)
- xxx+/xxx-: Min and max values of the available parameters

Templates

The templates are currently "starting points" for model setups. When selected with ENTER LONG they will replace the current model's mixers and settings with the usual ones for the usage scenario they correspond to (best used on a newly created model). This can be used to build upon or tweak to achieve the desired result, or simply to get an idea of what's required for that model type.

TEMPLATES   13/13
 00 **Clear Mixes**
 01 Simple 4-CH
 02 Sticky-T-Cut
 03 V-Tail
 04 Elevon\Delta
 05 eCCPM
 06 Heli Setup

First steps

Now that you've seen the basics and that your battery has some charge, what about a little bit of practice? The first thing to do with your radio would be to configure the general settings. Get to the relevant page with MENU LONG, set time, date, sound volume to your preference (the lower end of the volume slider is typically needed when using headphones, while the upper end is good for using with the internal speaker), play with the backlight setting, set the RF country code to your location, the default servo channel order to your preference, and the stick mode to match your flying style. Battery gauge and alarm are factory set for the supplied battery. Next, you'll want to calibrate your sticks and pots. Press PAGE LONG to switch to the last page of the general settings, and follow the instructions. It's important to centre the throttle stick when asked to set stick midpoints, but no need to do so for the pots.

The radio will have created an empty model for you, so after having gone back to the main view you'll be able to go to the model setup screen by pressing MENU SHORT and PAGE SHORT. There you'll want to make sure you've set the RF mode that matches the receiver you want to use. When using the internal module, to bind your receiver select the "Bind" field and press the ENTER key. The module will sound a beep every few seconds. Now follow your receiver's instructions for binding (press and hold the

F/S button then apply power for D and X receivers, connect jumper to S pins of servo channels 1 and 2 and apply power for V8x-II receivers). The receiver LED will flash fast to confirm binding. Press exit on the radio, Remove the jumper on the receiver if applicable, and cycle receiver power. You should now have servo control of servo channels 1-4 with the sticks.

Setting up a model

OpenTx basics

Now that everything works, it's time to stop a moment for some theory about the basic operation of the OpenTx firmware. As briefly described above, OpenTx differs from the majority of mainstram radio by its programming philosphy. Owners of Multiplex radios will however feel at home very quickly, as the principles are very similar. As opposed to common radios that offer a choice between a limited set of predefined usage scenarios (airplane, glider, helicopter), a number of functions that are commonly used with such models (delta, flaperon, camber, butterfly...), and have fixed assignations (sticks **always** control their respective servo channels), OpenTx offers a blank canvas on which you will build your setup: the mixer screen. This approach ensures maximum flexibility because whatever you do you will never have to work around what the radio expects you to do, which is a blessing for anybody having to work with "new" model types or configurations which still "don't exist" for mainstream radio manufacturers, and as such for which the built-in functions are usually useless. So you can see it that way: For some model types, usual predefined functions can allow setting up a model in seconds (just enable a function), but for others you'll spend hours trying to get around their limitations. On OpenTx everybody is more or less at the same level - it might take a little longer at the beginning to set up a seemingly simple model, but a complicated one won't take much more. As there is no existing function you can just turn on, it will require basic understanding of how your model is supposed to work, and what you want each control surface to do. This means that you might even learn something about your model in the process of setting it up!

The control order path starts from the sticks, goes through the STICKS screen (anything affecting control response like dual rates and exponential), continues to the mixer, and ends up being adapted to the mechanical characteristics of the model in the SERVOS screen.

Everthing about the mixer screen

We'll start with this as it is the centre of the radio. The mixer screen lists the 32 output servo channels to which you can link one or more inputs from a long list of physical controls (sticks, pots, trims, and switches), logic sources, other servo channels and trainer inputs. Each assignation is done with a mixer line. A new model will have 4 predefined mixer lines on servo channels 1, 2, 3 and 4 that link the 4 sticks to them according to the servo channel order preference you have set. These are there purely for convenience, and can of course be edited or deleted. Let's delete them all by highlighting them, pressing ENTER LONG and choosing "Delete". Your mixer screen is now empty, which means the radio does nothing at all. Well it does, it sends out the number of servo channels that are defined on the model setup page to the receiver (servo channels 1-8 by default), but as those servo channels are empty in the mixer screen no servo will respond, they'll all be cantered. You won't go very far with that, so you'll want to add control inputs to those servo channels. You'll create a mixer line on CH1 by highlighting it and pressing ENTER LONG, and will end up in the INSERT MIX page. Scroll to the "Source" field, press ENTER, and select the control you want to act on CH1. You can do it by browsing the list with the + and - keys, or take the easy route and just move the desired control (if it's a physical one, of course). Move the aileron stick, and the field will change to Ail (it might have already been there if your servo channel order preference set in the general settings had A for the first servo channel, as that's taken into account). You can leave the other parameters at their default settings, which mean:

- The mix ratio of this input is 100%, so the scaling of the mixer line's output will be equal to its input. A value of -50% would mean the output would be half of the input, and inverted.
- There is no offset, so with an input of 0 the output of the mixer line will also be 0. A value here would shift the response by that much percentage of (input x weight).
- Trim is ON, it could instead be excluded from the calculation (OFF), or one of the other trims could be used (for cross-trimming for example). D/R and expo (the entries on the STICKS screen for that servo channel) are used. Unticking the box would mean the mix receive the raw stick input even if a D/R is active.
- Differential is 0, so the mixer output will be symmetrical on both sides. A value of 20% would mean the line's output would be 20% less on the negative side than on the positive one. The "Diff" field is editable, and by using the +/- keys on it you'll be able to select a curve instead (predefined or custom).
- The mixer line is active for all flight modes. By "unticking" some of the numbers, you would disable that line whenever the corresponding flight mode is selected.

- No switch is assigned to the line, so it's always active (as long as the modes setting above allow it). Selecting a switch (physical or logical) would allow activating or deactivating the line whenever needed.
- Warning is off. If set to 1,2 or 3 the radio would emit 1,2 or 3 short beeps every few seconds to let you know that line is active.
- Multiplex is Add, so this line is just added to the previous ones on the same servo channel. If set to multiply it would multiply the **calculated result** of the lines above it, and if set to replace it would replace anything that's above it whenever it's active.
- Delays are 0, so if that line had a switch assigned it would be activated/deactivated instantly when the switch is toggled. Time is in seconds.
- There is no slowing down, so the line's output reacts instantly to input changes. Times set here are expressed in seconds to cover the entire range (-100 to +100). If 2 seconds are selected, the line's output will take 0.5 second to gradually sweep from 0 to +50% if the input was moved by that much. Note those slow up/down are not applicable to mix activation and deactivation, only for changes of the input. One would use a flight mode for that instead.
- You can also name the mixer line. This name is shown on the main mixer screen, so setting names is a good idea to help maintain complex setups where you might have many lines on each servo channel.

Note that at any time in the Mixer screen and the EDIT/INSERT MIX dialogs you can press MENU LONG to bring up the servo channel monitor. This makes it easy to try the different parameters and see their effect on the servo channel's output. In addition to this, you will see that on the mixer screen each active line has its name and source displayed in bold, so it's always clear at any given time as to which lines are actively contributing to the servo channel output.

The description is long, but in practice if we now do it again to control CH2 with the elevator stick it will only take a couple of seconds to select CH2, press ENTER LONG, scroll to Source, pres ENTER, mode the Elevator stick, and press EXIT twice. Setting up the mixer for a vast number of basic models is as simple as that. In addition to the 4 basic servo channels, if you have a model with flaps that have their own servo and that you want to control with switch SB you'll just find a free servo channel to connect your servo to (let's say CH6), you'll scroll to CH6 on the mixer screen, insert a mixer line, flip the SB switch when in edit mode on the source field, and EXIT twice. If you want to adjust the up/mid/full positions, a good idea would be to set up a 3-point custom curve. In the Curve setting, select c1, exit edit mode, and still on the curve field press MENU. You will be brought to the curve editor. Press Exit, and select "3pt". Press ENTER, select the first point with +/-, press ENTER, and adjust its position. Do the same for the other 2 points, and exit.

Now something more "complicated", if your model has retracts that you want to control with switch SA (which has 3 positions) but want only 2 possible output values (in and out) this won't work (choosing SA would give -100%, 0%, +100%). You'll then use the very convenient MAX source, that represents a fixed value. Create a mixer line on a servo channel (e.g. CH5) with MAX as source and +100% weight, you could name it "Gear Up". Now create a 2nd mixer line under the first one by pressing ENTER LONG on on it and selecting "Insert After". Choose MAX again as source, then set weight to -100%, for which it's time to remember the handy shortcut - enter edit mode, and press the + and - keys together. There, -100%. Scroll to the "Multpx" setting, and select "Replace". Now go to the switch setting, enter edit mode, flip SA in the UP position (flick it out of it first if it's already there), and press the + and - keys together. This will turn the "SAup" entry into "!SAup". This means the line is active when SA is NOT in the UP position. Name the line as "Gear Down" and you're done. What happens is: CH5 will be at 100% by default (the first mixer line is in effect), BUT when SA is either in the middle or in the DOWN position the 2nd line will activate and replace the first one, turning the output to -100%. If you go back to the mixer screen and play with SA you'll see that when not in the UP position the 2nd line will turn in bold as it becomes active, while the first one fades back to normal as it's been deactivated by the Replace type of the second line. Again that seems long, but takes as much as about 30 seconds when you're used to it. Of course if you've followed you'll certainly understood that we could have set the second line to use switch "SAup", and that subsequently the role of the 2 lines would be swapped (second active when switch is up, first in the other 2 positions). But then I wouldn't have had the opportunity to explain the !, and also as a personal preference I like my switch default positions to be UP, and the first mixer line on a servo channel to be the default value.

A little simple one next: You have 2 ailerons with separate servos. Using a Y-cable to link them is too old-school nowadays, so let's use another servo channel. We already have the first aileron on CH1, CH5 and 6 are taken by gear and flaps, so let's use CH7. We have an aileron that must move with the aileron stick, which is actually just like the first one. So let's jsut copy the first mixer by highlighting it and pressing ENTER LONG, and selecting copy. Move it to CH7 and press ENTER. This would work just fine, but I'll throw in a personal preference again, and change its weight to -100% because "logically" that aileron is supposed to move in the opposite direction. We'll see later why this makes sense.

Next up: a little mix. I'm going to be lazy and just tell you to go back up and check the mixer screen description a bit further up for the throttle -> elevator compensation. I'm sure it will seem much more clear now.

Let's do a delta mix. Again, what kind of control surfaces do we have, and what do we want them to do? We have 2 elevons. They must move in the same direction when the elevator stick is moved, but they must move in opposite directions when the aileron stick is moved. So, let's pick 2 servo channels to connect our servos to. CH3 and 7, because... why not. Trying to make you forget about old school fixed servo channel assignments here ;) CH3 must move with the elevator stick, so we create a mixer line with Ele as source on it. CH3 must also move with the aileron stick, so we create a 2nd mixer line with Ail as source. We leave multiplexing set to "Add", as that's exactly what we want to do - the 2 inputs must be added together. Now let's discuss the weights a little. They are now set to 100%. This means that a full deflection of the aileron stick will create a full deflection of CH3, same for the elevator stick. But now as we add the 2 together, if we put the stick in the upper right corner (assuming mode 2) we have 100% + 100% = 200% output on CH3. Now, the limits defined on the SERVOS screen are set to 100% - which means that the output will be clipped. When the mixer's output for a servo channel goes beyond 100%, the servo won't move further. This is not different from other radios - predefined delta mixes will usually give you ratios to enter for elevator and aileron authority, which is just the same. If you enter too high ratios some of the stick throw will be ineffective. Now the discussion as to what to set the ratios to is probably endless - some are happy with 100% and clipping, some will like 50% so that there is never any clipping, and some like myself will like something a bit in the middle - I use 70%. So, let's say we now have 2 mixer lines on CH3, 70% Ail and 70% Ele. As we said, CH7 must respond the same way to the elevator input, so we add a 70% Ele mixer too. It must respond to the aileron stick by the same amount, but in the opposite direction, so we'll set... -70%. This is the reason for which I set -100% in the previous dual aileron example. Forcing yourself to enforce that logic thinking even when not really necessary will help you to get it right when it's needed. For example in the dual aileron scenario we could have set both ailerons to 100%, then used servo reverse to invert one aileron to achieve the same result on the model. BUT in the delta scenario this wouldn't work.

Servos screen

Now that the mixer is configured and the controls' behaviours are defined, the next step is to set up the way these orders will be translated to the servos. At this point you'll want to actually connect your servos to your receiver, remove the control horns from the servos, the props from the motors (safety first), and connect a receiver battery. Bind the receiver if not done yet. Centre all controls (you can look at the servo channel monitor and aim for 0), and for each servo start by mounting the horns so that they're as close to perpendicular to the control linkage they're going to drive as possible. Murphy's law ensures that it's always right between 2 of the steps, so use the PPM centre adjustment to make them perfectly perpendicular. Using this setting instead of subtrim avoids losing throw, and makes sure the outputs seen in the servo channel monitor are real "control" inputs. Connect your linkages so that the control surfaces are at neutral (or middle of their expected throw for things such as flaps). Now move the radio's controls carefully to exercise the servos but being aware of possible mechanical binding. Set servo reverse where needed. Adjust the linkages in order to have a little more throw than what you'll ever need in both directions. If there is a little binding on one side to reach the appropriate side on the other and/or the throws are not symmetrical it's not a problem. Then adjust the min and max limits. These should be set so that:

- You have a little bit more throw than what you'll ever need.
- There is no mechanical binding.
- Throws are the same on both sides with full control input deflection.

We're done for this screen. You've already named your servo channels of course ;)

Sticks screen

You've probably noticed there's one thing we haven't done yet - adjust throws. That's what we'll do now. For each stick, create a rate line. Set the weight to achieve the desired throws. Add expo if desired. This is your default rate, so don't choose a switch. If you want multiple rates, create a new line **BEFORE** the default one, enter the new rate/expo, and choose a switch. Repeat as many times as desired. What's important to know is that the **first line** that has its switch on (starting from the top) will be the active one. So if you create rates below one with no switch - it will never be active. Think about the priority if you choose switch combinations that can lead to 2 rates having their switch on - the top one will override the other. Ideally you should choose your switches so that never happens.

There, we can go and fly!

Model setup guidelines

Time for a little summary. As we've seen, there's literally an infinite number of ways to do the same thing in the firmware, so let's mention a few good practices when setting up models. If you stick to them they will help you set up your model quicker, keep your setup clean, and understand what you did 6 months later. With a simple 4-channel model where each servo is controlled by only one control input, if you want to reduce aileron throw you could do it either with the aileron D/R, in the weight of the mixer line linking the Aileron stick to the aileron servo channel, and with the Limits for that servo channel. For such a simple model it won't matter much where you do it, but as soon as you'll get to more complicated models with flaperons, butterfly mixes etc., doing it in the limits for example would simply make it impossible to set up the model properly.

- Start with the mixer setup. As we did above, think about what controls you have on your model and what they should do, and choose which receiver output channel you want to use for each of them. On each of those servo channels, create one mixer line for each of the transmitter controls that should act on it. Figure out the relative amount of movement each of those must lead to, based on 100%. Forget about throws for now, if one control must have half the authority of the other set one to 100% and one to 50%. Keep the mixer dedicated ONLY to the "logical" part of the setup. If for example for complex gliders you have more than one control surface that needs to receive the same group of mixers, isolate those as a "Function" on a free "virtual" servo channel you know you won't use it for a servo, e.g. CH10. Then reference it in the required output channels with a 100% CH10 mixer line. This will save mixer lines and add to clarity. Name your servo channels and mixes that aren't self-explanatory.
- Set the servo parameters. Take good care of the mechanical setup, the better it is the easier the radio setup and the more precise your controls will be. If you need to use subtrim to artifically shift a control (for example in case of flaperons that need a far greater throw on the low side than on the high side), remember to use the "=" output mode to keep symmetry.
- Always define control throws using the Sticks screen.

Now the throws are adjusted, the mixer is set for good logic and the outputs are set for good mechanical fit. As every part of the setup is clearly separated, should you need to change something any adjustment will only require intervention on one of the screens. If you crash or change something mechanically, it will be the SERVOS screen. If your throws are too big, Sticks screen. If a compensation amount or mixing ratio is wrong, mixer screen.

Remember that there are custom switches that can be set to combine various functions, for example allow activation of some mixers only if another one is active, etc. It is also good practice to make use of the "Safety CHx" custom function to define a safety switch for the throttle channel of electric models. Select your throttle lock switch, select the correct function for your throttle channel, set the value to -100, and then tick the box. While you should always set up your model without it being powered, or at least without a prop mounted, the safety box is there to avoid forcing the channel to the default value of 0 (mid throttle) while browsing the function list if your switch is active.

The "Instant Trim" custom function allows adding the current stick positions to their respective trims. It's useful for example on a new model that might be badly out of trim. Instead of having to press and hold the trim tab until the effect is sufficient, just hold the stick where required to keep level flight, and flick the selected Instant Trim switch (it should be momentary). This custom Function should be disabled once the model is trimmed, as hitting it by mistake can have the opposite effect. Once the flight is over, the "Trims -> Offsets" function at the bottom of the SERVOS page can be used to transfer the trim contents into the subtrim settings. Be aware that unless the servo mode is set to "=" an excessive subtrim amount can lead to dissymetric throws and affect settings like differential.

Advanced features

Flight modes

Flight modes in OpenTx are relatively simple compared to most radios. The settings are simple: A name (displayed on the main views), a switch to activate them, a trim setting and 2 fade in/out settings. Yet they are very powerful, because the main settings are actually just located somewhere else: in the D/Rs and mixers. Each of these has a flight mode selection list, that will determine in which one(s) they are active. So (nearly) everything is done through dedicated mixers. The mixers that are controlled by a flight mode will see their activation fade in/out according to the mode's settings. This can be used to create interesting functions: For example, in our example earlier we had flaps controlled by a 3-position switch. If we wanted to slow them down, we could just use the Slow setting in the mixer. With the gear example though, as we use the MAX source and activate/deactivate a mixer line, the Slow parameter would not do anything. One solution is to leave the Switch for our second

line empty, and instead assign that switch to a flight mode. The mixer line would now see its flight mode selector set to only the flight mode in question. Slow up/down is set in the flight mode paramaters, and we get our nice slow gear operation. A "side effect" is that we can now also use the separate set of trims that comes with the flight mode, and take advantage of it to counter the extra drag from the gear that often causes a pitch down action.

Telemetry

This subject in itself has actually mostly been covered already. The telemetry settings page allows you to configure the different parameters that have been explained in the menu overviews. The telemetry views will show the data as configured. If you have a microSD card in your radio, you can use the "SD Logs" custom function to record the telemetry data while in flight. It can then be played back in companion9x.

Audio

One of the major features of the radio is the speech output function. Providing a microSD card (FAT12/16/32 format) loaded with the sound pack available for download from within companion9x is inserted in the slot in the battery compartment, the radio will be able to play audio files in response to various events like reaching trim centre/ends and activation of a switch (physical or custom), to play a background music file, and last but not least to announce every available value (telemetry, parameter, stick position) in clear voice. Custom sounds can be placed in the SOUNDS folder of the card and will be available for use. Audio operation is relatively simple as it only consists of 5 "and a half" Custom Functions:

- Play Track: Just play an audio file from the SD card when the associated switch is active. A repeat option is available, when set the sound will repeat at the set interval as long as the switch is active. This can be used to announce flight modes, gear position, flap position etc. when the associated switch is activated or on request.
- Play Value: Say the value of the selected parameter when the switch is active. The repeat parameter is available too.
- BgMusic: Starts playback of a background music track (that can of course also be a timed flight program announcement). The switch must stay on in order to continue playback.
- BgMusic ||: This pauses the background track while active, and resumes playback when deactivated. The BgMusic switch must stay active the whole time or the track will start from the beginning again.
- Vario: Reproduces the sound of a glider variometer using the altitude or Vertical speed telemetry data.
- Volume: Adjusts the audio volume for the entire radio to the value of an input, e.g. a pot.

Global variables

We have already mentioned how global variables could be used to group multiple adjustments in one place, and to make that adjustment flight mode specific. It was also noted that these could be adjusted in flight - this is done using the AdjustGVx custom functions. Any time the custom function's switch is ON, the value of the global variable will follow the selected input. As a reminder, there are 4 groups of inputs that can be switched between by pressing ENTER LONG on the input field, and don't forget to tick the safety box once you're done configuring and you've made sure the switch is off - again to avoid overwriting your GVAR by mistake while scrolling the source list. This is the way to adjust values in flight. The custom function's switch serves as a "lock" to freeze the value or allow adjustment. When a variable is being updated, a popup with the variable name and new value will show up on the main views. One of the available sources for adjusting global vars is the list of servo channels. This is probably the main way you'll use to adjust GVARs for a simple reason: Let's say you want to adjust a D/R ratio with the S1 pot. If you select GV1 as the weight parameter of that rate line and just use the Adjust GV1 custom function with S1 as source, you will now be adjusting your rate between -100% and +100%. Being able to disable and even reverse your rate doesn't sound terribly fun, so you'll want to limit the adjustment range. The easiest way is to use a free servo channel for that. Create a mixer line on say CH12, and use the weight/offset/curve parameters to make that servo channel's output cover a range of say +50 to +80% over the pot's throw. Then, set the Adjust GV1 source to CH12.

A few interaction examples

The power of the system now comes from the combination of the different features. Custom switches can be used to create conditions that will trigger audio playback, for example using custom switch "CS1|d|>x Alt 10" as trigger for "Play Value Alt" would result in the altitude being announced everytime it has changed by 10m/ft. "CS2 a<x Spd 35" triggering "Play Track lowspd" would play the lowspd.wav file on the SD card, that would be recorded to say "Low Speed" when GPS speed got under 35km/h. If you have several parameters you want to have announced sequentially on request, you could set several Play Value Custom Functions all triggered by the SHdown momentary switch. A press of this switch will then trigger playback of all the parameters one after the other.

But as we know that custom switches can be used anywhere a switch is definable, nothing prevents you from reusing that same CS2 to trigger automatic flaps deployment once speed got below 35km/h. That's right, anything can be used to affect anything.

Introduction to companion9x

As we have briefly mentioned, OpenTx comes with a computer-based counterpart that runs on Windows, Mac OS and Linux, companion9x. This software will allow you to backup, edit and share your radio's settings. It can also simulate both a model's setup and the radio's own interface on the computer, so it's a great tool to try things even without a radio. When you have one, it can speed up new model setups significantly thanks to the PC interface that's not limited to a small screen and a few buttons.
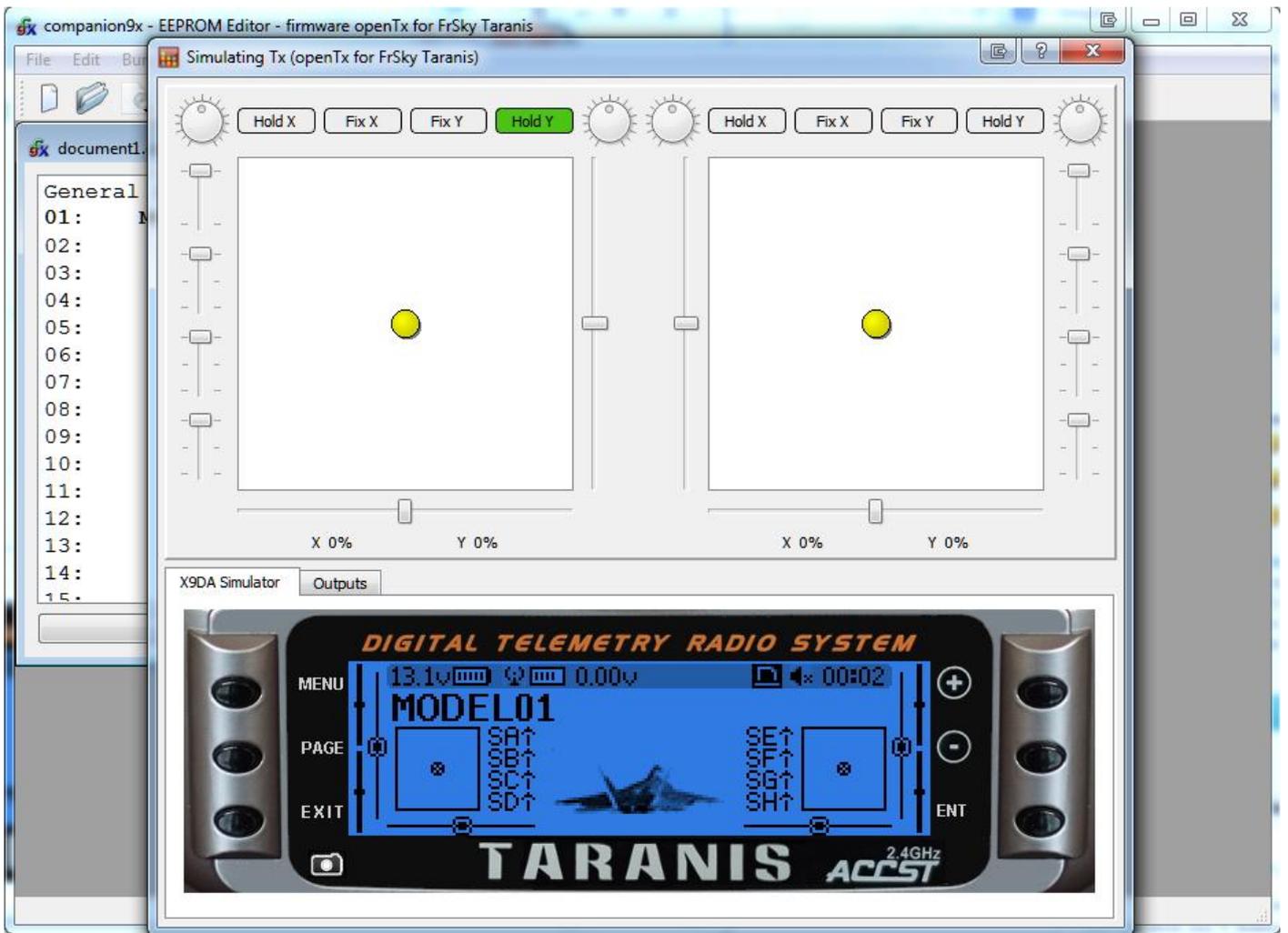
Previewing the radio

To have a go, start by downloading and installing the appropriate version for your system. Once the program is launched, you will find the main window. Open the Preferences Dialog with File->Preferences.
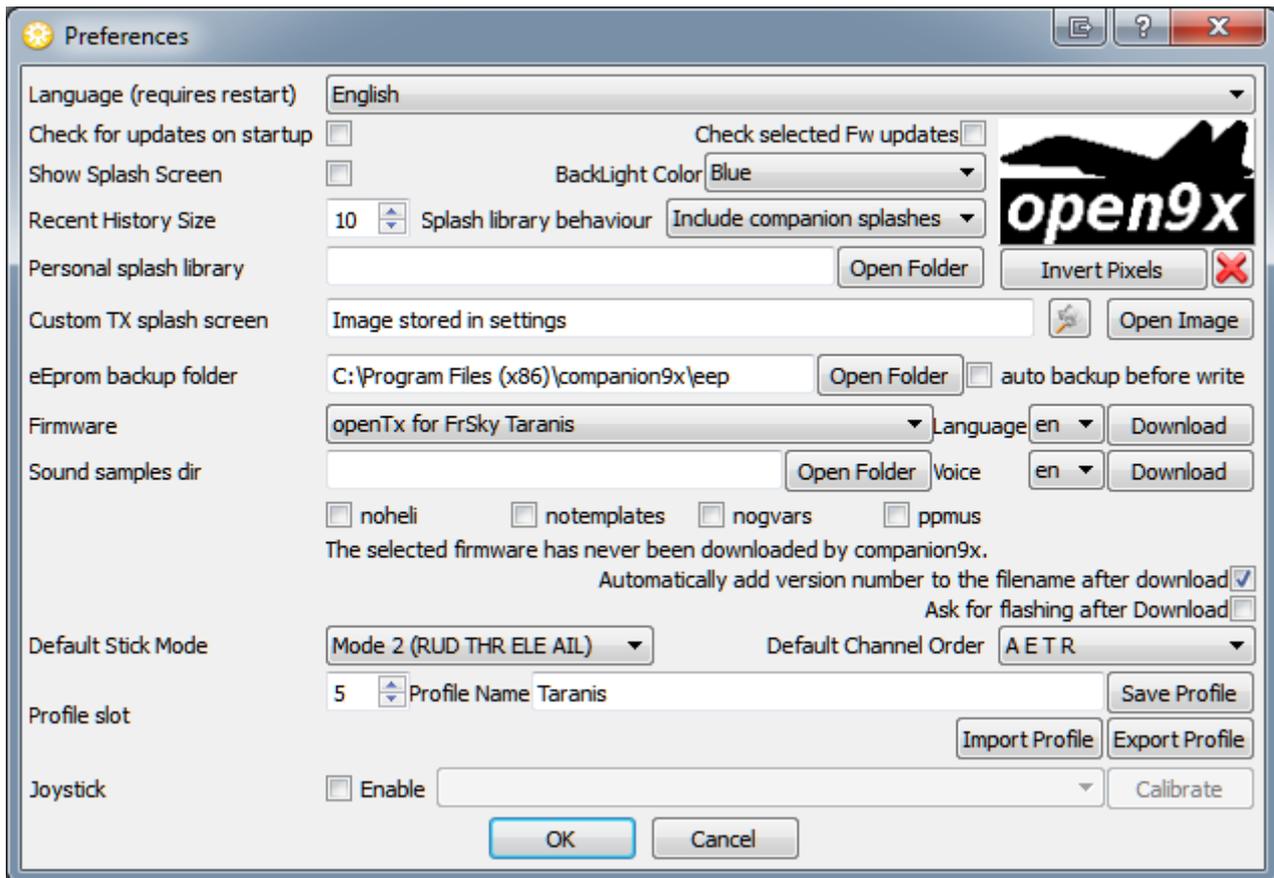
Select "openTx for FrSky TARANIS X9D" in the firmware dropdown. Select your firmware language, and the voice language. A few option checkboxes are there to allow some customisation of the firmware, such as removing the heli, templates and global variable pages, or changing the percentage displays into microsecond units. The top Download button will compile and download the latest available firmware version with the selected language and options. Set your flight mode and preferred servo channel order in the dropdowns below, and dismiss the Preferences dialog with OK for now.

You can now create a new document. A window will appear, with the first line being the radio's general settings, and the next being the model slots. You can have a look in the general settings and create a model by double-clicking in an empty slot. There are 2 ways to simulate either a model or the whole radio.

- In the model editor, the bottom Simulate button will open the model simulator with the current settings. Note that if a change is made in the model while the simulator is open, it needs to be closed and reopened.
- At the bottom of the "document" window is a "Simulate Tx" button that will open a similar simulator, however this time with an extra tab showing the radio's LCD screen and UI buttons. The virtual radio will have the same data as the document when the simulator is started. Note that changes on the radio interface are not carried over back to the document.

More info about companion9x: http://www.youtube.com/watch?v=uSGzSf9jelg

More info about Open9x: http://code.google.com/p/opentx/