

# ER9x Manual

because you asked for it!



r290 - Dec 19, 2010

## Table of Contents

Disclaimer.....	3
Introduction.....	4
How it works.....	5
Nomenclature.....	6
Edit buttons.....	7
Navigation.....	7
Editing and Saving.....	8
On Startup – Quick Model Select.....	8
Transmitter Layout.....	9
Main Screen.....	10
General view.....	10
Statistics Screens Statistics Screens.....	11
General Settings.....	12
Radio Setup (1/6).....	13
PPM In (2/6).....	15
Version Info (3/6).....	15
Diagnostics (4/6).....	16
Analog Inputs (5/6).....	16
Calibration (6/6).....	17
Model Setup.....	18
Model Select (1/9).....	19
Model Setup (2/9).....	20
Expo/Dr (3/9).....	22
Triple Dr Example.....	22
Mixer (4/9).....	23
Main Screen.....	23
Edit Mix.....	24
Limits (5/9).....	26
Curves (6/9).....	27
Custom Switches (7/9).....	28
Safety Switches (8/9).....	29
Templates (9/9).....	30
Examples.....	31
Programming a throttle cut.....	31
Build and Program Instructions.....	33
Building from Source.....	33
Flashing .....	33
make targets.....	34
make options .....	34
MORE.....	35

## **Disclaimer**

THIS FIRMWARE IS PROVIDED ON AN "AS-IS" BASIS WITHOUT WARRANTY OF ANY KIND AND ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE DISCLAIMED. IN NO EVENT SHALL THE DEVELOPER AND/OR AUTHOR BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO: PERSONAL AND/OR PROPERTY DAMAGE) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS FIRMWARE, EVEN IF THE DEVELOPER AND/OR AUTHOR. HAS BEEN ADVISED BY USER OF THE POSSIBILITY OF SUCH POTENTIAL LOSS OR DAMAGE. USER AGREES TO HOLD THE DEVELOPER AND/OR AUTHOR. HARMLESS FROM AND AGAINST ANY AND ALL CLAIMS, LOSSES, LIABILITIES AND EXPENSES.

Yeah, and no spitting either!

## Introduction

The IMAX/FLYSKY/TURNIGY/EURGLE 9x is a computerized radio from china. The transmitter is outfitted with a 128x64 pixel monochrome LCD, 2-2axis gimbals, 3 variable potentiometers (pots), 6 2-position switches, 1 3-position switch and some funky red trim.

The big thing about this transmitter is the price. At the time of writing radios may cost anywhere from \$180 for simple units up to \$1000+ for super blinged out bazillion channel super heavyweight monsters.

This one costs \$60.

Where's the catch then? (you might ask) The catch is in the software (firmware - FW). The original FW is less-than-perfect. It has bugs, funky navigation and the most annoying beeping I have ever heard. Not good.

However, some neat guy called Thus figured out that the whole radio is made from gimbals, switches, funky trim and a very generic main processing unit that does absolutely everything. He had one of those ah-ha moments where insanity overrides common-sense and decided to completely rewrite the original software and replace it with his own.

At some point I decided that while Thus' FW is great I really wanted more bling for my TX. So in the spirit of open-source Thus' source was stolen and ER9x was born. (Yeah, I was vain. ER are my initials)

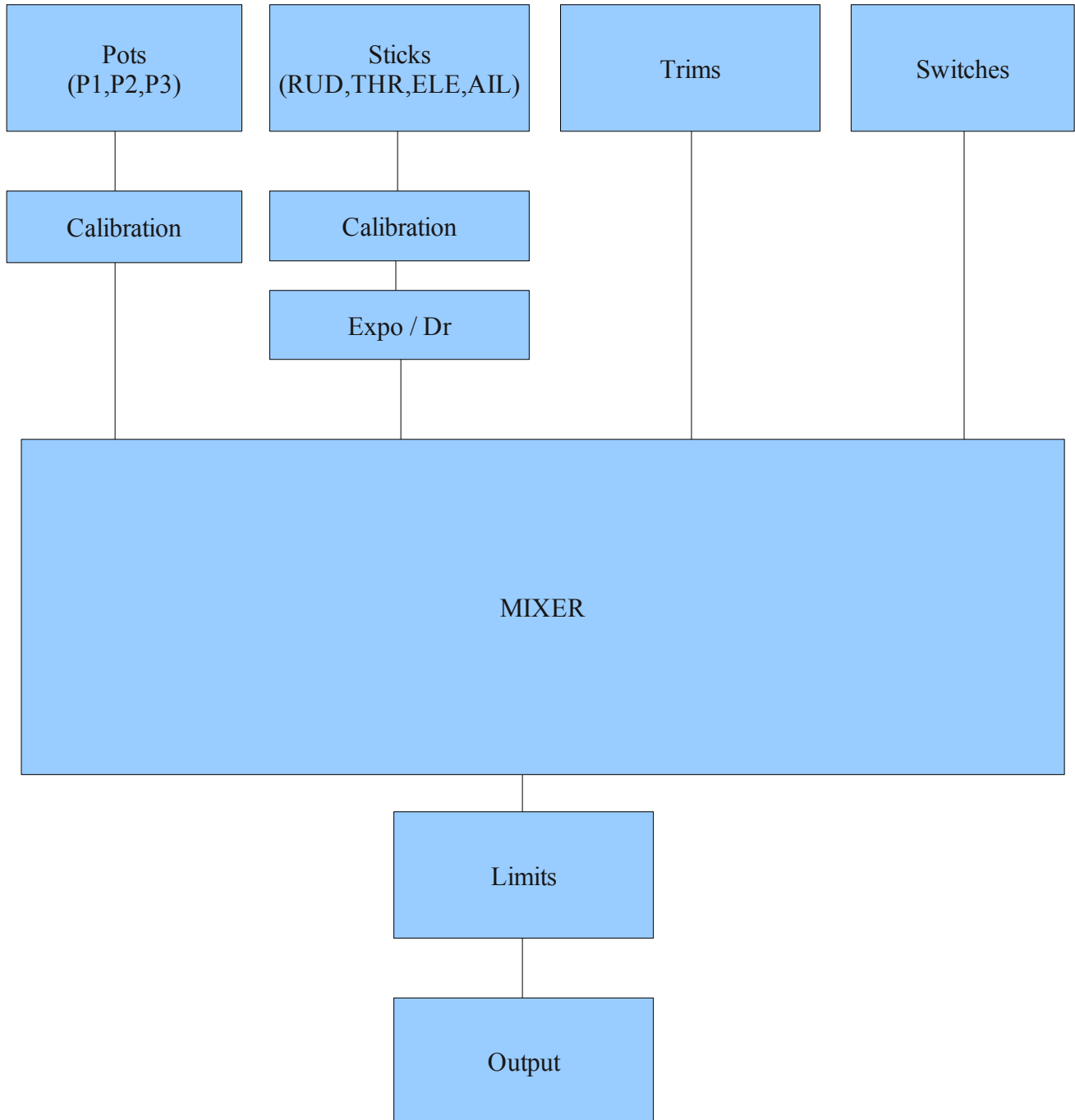
You might want to check out Thus' code – it's available here: <http://code.google.com/p/th9x/>

While you're at it check out RadioClone's code – which also runs on the 9x. While ER9x is based on Thus' code, I have managed to pilfer some of RC's excellent code. His FW is more complex but also more powerful. Check it out here: <http://radioclone.org/>

Got you all worked up about this? Good. Go now to the kitchen, make yourself a nice cup of coffee. This is a long read. I'll wait here till you're ready. Promise!

## ***How it works***

Bear with me here – some flow charts coming up:



What the heck was that?

The system receives 4 types of inputs:

1. Main Sticks
2. Potentiometers
3. Trims
4. Switches

The analog inputs (sticks and pots) go through a calibration phase. The sticks can also go through Expo and Dr filters before going to the mixer.

The mixer does it all. It directs each input to the desired output (CH1..CH16). It controls how the inputs are added. It also controls the timing of each function.

After the inputs are processed by the mixer they are directed to the relevant output channels. The limit procedure takes over and makes sure no output goes too far.

Finally the channels are encoded and sent to the RF module to take that nice little hike through the air to your model.

## ***Nomenclature***

(just so we understand each other)

Inputs:

1. RUD – Rudder.
2. ELE – Elevator.
3. THR – Throttle.
4. AIL – Aileron.
5. P1/P2/P3 – Pots.
6. Switches:
  1. THR – Throttle cut switch, don't confuse this with the THR stick. The THR switch is located on the back left side.
  2. RUD – Rudder Dr switch.
  3. ELE – Elevator Dr switch.
  4. ID0, ID1, ID2 – Three position switch. These 3 define the 3-position switch. ID0 is the top position, ID1 – mid position and ID2 – bottom position.
  5. AIL – Aileron Dr switch.
  6. GEA – Gear switch.
  7. TRN – Trainer switch. This switch is spring loaded.
  8. SW1..SW6 – Custom switches. More on these later.

It should be stated that every function in this FW is assignable. There are no fixed switches. You can choose the TRN switch to be throttle cut and use the triple switch to control Dr. The names are useful since they are labeled like that on the Tx.

## **Edit buttons**

There are 6 edit buttons on the Tx. In this manual they are noted with square brackets ([MENU]). Some functions need the button to be pressed and held for a second or so. They are noted as “long” presses like so: [MENU LONG]

Also since the “+” and “-” keys are placed stupidly in the original Tx I’ve switched their position. So [+] is actually [-] and vice-versa. This is actually more intuitive than the original (trust me, I’ve tried using them as is).

Since to upload this FW you need to open up your Tx and do some modifications (which void your non-existent warranty FYI) it is highly recommended you switch between the [+] and [-] keys. It’s a simple job, so don’t skimp, you’ll thank me later.

To avoid confusion with people who modded their keys and all the others I’ll refer to the [+] and [-] keys as [LEFT] and [RIGHT] from now on. (I hope that left and right are still universal values – you can never tell today)

The “!” sign. Whenever you see the “!” sign you can read that as “not” or “inverted”. Switches can be “normal” or “inverted”. So when choosing the elevator d/r switch ELE is normal operation and !ELE denotes inverted operation.

## **Navigation**

As a general rule the [UP]/[DOWN]/[LEFT]/[RIGHT] move the cursor appropriately. The [MENU] key is used for selection and for editing. The [EXIT] key is used for exiting (surprise). Pressing [EXIT] will generally bring the cursor to the top of the screen. Another press will exit the menu to the main screen. Pressing [EXIT LONG] will exit immediately to the main screen.

Pressing [MENU] from the main screen will take you back to the last menu.

From the main screen you can press [RIGHT LONG] to enter the model setup pages. Pressing [LEFT LONG] will enter the general setup menus.

Once in the menus you can navigate between different screens using the [LEFT]/[RIGHT] keys as long as the cursor is at the top right position of the screen.

## ***Editing and Saving***

As a rule once a value is changed it is saved. You can turn off your Tx and turn it back on and the values will be saved. The values are saved internally in the MCU's eeprom. However there is a slight delay sometimes so it's probably a good idea to wait a couple of seconds before turning off. There is no undo functionality. Once something is erased/changed it's changed for good.

Generally, when a value is highlighted and you cannot move left or right then pressing [LEFT]/[RIGHT] will change that value.

When moving left or right is possible you need to press [MENU] to edit that value. Edit-mode is displayed by the cursor blinking. To exit edit-mode press either [MENU] or [EXIT].

When editing, pressing both [LEFT] and [RIGHT] simultaneously inverts the value. Try it, it's cool! Also, with r155 and up it is now possible to change values with the P3 pot (the one at the front of the Tx called PIT. TRIM/AUX 2).

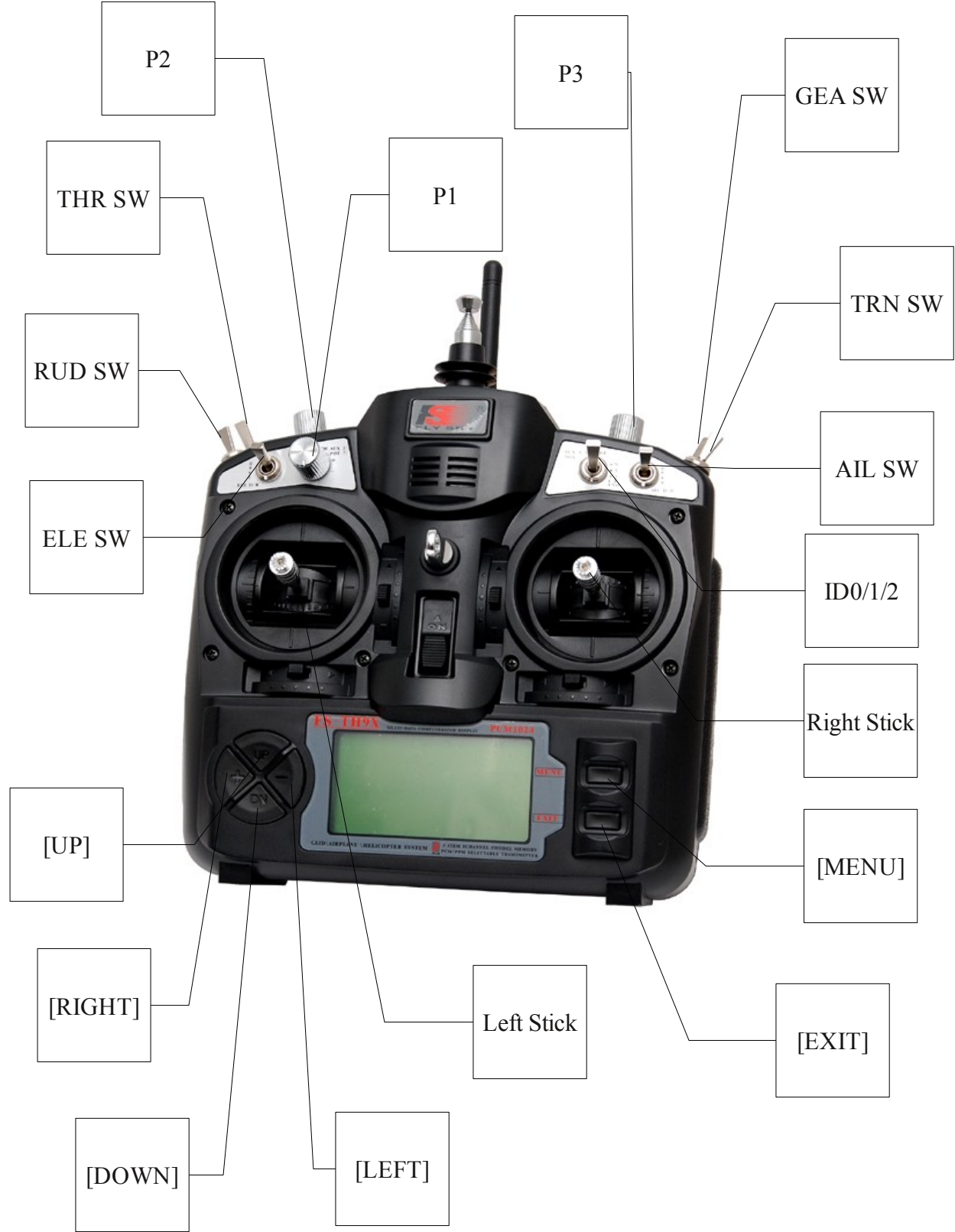
## ***On Startup – Quick Model Select***

On startup holding a certain key will load an associated model memory. This is useful for quickly changing between model memories:

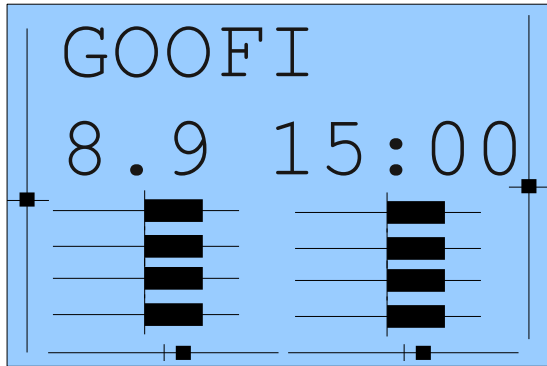
- 1) Holding **[MENU]** Will load Model memory **#1**
- 2) Holding **[EXIT]** Will load Model memory **#2**
- 3) Holding **[DOWN]** Will load Model memory **#3**
- 4) Holding **[UP]** Will load Model memory **#4**
- 5) Holding **[RIGHT]** Will load Model memory **#5**
- 6) Holding **[LEFT]** Will load Model memory **#6**



**Transmitter Layout**



## Main Screen



(Cool back light here, huh?)

### ***General view***

The main view is split into top and bottom. The top contains the following:

- The current model's name. (GOOFI in this case and yes, it's a real airplane)
- The battery voltage.
- Trim increment information.
- Timer and timer trigger information. Pressing [EXIT LONG] resets the timer.
- Throttle trim activation information.

The bottom consists of three screens. You can flip between these with the [UP]/[DOWN] keys.

The 3 screens are:

- Value bars – these show the output values for the first 8 channels.
- Value values – The output values for the first 8 channels.
- Input values – Stick position and switch indicators.

## Statistics Screens Statistics Screens

```
STAT      08:02 TOT
TME 08:02 00:00 TSW
STK 00:00 00:00 ST%
```

```
STAT2
tmr 1Lat max 5 us
tmr 1Lat min 5 us
tmr 1 Jitter 0 us
tmain      6,31 ms
```

From the main screen pressing [UP LONG]/[DOWN LONG] will enter the statistics screen.

The first shows some available timers and traces the throttle stick as well.

The second shows general timing of the Tx. The value “tmain” shows how long the math takes. This will increase as you add more mixers. It can be very large sometimes depending on eeprom writes. You can reset the timers by pressing [MENU].

## General Settings

From the main screen pressing [LEFT LONG] will enter the general settings menus. Here you can set up settings that will be the same regardless of chosen model.

The menus are as follows:

1. Radio Setup
2. Startup Warnings
3. PPM In Calibration
4. Version Information
5. Diagnostics
6. Analog Inputs
7. Calibration

## Radio Setup (1/6)

```
RADIO SETUP          1/6
Owner Name ME OFCOURSE
Beeper               Quiet
Contrast             25
BAT Warning          9,0v
Inactivity Alarm     0m
Mode  ↔☀   ↑☀   ☀↑   ☀↔
      2  RUD THR ELE AIL
```

Use this screen to set up general functions for the Tx:

1. Owner Name: The radio owner's name. You... Unless.... (hmmm...) This will also be displayed on the splash screen.
2. Beeper: Sets Beeping levels
  - i. Quiet. No beeping at all. No warning – nada. If the kids are sleeping and you must setup the model in your living room this is the mode to use. Just remember that the Tx will not even warn you when the battery is low. If you're using a Lipo watch out!
  - ii. No keys. The beeps are normal but edit keys are silent.
  - iii. Normal. Normal beeping.
  - iv. Long beeps. For those who want to annoy other people.
  - v. Extra long beeps....
3. Contrast: The LCD's contrast. The values can be 20..45. The higher the value the darker the screen.
4. Battery warning: Battery voltage warning. When the connected battery's voltage drops below this voltage the Tx will beep. Though the Tx will continue to function normally it's really advisable to land as it is known that this FW was not able to fix the “zero voltage non-functionality” problem of the original.
5. Inactivity alarm: This will set up a warning that will beep if the Tx is left unattended for the specified amount of time. Values can be from 1 to 250 minutes. To reset the timer simply move one of the sticks.
6. Filter ADC:
  - i. SING: Single conversion. This is the fastest conversion but base resolution is 1024.
  - ii. OSMP: Oversampling. This uses extra samples to increase resolution to 2048. Just slightly slower than SING.
  - iii. FILT: Filtered. This is in case you have excessive noise from the conversion (servo jitters). This will filter the input and prevent that noise. It will, however, increase latency by ~30msec.
7. Throttle reverse: This is for all you wacky people who fly with the throttle backwards (e.i. idle is far from you and full is close to you). Though I personally don't understand how you fly like that it's a nice feature. The reverse will also reverse the throttle warning on startup and some other throttle related functions.
8. Minute beep: Beeps every full minute while the timer is running.

9. Countdown beep: Beeps at 30, 20, 10, 3, 2 and 1 seconds before the timer ends.
10. Flash on beep: Flashes the backlight on timer beeps.
11. Light switch: This chooses a switch which can be used to turn on a backlight if connected.
12. Light off after: When this is not OFF any keypress will turn on the backlight and turn it off after the specified number of seconds.
13. Splash screen: Show the logo on radio startup. Btw, you might not know this but the splash screen can be skipped on startup by pressing any key.
14. Throttle warning: If ON will show a warning when throttle is not at idle when the Tx is turned on. The Tx will not output a signal until the alert is cleared.
15. Switch warning: If ON will show a warning when the switches are not at the default position when the Tx is turned on. The Tx will not output a signal until the alert is cleared.
16. Memory warning: If ON will show a warning when the available eeprom memory is less than 200 bytes when the Tx is turned on. The Tx will not output a signal until the alert is cleared.
17. Alarm warning: This will give you a “heads up” if your beeper is silent. If on and the beeper is set to '0' (Quiet) you will receive a warning on startup. This has been added after a programming session left a user flying on silent. I find it really useful!
18. Mode: Choose between MODE1, MODE2, MODE3 and MODE4.

2

## **PPM In (2/6)**

```
PPMIN                                2 / 6

Cal    0,0    0,0    0,0    0,0
        0,0    0,0    0,0    0,0

Multiplier 1,0
```

This menu allows you to calibrate the mid point for the input PPM channels.

Highlighting “Cal” and pressing [MENU] will calibrate the mid point for all PPM IN channels.

PPM IN is read from the signal at the trainer port of the Tx.

The multiplier does as it's name suggests. It multiplies the ppm Input by a set amount. Great for dealing with different tx's whose makers don't know how to encode PPM :-P.

## **Version Info (3/6)**

```
VERSION                                3 / 6

SVN: trunk-r98
VERS: V1.2484-erez
DATE: 06.09.2010
TIME: 09:19:32
```

This screen shows the version information for the current FW:

SVN: The SVN name of the current revision.

DATE: Compile date for the current FW.

TIME: Compile time for current FW.

VERS: Version number.

Since ER9x is OPEN SOURCE I try to help out anyone who has problems. Please feel free to open new issues for defects and/or enhancement requests at the project's code page:

<http://code.google.com/p/er9x/issues/list>

Your participation is what helps me makes the FW better (and your donations of-course!). Please use the revision number stated in this screen when you state a problem.

## Diagnostics (4/6)

DIAG		THR	0		4 / 6
		RUD	0		
Left	0	ELE	0		
Right	0	ID1	1	Trim-	+
Up	0	ID2	0	↔☼	0 0
Down	0	AIL	0	↓☼	0 0
Exit	0	GEA	0	☼↑	0 0
Menu	0	TRN	0	☼↔	0 0

This menu will help you visualize the current state of the trims, keys and physical switches. Each Key/Switch/Trim is represented. When pressing a key or switch they are highlighted.

## Analog Inputs (5/6)

ANA	A1	0422	0	5 / 6
	A2	0347	63	
	A3	0466	0	
	A4	0414	0	
	A5	07EE	-30	
	A6	0345	-30	
	A7	06AE	80	
	A8	028B	8,7v	

Here you can see the analog inputs in hexadecimal format to save space and annoy you at the same time.

Values range between 0..0x3FF (0..1023).

A1..A4 are the gimbals (sticks).

A5..A7 are the pots.

A8 is battery voltage. You can press [DOWN] and highlight the battery voltage. Pressing [LEFT]/[RIGHT] will increase and decrease the value and so enable you to calibrate the battery voltage monitor.



## Calibration (6/6)

CALIBRATION	7 / 7
	0355<0422 >033F
SetMid	0200<0414 >0353
SetSpan	0302<0410 >0354
Done	0360<0416 >03E0
	03B0<0200 >0344
	03D0<0233 >03FF
	03F0<0268 >03FF

This screen allows you to calibrate the analog channels (A1..A7).

The calibration method goes like this:

1. Press [DOWN] → (SetMid)
2. Set Sticks to center. (Including throttle and pots)
3. Press [DOWN] → (SetSpan)
4. Move sticks and pots through full range.
5. Press [DOWN] → (Done) – Values are saved here.
6. Press [DOWN] (Back to top)

The values are calculated when you press [DOWN].

They are saved when you press [DOWN] to (Done).

(Works surprisingly well for a cheap Chinese Tx)

## Model Setup

From the main screen pressing [LEFT RIGHT] will enter the model select/settings menus. Here you can set up settings that model specific.

The menus are as follows:

1. Model Select
2. Model Setup
3. Expo/Dr
4. Mixer (This is the important one)
5. Limits
6. Curves
7. Custom Switches
8. Safety Switches
9. Templates

## Model Select (1/9)

```
MODELSEL  free 1560 1/9

*01 GOOFI          114
 02 YAK 55         60
 03
 04
 05
 06
```

In this screen you can see, select, copy and move models between different memory “slots”. I quote the word “slots” because memory management is dynamic. The available memory is displayed at the top of the screen.

Memory usage for each model is displayed on the right. The more complex your model (mixes/curves/options/limits/etc) the more memory it'll take.

The “\*” on the left shows the currently loaded model memory.

Pressing [UP]/[DOWN] will move the cursor between different models.

Pressing [MENU] will highlight the model. Pressing [UP]/[DOWN] with the model highlighted will move it up/down. Pressing [EXIT] will un-highlight the model.

Pressing [EXIT] will load the highlighted model.

Pressing [EXIT LONG] will load and exit to the main screen.

Pressing [MENU LONG] or [RIGHT LONG] will load the model and go to the next screen (Model Setup).

## Model Setup (2/9)

SETUP 01	2 / 9
Name	GOOFI
Timer	15:00
Trigger	Ths
Timer	Count Down
T-Trim	ON
T-Expo	ON
Trim Inc	Medium

Lots of options here:

1. Name: Unsurprisingly here you edit the model's name. To edit: scroll down until the name is highlighted and press [MENU].  
Once you press [MENU] only one letter will remain highlighted. To change the letter you press [UP]/[DOWN]. To move the cursor press [RIGHT]/[LEFT].  
Once done, press [MENU]/[EXIT] to exit the edit.
2. Timer: Here you set the value for the timer.  
Press [RIGHT]/[LEFT] to choose between minutes and seconds.  
Press [MENU] and the cursor will blink. To edit use the [UP]/[DOWN]/[RIGHT]/[LEFT] buttons and [MENU]/[EXIT] when done.
3. Trigger: Choose what triggers the timer → (remember – by pressing [LEFT] you'll see the same values with the “!” sign. This means that the usage is inverted)
  1. OFF – timer is off.
  2. ABS – timer is on.
  3. RUs/RU%/ELs/EL%/THs/TH%/ALs/AL% - chooses to activate the timer based on stick position. When a XXs is selected (THs for example) The timer starts whenever the stick is not at zero.  
The XX% sign is the same except the timer speed is determined by stick position. When at zero, the timer is stopped. When at full the timer goes at normal speed. When midway the timer's speed reflects the sticks position.
  4. Switches – You can specify a switch so whenever that switch is activated the timer counts.
  5. Momentary switches. A switch denoted with “m” (like TRNm) means “momentary”. That means that moving the switch once to the on position and back turns the timer on. Moving it on and off again turns the timer off. (difficult I know, take a sip from your coffee, relax a bit, take a break – it's not difficult once you try it out :))
4. Timer: Here you can choose whether the timer counts up or down.
5. T-Trim: Throttle trim. This is a nifty feature for power fliers. When activated a couple of things happen. First off the center detent for the throttle trim is removed. Also the throttle's trim will now only affect the “low” side. That means you can use the trim for setting idle while full throttle remains unchanged.
6. T-Expo: 'nother throttle related function. This one makes the throttle stick's expo go from zero to full instead of having a center like all the others. Always the odd kid out this throttle is.
7. Trim Inc: Trim increments:

1. Exp – Exponential. With this the trims are fine near the center and get progressively coarser farther out.
2. ExFine – Extra fine – 1 step per click.
3. Fine – 2 steps per click.
4. Medium (my personal favorite) – 4 steps per click.
5. Coarse – 8 steps per click.
8. Trim Sw: Neat little function this is. When in flight if this key is activated it reads the current position of the sticks and trims and copies that into the subtrims. After that it zeros the trims. This is really neat for new models when you might have a hard time taking your hands off the stick and pressing the trims. Simply hold the plane level with the sticks and press the selected trim switch. Voilà – the plane is trimmed. It's magic! No it ain't. It's ER9x!!!
9. Beep Cnt: Beep Center. Here you set center warnings. The string RETA123 corresponds to: RUD, ELE, THR, AIL, P1, P2, P3.  
When the letter corresponding to the analog channel is highlighted the system checks for center. When the input is at center a short beep will sound enabling you to hear when the input is centered. This is useful for checking the center of the pots without looking.
10. Proto: encoding protocol
  1. PPM – with ppm you can choose how many channels to encode. Anything from 4 to 16 channels. You can also change the pulse spacing. This is useful for systems which might experience jitter. On the whole it might be a good idea to leave it alone.
  2. Other protocols include Silver A/B/C and TRAC09.
11. Shift Sel: Shift select. POS/NEG. Select signal shift. POSitive or NEGative.
12. E. Limits: Extended limits. Allows limits to go to  $\pm 125\%$ . **Please test first and make sure this does not cause unwanted mixing between channels.**
13. DELETE MODEL [MENU]: Guess....  
This deletes the current model. You need to press [MENU LONG] for that to happen though.

### **WARNING!**

**Deleting a model causes the memory to jump to the previous model memory in the list. Do not delete a model memory while you have a model "listening". Always shut down your receiver before deleting a model.**

(This all sounds perfectly reasonable until you actually forget to turn off your electric model and have it fly around your house uncontrolled – you've been warned!)

## Expo/Dr (3/9)

EXPO/DR	3/9					
	exp	%	sw1	sw2		
RUD	0	100	-	---	---	H
THR	50	100	-	---	---	H
ELE	0	100	-	---	---	H
AIL	0	100	-	---	---	H

This screen allows you to enter and edit Expo and D/R values for the main controls (RUD/ELE/THR/AIL).

For each control you can input values for Left/Right for both Expo and D/R. To edit expo values highlight the value in the “expo” column and press [MENU]. Once the cursor blinks you can use the [UP]/[DOWN]/[LEFT]/[RIGHT] buttons to change the value. Notice that while there is a telltale that shows you which side of travel you are adjusting:

- “-”: This means both left and right values are equal. Pressing [UP]/[DOWN]/[LEFT]/[RIGHT] will change **both** values simultaneously.
- “←”, “→”: When moving the stick you can see either of these symbols. When this symbol is visible you are only changing that side of travel.

For each control you can set 2 switches. The main switch changes between high rate/high expo and mid rate. If the main switch is “low” (e.i. mid rate) the second switch can switch between mid and low rate.

At the end of each line there's a telltale that shows you which rate you are on:

- H: High.
- M: Medium.
- L: Low.

Pressing [MENU LONG] while the cursor is on a control will take you to the Edit Expo/Dr screen. In this screen you can adjust the values for that single control. You will also see a graph indicating the action of that control. Press [EXIT] to return to the main Expo/Dr screen.

## Triple Dr Example

The "F.Mode" switch can be used as a triple rate switch for any one axis, or it can be used as a triple rate flight mode switch, controlling rates and expos for some or all of the flight axes at once. To use it as a triple rate/flight mode switch, set sw1 to "!!ID2" and sw2 to "!!ID1". If you want rudder, elevator, and aileron all assigned to this switch for flight modes, be sure to set sw1 and sw2 as above for each axis. With the switch in the up position, it will be at low rate, as indicated by the "L" at the end of the line. In the mid position, it will be mid rate, and at the down position, it will be at high rate. You can also include throttle if you'd like, to have different expo curves for each of the flight modes.

## Mixer (4/9)

I'm actually writing this last since it's the most important menu. If you're still awake now would be a good time to sip that coffee and wake up. You want to understand ER9x? Understand the mixer and you're very nearly there.

The function of the mixer is to take the inputs, perform some function on them and route them to the output channels. Since selection is totally free you have a very flexible system which is extremely powerful and very quick to boot.

## Main Screen

When you enter the screen for the first time you'll probably see a list like so:

MIXER		4 / 9		
	wt	src	sw	crv
CH1	100%	RUD		
CH2	100%	ELE		
CH3	100%	THR		
CH4	100%	AIL		
CH5				
CH6				

What this is telling you is that the rudder stick's input is being routed with a weight of 100% to CH1. Same for the elevator, throttle and aileron. Though not visible now you can also see the switch column which will tell you if a switch is assigned to the mix and also a crv (curve) column which tells you what curve is applied to that mix.

When you scroll down you'll see that sometimes the weight is being highlighted and sometimes the channel's number is underlined. When the weight is highlighted, pressing [LEFT]/[RIGHT] will edit that value and pressing [MENU LONG] will enter the Edit Mix screen and allow you to edit that mix. When the channel's number is underlined, pressing [MENU LONG] will insert a new mix for that channel and take you to the edit mix screen for it.

You can also press [MENU]. This will highlight the mix. Then you can press [UP]/[DOWN] to move or copy the mix. Notice that moving or copying is decided by whether you press up or down on the first press after highlighting the mix. If you first try to move it down it will be copied. Subsequent presses of [UP]/[DOWN] will move the copy up or down until you press [MENU] or [EXIT]. Pressing [UP] will move the mix without copying it. Again, subsequent presses of [UP]/[DOWN] will move the copy up or down until you press [MENU] or [EXIT].

## Edit Mix

EDIT MIX	CH1
Source	RUD
Weight	100
Offset	0
Trim	ON
Curves	c1
Switch	---
Warning	OFF

In this screen you edit individual mixes.

Here are the available options for each mix:

1. Source: This is the input for the mix. It can be the following:
  - i. Stick or pot: Self explanatory.
  - ii. MAX: The output is either 0 or the value describes in “weight”. This is controlled by the switch.
  - iii. FULL: Same as MAX but the value is “-weight” if the switch is off or “weight” if the switch is on.  
MAX and FULL can be a little confusing. Look in the examples section for, well, examples :).
  - iv. PPM1..PPM8: PPM input channels. These are fed by the ppm input or “trainer port”. You can use these to configure a buddy system or to simply extend your radio with more functions (like head tracking for you FPV guys).
  - v. CH1..CH16: These are the outputs of the other mixes. You can use these to chain mixes for very complex behavior.
2. Weight: This value multiplies the value from the input. It can be -125% to 125%.
3. Offset: This value is added to the value from the input. It can be -125% to 125%.
4. Trim: When this is “ON” the trim value (if exists) will be carried on through the mix. When “OFF” it is ignored.
5. Curves:
  - i.  $x > 0$ : The value of the source is carried through only if it is positive (greater than zero). Otherwise it is zero.
  - ii.  $x < 0$ : Same but for negative values.
  - iii.  $|x|$ : The value is passed as an absolute value.
  - iv.  $f > 0$ : If source is positive then the output value is “+weight” otherwise it is 0.
  - v.  $f < 0$ : If source is negative then the output value is “-weight” otherwise it is 0.



- vi. |f|: Output is either “+weight” or “-weight” depending on the sign of the source.
  - vii. c1..c16: custom curves. These are defined in the “CURVES (6/8)” screen. You can also press [MENU] to edit the curve directly.
6. Switch: Here you select the switch that operates the mix. If the switch is not selected then the mix is on by default.
  7. Warning: Here you can select an audible warning that will sound whenever a mix is active. (This will only work when a switch is defined). You have an option of 1, 2 or 3 beeps. The warnings will sound in succession so you can hear them individually.
  8. Multpx: This value defines how the mix will be added to the channel.
    - i. Add: This is the default value. With this value the mix is added to the previous values in the same channel.
    - ii. Multiply: Use this to multiply the previous values in the same channel.
    - iii. Replace: This value is used in conjunction with a switch. When the switch is off the value is ignored. When the switch is on the value discards the previous values and places it's own value in the channel.
  9. Delay Down/Up: Use this to delay use of this channel. Usually used with a switch. When the switch is turned “ON” or “OFF” the mixer will wait the specified number of seconds before changing the value.
  10. Slow Down/Up: Slow the rate of change in the channel. When not zero these will determine the maximum speed with which the value can change. The specified value is the number of seconds to go between -100% to 100%.
  11. DELETE MIX [MENU]: Pressing [MENU LONG] here will delete the mix and return to the main mix screen.

## Limits (5/9)

LIMITS				5/9
	subT	min	max	inv
CH1	-5, 9	-100→	100	---
CH2	0, 7	-100→	100	INV
CH3	0, 0	-95 ←	40	---
CH4	-14, 4	-100→	100	INV
CH5	45, 9	-100→	100	INV
CH6	0, 0	-100→	100	---

This is probably the second most important menu.

The limits operate on the output channels (as you can see from the flow chart in the introduction). In the LIMITS menu you can set the center point (subtrim), limits (both left and right) and reverse the channel's output (inv – invert).

Each channel here corresponds to a channel in your receiver. The limits you set will be used on that channel only.

Columns:

1. subT: SubTrim. This sets the channel's center point.  
HINT: The values of subT can be -100 to 100 with increments of 0.1. This is done so to have excellent resolution when setting the center of each surface. You can use your stick to set the center point as well. While the subT is highlighted hold the stick so that the surface is centered. Press [MENU LONG] and the position will be recorded! It's the magic of ER9x again :).
2. Min/Max: These set the endpoints of the channel. Notice that there's a telltale that hints as to which side is active at the moment. Each limit point can range between -100% to 100%. The limits act both as gains and as absolute limits. The servo will not go beyond the limits you set here.
3. inv: Invert. This function reverses the output of the channel.

## Curves (6/9)

CURVE	6 / 9				
CV1	-75	-40	0	45	75
CV2	0	0	0	0	0
CV3	0	0	0	0	0
CV4	0	0	0	0	0
CV5	0	0	0	0	0
CV6	0	0	0	0	0
CV7	0	0	0	0	0

Surprisingly in this menu you set your custom curves. Curves are nifty things that can tell your servo how to move when you move your stick. In ER9x there are 8 5-point curves and 8 9-point curves.

A 5pt curve is a curve you can edit at position -100%, -50%, 0%, 50%, 100%.

A 9pt curve is a curve you can edit at position -100%, -75%, -50%, -25%, 0%, 25%, 50%, 75%, 100%.

When you enter the menu you see a long list of zeros. Scroll down to the curve you wish to modify and press [MENU] or [RIGHT]. This will bring up the screen for editing the curve. Depending on whether you chose a 5pt or a 9pt curve you will see 5 or 9 editable points. Scroll through the points with [UP]/[DOWN]. Change the value with [LEFT]/[RIGHT].

At the bottom you will see a “preset” entry. Pressing [LEFT]/[RIGHT] on that will populate the values with a linear curve that is a good starting point.

You can also change the curve graphically. Highlight the “EDIT->” line and press [RIGHT]. This will highlight the curve points. Pressing [UP]/[DOWN] will change the values and pressing [LEFT]/[RIGHT] will select a different curve point.

## Custom Switches (7/9)

CSWITCH		7 / 9	
	Function	V1	V2
01	v<ofs	-60	THR
02	AND	ID0	ID1
03	----	0	----
04	----	0	----
05	----	0	----
06	----	0	----

I really like this feature.

Custom switches are not really switches at all but rather a set of logical conditions that can be used as switches.

You might have noticed that beyond the physical switches there are 6 switches called SW1..SW6. These correspond to the list you see in this screen. Once the condition defined for the switch is met it's value will be "ON".

1. First we define the condition. This can be  $v > \text{offset}$ ,  $v < \text{offset}$ ,  $|v| > \text{offset}$  and  $|v| < \text{offset}$ , or it can be a logical condition: AND, OR, XOR, or it can be an evaluation between 2 sources.
2. If you've selected a regular condition you need to specify a source and an offset:
  1. The source can be a stick, a pot, a PPM input or an output channel.
  2. An offset can be anywhere between -100 and 100. This will be the test point for the condition.
3. If you've selected a logical condition the switch results the condition applied to the 2 selected switches.  
For example: OR ID1 ID2 will be "ON" if either ID1 or ID2 is on. Cool, huh?
4. If you've selected an evaluation you (" $==$ ", " $>$ ", " $<$ " etc...) you need to select the 2 sources to evaluate between.  
For example: Switch on only if CH1 is less than RUD  $\rightarrow$  V1<V2 CH1 RUD

Example:

Say you have a glow plug driver which you want to turn on when the throttle is below 10%:

1. Highlight SW1
2. Select the source as THR.
3. Select the offset as -80 (remember -100 – 100 so 10% from idle is -80).
4. Select the condition as v<ofs.

Now you need to use a mix to run the switch. Go to the mixer menu. Select the CH8 as the channel you want the GP driver to operate on. On that channel select source as "MAX" and Switch as "SW1". Now whenever the throttle goes below 10%, CH8 will go to 100%. Cool, huh?

## Safety Switches (8/9)

SAFETY SWITCHES			8 / 9
ch	sw	val	
CH1	---	0	
CH2	---	0	
CH3	---	0	
CH4	---	0	
CH5	---	0	
CH6	---	0	

Safety switches allow you to select a switch and have it write a value for a channel that will overwrite any other value.

For example – you might want to set a switch on the channel your electric esc is placed. That way you can work on your model and not worry that a chance programing error will spin up the propellor.

### **This does not make your radio fool proof!**

You must be careful at all times. Hopefully this can add another level of safety and reduce the risks associated with this hobby.

## Templates (9/9)

```
TEMPLATES                      9/9
01 Simple 4-ch
02 T-Cut
03 V-Tail
04 Elevon\Delta
05 eCCPM
Channel Order RETA
CLEAR MIXES [MENU]
```

The templates are there to help you get started. When entering the screen you'll see a list of available templates. To choose a template, scroll down to it and press [MENU LONG]. This will **add** the template to the existing mixes.

Channel order:

This will allow you to set the way the templates are written to the mixers.

RETA means RUD = 1, ELE = 2, THR = 3, AIL = 4.

AETR means AIL = 1, ELE = 2, THR = 3, RUD = 4.

(and so forth).

At the bottom you'll see an option called "CLEAR MIXES [MENU]". Pressing [MENU LONG] on this will clear all the mixes leaving you with a clean slate.

The templates are:

1. Simple 4-CH: Plain vanilla 4-ch airplane.
2. T-Cut: This adds a throttle cut mix on your throttle channel.
3. V-Tail.
4. Elevon\Delta.
5. ECCPM; A generic ECCPM mix.
6. Heli Setup: This will clear your mixes and curves and setup a preliminary eCCPM heli.
7. Servo Test: This will setup a servo test output on CH15.  
To test your servos choose the mixer's source as CH15. It will cycle slowly between -100 and 100.

## Examples

### *Programming a throttle cut*

Though you can use a template for this it's instructional to do it via the mixer.

Start off with the default 4 mixes.

Scroll down until CH3 is underlined, like this:

```
MIXER                                4 / 8
      wt  src  sw  crv
CH1   100% RUD
CH2   100% ELE
CH3  100% THR
CH4   100% AIL
CH5
CH6
```

Press [MENU LONG] to enter the "Insert/Edit Mix" screen.

```
EDIT MIX  CH3
  Source   ELE
  Weight   100
  Offset   0
  Trim     ON
  Curves   ---
  Switch   ---
  Warning  OFF
```

Change source to "MAX" and Weight to "-100".

Also set the Switch to THR. Like so:

```
EDIT MIX  CH3
  Source   MAX
  Weight   -100
  Offset   0
  Trim     ON
  Curves   ---
  Switch   THR
  Warning  OFF
```

Keep on scrolling down until you reach Multpx.

Change the value to "Replace"

```
EDIT MIX  CH3
  Weight  -100
  Offset   0
  Trim     ON
  Curves   ---
  Switch   THR
  Warning  OFF
  Multpx   Replace
```

Now press [EXIT]

You should see the following screen:

```
MIXER                                     4/8
      wt  src  sw  crv
CH1  100% RUD
CH2  100% ELE
CH3  100% THR
      R-100% MAX  THR
CH4  100% AIL
CH5
```

What it tells you is that on CH3 you have 2 mixes defined.

The first takes the value of the throttle stick. The second depends on the THR switch. When the switch is off the mix is ignored so the only value will be the value of the throttle stick. When the switch is on that value will be replaced with -100%.



## Build and Program Instructions

You might want to play with the code and modify it for your own needs. It's really easy if you know a little C.

First, to program the MCU, download the full programing instructions:

[Flashing the 9x](#) by Jon Lowe.

### ***Building from Source***

First checkout using svn: `svn checkout http://er9x.googlecode.com/svn/trunk/ er9x`

Enter the src/ directory.

To make the standard version type: `make`

To make the JETI DUPLEX enabled version type: `make EXT=JETI`

### ***Flashing***

(you may have to run as admin to access the USB port in Linux)

To write the FW: `make wflash AVRDUDE_PROGRAMMER=usbasp`

To write the EEPROM: `make weeprom AVRDUDE_PROGRAMMER=usbasp`

To read FW: `make rflash AVRDUDE_PROGRAMMER=usbasp TARGET=backupflash`

To read the EEPROM: `make reeprom AVRDUDE_PROGRAMMER=usbasp TARGET=backupeeprom`

*Make sure you replace "usbasp" with the name of your programmer.*

*To list available programmers type: `avrdude -c ?`*

## ***make targets***

- make all (default): build the source
- make clean: Remove compiled files and directories.
- make wflash: Write flash (program) memory.
- make rflash: Read flash memory.
- make weeprom: Write eeprom.
- make reeprom: Read eeprom.
- make coff: Convert ELF to AVR COFF.
- make extcoff: Convert ELF to AVR Extended COFF.
- make debug: Start either simulavr or avarice as specified for debugging, with avr-gdb or avr-insight as the front end for debugging. (for debug info look into the makefile)
- make filename.s: Just compile filename.c into the assembler code only.

## ***make options***

- EXT=JETI: make jeti version.
- AVRDUDE\_PROGRAMMER: Set avr programmer name - *default: usbasp*  
(to list all available: avrdude -c ?)
- TARGET: Set target name - *default: er9x*
- OPT: Set optimization level - *default: s*
- FORMAT: Set format (can be srec, ihex, binary) - *default: ihex*
- MCU: Set MCU - *default: atmega64*

## MORE

I sincerely hope you enjoy both the ER9x FW and this manual.

I also sincerely hope you're still awake. If you are I applaud you :)

This is an Open Source project. It means that I request no money for it. You are free to look up, download, modify and release the code under the GNU v2 software license.

If you have any questions, requests and/or gaudy compliments I'll be happy to hear them either on the FW's code page:

<http://code.google.com/p/er9x/>

Or on the following threads in RCG or RCModelReviews:

<http://www.rcgroups.com/forums/showthread.php?t=1266162>

<http://www.rcmodelreviews.com/forum/viewtopic.php?f=47&t=292>

Also bug reports and enhancement requests can be reported here:

<http://code.google.com/p/er9x/issues/list>

eePe and er9x are free to use under the GNU v2.0 License. Feel free to use, copy and modify it as you wish! I have spent a lot of time (and will continue to) to make this software as good as possible. If you feel that this software has been beneficial to you please show your support by donating 5\$USD. This will be greatly appreciated and you'll be added to the "contributors" list in the code (optional of-course).



If you feel you'd like to contribute time, software code, documentation, tutorials, examples and/or money (I like money :) Please feel free to email me at: [erez.raviv@gmail.com](mailto:erez.raviv@gmail.com)

Please tell your friends about this cheapie \$60 Chinese Tx. I bet They'll roll their eyes up and tell you to go buy a \*real\* system. That's o.k. You'll have more money for \*real\* models!

