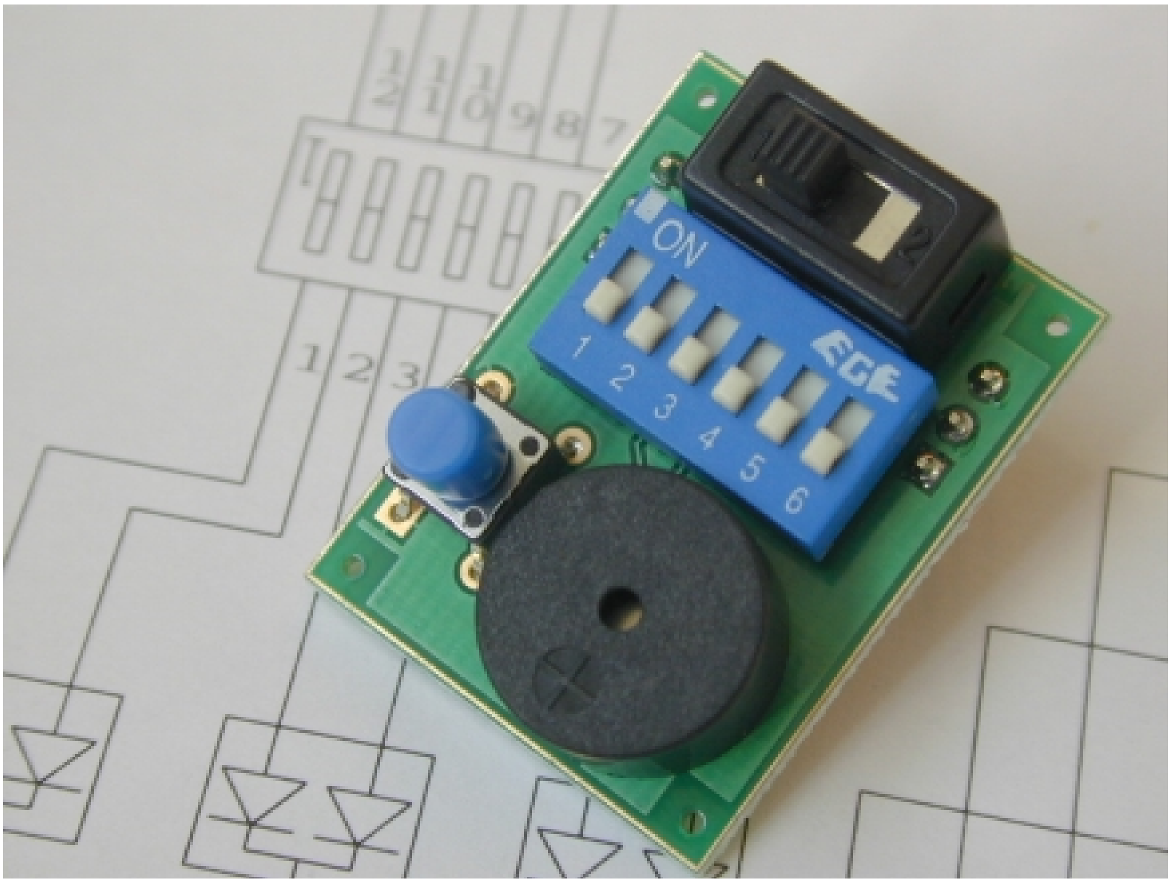
FlytProf-Four

Free-Flight Controller



User Manual

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Introduction

FlytProf-Four is a small, self-contained and simple-to-operate microprocessor based unit designed to provide electric free-flight modellers with a means of controlling an aircraft's flight profile. It operates as the central, controlling element of a Flight Control System by stepping through a pre-programmed sequence of timed Phases and, for each Phase, provides two standard R/C servo drive outputs.

The first of these is intended to drive an external motor speed controller [ESC] to provide power control and the other, usually connected to a servo, provides an auxiliary [AUX] function and is connected to the PCB terminal marked ‘DTS’.

FlytProf-Four enables complex flight profiles to be implemented by providing 4 fully independent, user-programmable Flight Phases, which may be considered to provide the Rise-off-Ground, Climb-Out, Cruise and Glide sections of a typical flight. The programmable Flight Phases are bracketed by two fixed Phases; the Launch Phase, which runs the motor up to the speed set in the R.O.G. Phase while still on the ground and the Landing Phase, in which the motor is shut down to bring the model down.

Each of the 4 programmable Flight Phases has programmable ESC drive, AUX drive and Duration parameters – see the Phase Timing and Signal Table section. Setting of the three programmable parameters is achieved by means of an on-board 6-way DIP switch and timed push-button presses and, once entered, the flight profile program is stored in non-volatile memory [NVM] ready for immediate use on the flying field.

There is no practical limit to the number of times the parameters may be re-programmed.

FlytProf-Four has two operating modes, known as Flight and Programming. Selection of the operating mode and control of the unit in each mode is performed by the board mounted push-button with acoustic feedback provided by the on-board buzzer.

FlytProf-Four may be identified within the FlytProf family by the blue push-button.

Flight Mode

Powering-up FlytProf-Four without pressing the push-button causes it to enter Flight Mode in a Pre-Launch state. In this condition the ESC drive is set to 1.00ms – in order to 'arm' the speed controller – and the AUX drive is set to its central position of 1.50ms. The buzzer emits a continuous sound indicating that the unit is waiting for the push-button to be pressed.

Momentarily pressing the push-button causes FlytProf-Four to enter the Launch Phase in which it sets the AUX output and ramps up the motor speed to the values programmed in for the first Flight Phase. Once the motor has reached its programmed speed FlytProf-Four automatically enters Flight Phase 1 (the R.O.G. Phase) and begins timing its Duration. Short 'ticks' are emitted by the buzzer at 1-second intervals confirming that the timing system is operating correctly.

On expiry of the timer, FlytProf-Four enters the next Flight Phase in which the ESC and AUX drives are set to the corresponding user-programmed values and the duration timer is restarted with the next programmed value. This process continues until each of the 4 Flight Phases has been executed and, at the end of the Glide Phase, the unit enters the Landing Phase shutting down the motor to bring the model down.

On recovery of the model the buzzer will be heard emitting 1-second ‘ticks’ indicating that the flight sequence completed normally.

To accommodate flights that end prior to the programmed duration pressing the push-button until a continuous sound is heard, and then releasing it, at any time after the completion of Flight Phase 1 cancels the current flight timing sequence and places FlytProf-Four back into its Pre-Launch condition ready to enter a new Launch Phase.

This permits a new sequence to be started without the need to cycle the power.

Flight Phase Timing

To increase the unit’s flexibility, the Duration of each Flight Phase is programmable with two resolutions. Settings in the first section of the DIP Switch Settings Table offer timings of between 1 and 15 seconds in 1-second steps while the remaining 3 sections permit Flight Phase Duration values from 20 seconds to 255 seconds (4.25 minutes) in 5-second increments to be programmed.

NOTE: contrary to typical mechanical timers in which all timers are started at launch, FlytProf-Four starts timing each Flight Phase at the expiry of the previous Phase. Thus, for the normal application, a setting of 10 seconds for each Phase results in a flight lasting for 40 seconds.

In-Flight Safety Features

FlytProf-Four has two safety features built in to its program. The first of these is a battery voltage detection system which, in the event of a significant dip in supply voltage during a flight, causes the unit to re-enter its Pre-Launch condition shutting down the motor .

On recovering the model the activation of this mechanism may be determined by a continuous tone being emitted from the buzzer rather than the normal 1-second 'ticks'.

The second safety feature detects a stuck pushbutton. At the end of the first Flight Phase – R.O.G. – the pushbutton is checked and if it is found to be 'pressed' the unit immediately enters a Safety Phase shutting down the motor and setting the AUX output to its central position to bring the model down.

The buzzer issues a buzzing sound to indicate that this mechanism has been triggered and the power must be switched off to cancel this condition.

Programming Mode

Holding the push-button pressed while powering-up causes FlytProf-Four to enter Programming Mode, which it confirms by emitting 3 short 'beeps' from the buzzer. Releasing the push-button causes the buzzer to emit a continuous sound indicating that the unit is waiting for a button press. It is from this 'idle' state that the user first selects which of the 4 Flight Phases is to be programmed.

The Flight Phase selection sequence is started by pressing and holding the push-button. The buzzer then starts emitting a sequence of four 1-second long 'silences' followed by 1-second long 'bursts-of-bips' – indicating the four possible Phase selections. Releasing the button during any one of the four 1-second 'burst-of-bips' determines which of the four Phases is to be programmed in the following Phase Parameter programming section. The Flight Phase selection is confirmed by the buzzer emitting a corresponding number of short ‘bips‘.

NOTE: the Flight Phase selection sequence is cyclic and so, if the intended phase selection slot is missed, then simply keeping the push-button pressed until the appropriate slot in the next cycle will make the selection correctly. The start of a new selection cycle is indicated by an extended period of silence.

Once the Flight Phase has been selected FlytProf-Four automatically enters the next section of the programming process permitting the corresponding three Phase Parameters to be programmed. It enters an ‘idle’ state, which is indicated by the buzzer emitting a continuous tone, and it is in this ‘idle’ state that the DIP switch may be set to determine the value of the parameter to be programmed – see the DIP Switch Settings Table.

Once the DIP switch has been set, the Phase Parameter programming sequence is started by pressing and holding the push-button. This immediately silences the buzzer, which then starts emitting a sequence of three 1-second long 'silences' followed by 1-second long 'beeps' – indicating the three Phase Parameter programming slots. Releasing the button during one of the three 1-second 'beeps' determines which of the parameters is to be programmed:-

1. Motor Speed Pulse Width — in ms
2. Auxiliary Output Pulse Width — in ms
3. Flight Phase Duration — in seconds – see DIP Switch Settings table

Confirmation of programming is indicated by the emission of two short 'beeps' and FlytProf-Four then returns to its idle state, with the buzzer sounding continuously, waiting for a push-button press to initiate programming of the next Phase Parameter.

Any, or all, of the Phase Parameters may be programmed as many times as required during each programming session.

NOTE: the Phase Parameter programming sequence is cyclic and so, if the intended programming slot is missed, then simply keeping the push-button pressed until the appropriate slot in the next cycle will program the unit correctly. The start of a new Phase Parameter programming cycle is indicated by an extended period of silence.

To exit Programming Mode switch off the power when FlytProf-Four is in its idle state and emitting a continuous sound.

To program the Phase Parameters for another Flight Phase, re-enter Programming Mode by powering-up the unit while depressing the push-button.

Phase 4 AUX Output Setting

During the fixed Landing Phase FlytProf-Four automatically sets the ESC output to 1.00ms to shut the motor down and, additionally, it maintains the user's programmed setting for the AUX output from Phase 4.
It is, therefore, important to consider this aspect when deciding on the value to be programmed for the AUX output during Phase 4.

Default Settings

FlytProf-Four is shipped with a set of default Parameter values as indicated by the Default Settings Table. These provide a range of ESC and AUX output settings and short Flight Phase durations and are suitable for initial land-based testing.

They may be restored separately for each of the four Flight Phases, as a set of three Parameters, at any time by first selecting the appropriate Flight Phase and setting the DIP switch to the all-zeros code and programming any one of the 3 Phase Parameters. Confirmation that the default values for the selected Flight Phase have been successfully restored is indicated by the buzzer emitting 4 short 'beeps' rather than the usual two.

The Flight Control System

Power Supply

The Flight Control System is powered by the Battery Eliminator Circuit [BEC] within the ESC – see the Specification Table section. Using this method the flight-pack voltage is reduced within the ESC to about 5V and is typically provided on the central pin of its servo-lead connector.

The FlytProf-Four PCB is wired to route this supply via the Power Switch to the on-board electronics and to the central pin of the AUX [DTS] connector. Thus the flight-pack provides power for the entire Flight Control System saving the weight and bulk of a separate pack.

NOTE: in order to prevent possible erratic operation in flight, it is important to verify, by means of ground-based testing, that the BEC can provide enough current to drive the AUX Servo under worst case battery and load conditions.

Electronic Speed Controller

The choice of ESC is not critical and may be selected from the available range based on the preferred motor type, brushless or otherwise, and power rating. It must be capable of accepting the standard R/C servo control signal of a 20ms frame containing a 1-2ms positive-going pulse and interpreting a pulse width of about 1.00ms as zero power and a pulse width of about 2.00ms as full power.

Additionally, it must be verified that its on-board BEC can provide enough current to drive the chosen AUX Servo and that it will operate successfully from the desired flight-pack voltage – some ESCs place a limit on the maximum number of flight-pack cells if their on-board BEC is to be used.

Auxiliary Servo

The selection of AUX Servo is also not critical and should be based on the weight and power requirements of the model. During a typical flight the AUX Servo is idle for most of the time, operating for only a second or so at every Flight Phase change, and thus its overall power requirements are very low. Selecting a low-current servo will reduce the risk of control system failure due to battery voltage droop.

Connecting Up

Two non-polarised, 3-pin male connectors compatible with standard servo leads are fitted to the rear face of the PCB. They are identified by the acronyms 'ESC' and 'DTS' and are intended for connection to the Electronic Speed Controller and Auxiliary Servo respectively.

Connection orientation is indicated on the PCB by means of an irregular outline corresponding to the shape of a typical servo lead plug and the pin assignments of each of these 3-pin connectors conforms to the standard "0V : 5V : Signal" adopted by Futaba, JR, Hitec etc. – see PCB Component Layout.

It is recommended that a device for isolating the battery is included in the wiring harness, as shown on the Wiring Diagram, and using a suitably rated two-part connector will also provide a convenient connection point for recharging the flight-pack.

Power-Up Sequence

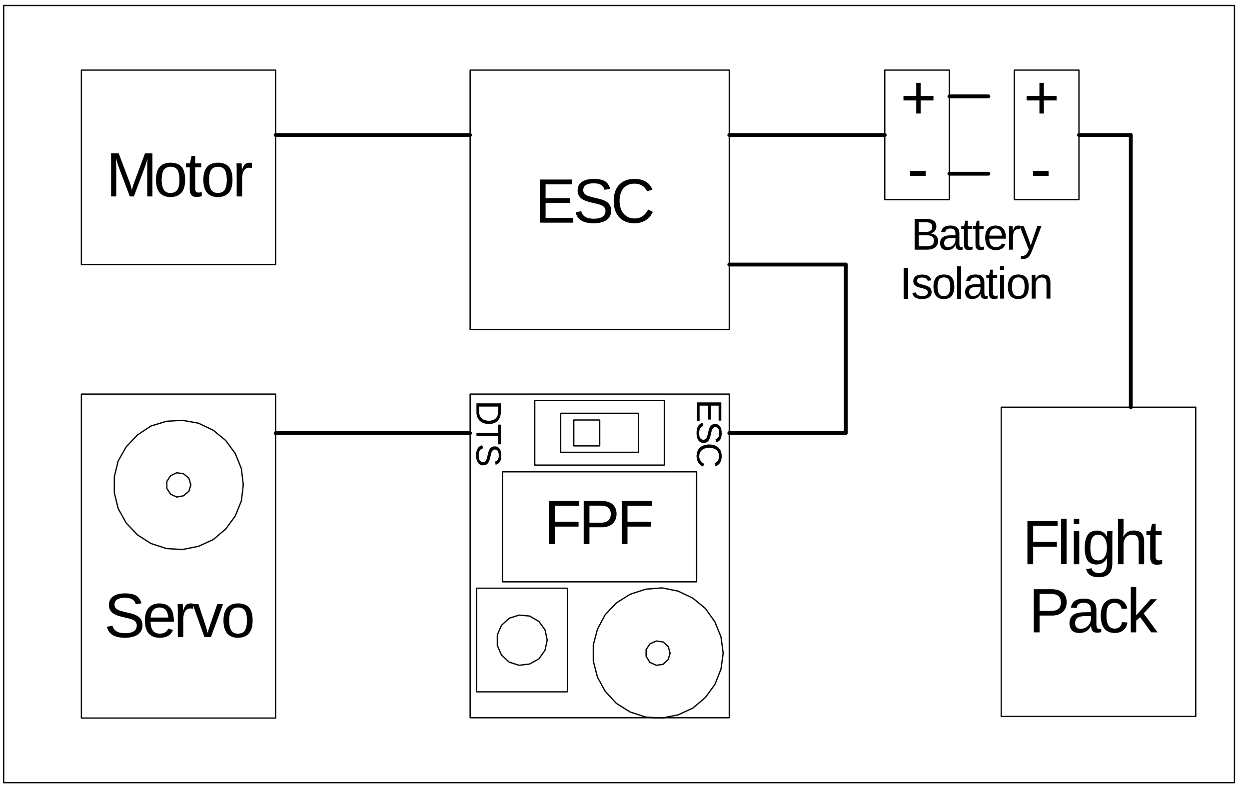
Before making the battery connection ensure that FlytProf-Four's Power Switch is in the Off position. Once the battery is connected the Flight Control System may be powered-up by moving the Power Switch to the On position.

Follow the reverse procedure to power the system down.

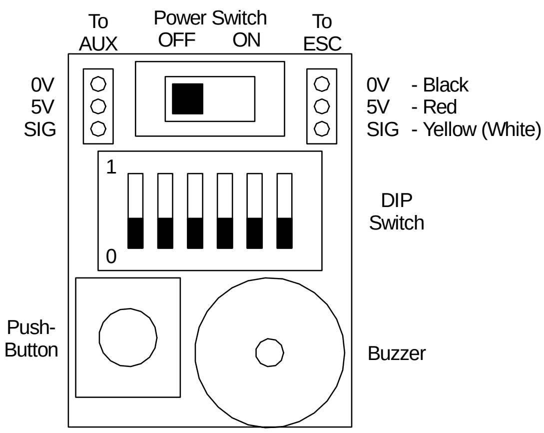
Acknowledgement

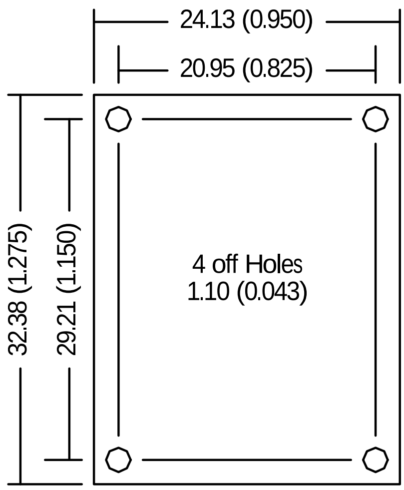
Thanks are due to Ian Middlemiss of Peterborough Model Flying Club for providing the original idea for the FlytProf free-flight controller range and also for his considerable efforts and guidance during the development and testing of this product.

Wiring Diagram



PCB Component Layout and Mechanical Details





Dimensions in mm (in)

Programming Examples

To aid the understanding of the Programming process this section provides a few 'worked examples' of Flight Profiles. For each example a textual description is given followed by a table detailing the Parameter settings for each Flight Phase.

Standard Flight – taking off from the ground

This example describes a typical R.O.G., Climb, Cruise, Glide Flight Profile. The AUX output is connected to the rudder servo and is used to both counteract motor torque during climb and also to set the model into a turn during Cruise and Glide to bring it home. For R.O.G. a high power setting is used for a few seconds, with corresponding right rudder to counteract motor torque. This is followed by a more gentle setting for a longer Climb phase and in the Cruise phase the motor power is reduced further and the rudder set slightly left to induce the turn. The Glide phase reduces the motor power still further and sets the rudder to a suitable position for Landing.

	Phase 1 – R.O.G.		Phase 2 – Climb		Phase 3 – Cruise		Phase 4 – Glide	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive	1.70 ms	101101	1.50 ms	000001	1.40 ms	100110	1.20 ms	110100
AUX Drive	1.70 ms	101101	1.60 ms	011001	1.40 ms	100110	1.40 ms	100110
Duration	5 secs	101000	10 secs	010100	15 secs	111100	20 secs	000010

Double 'Climb and Glide' Flight – hand launched

This example describes a hand-launched flight with two separate "Climb / Glide" sections. Phase 1 is re-assigned to provide the initial Climb and Phase 2 provides the first of the two Glide phases. Phases 3 and 4 are set to duplicate this. The intended flight pattern would be a 180 degree climb followed by a gradual low-power circling descent. A second, longer circular climb would be followed by a final circling descent into land.

	Phase 1 – Climb 1		Phase 2 – Glide 1		Phase 3 – Climb 2		Phase 4 – Glide 2	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive	1.55 ms	110001	1.35 ms	011010	1.55 ms	110001	1.10 ms	101000
AUX Drive	1.60 ms	011001	1.40 ms	100110	1.60 ms	011001	1.40 ms	100110
Duration	10 secs	010100	10 secs	010100	15 secs	111100	20 secs	000010

Timed De-Thermaliser Function – hand launched

To avoid the risk of model fly-away the AUX output may be used to provide a de-thermaliser function in conjunction with a release pin arrangement. Circling trim must be provided by a manual trim-tab in this example.

A high motor power setting is used for the Climb phase, followed by a reduced setting for the Cruise phase prior to shutting the motor down for an extended Glide phase. During all these phases the AUX servo is set to its initial, central position holding the release pin in place and at Phase 4 the release pin is pulled activating the DT mechanism. On recovering the model, the release pin may be re-inserted when FlytProf-Four is in its Pre-Launch condition with the AUX servo in its central position.

	Phase 1 – Climb		Phase 2 – Cruise		Phase 3 – Glide		Phase 4 – DT	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive	1.60 ms	011001	1.40 ms	100110	1.00 ms	100000	1.00 ms	100000
AUX Drive	1.50 ms	000001	1.50 ms	000001	1.50 ms	000001	2.00 ms	111111
Duration	10 secs	010100	10 secs	010100	30 secs	010010	3 secs	110000

Removing a Flight Phase

There may be occasions when all 4 Flight Phases are not required and this may be achieved by programming the unwanted Phases with minimum values for ESC Drive and Duration. This shuts down the motor and produces a Flight Phase that lasts for only 1 second – effectively removing it from the Flight Profile.

The choice of Phase to be removed is not critical but it is important to remember the following points:-

1. If a removed Phase is to be placed between two used Phases then ensure that the AUX output drive is set appropriately during the removed Phase.
2. If the removed Phase is to be Phase 4, ensure that its AUX output drive is set to a value appropriate for the fixed Landing Phase.

	Phase 1 – Climb		Phase 2 – Glide		Phase 3 – Removed		Phase 4 – Removed	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive	1.60 ms	011001	1.00 ms	100000	1.00 ms	100000	1.00 ms	100000
AUX Drive	1.70 ms	101101	1.50 ms	000001	1.50 ms	000001	1.40 ms	100110
Duration	10 secs	010100	30 secs	010010	1 sec	010010	1 sec	100000

NOTE: the shaded entries in the tables above show values that cannot be programmed exactly so the nearest permissible settings are used. In each case, the difference is negligible.

Blank Programming Tables

This section provides the user with some blank Programming Tables in a similar format to those given in the previous Programming Examples section.

Flight Title								
Ph. Name	Ph 1:		Ph 2:		Ph 3:		Ph 4:	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive								
AUX Drive								
Duration								

Flight Title								
Ph. Name	Ph 1:		Ph 2:		Ph 3:		Ph 4:	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive								
AUX Drive								
Duration								

Flight Title								
Ph. Name	Ph 1:		Ph 2:		Ph 3:		Ph 4:	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive								
AUX Drive								
Duration								

Flight Title								
Ph. Name	Ph 1:		Ph 2:		Ph 3:		Ph 4:	
Parameter	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.	Value	DIP Sw.
ESC Drive								
AUX Drive								
Duration								

Specification Table

Parameter	Min	Typ	Max	Units	Comment
Supply Voltage	4.5	5.0	6.0	Volts	Provided by ESC BEC function
Supply Current			1.5	mA	No external loads
ESC & AUX Servo Pulse Width Range	1.00		2.00	ms	
ESC & AUX Servo Pulse Amplitude	4.0		5.0	Volts	No external loads

Phase Timing and Signal Table

Phase	Parameter	Min	Typ	Max	Units	Comment
Pre-Launch (or Idle)	Duration	N/A				Determined by user with push-button
	ESC Drive pulse width	0.98	1.00	1.02	ms	Fixed
	AUX Servo pulse width	1.48	1.50	1.52	ms	Fixed
Launch	Duration	0.02		1.28	sec	Determined by Motor Speed setting
	ESC Drive pulse width	1.04		1.97	ms	Ramps up to programmed value
	AUX Servo pulse width	1.04		1.97	ms	Setting as for Flight Phase 1
Flight (any)	Duration	1		255	sec	See DIP Switch Settings table
	ESC Drive pulse width	1.04		1.97	ms	Programmable in 63 equal steps
	AUX Servo pulse width	1.04		1.97	ms	Programmable in 63 equal steps
Landing	Duration	N/A				
	ESC Drive pulse width	0.98	1.00	1.02	ms	Fixed
	AUX Servo pulse width	1.04		1.97	ms	Setting as for Flight Phase 4

Default Settings Table

Parameter	Flight Phase 1	Flight Phase 2	Flight Phase 3	Flight Phase 4	Units
ESC Drive pulse width	1.75	1.50	1.30	1.25	ms
AUX Drive pulse width	1.30	1.40	1.50	1.75	ms
Duration	5	10	15	10	secs

NOTE: all specification and timing values assume a nominal supply voltage of 5V.

DIP Switch Settings Table

DIP Switch Setting 123456	ESC Drive (ms)	AUX Drive (ms)	Flight Phase Duration (secs)	DIP Switch Setting 123456	ESC Drive (ms)	AUX Drive (ms)	Flight Phase Duration (secs)	DIP Switch Setting 123456	ESC Drive (ms)	AUX Drive (ms)	Flight Phase Duration (secs)	DIP Switch Setting 123456	ESC Drive (ms)	AUX Drive (ms)	Flight Phase Duration (secs)
000000	See Default Table			000010	1.27	1.27	20	000001	1.51	1.51	100	000011	1.75	1.75	180
100000	1.04	1.04	1	100010	1.28	1.28	25	100001	1.52	1.52	105	100011	1.76	1.76	185
010000	1.06	1.06	2	010010	1.30	1.30	30	010001	1.54	1.54	110	010011	1.78	1.78	190
110000	1.07	1.07	3	110010	1.31	1.31	35	110001	1.55	1.55	115	110011	1.79	1.79	195
001000	1.09	1.09	4	001010	1.33	1.33	40	001001	1.57	1.57	120	001011	1.81	1.81	200
101000	1.10	1.10	5	101010	1.34	1.34	45	101001	1.58	1.58	125	101011	1.82	1.82	205
011000	1.12	1.12	6	011010	1.36	1.36	50	011001	1.60	1.60	130	011011	1.84	1.84	210
111000	1.13	1.13	7	111010	1.37	1.37	55	111001	1.61	1.61	135	111011	1.85	1.85	215
000100	1.15	1.15	8	000110	1.39	1.39	60	000101	1.63	1.63	140	000111	1.87	1.87	220
100100	1.16	1.16	9	100110	1.40	1.40	65	100101	1.64	1.64	145	100111	1.88	1.88	225
010100	1.18	1.18	10	010110	1.42	1.42	70	010101	1.66	1.66	150	010111	1.90	1.90	230
110100	1.19	1.19	11	110110	1.43	1.43	75	110101	1.67	1.67	155	110111	1.91	1.91	235
001100	1.21	1.21	12	001110	1.45	1.45	80	001101	1.69	1.69	160	001111	1.93	1.93	240
101100	1.22	1.22	13	101110	1.46	1.46	85	101101	1.70	1.70	165	101111	1.94	1.94	245
011100	1.24	1.24	14	011110	1.48	1.48	90	011101	1.72	1.72	170	011111	1.96	1.96	250
111100	1.25	1.25	15	111110	1.49	1.49	95	111101	1.73	1.73	175	111111	1.97	1.97	255

Key: the ‘0s’ and ‘1s’ in the DIP Switch Setting columns represent the individual switches placed in the Off and On positions respectively

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