Th9x

MANUAL EURGLE TH9X NG

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Version:	V1.1	
	V1.2	Firmware r46
	V1.3	Firmware r59
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Contents

1 Introduction

The remote control Eurgle th9x, also sold under some other labels like Imax, Turborix or Turnigy manufactured by FlySky is a very low cost 2.4GHz radio with impressive hardware-features but with a less convincing firmware.
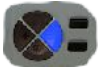
2 Performance

- 16 model memories
- two stage mixer allows any combination of input-channels to form output signals
- adjustable signal delay for each mixer line even with different values for up and down movement
- 4 pitch curves with 5 or 9 nodes
- dynamic memory management
- servo reverse feature and tunable servo range limits
- expo and dual rate features
- tunable battery warning
- support for lighted display (hardware upgrade necessary)
- trainer mode with selectable channel behavior
- stick calibration
- timer with three modes
- option-switches for several features.

3 Menu structure

3.1 Basic concepts

six buttons are available for operator interface.

key		function
	key left	➡*move to previous menu* ➡*ore move cursor left, or decrease a value*
	key right	➡*move to next menu* ➡*or move cursor right or increase a value*
	key up	➡*move cursor up* ➡*or increase a value*
	key down	➡*move cursor down* ➡*or decrease a value*
	key menu	➡*open a sub menu* ➡*or confirm an action*
	key exit	➡*exit current menu and return to the calling menu. This is only valid when the cursor is positioned at the top right edge* ➡*else move the cursor to the top right edge*
LONG	*key exit*	➡*return immediately to the uppermost screen*

- Key can be pressed short or long or very long and each time another action can be triggered

- Most actions appear immediately after a sort key-press.

- When a key is pressed for long time, then an action is repeated

- In some cases a long-time key press is required to trigger the action. This behavior is used for preventing unintentional operations in the standard screen.

- There is no undo functionality. If you change a value or remove something by mistake then you have to re-edit the former values manually.

- Attention!! Values are stored to the EEPROM-Memory with a short time-delay after the last key press. The storage procedure is announced by some buzzer-beeps

3.2 Main screen
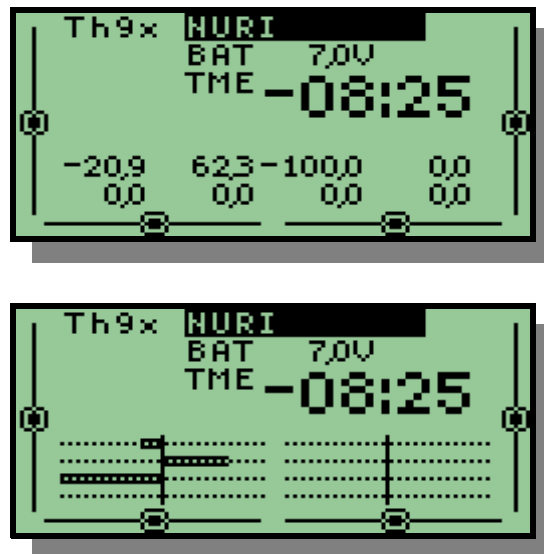
Screen contents:

- the current model name (NURI)

- a cursor selection either at Th9x or at the model name

- the battery voltage (6.9V)

- the remaining timer value

- the output values by numbers..

- ..or in a graphical representation

- the trimmer values in a graphical representation.

key	function
LONG	*Open menu-set '**Global Setup'***
LONG	*Open menu-set '**Model-specific Setup'***
LONG	*Move to menu '**Timing statistic'***
	*Change output view mode from graphical **view to numeric view***

Trim keys	Change the Trim Values. *Attention!! the values are evaluated in a non linear manner.*
	move cursor left
	move cursor right
LONG	*Open menu-set '**Global Setup**'* *or Open menu-set '**Model-specific Setup**'*
LONG	*reset timer*
	stop timer alarm.

3.3 Model-specific Setup

This set of menus does handle any settings which are related to one unique model. All menus are consecutively numbered and they are cycled by pressing the left or right key. The menu 1/7 is used to select one of 16 memory slots which holds any setup-data related to one model.

key	function
	cycle through the model menus

3.3.1 Model selection 1/7

Select one of 16 memory-slots by cursor movement up or down. Then activate this slot by pressing exit or by cycling to the next model-menu.

Please notice the free memory value in the title line. If this value gets lower than about 200 bytes then you should remove some model slots. Properly storage operation is only guaranteed if enough memory is available.

key	function
	Select memory slot by cursor movement.
	cycle to next menu
	back to main screen
	select current line for edit commands.(model name is blinking)
	move current line up or down.
	duplicate the selected model into next free memory-slot.

3.3.2 Model basic setup 2/7

- In edit field 'Name' you can change the model name. Move the cursor right to a character position and then change the value.

- In field 'Proto' you can select one of several transmitter protocols. Normally you select PPM here.

- In field Timer you can preset a count down start value and a count down mode. This value is then decremented according to the selected mode OFF / ABS / THR / THR%.

  - OFF: no decrementing.
  - ABS: always count down.
  - THR: only count down when the Throttle Stick is not in its neutral position.
  - THR%: like before, but count down more or less fast dependent to the THR-position.

- When the cursor is positioned to RM then the whole model memory can be removed by pressing menu

key	function

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1.		*move cursor up and down*
2.		*move cursor left right*
3.	*oder*	*change values*
4.		*reset cursor to the upper right edge*
5a		*leave this menu*
5b		*cycle to the next menu*
	LONG	*Remove this model memory. Only valid if Cursor is positioned at RM.*

3.3.3 Expo function 3/7
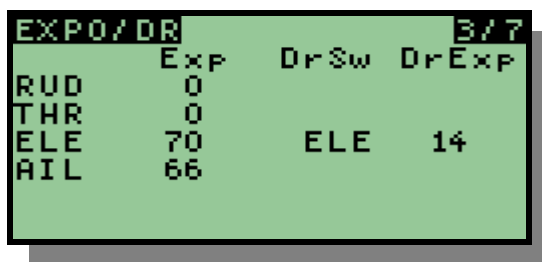
In this menu you can set up an exponential behavior for each of the four sticks. Select a value between -100 up to +100.

You can open a sub menu '**Expo function Details**' to see even more settings like a dual-Rate-switch and a dual rate expo function.

	key	*function*
1.		*move cursor up and down*
2.		*change values*
3a		*open menu Expo function Details*
3b		*reset cursor to the upper right edge*
4a		*leave this menu*
4b		*cycle to the next menu*

3.3.4 Expo function Details
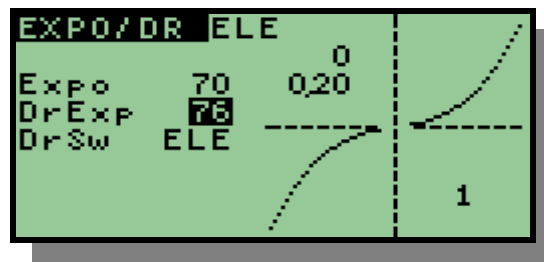
You can change the two expo values and the expo switch in this menu. In the diagram you see the shape of the expo function.

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3.3.5 setup trim values 4/7
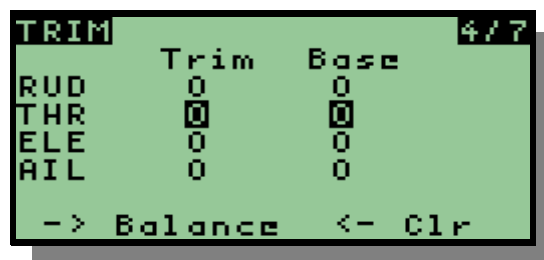
Here you can swap the trim values to a base value. After this operation, the trim values in the main screen are repositioned to zero.

	key	function
1.		move cursor up and down
2a.		add the trim value to the base value and reset the trim value to zero
2b.		reset the base value,
3.		reset cursor to the upper right edge
4a		leave this menu
4b		cycle to the next menu

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3.3.6 Mixer 5/7

```
MIXER                 5/7
CH1  -80% ELE
     100% AIL
      20% AIL   ID1 |x|
CH2   80% ELE
     100% AIL
     -20% AIL   ID1 |x|
CH3  100% THR
```
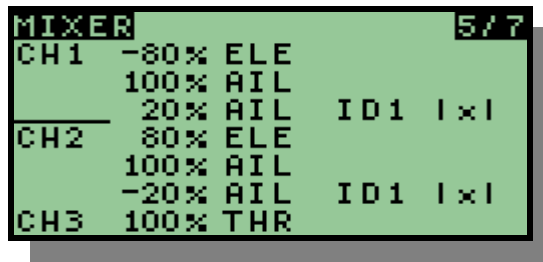
This menu is the most important menu of the whole arrangement. You can combine here several Inputs like stick values, pots-values or constants into each one of the output channels. Additionally there are four Helper channels which are used as temporary values X1-X4. These values are calculated first, and can then be used as inputs.

Each mixer line can contain a weight, an input channel, an optional switch, a curve and some delay values. Switches are available in a normal or in an inverted style.

Curves:

There are 8 kinds of curves: -- , >0 , <0 , |x| , cv1, cv2, cv3 and cv4

- ⬛ -   : no curve, or y=x

- ⬛ >0 : y=x | x>0, else y=0

- ⬛ <0 : y=x | x<0 else y=0

- ⬛ |x| y=|x|

- ⬛ Cv1..Cv4 Use one of four user defined curves.
   Cv1 and Cv2 have 5 nodes at x=-100, -50, 0, 50, 100;
   Cv3 and Cv4 have 9 nodes at x=-100, -75, -50, -25, 0, 25, 50, 75, 100

	key	function
1.		*move cursor at or between two lines*
2a.		*change weight value.*
2b.		*Open menu 'Edit-Mixer'. if the cursor was positioned between two lines, then a new line is generated, else the current line is edited.*
3.		*reset cursor to the upper right edge*
4a		*leave this menu*
4b		*cycle to the next menu*

3.3.7 Edit Mixer

```
EDIT MIX CH1
     AIL SRC
      20 PRC
     |x| CURVE
     ID1 SWTCH
 <  0 >  0 SPEED

     RM remove [Menu]
```

In this menu you can adjust all the details of one single mixer line.

- *SRC: select the input channel **RUD, THR, ELE, AIL, P1, P2, P3, X1, X2, X3, X4, MAX FUL***.
  with **MAX** you can emit a constant value 0 or +100%

  with ***FUL** you can emit a constant value -100% or +100%*

- PRC: weight from -125% to +125%

- CURVE: one of eight curve types.

- SWTCH: a switch. Dependent from the SRC-Value the switch acts in two different manners.

  When SRC=MAX or FUL then the switch selects one of two fixed values as input values and the line is calculated with the whole set of parameters.

  When SRC!=MAX or FUL then the switch can switch on the whole line or it can switch off the whole line. In the last case none of the remaining parameter has any effect.

- SPEED: These two values determine the speed in which rising or falling input values are propagated to the output channel

- RM: This field is used to remove the whole mixer-line.

	key	*function*
1.		*move cursor up and down*
2a.		*change values*
2b		*remove whole line,. Tis is only valid when cursor is at **RM**.*
2c		*edit curve. This is only valid when cursor is at **CV1**-**CV4***
3.		*leave menu*

3.3.8 Curve 6/7

```
CURVE                    6/7
CV1   -50  -25    0   25   50
CV2     0    0    0    0    0
CV3     0    0    0    0    0
        0    0    0    0
CV4     0    0    0    0    0
        0    0    0    0
```

3.3.9 Edit Curve

```
CURVE  1
 -50
 -25
   0
  25
  50
PRESET
```
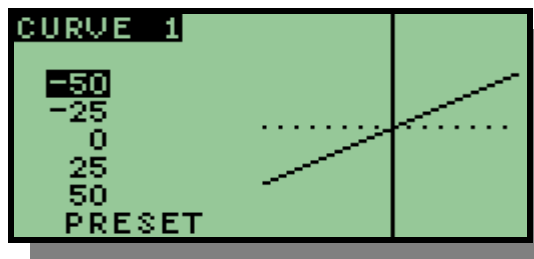
	key	function
1.		*move cursor up / down*
3.		*change value.* *select predefined curve. This is only valid if cursor is at PRESET*
4		*leave menu*

3.3.10 Limits 7/7

```
LIMITS                   7/7
        min    max   inv
CH1    -100    100    -
CH2    -100    100    -
CH3    -100    100    -
CH4    -100    100    -
CH5    -100    100    -
CH6    -100    100    -
```

In this menu you can revert output channels and you set up the output value limits.

	key	function
1.		*move cursor up / down*
2.		*move cursor to a column.*
3.		*change value.*
4		*reset cursor to the upper right edge*
5a		*leave menu*
5b		*cycle to the next menu*

3.4 Global setup, diagnosis and calibrating

In this group of menus is combined any setups that are not model specific. The menus are numbered as well and can be cycled with the left and right keys as the group above.

key	function
	Cycle through the menus. This is only valid if the cursor is positioned at the upper right edge.

3.4.1 Global Setup I

In this menu you can change some global values.

Screen contents:
- The contrast value.
- The warning level for the battery voltage alarm.

- A switch which is used to control the lcd-back light.
  Attention! This feature requires a hardware extension..

- The mode selection is used to assign a specific function to any input stick. At the end it changes the labels which are shown in all other menus where input values are selected.

	key	function
1.		move cursor up / down
2.		change values
3.		reset cursor to the upper right edge
4a.		leave this menu
4b		cycle to the next menu

3.4.2 Global Setup II (Options)

```
SETUP OPTS          2/7

     OFF THR Warn
     ON  SW  Warn
     ON  Mem Warn
     ON  Key Beep
```
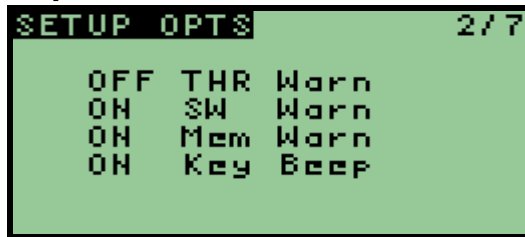
In this menu you can select several options like warnings or the key-beep.

3.4.3 Trainer Mode

```
TRAINER             3/7

RUD off    0 ch1    -
THR off    0 ch1    -
ELE off    0 ch1    -
AIL off    0 ch1    -

Cal     0,0   0,0   0,0   0,0
```
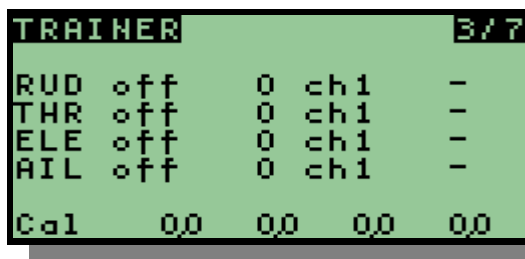
Here you can decide how each Input stick is handled in trainer mode.

Each line shows:
- RUD   the input channel in the trainer radio

- off   no student activity

- +=   trainer and student values are both added and then used as input signal

- :=   only the student controls this channel

- 98   the students values are weighted by this value

- ch1   this is the channel number which is received from the students radio. In the students radio this channel has to be connected to one single stick.

- RUD   Here you can define a switch which controls this trainer line

- Cal: This line shows the input values which are received from the students radio. If you press Menu, then the current values are defined as reference values for the student inputs.

3.4.4 Software Version

Shows the current software version

	key	function
1a.		*leave this menu*
1b		*cycle to the next menu*

3.4.5 key diagnosis

Show the current levels of any key,switch or trim-switch

	key	function
1a.		leave this menu
1b		cycle to the next menu

3.4.6 Diagnosis of Analogue inputs and calibrating of battery voltage measurement

Shows the values of all analogue inputs with 10 bit resolution. The stick-values are also shown in %.

Value number eight shows the battery voltage. Here you can also calibrate the shown voltage level.

	key	function
1.		move cursor up and down
2.		change shown battery voltage.
3.		reset cursor to the upper right edge
4a.		leave this menu
4b		cycle to the next menu

3.4.7 Calibrating the sticks

With the help of this menu you can calibrate the values of all four sticks in a four step procedure.
The procedure requires moving the sticks to a given position and then press cursor down while holding the sticks in this position ..

	key	function
1.		➜move cursor to **SetMid** ➜move all sticks into the center-position and hold them
2.		➜move cursor to **SetLow** ➜move all sticks to the lower left edge and hold them.
3.		➜move cursor to **SetHigh** ➜move all sticks to the upper right edge and hold them.
4.		➜move cursor to **Ready** ➜now its finished
5		*change to previous menu and check the shown percentage values.*

4 Function

4.1 Power on sequence

During power on sequence some important tests are executed.

First the EEPROM data is loaded and verified. In case of fault a warning is given and the whole EEPROM is formatted.

After this it is checked if free memory is enough to store at least one additional model memory. In case of fault a warning is given.

After this it is checked the throttle stick is located at its initial position. In case of fault a warning is given.

Then switches are checked. If any switch is in an on position then the warning screen is shown that displays the switch values.

Each warning screen can be left with the exit key.

4.2 Data flow

How we mentioned earlier, this radio works with a very simple calculation model. Any stick value and any switch value is considered to calculate the value of the outputs. Special attention is taken to handle any input with the same priority and without any special function dependent meaning.
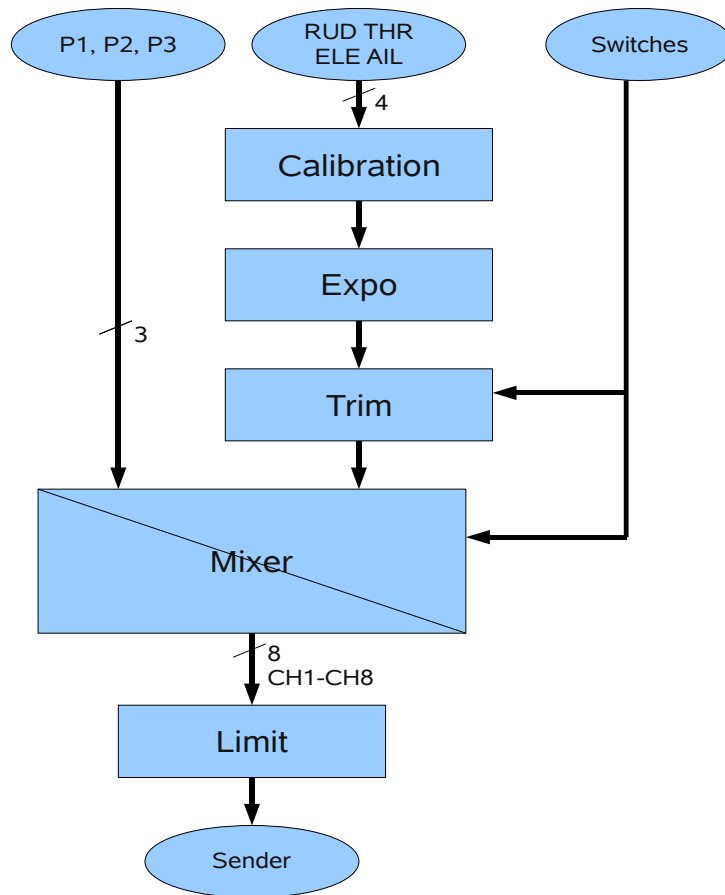
Data-flow Diagram:

4.2.1 Calibrating

This first block changes the 10bit AD-value into a symmetrical value from -512 up to +511. It is guaranteed that the center position of the sticks leads to the value 0. Potentiometer-values are handled according to this.

4.2.2 Expo

The expo function transfers the linear input values into some output values with non linear behavior. This means that the sensitivity of a stick is dependent on the working position of this stick.

As an approximation to the expo-function the following polynomial is used.

$y = f(x) = x^3 *k + x * (k-1)$ with $0 < k < 1$

y = f(x) = x^k with 1<=k<=3
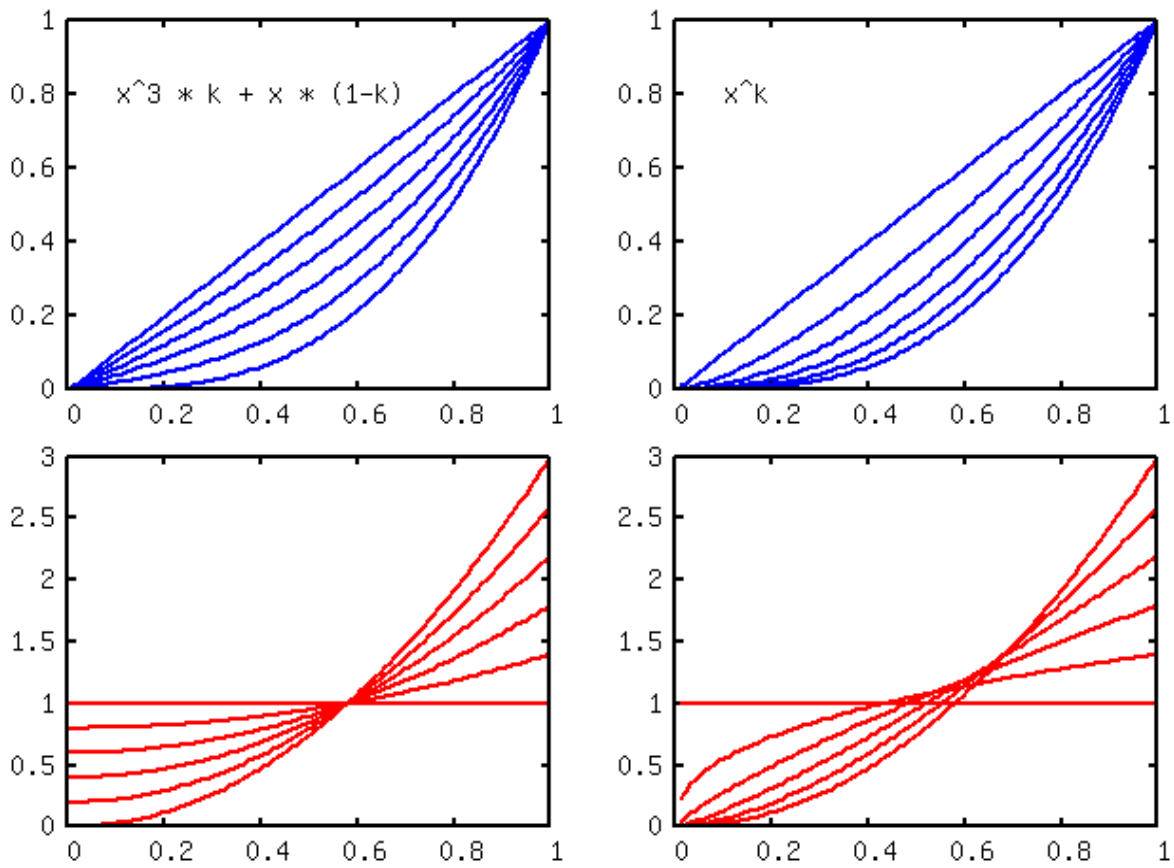
This diagram shows both curves, the polynomial and the original expo-function in a blue colored line. The lines in red show the derivation of the blue line. Therefore you can recognize the sensitivity of the stick at several working positions..

The polynomial was used in the implementation because we can evaluate it without usage of any floating point arithmetic's.

```c
#define RESX   512ul
#define RESK   100ul
uint16_t expou(uint16_t x, uint16_t k)
{
  // k*x*x*x + (1-k)*x
  return ( (unsigned long)x * x * x / 0x10000 * k /
            (RESX*RESX/0x10000)
        + (RESK-k) * x + RESK / 2 ) / RESK;
}
```

This implementation needs only one real 32-bit Integer-Division.

4.2.3 Trim

This block adds the current trim-value to the associated input value..

This trim value is generated by pressing the trim-keys. The range of this trim -value is -31 to +31. This value is directly shown in the graphical representation in the main screen. To extend this value range at up to +/. 512 we use a quadratic polynomial..

This polynomial allow a resolution of 1 in the mid range and it reduces the resolution in outer ranges. At the same time we can reach the whole value range in 31 steps.
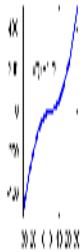
4.2.4 Mixer

The mixer block combines several input channels to the output channels. The inputs are weighted by some percentage-value and they are assigned to the outputs. In addition to this weight we can assign a user defined curve to this value and we can assign some delay-values to one mixer line.

4.2.5 Curves
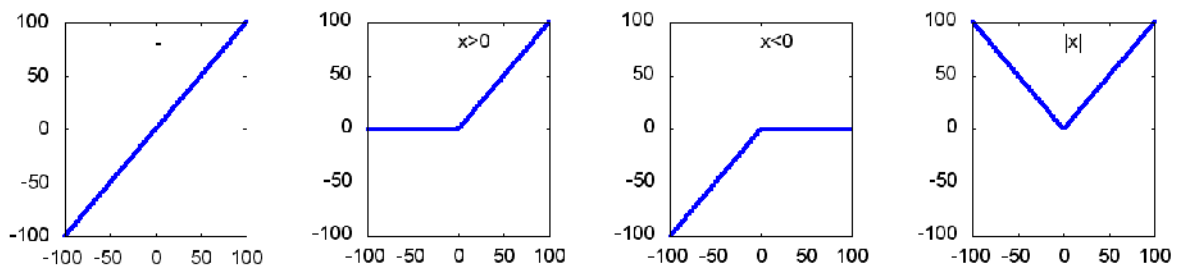
■ - : no curve,. y=x

■ >0 : y=x | x>0, else y=0

■ <0 : y=x | x<0 else y=0

■ |x| y=|x|

■ Cv1..Cv4 use one of four user defined curves.
Cv1 and Cv2 use 5 nodes at x=-100, -50, 0, 50, 100;
Cv3 and Cv4 use 9 nodes at x=-100, -75, -50, -25, 0, 25, 50, 75, 100

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4.2.6 Limits

Before this output values are sent to the receiver, they are checked against the maximum limitations given by the limits menu. Additionally each channel can become reversed.

4.3 Trainer mode

To use trainer mode, we need two separate radios..One radio works as a students radio and the other works as a trainer radio Please note that the students radio must have the power-button switched off..

▪ Power-Off is students radio, no sender module necessary.

▪ Power-On is trainer radio.

Both radios become connected with a stereo cable. After connecting the radios, the students radio gets powered by a small switch inside of the connection-plug.

Now change to the trainer menu and look for the students stick values..

Any further computations are done in the trainer device. Student and trainer values can be exclusive or added to each other.

4.4 Flash programming

4.4.1 Programming plug connections
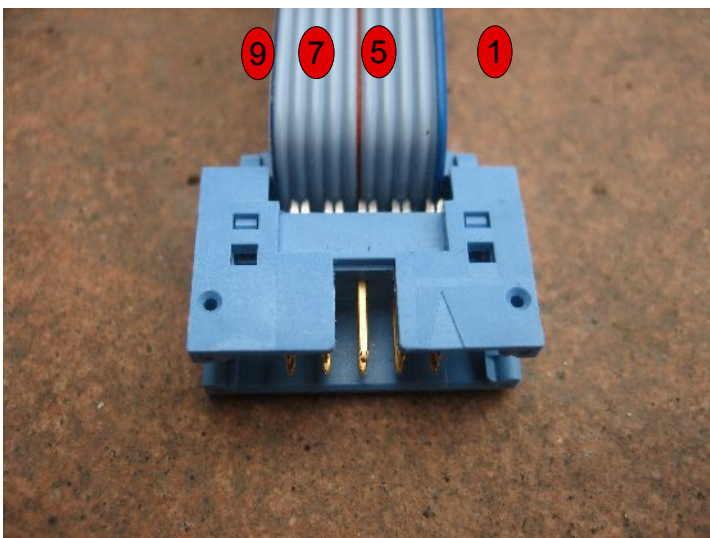
1. MOSI
2. -
3. -
4. -
5. RESET
6. -
7. SCK
8. -
9. MISO
10. GND
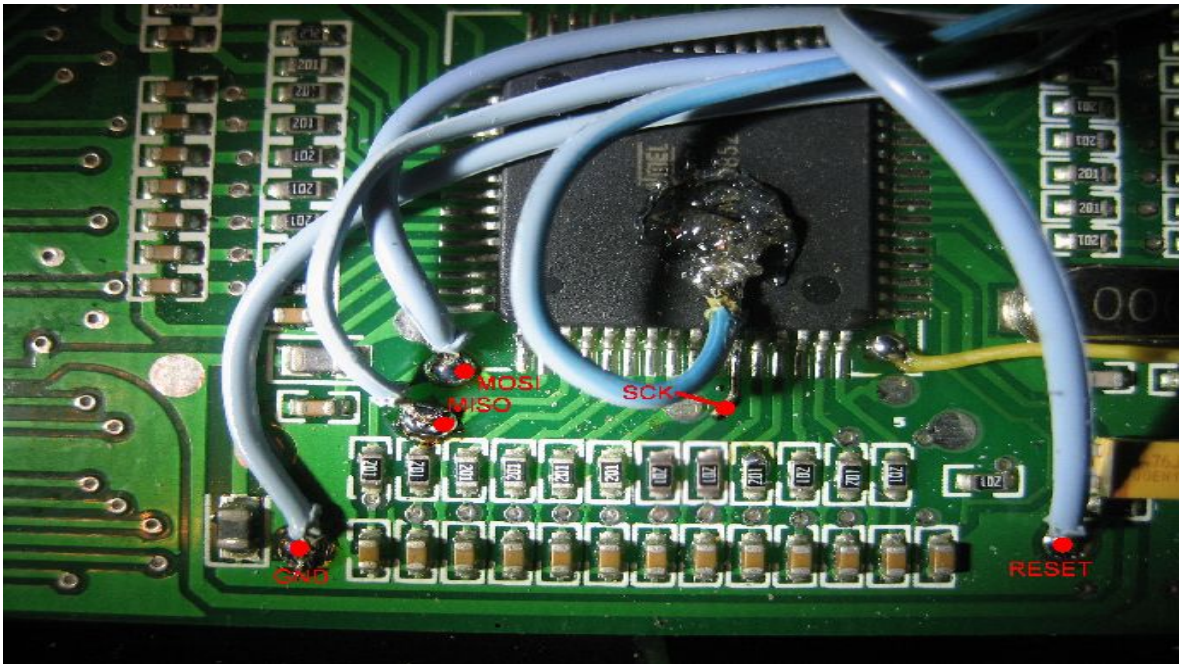
4.4.2 Fuse Bits

When you reload the firmware you do not need to change the fuses in any way. If this does happen I have listed my original values:

```
sig=1e,96,02,ff  Atmel AVR ATmega64
Lock Bits:            0xff 0b11111111
Fuses low:            0x0e 0b00001110
Fuses high:           0x89 0b10001001
Fuses ext:            0xff 0b11111111
```

4.5 LCD Back light

In rcline-forum its described how to install an EL-Back light behind the LCD-Display see here:
http://www.rclineforum.de/forum/thread.php?
threadid=239048&sid=&threadview=0&hilight=&hilightuser=&page=22
The th9x is prepared to switch on and off this back light by means of an unused port Bit of the controller (Pin PB7). You need only a few additional components. In the schematic diagram you see an example how to connect the controller via one single FET (BS170) to a 5V-Inverter and then to the EL-Back light. In case of using an inverter with another input voltage, you have to change the diagram at the VC-side of

the inverter. The FET remains the same. In the picture you see a yellow cable which connects to the PB7 of the controller.
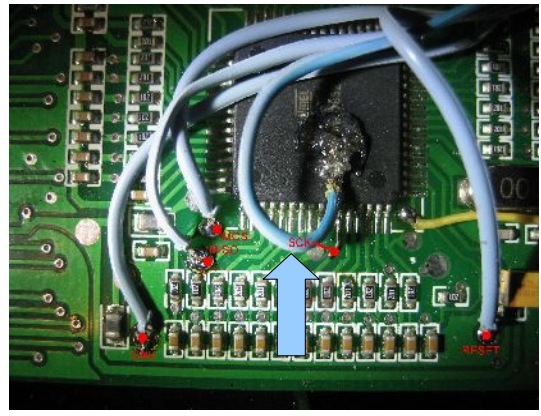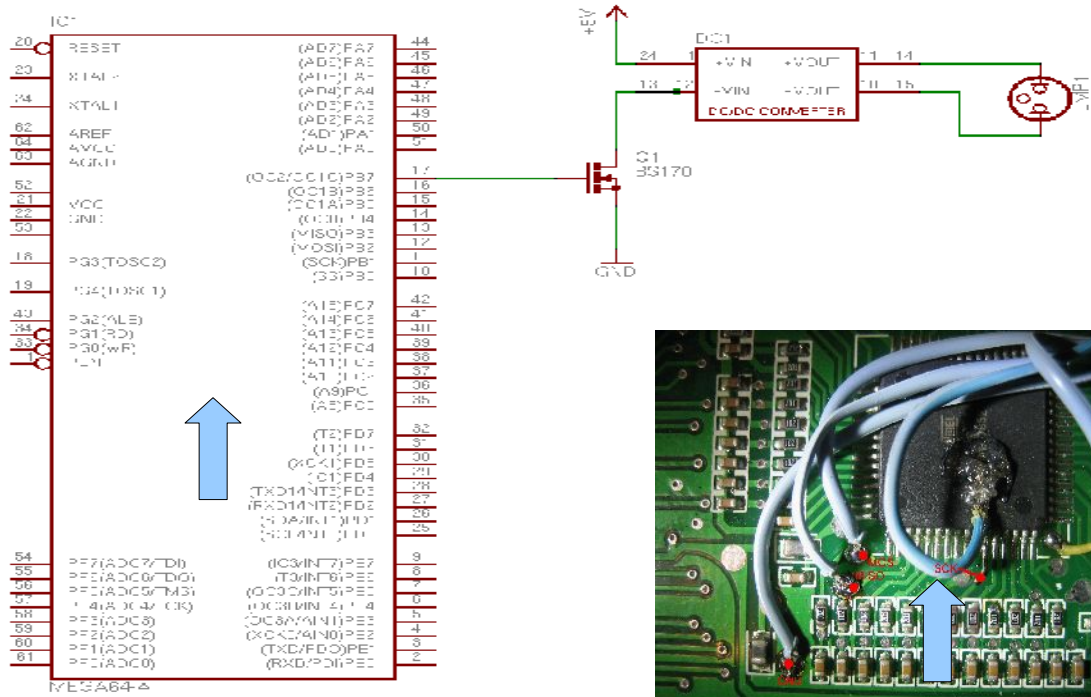
5 Programming examples

Basics:

Unlike other radios, there are no ready-mixed programs (Plane, Heli). This makes the programming more complex, but less restrictive. The solution shown here is very flexible. However, setting the model with the desired functions may take a little more thought, but the system is very easily understood.

You can use all 8 outputs for arbitrary functions (servos). So there is no specific assignment, as with other computer radios.

5.1 Glider or powered plane with rudder, elevator and aileron

5.1.1 Assignment of the channels

Channel 1:	Rudder
Channel 2:	Elevator
Channel 3:	left aileron
Channel 4:	right aileron
Channel 5:	Motor

5.1.2 Special control functions:

■ Each aileron is controlled with a separate servo so that they can be used with P1 as air brakes.

```
MIXER              5/7
CH1  100% RUD
CH2  100% ELE
CH3 -100% AIL
     100%  P1      x>0
CH4  100% AIL
     100%  P1      x>0
CH5  100% THR
```

5.1.3 Explanation

♦ The control functions RUDder, ELEvator and THRottle are transferred 1:1 to the outputs 1, 2 and 5..

♦ P1 (airbrakes) will output both channel 3 as well as 4. Here only positive values are taken into account because otherwise the negative values of P1 would result in flaps movement into the wrong direction.

♦ The ailerons are mixed one positive and the other negative, so that they move in opposite directions.

♦ However, if the servos are connected mirror inverted (which is probably the normal case) then one output channel has to be inverted in the LIMITS-menu.

Channel 1:	*Rudder*	*1:1 Stick Rudder*
Channel 2:	*Elevator*	*1:1 Stick Elevator*
Channel 3:	*Aileron left*	*-100% Stick Aileron* *1:1 airbrakes P1*
Channel 4:	*Aileron right*	*1:1 Stick Aileron* *1:1 airbrakes P1*
Channel 5:	*Motor*	*1:1 Stick THROTTLE*

5.2 Glider with 4 flaps

5.2.1 Assignment of the channels:

Channel 1:	*Rudder*
Channel 2:	*Elevator*
Channel 3:	*Aileron left outside*

Channel 4:	flaps left inboard
Channel 5:	Aileron right outside
Channel 6:	flaps right inboard

5.2.2 Special control functions:

- Inboard flaps shall be used as airbrakes and for aileron assistance

- The outer and inner flaps are to be placed on different positions (high speed, thermal flight ...) selected by a switch.

- When setting the flaps the elevator is to be corrected delayed

- On landing, the butterfly position should be used, in which the ailerons are up and the inner flaps down.

```
MIXER                5/7
CH1  100% RUD
CH2  100% ELE
     100% MAX   THR  cv1
CH3  100% AIL
     -50% MAX   THR    s
      10%  P1   RUD
CH4   10% AIL
```

```
MIXER                5/7
CH4   10% AIL
     100% MAX   THR    s
      10%  P1   RUD
CH5  100% AIL
     -50% MAX   THR    s
     -10%  P1   RUD
CH6   10% AIL
```

```
MIXER                5/7
CH6   10% AIL
     100% MAX   THR    s
     -10%  P1   RUD
CH7
CH8
 X1
 X2
```

```
EDIT MIX CH2
     MAX  SRC
     100  PRC
     cv1  CURVE
     THR  SWTCH
< 0  > 3  SPEED

    RM remove [Menu]
```

```
CURVE 1
     0
     0
     0
     0
    25
   PRESET
```
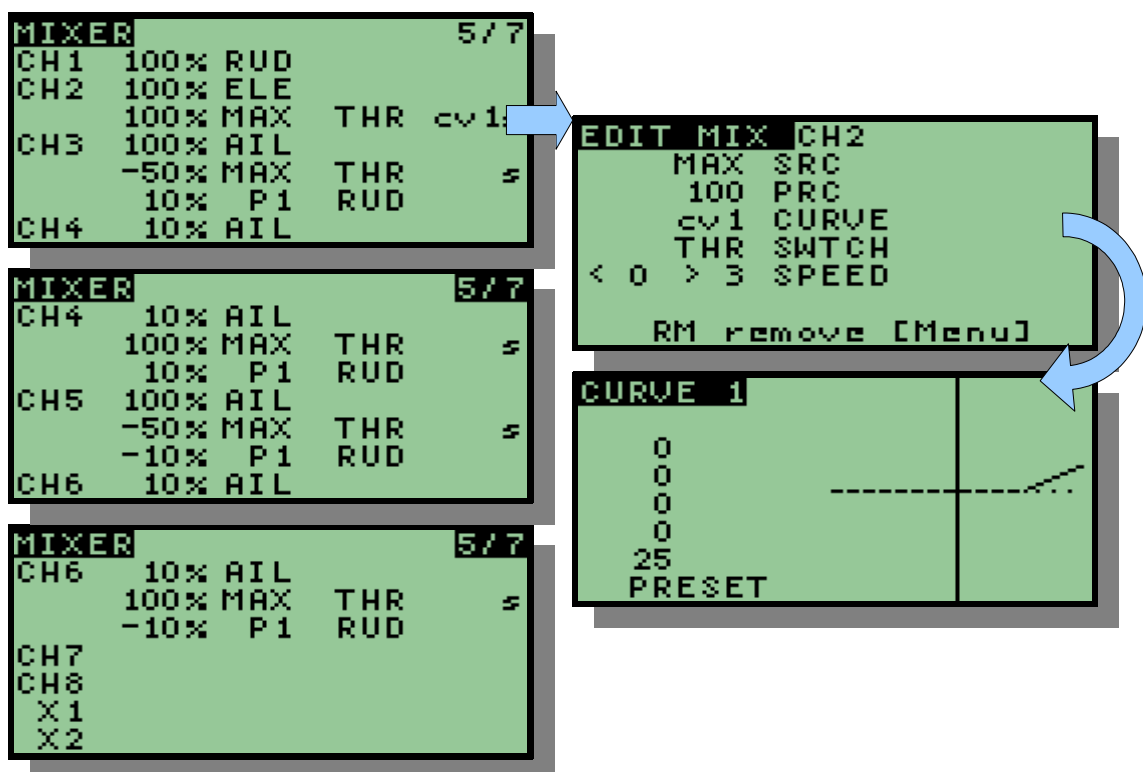
5.2.3 Explanation

- Butterfly-mode is activated with THR-switch

- The flight-phases are selected with the RUD-switch and the intensity is selected with P1.

Channel 1:	Rudder	1:1 Stick Rudder
Channel 2:	Elevator	1:1 Stick Elevator 25% when airbrakes are active; this is delayed by Curve1 and the speed-settings
Channel 3:	Aileron left outside	1:1 Stick Aileron -50% Butterfly inverse 10% P1 during flight-mode (RUD-switch)
Channel 4:	flaps left inboard	When THR is set then the flaps are deployed slowly 10% Aileron is added 10% P1 during flight-mode (RUD-switch)
Channel 5:	Aileron right outside	1:1 Stick Aileron -50% Butterfly inverse -10% P1 during flight-mode (RUD-switch)
Channel 6:	flaps right inboard	When THR is set then the flaps are deployed slowly 10% Aileron is added -10% P1 during flight-mode (RUD-switch)

5.3 Powered plane with retractable landing gear and landing gear doors

DST	PRC	SRC	SWTCH	CURVE	FADE	
..						
CH5	100%	FUL	GEA	x<0	< 5	> 5
CH6	100%	FUL	GEA	x>0	< 5	> 5

5.4 Helicopter with 120° Swash Plate

DST	PRC	SRC		
CH1	72%	ELE	1	
CH2	-36%	ELE	2	50% of 1
	62%	AIL	3	86% of 1
CH3	-36%	ELE	4	50% of 1
	-62%	AIL	5	like 3

5.5 Helicopter with 120° Swash Plate and Pitch

DST	PRC	SRC		
CH1	72%	ELE	1	
	30%	THR	2	
CH2	-36%	ELE	3	50% of 1
	62%	AIL	4	86% of 1
	30%	THR	5	like 2
CH3	-36%	ELE	6	50% of 1
	-62%	AIL	7	like 4
	30%	THR	8	like 2

5.6 Phase switch

As in Example 5.2.2 this can be setup by a switch, in conjunction with a poten-
tiometer or a fixed value, an offset can be added on each channel.