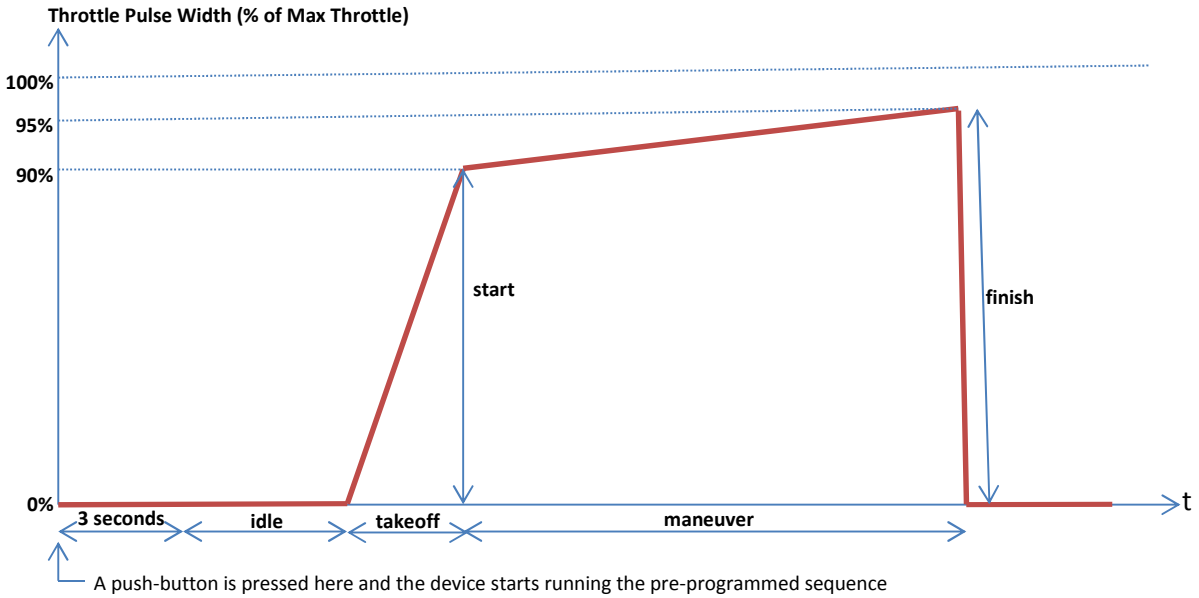
Programmable ESC Driver for Electric Control Line Model Aeroplanes

Document Version 2.0

This device allows you fly control-line model aeroplanes using electric brushless motors and ESC (Electronic Speed Controller). Brushless motors and ESCs are normally used in radio controlled (RC) electric model aeroplanes.

This device produces throttle signal required by ESCs, thus effectively substituting radio control RXs. The throttle signal is fully programmable to allow for adjustable timing and rpm settings, which are critical to flying control-line model aeroplanes.

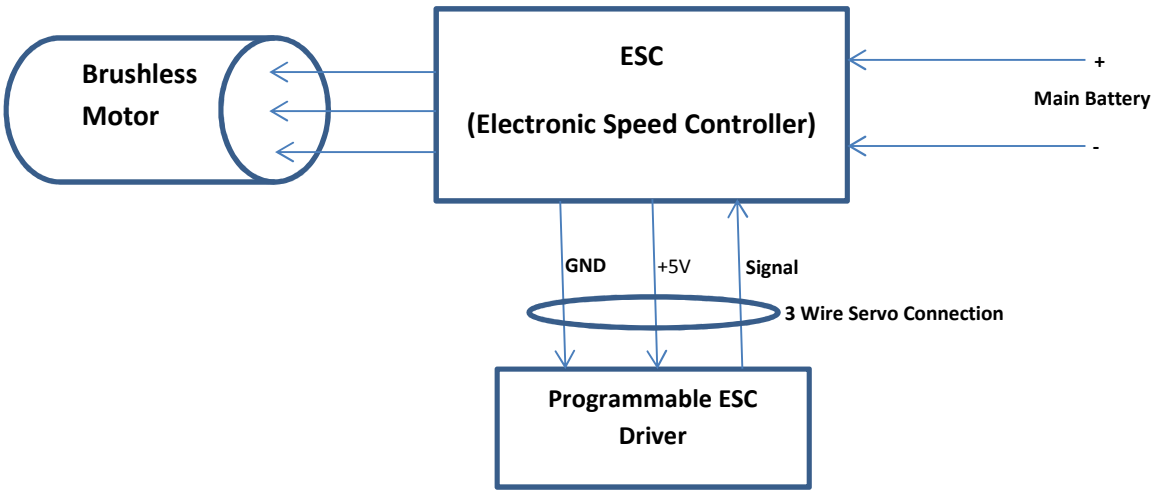


The Programmable Parameters (refer to the graph above)

Name	Min Value	Max Value	Description
idle	1 second	65 seconds	The preset time period for the pilot to get ready. In this period, the throttle is held at 0%.
takeoff	1 seconds	129 seconds	The preset time period for the throttle to ramp up from 0% to the preset **start** throttle value.

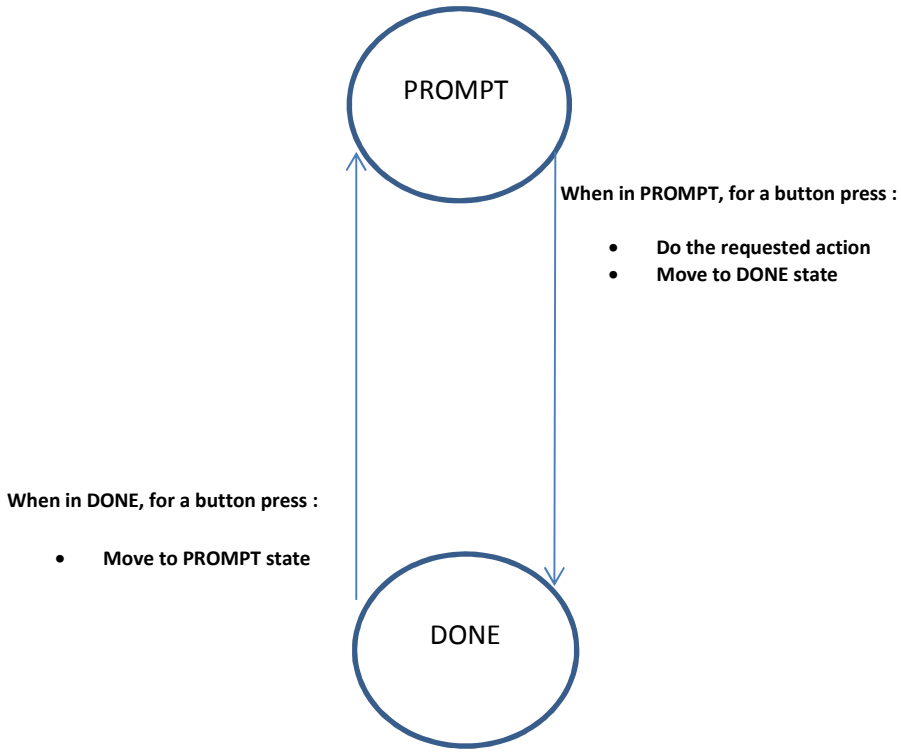
maneuver	30 seconds	632 seconds	The preset time period for the normal **maneuver.**
start	50% of max throttle	100% of max throttle	The preset throttle to start the **maneuver.**
finish	50% of max throttle	100% of max throttle	The preset throttle to reach at the end of the **maneuver**

Typical Wiring Diagram



Simple LED and Push Button Based User Interface

The device operates in 2 simple states namely PROMPT state and DONE state.



PROMPT State

The LED is blinking, the system waits for user to give command by setting the DIP switch and finally enter the command by pressing the push-button.

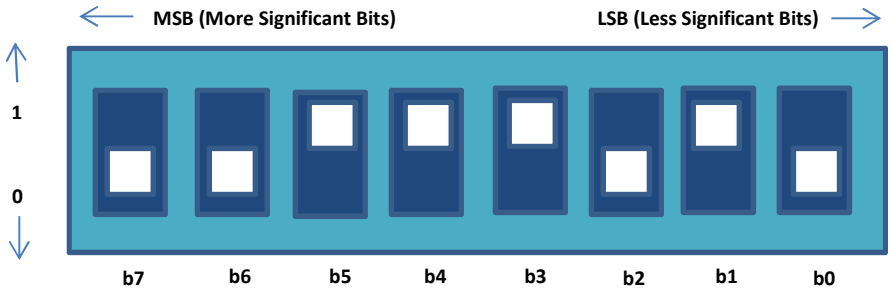
DONE State:

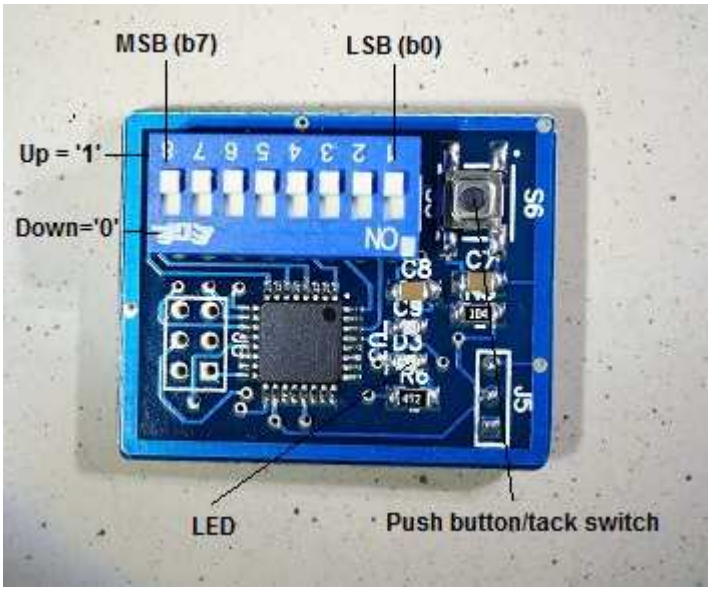
The LED is glowing, the system has done the requested action successfully and now wait for user to confirm by pressing the push-button.

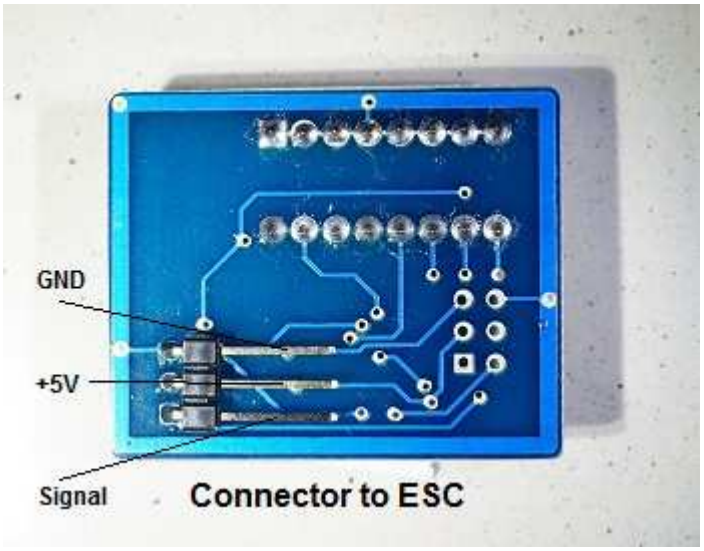
Board Layout, Switches and Connector Orientation

For example,

$(00111010)_2$ ➔







Parameter Settings (refer to the graph on the first page)

PARAMETER	b7	b6	b5	b4	b3	b2	b1	b0
				N is 5 bit binary number formed by (b4 b3 b2 b1 b0)				
idle	0	0	1	N determines a value in the range of [1 second, 65 seconds) with the following formula, **idle = 1s + [N*(65s - 1s)] / 32**				
start	0	1	0	N determines a value in the range of [50%, 100%) of Max Throttle with the following formula, **start = 50% + [N*(100% - 50%)] / 32**				
takeoff	0	1	1	N determines a value in the range of [1 second, 129 seconds) with the following formula, **takeoff = 1s + [N*(129s – 1s)] / 32**				
finish	1	0	0	N determines a value in the range of [50%, 100%) of Max Throttle with the following formula, **finish = 50% + [N*(100% - 50%)] / 32**				
maneuver	1	0	1	N determines a value in the range of [30 seconds, 632 seconds) with the following formula, **maneuver = 30s + [N*(632s – 30s)] / 32**				

***All formulas assume standard arithmetic precedence: Division ('/') takes precedence over addition ('+')**

Example 1: we want to set parameter **start** to 90%.

Formula for **start**:

start = 50% + [N * (100% - 50%)] / 32

So, for **start**=90%, we have,

90% = 50% + [N*(100% - 50%)] / 32

Solving for N and rounding the value to the nearest integer, we get N = 26

N = 26 ➔ or in 5 bit binary, N = $(11010)_2$

Concatenating the 3 more significant bits (b7 b6 b5 - for **start** obtained from the table above) with the 5 bit N value 11010 we just calculated. We have,

(b7 b6 b5) for parameter **start** as per table above			The 5 bit binary value of N we just calculated above				
0	1	0	1	1	0	1	0

So, we need to set the DIP Switch to $(01011010)_2$.

1. Bring the device to the PROMPT state (Blinking LED).
2. Set the DIP Switch to the value above $(01011010)_2$.
3. Press the push-button to apply the setting. (note: press once only)
4. Make sure you now see device in DONE state (Glowing LED).
5. Press the push-button to go back to PROMPT state and you are now ready to set another parameter…

Command to Perform an Action

Apart from setting the parameters, we can also command the device to perform some action. Here is the list of the available actions.

ACTION	**b7**	**b6**	**b5**	**b4**	**b3**	**b2**	**b1**	**b0**
						N is 3 bit binary number formed by (b2 b1 b0)		
<u>Save</u> the current set of parameter to the persistent Profile N	1	1	1	0	0	Profile N		
<u>Load</u> from the persistent Profile N onto the current set of parameters	1	1	1	0	1	Profile N		
<u>RUN</u> the flying sequence	1	1	1	1	1	1	1	1

Beware of the '**RUN the flying sequence**' action. If you give this command by accident, the only way to cancel it is to disconnect the main battery.

All settings are stored in non-volatile memory. There should be no worries about losing changes. The next time you power up the device, your last change will be there instantly.

When performing an action, the LED is off. It can happen in a very short duration, for example when applying a setting to a parameter value, which takes less than a second. This is unnoticeable. However, the '**RUN the flying sequence**' action takes several minutes, definitely we will notice that the LED is off. In this situation, we are likely to observe the spinning propeller instead of this device.

First Time Power Up

When power is first applied to a brand new device, the device performs power up reset. Right after the reset, the current set of parameters are having factory default values as follows,

Factory Default Values

idle	start	takeoff	finish	maneuver
60 seconds	**95% of Max Throttle**	**5 seconds**	**100% of Max Throttle**	**180 seconds**

Although we have made these values as widely acceptable as possible, they can't be considered as fail safe values for your model! Depending on your model, your model may crash or may still fly safely using these default values.

For your model to fly the best, you must calculate, adjust and tune each parameter carefully.

Persistent Profiles

The device has 8 persistent profiles. Numbered from 000, 001, 010…until 111.

Except profile 000, each of them is ready to become a storage space of the current set. However, please note that saving onto a profile will overwrite whatever was saved previously in the profile. There will be no warning about this.

Profile 000 is special because profile 000 is actually the current set. Saving onto and loading from this profile do not have any effects.

You can use persistent profile feature to store sets of parameters, which you may want to use for certain flying conditions. For example, conditions related to various weather situations, for example levels of wind speed.

For brand new devices, all persistent profiles uniformly store default values. So, if you accidentally load from a profile before ever saving onto it, your current set will have the factory default values. Please beware.

Happy Flying!

APPENDIX A:

The Scale of Five Bit Binary Unsigned Integer

N	5 Bit Binary
0	0 0 0 0 0
1	0 0 0 0 1
2	0 0 0 1 0
3	0 0 0 1 1
4	0 0 1 0 0
5	0 0 1 0 1
6	0 0 1 1 0
7	0 0 1 1 1
8	0 1 0 0 0
9	0 1 0 0 1
10	0 1 0 1 0
11	0 1 0 1 1
12	0 1 1 0 0
13	0 1 1 0 1
14	0 1 1 1 0
15	0 1 1 1 1
16	1 0 0 0 0
17	1 0 0 0 1
18	1 0 0 1 0
19	1 0 0 1 1
20	1 0 1 0 0
21	1 0 1 0 1
22	1 0 1 1 0
23	1 0 1 1 1
24	1 1 0 0 0
25	1 1 0 0 1
26	1 1 0 1 0
27	1 1 0 1 1
28	1 1 1 0 0
29	1 1 1 0 1
30	1 1 1 1 0
31	1 1 1 1 1

APPENDIX B:

ESC Driver for e-CL

b7 b6 b5	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1					
N	**idle**	**start**	**takeoff**	**finish**	**maneuver**	5 bit binary				
	time	power	time	power	time					
	(sec)	(% of max throttle)	(sec)	(% of max throttle)	(sec)	**b4**	**b3**	**b2**	**b1**	**b0**
0	1	50	1	50	30	0	0	0	0	0
1	3	52	5	52	49	0	0	0	0	1
2	5	53	9	53	68	0	0	0	1	0
3	7	55	13	55	86	0	0	0	1	1
4	9	56	17	56	105	0	0	1	0	0
5	11	58	21	58	124	0	0	1	0	1
6	13	59	25	59	143	0	0	1	1	0
7	15	61	29	61	162	0	0	1	1	1
8	17	63	33	63	181	0	1	0	0	0
9	19	64	37	64	199	0	1	0	0	1
10	21	66	41	66	218	0	1	0	1	0
11	23	67	45	67	237	0	1	0	1	1
12	25	69	49	69	256	0	1	1	0	0
13	27	70	53	70	275	0	1	1	0	1
14	29	72	57	72	293	0	1	1	1	0
15	31	73	61	73	312	0	1	1	1	1
16	33	75	65	75	331	1	0	0	0	0
17	35	77	69	77	350	1	0	0	0	1
18	37	78	73	78	369	1	0	0	1	0
19	39	80	77	80	387	1	0	0	1	1
20	41	81	81	81	406	1	0	1	0	0
21	43	83	85	83	425	1	0	1	0	1
22	45	84	89	84	444	1	0	1	1	0
23	47	86	93	86	463	1	0	1	1	1
24	49	88	97	88	482	1	1	0	0	0
25	51	89	101	89	500	1	1	0	0	1
26	53	91	105	91	519	1	1	0	1	0
27	55	92	109	92	538	1	1	0	1	1
28	57	94	113	94	557	1	1	1	0	0
29	59	95	117	95	576	1	1	1	0	1
30	61	97	121	97	594	1	1	1	1	0
31	63	98	125	98	613	1	1	1	1	1