E-ZEE EFF4 – Electric Free Flight Timer Mk4

Note:
In response to customer feedback the motor run time maximum setting has been increased to 90 secs……so the timer is now designated the EFF4…..but other than that the features remain exactly the same as the EFF3

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Introduction

Electric Free Flight is clean and quiet, ideal for the 21st century environment. The huge Electric RC market ensures that components such as motors and ESC's for Free Flight are available at very attractive prices and are totally reliable. Battery technology has progressed such that the weight of an electric power train can be similar or better than conventional glow or diesel power.

Accurate and repeatable control of motor power, run and DT timing plus an optional RDT override make for enjoyable frustration free flying. The E-ZEE Free Flight timer has been designed and developed so that sports flyers can enjoy all these advantages at a realistic price.

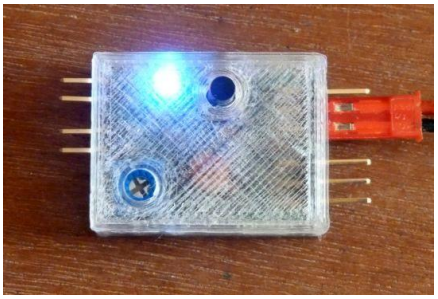
The timer controls motor speed and run-time (via an ESC) and after a further delay drives a D/T servo to terminate the flight.

0-100% motor speed is set by a single turn potentiometer on the timer

Motor run and D/T periods are set by using the timer mounted button and LED

The timer has an RDT interface which both powers the RDT receiver and processes its trip signal, allowing flights to be terminated at will.

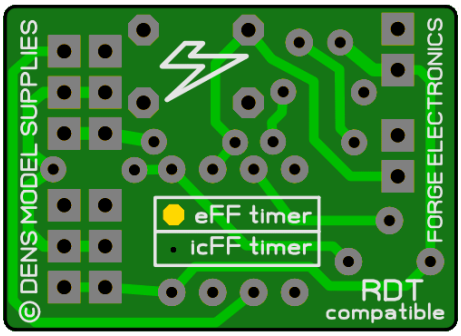
Available seperately is a 3D printed case in clear PETG (Polyethylene Terephthalate Glycol-modified!) is available. This provides mechanical protection for the timer and may make mounting considerably easier. The LED is enclosed but easily visible through the casing.



Key Features

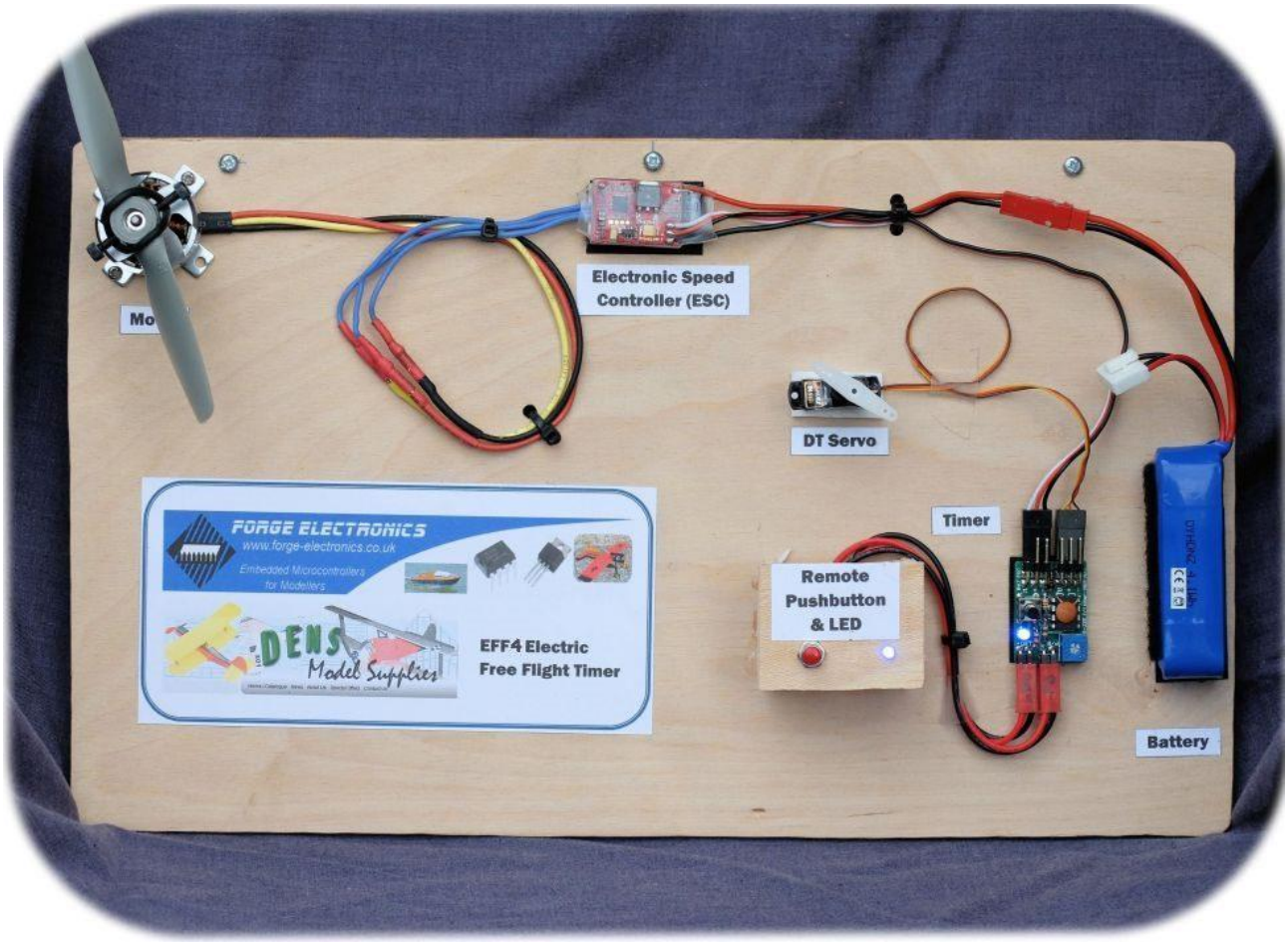
- motor run duration:- adjustable 1 to 90 seconds, set in 1 second increments
- d/t duration:- adjustable 10 seconds to 10 minutes, set in 10 second increments
- motor power:- adjustable at all times from zero to full throttle (by potentiometer)
- motor soft start:- adjustable 0 to 10 seconds
- motor run down:- adjustable 0 to 10 seconds
- option to reverse DT servo direction of rotation to suit installation in model
- RDT compatible
- push button immediately stops the motor at any point during the flight profile
- duration settings saved in memory – so a single button push can repeat the flight.
- provision to fit remote pushbutton and remote LED
- ESC configuration capability

IDENTIFICATION



This PCB is also used for an IC Free Flight Timer version, which of course has different firmware, so to distinguish between the two variants, the PCB underside is marked with a yellow paint blob against the appropriate legend.

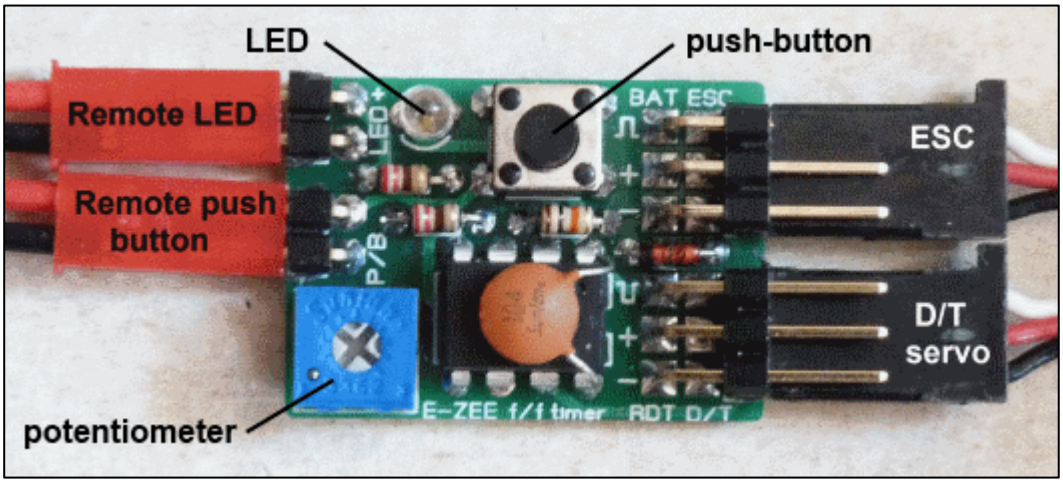
INSTALLATION



This image shows the system components, note that power does not flow through the timer. The timer is fed from BEC (Battery Eliminator Circuit) provided by the ESC and in turn sends signals to the ESC and the DT servo. **So the timer can be used with any size of motor/ESC/battery combination subject to the following warning**

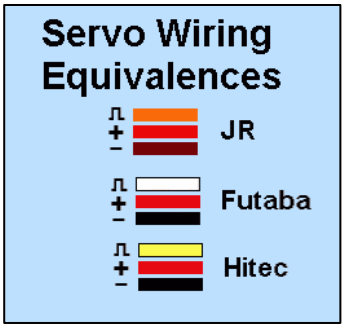
The chip used in the timer has a maximum rating of 5.5v, so ESCs with a 6v BEC must NOT be used.

The remote pushbutton & LED are used if the timer is inaccessible…..they mimic the same items provided on the timer….when connected either pushbutton can be used and both LED's indicate simultaneously



The image above shows the various leads connected to the timer in close up.

If used, the polarity of the remote LED must be observed as shown, but no damage will occur if the polarity is reversed, it simply won't work. Note the PCB has a silk screen marking '+' to assist with correctly connecting the read lead of the remote LED. The pushbutton can be connected either way round.



The ESC connects to the bottom layer pins of the upper connector. Note the PCB has silk screen markings of plus, minus and signal to assist with correctly connecting the ESC lead.

The DT servo connects to the bottom layer pins of the lower connector and again the silk screen markings assist with correctly connecting the servo lead.

The two top layer pins of the upper connector are not used for Electric Free Flight models

If RDT is used, the host timer lead from the receiver connects to the top layer (3) pins of the lower connector (shown unused in the photo above). See later notes about RDT compatibility.

QUICK START

Having connected and checked the system components it's time to power up and simulate a flight

As received your timer will be set as follows:-

Motor Speed approx. 50% **(best to remove the prop before testing)**

Motor Run Time 5secs DT Trip Time 10sec

Motor Run and DT trip time start together….. so the factory settings will cause the motor to run for 5 secs and the DT to Trip 5 secs after it stops

Step 1 Standby Mode

Connect the battery; there is a five second delay at power up.

Most ESC's will enter their setup routine if they detect full throttle at start. Thus without the enforced five second delay, trying to start a flight immediately after power up could cause the ESC to enter its set-up routine.

During the start delay the LED will flash at 1 sec intervals and after 5 seconds settle in to a continuous flicker….. ***LED in continuous flicker indicates 'Standby Mode'***

Step 2 Simulating a flight

Push the button and upon release the motor will start……..after 5 secs the motor will stop…..and 5 sec later the DT servo will operate…. the LED will flash at 1 sec intervals for the whole timed period.

For safety the pushbutton is disabled at the end of the timed period so that an inadvertent start will not occur on retrieval…..the DT Servo holds its position….this situation will continue until the system is reset…. At the end of the timed period the LED will stop flashing and remain ON permanently….***LED ON permanently indicates 'End of Flight Mode'***

The timed period may be aborted by a brief press of the button at any time and the unit will indicate end of run and require resetting

Step 3 Resetting the system after a flight

To reset the system disconnect and reconnect the battery…..this will take you back to *Step 1***.** Simulate a flight a number of times until you are familiar with the routine and LED indications…..you can also try adjusting the motor speed during the motor run….use the pot on the timer……it's the small blue cube on the timer with a white dot in the centre….the white dot has slots and can be rotated with a small screwdriver.

Step 4 Adjusting Motor Speed

Motor speed is adjustable from 0 to 100% and may set by the potentiometer at any time. If carried out whilst ground handling in Flight Mode, the motor will be running and its speed will respond directly to the potentiometer, allowing the user to judge the thrust being delivered. Once the power has been set, the timed period may be aborted by a brief press of the button and the unit returns to standby. A non-linear adjustment curve is employed to give finer control of the motor power at the levels likely to be used for flying – thus, the first 50% of the power is reached in the first quarter turn of the potentiometer whilst the final 50% of the power is adjusted over the remaining three quarters of a turn.

Adding RDT….<u>Ignore if you are not using this feature</u>

The RDT system is connected to the timer on the pins immediately above the DT connection…**<u>observe polarity</u>**

When RDT is fitted, operating the RDT transmitter during the 'glide' phase will cause the RDT servo to operate. For safety RDT commands issued during the motor run have no effect

Notes on RDT Compatibility

There are a number of RDT systems on the market. Some are sold as 'stand-alone' which means they drive the DT servo directly so cannot be interfaced to the timer. However, if the timer is used for motor control only, the RDT receiver's battery lead can usefully hitch a ride on the timer's RDT connector to obtain its power – thus obviating the need to make up a 'Y' lead arrangement.

RDT systems which feed a trip signal to the timer, the latter controlling the DT servo, are referred to as 'host timer' systems. There are a number of these systems on the market but it has not been possible to test the timer with every single one of them. It is known to work with the Aeris and LeoBodnar 'host timer' systems – both of which issue negative going pulses to trip the DT and it is understood that other popular systems use similar trip protocols. So I would ask users of other systems to report their success or otherwise of using them with this timer such that RDT compatibility information can be shared with the rest of the FF community. The timer has a pullup resistor on its RDT input so that open collector or open drain devices can operate it. It can resolve a pulse as narrow as 5mSec from the Aeris – the LeoBodnar pulse is 100mSec wide. Note that some other systems issue a succession of pulses per transmission but this is of no consequence, the first pulse operating the DT and subsequent pulses merely serve to confirm the 'tripped' condition.

Users should also be aware that in order to minimize power consumption (in gliders or ic powered models where the RDT receiver runs from a small single cell LiPo battery rather than from the main propulsion battery via the ESC's built in BEC) some RDT receivers go to sleep and only wake periodically to see if an RDT transmission is being made so there may be a delay between operating the transmitter and the RDT receiver issuing a trip pulse.

There are also 'homebrew' RDT systems which utilize standard RC receivers. Whilst a standard transmitter can be used most 'homebrew' systems feature much smaller purpose-designed transmitters using the Phil Green encoder to drive a commercial 2.4GHz RF module. The resulting RDT trip signal is therefore a continuous stream of positive going pulses at 20mSec repetition rate whose widths change from 1mSec to 2mSec at trip time - or vice versa depending which way the DT servo has been selected to move. This is totally at odds with the negative going pulse or pulses from the 'host timer' systems previously described.

So to allow the EFF4 Timer to be used with these 'homebrew' systems a small adaptor module is fitted between the receiver and the Timer's RDT input to convert the standard RC Servo protocol to match that required by the Timer.

The module is available as an accessory and is supplied with a standard Futaba receiver lead.

Users should note that there are concerns about the signal range of these standard RC systems when used for RDT – remember they are unlikely to be designed to be capable of controlling models that are too far away to see – unlike FF flyers, radio flyers don't follow their models with binoculars!

Changing the Timer settings

The timer has four adjustable features that govern the flight and two useful features relevant to the setup of the model….these are shown in the chart below:-

Feature Number	Parameter	Data Input & Reporting	Increment	Range
1	motor run	short	1 sec	1-90 secs
		long	10 sec	
2	DT period	short	10 sec	10-600 secs
		long	1 minute	
3	ramp up	short	1 sec	0-10 secs
		long	10 sec	
4	ramp down	long	1 sec	0-10 secs
		short	10 sec	
5	reverse DT servo	~	~	~
6	configure ESC	~	~	~

Feature No's 1 & 2 are self-explanatory…..used frequently

Features 3 & 4 may be of interest if you want the motor to ramp up to speed at start or ramp down at the end of the motor run…..the former could be useful if an ROG was required……the latter may help to prevent a power off stall……used occasionally

Feature 5 allows the servo position to be reversed to suit your installation….used infrequently

Feature 6 allows your ESC to calibrate the throttle range…. used infrequently

The chart also shows the range available for the adjustable features and the increments available. **Features 5 & 6** do not require a range or increment

Data Input is entered by pressing the pushbutton for long or short periods

Reporting is indicated by LED flashes ….solid for long increment….flashing for short increment

Feature Selection

To alter any of the settings a feature must be selected first

The feature selection cycle

1) From standby mode hold the button down continuously
2) LED ON and
3) Two seconds later LED OFF
4) Continue to hold the button down….LED remains OFF
5) Release the pushbutton
6) **LED ON but dimmer….this is the 2 sec feature selection period**
7) Two seconds later the LED reverts to the 'Standby' mode flicker

In the above example because no feature was selected the timer returned to the 'standby' mode……try this cycle a few times to familiarise yourself to recognise the two second 'feature selection' period.

Data Entry

1. Go to the feature selection 2 sec period

2. Select a feature by making a number of brisk button presses as follows (the LED lights for each press)
   [1 Press] set motor run
   [2 Presses] set DT period
   [3 Presses] set ramp up
   [4 Presses] set ramp down
   [5 Presses] reverse DT servo direction of operation
   [6 Presses] ESC configuration

   You have two seconds upon entering this stage to press the button….. if the button is not pressed during this time, the timer reverts to standby mode. The length of time the button is held pressed is not critical and the two second timeout is reset each time the button is released to give a further 2 sec period to make the next button press if necessary These timeouts allow the timer to ascertain when the user has finished pressing the button.

3. Having selected the feature by the required number of presses the dimly glowing LED goes off 2 secs after the last button release to signal the start of a 2 sec data entry period for the selected feature

4. Short or a long button presses are made to set the various timer durations using the increments shown in the table above.

   To make a **long press** hold the button down until the LED stops flashing and goes ON

   To make a **short press** release the button before the LED stops flashing

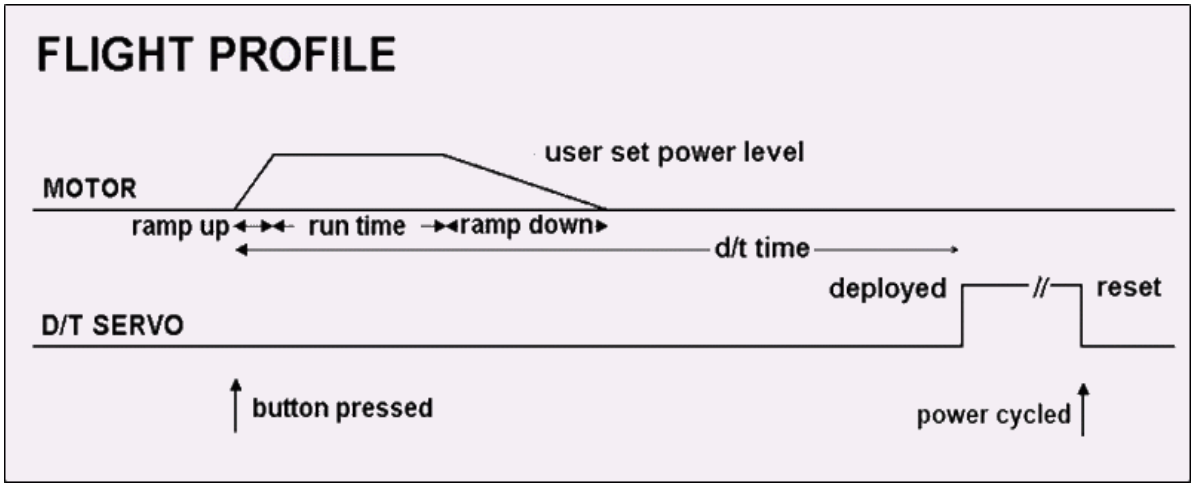
Short and long presses may be made in any order and the overall time is accumulated and stored in memory.

If the number of presses exceeds the feature range the highest feature setting is stored

When data entry is complete, after a brief pause the LED verifies the settings entered for motor run or DT period by a series of flashes and then by a series of flickers as follows.

- LED flashes
  - motor run – units of ten seconds
  - DT period – units of one minute
- LED flickers
  - motor run – units of one second
  - DT period – units of ten seconds

The less critical and infrequently adjusted ramp up and ramp down periods are not reported after setting. If no presses are made during the ramp adjustment periods the data entered is zero seconds. Note that using the Ramp settings extends the overall running time of the motor as shown in this diagram:-



When modifying ANY of the duration settings, if the user enters a duration which causes the DT period to be less than or equal to the total running time of the motor (ie ramp up + motor run + ramp down) this setting is not accepted and the LED gives three rapid blinks repeated at one second intervals to warn the user of this dangerous conflict. Pressing the button returns the user to standby mode with the previous (safe) duration value intact.

Reporting the current Motor & DT Settings

If no presses are made during the data entry period the current values are unaltered, but the timer reports the value set in the method described above. So selecting eg ‘set motor run’ and waiting until the data entry timeout is a useful method of checking the current ‘motor run’ setting.

DT Servo Reversal

DT servo reversal is a special case – no data entry as such is made. After the two second time out the servo will drive to the opposite end of its travel. This is now the new DT SET position (as opposed to the DT TRIPPED position). If desired continue pressing and releasing the button to toggle servo direction – useful for setting up and/or testing the DT mechanism. Disconnect power to exit this endless loop.

ESC Configuration

ESC configuration is a further special case and for those not familiar with this term a brief description follows.

ESCs generally have a number of parameters which need to be configured for optimum performance and/or user preferences - such as battery type (Li-Po/NiMh), Li-Po cut off voltage, signal span, brake on/off, motor timing etc. In particular, if the ESC's signal span is not set to match that of the timer (the latter being set to the industry standard of 1 mSec to 2 mSec), the motor may not respond to the timer's power setting pot at it's extreme of rotation (thereby coarsening the user's power setting adjustment) or worse still the user may not be able to get the motor to achieve full speed.

The ESC manufacturer expects as a minimum that users have access to a RC transmitter and receiver in order to set up these parameters. However, the majority of settings can be more easily configured with the manufacturer's programming card for the appropriate ESC (if available) *but with the exception of signal span which requires to be matched to the transmitter itself (or in this case, the timer)*

The timer's ESC configuration mode allows the user to implement the ESC manufacturer's set-up instructions by using the button as though it were the throttle joystick of a transmitter (ie to assert zero or full throttle as required in the instructions).

Typically, an ESC requires to see a full throttle signal immediately at power up in order to enter its configuration routine(s) – usually for a short period to set signal span or for a longer period to access the remaining parameters. Now an ordinary timer would of course be putting out a closed throttle signal at power up whilst awaiting a button press to commence a flight. The E-ZEE timer offers this special ESC configuration mode in the event that the user does not possess a programming card and/or RC transmitter/receiver or does not have access to them in the field.

Following the six button presses to select this mode, after the two second time out the LED will blink ON/OFF at one second intervals and further timer operation is inhibited. The power must now be cycled, whereupon the timer now enters an endless loop where the ESC output may be repeatedly toggled between full and zero power by successive presses of the button in order to configure the ESC. Full power is indicated by a bright LED, zero power by a dim LED. Disconnect power to exit this endless loop.

SAFETY

The motor must be considered 'live' whenever the propulsion battery is connected. Be careful not to inadvertently press the start button during handling the model as the prop may begin to turn as soon as the button is pressed.

Whilst familiarising yourself with the timer operation, for greater safety a standard servo may be used in place of the ESC – its arm position indicating the throttle setting. In this instance a battery box for the 5v supply to the timer may be connected to the 2 pin connector immediately above the ESC connector.

Be aware that electric motors behave differently to IC engines. With the latter your straying fingers might get anything from a smart whack to a nasty gash depending on the size of the engine, but nine times out of ten the engine will stop instantly. With electric motors, no matter what the size of the motor, as long as the battery remains connected, it will attempt to turn, and continue doing so - even if it becomes so overloaded that it melts itself, the ESC or the battery in the process. So, an encounter with a spinning prop can result in your fingers being continually slashed, until the power is cut. A few high-end ESCs ***do*** *feature a safety cut-out if the prop is stalled or the governed revs drop below a predetermined threshold but you should not rely on this. YOU WERE WARNED!*

Note that the blue LED used is a high brightness type to ensure good visibility outdoors in bright sunlight. If the timer is operated in the workshop under poor lighting conditions avoid looking directly at the LED to avoid potential damage to your eyes.