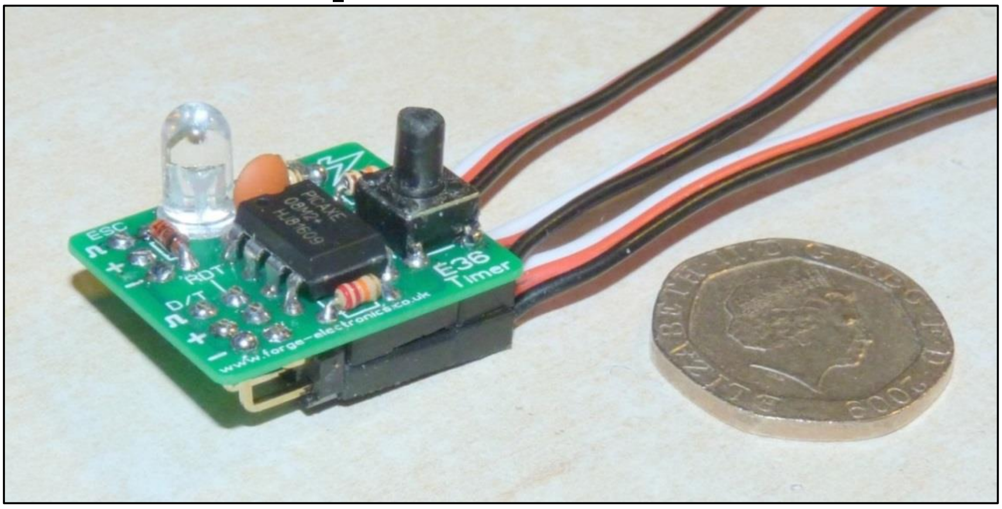
FORGE ELECTRONICS
www.forge-electronics.co.uk
Embedded Microcontrollers for Modellers

E36 Competition Timer MK2



This electric free flight timer was developed for the needs of E36 competition models that are not met by the current electric free flight 'sport' timer the EFF4. The specification, functionality and packaging of the MK1 were originally guided by John Thompson, the SAM1066 Chairman and experienced international contest flier. In comparison with the EFF3, the unit needed to be accommodated within the fuselage with just the push button and LED showing through a ply mounting plate affixed to the timer on short stand-offs. The power setting potentiometer was not required as only full power is used and neither the motor soft start or run down were required. A maximum motor run time of 20 seconds was specified but unlike the EFF4 the time period requires to be set to a resolution of 0.1secs.

Exclusive Stockists:-

In the UK

scalewarship

Scale Warship Ltd
5 Beechwood Avenue
New Milton
Hants,
BH25 5NB

Mob: 07855 941117
enquiries@scalewarship.com

In the USA

stevens aeromodel

Stevens AeroModel
26405 Judge Orr. Road
Calhan
CO
80808
USA

Tel: 719-387-4187
sales@stevensaero.com

This is an improved version of the original timer which now allows the user to set the (previously fixed) DT failsafe period and features a new method of directly accessing settings rather than having to scroll through the entire set to find the one in question. Data entry using this new method also minimizes the number of button presses required when setting long periods

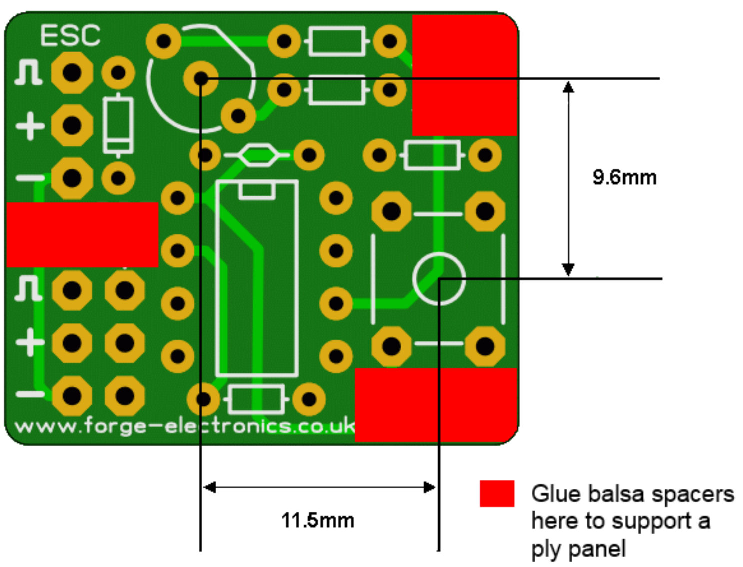
Key Features

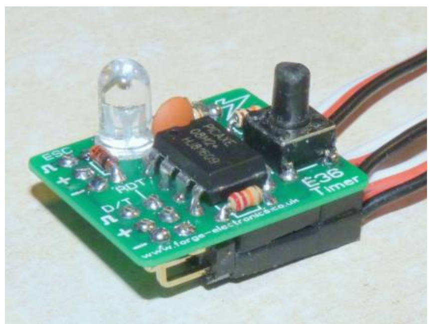
- motor run adjustable up to 20 secs in 0.1sec increments
- RDT compatible
- fail-safe of D/T in event of radio system malfunction
- fail safe period adjustable up to 10 minutes in 15 sec increments
- option for RDT to abort motor run
- option to change direction of D/T servo movement
- simple to operate pushbutton/bi-colour LED user interface
- timer powers the RDT receiver – no ‘Y’ lead required
- build options to best suit user requirements*

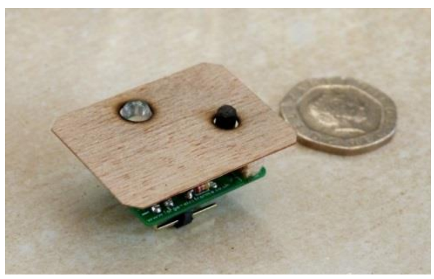
PACKAGING

The timer has been designed to be mounted on a thin ply panel mounted flush on the side of the fuselage, the push button and LED protruding through holes in the panel.

Three areas on the PCB have been left clear onto which the user can glue spacers, the ply panel being subsequently stuck to the spacers as shown in the photos below. Scraps of balsa sheet were used for the spacers in the version shown here. Deluxe Materials “Super ‘Crylic” glue is recommended.



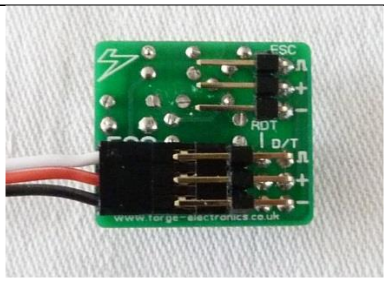
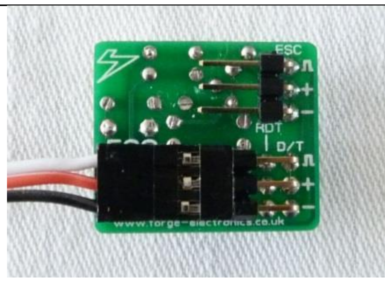




POWER

The timer is powered from the BEC within the model's ESC (5v assumed). The maximum voltage rating for the microcontroller chip is 5.5v and this must not be exceeded – *ie ESCs* with a 6v BEC option must NOT be used. *Users should check that their RDT receiver, often capable of working on a single cell (3.7v) LiPo, can withstand the ESC's BEC voltage.*

CONNECTIONS

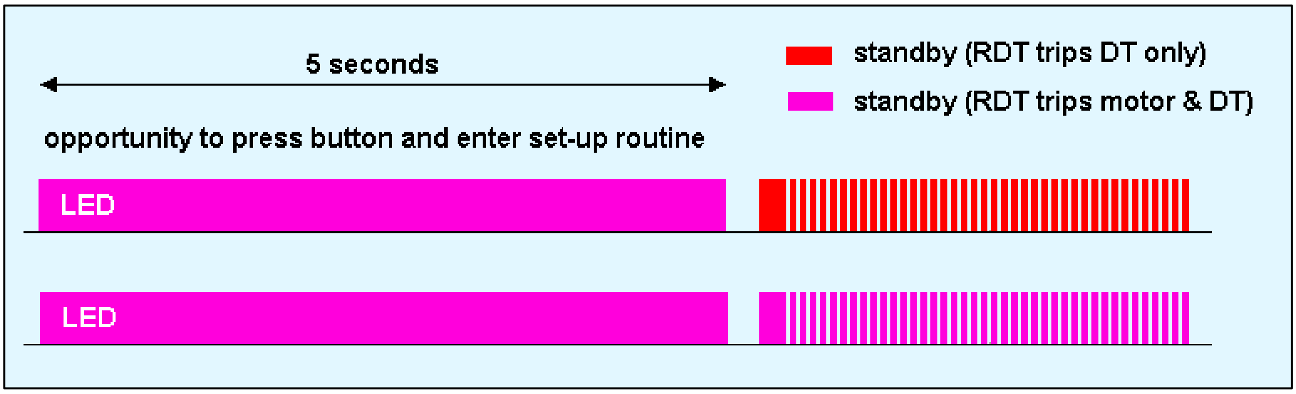
		
ESC Lead	**RDT Receiver**	**D/T Servo**

Note the silk screening on the PCB identifies the ESC connector and the polarity of its connections. In the case of the vertically stacked connectors the RDT receiver is the one closest to the PCB with the D/T servo immediately above it, the polarities again clearly marked. Note the silk screened 'RDT' and 'D/T' legends are aligned to the connector's soldered pins so users may trace back to which row of pins to plug into if this document is not to hand.

As these timers are made to special order, buyers have the option to have one or both connectors fitted pointing away from the PCB rather than as shown above to optimize the cabling in their particular installation.

QUICK GUIDE

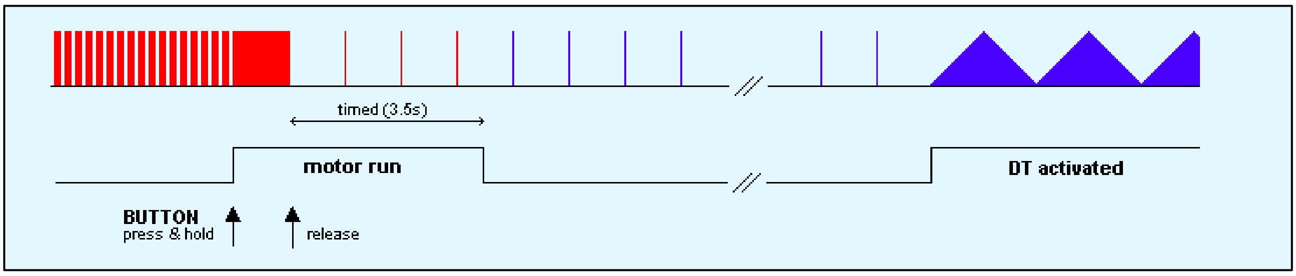
POWER UP



- connect battery
- wait 5 seconds whilst the LED is bright magenta (chance to enter setup routine)
- after a brief pause the unit enters standby mode – LED flickers red/magenta

- red – RDT is only enabled once the motor has stopped running
- magenta – RDT can stop the motor and a second activation trips the D/T

FLY



- from standby mode, press and hold the button – the motor starts immediately and the LED goes solid red for the duration of the button hold.
- when ready to launch, release the button – the timing period now commences, the LED goes out and then briefly flashes red to indicate each second being counted off
- re-pressing and holding the button (LED solid red) at during the active motor run resets the elapsed time and returns to the ready to launch condition above
- following the successful end of a motor run, the LED now flashes blue counting off the remaining seconds until a DT is initiated. The LED then slowly fades up and down indicating this point in the flight profile occurred
- switch unit off and back on again to reset the timer

DETAILED GUIDE

Until the user is fully familiar with operating and configuring the timer, for safety and convenience it is recommended that the user bench tests the timer prior to installing in the model. To do this, do not attach the ESC/motor/main battery. Instead use a ‘Y’ lead attached to the timer’s ESC connector to connect a servo and a standard receiver battery pack (4x 1.2v NiMh AA cells = 4.8v) *DO NOT use 4x 1.5v Primary AA cells = 6v !*

The servo will mimic the motor being powered up and down thus avoiding the noise, airflow, danger and rapid discharge of the main battery were a motor used.

Users will note that when starting a ‘flight’, after releasing the button the servo moves back very slightly. This is a deliberate feature incorporated for automated testing of the timing accuracy using an electronically triggered stopwatch following manufacture of the timer.

At the beginning of a flight the motor is running at full power with the button held but timing only begins when the button is released. Thus the timer signals to the stopwatch by a slight reduction in the motor drive signal that the timing period has commenced.

The standard for full power motor drive is a 2.0mSec pulse applied to the ESC. Whilst the button is held pressed the timer asserts 2.05mSec, reverting to 2.0mSec when the button is released *so the user’s full power signal is not compromised*. When attached to a motor/ESC should a slight drop in motor power be observed when releasing the button then the ESC is not set up correctly and its signal span should be adjusted accordingly.

So this is in fact a useful feature to check you really are getting full power from your motor!

POWER UP

There is a five second delay at power up, during which the LED shows magenta. The purpose of this is that having mated the battery connector the user still has time to press the button to enter the set-up routine.

SET-UP ROUTINE

Apart from operating the timer for a normal flight, there are three other types of user interaction with the timer.

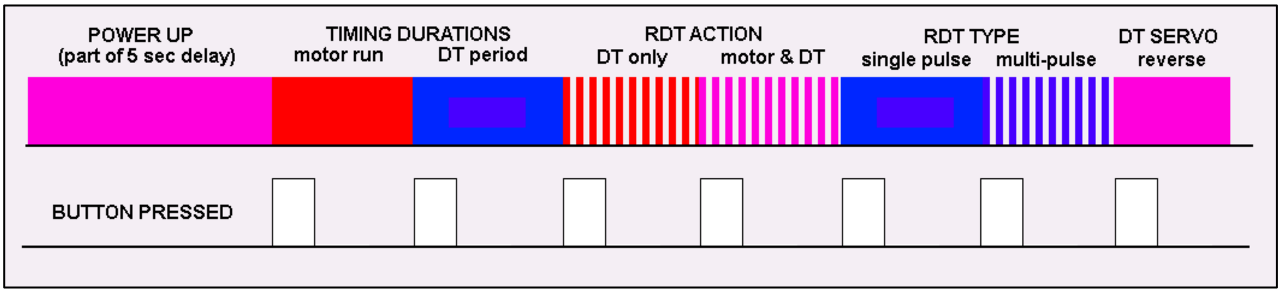
- **Adjustments** – frequently used
  Set Motor Run Time / Set DT Period
- **RDT Operation** – used less frequently
  RDT action – trip DT only / RDT action – trip Motor & DT
- **Fixed Settings** – specific to the build of the model, typically set once only
  RDT type – single pulse / multi-pulse
  Direction of movement of DT servo

Thus the parameters to be set have been arranged in order of most frequent use.

During the first five seconds after power up, whilst the LED shows magenta, the parameter to be modified is selected by making a number of brisk button presses as follows. The LED lights in different ways to help identify the parameter to be altered for each press, though it is only necessary to count the pushes. *Having set a parameter, the power must be cycled before it is possible to set up a further parameter.*

PRESS	LED	FUNCTION	TYPE
1	**RED**	Set Motor Run	Adjustment
2	**BLUE**	Set DT Period	Adjustment
3	flashing **RED**	Set RDT action - DT Only	RDT Operation
4	flashing **MAGENTA**	Set RDT action - Motor & DT	RDT Operation
5	**BLUE**	Set RDT type - single pulse	Fixed Setting
6	flashing **BLUE**	Set RDT type - multi-pulse	Fixed Setting
7	**MAGENTA**	Reverse DT Servo	Fixed Setting

The length of time the button is held pressed is not critical but following (each) release there is a two second timeout during which the user can elect to press again to move onto the next parameter or wait until the timeout occurs whereupon the selected parameter is now ready to be adjusted. These timeouts allow the timer to ascertain when the user has finished pressing the button.



[1] Set Motor Run

Initially the LED shows solid RED indicating the motor run setup has been selected. *Wait until the LED goes OFF*. In the next two second timeout the user has the option to make a number of long or short button presses to set the duration of the motor run as follows

- long press – add one second
- short press – add tenths of seconds

During a short press the LED flickers, but if the button continues to be held the LED then lights fully, indicating that a long press has been made. The two second timeout is reset after each push.

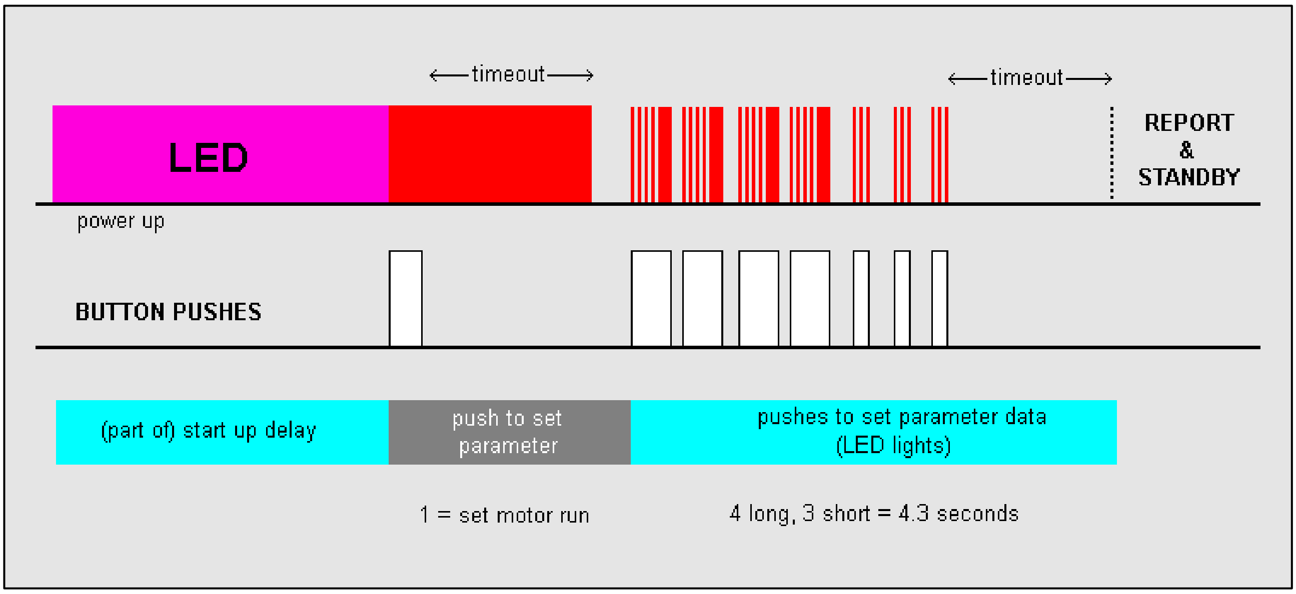
Short and long presses may be made in any order and the overall time is accumulated and stored in memory. Any presses which cause the entered period to exceed the maximum value of 20 seconds result in the period being truncated at that maximum value.

Short presses in excess of nine roll over and accumulate as seconds eg 15 presses would result in adding 1.5 seconds to the total

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

- LED flashes – units of one second
- LED flickers – units of one tenth of a second

Note that if no presses are made the current motor run duration remains unaltered, but the timer reports the value set in the method described above. So selecting ‘set motor run’ and waiting until the data entry timeout is a useful method of checking the current ‘motor run’ setting.



When modifying the motor run duration, if the user enters a duration which equals or exceeds the current DT period, then when the timer reverts to standby mode to prevent the user operating with this dangerous condition, the timer is inhibited and enters an endless loop with the LED showing permanent MAGENTA. Power must be cycled and the motor run or DT period altered to safe non-overlapping values.

[2] Set DT Period

Initially the LED shows solid BLUE indicating the DT setup has been selected. *Wait until the LED goes OFF*. In the next two second timeout the user has the option to make a number of long or short button presses to set the duration of the motor run as follows

- long press – add one minute
- short press – add fifteen seconds

During a short press the LED flickers, but if the button continues to be held the LED then lights fully, indicating that a long press has been made. The two second timeout is reset after each push.

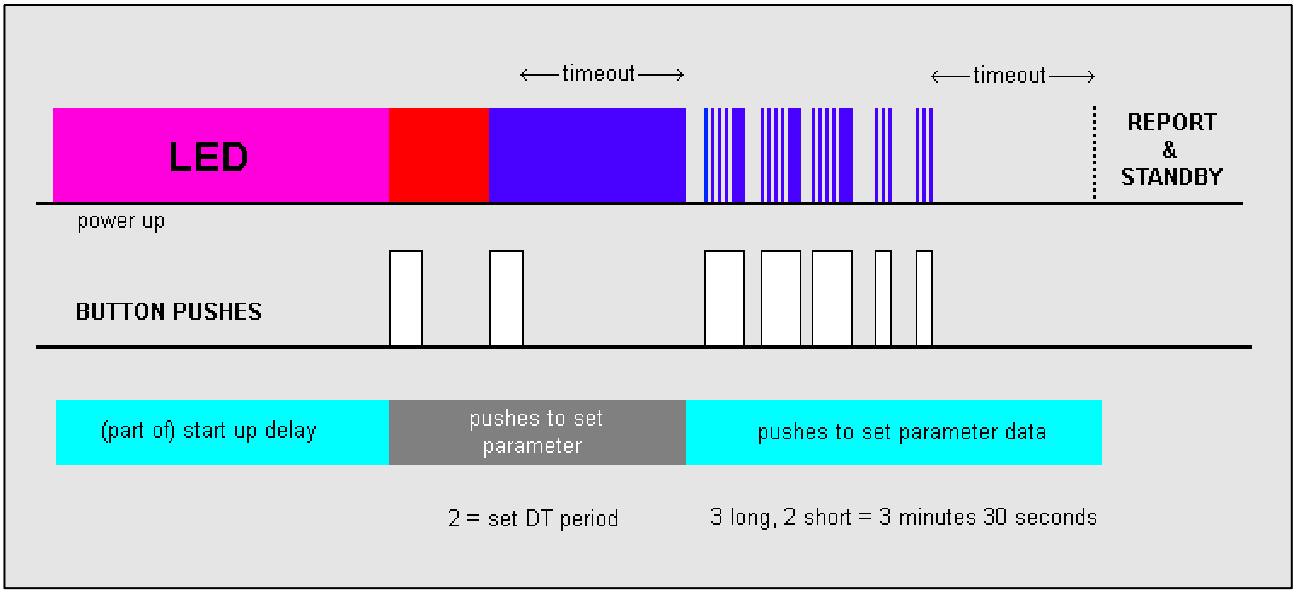
Short and long presses may be made in any order and the overall time is accumulated and stored in memory. Any presses which cause the entered period to exceed the maximum value of 10 minutes result in the period being truncated at that maximum value.

Short presses in excess of four roll over and accumulate as minutes eg six presses would result in adding one minute thirty seconds to the total

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

- LED flashes – units of one minute
- LED flickers – units of fifteen seconds

Note that if no presses are made the DT period remains unaltered, but the timer reports the value set in the method described above. So selecting 'set DT period' and waiting until the data entry timeout is a useful method of checking the current 'DT period' setting.



When modifying the DT period, if the user enters a duration which equals or is less than the motor run period, then when the timer reverts to standby mode to prevent the user operating with this dangerous condition, the timer is inhibited and enters and endless loop with the LED showing permanent MAGENTA. Power must be cycled and the motor run or DT period altered to safe non-overlapping values.

[3] Set RDT Action – DT Only

This allows the user to choose the scope of the timer's interaction with the RDT system to cause it to operate the DT only. Further information about RDT is given in the appendix "MORE ABOUT DT". <u>It is expected this mode will be principally used for 'competition' flights.</u>

No data entry as such is made and no button press is required. Wait until the two second timeout expires and the timer will revert to standby. In standby the LED now flickers RED to show that this option is selected. Selecting this option serves to set a 'flag' in the software such that RDT is only enabled during the 'glide' phase of the flight.

[4] Set RDT Action – Motor and DT

This allows the user to choose the scope of the timer's interaction with the RDT system to allow the motor run to be aborted followed by next operating DT at the user's discretion. The various issues involved with this are described in the appendix "MORE ABOUT DT". <u>It is expected this mode will be principally used for 'trimming' flights.</u>

No data entry as such is made and no button press is required. Wait until the two second timeout expires and the timer will revert to standby. In standby the LED now flickers MAGENTA to show that this option is selected. Selecting this option serves to set a 'flag' in the software such that RDT is enabled in both the 'motor run' and the 'glide' phases of the flight.

[5] Set RDT Type – Single Pulse

Depending on the RDT system fitted, the user needs to set the timer to match the pulse protocol of the RDT. The various issues involved with this are described in the appendix "MORE ABOUT DT"

No data entry as such is made and no button press is required. Wait until the two second timeout expires and the timer will revert to standby. Selecting this option serves to set a 'flag' in the software such that the timer responds to a single pulse trip signal.

[6] Set RDT Type – Multi-Pulse

Depending on the RDT system fitted, the user needs to set the timer to match the pulse protocol of the RDT. The various issues involved with this are described in the appendix "MORE ABOUT DT"

No data entry as such is made and no button press is required. Wait until the two second timeout expires and the timer will revert to standby. Selecting this option serves to set a 'flag' in the software such that the timer responds to the first of the multiple pulses in the trip signal and 'blocks' any further pulses in the transmission for a period of three seconds which could otherwise cause damage to the model in the case of RDT being enabled for 'motor and DT' as in [4] above. The three second 'blocking' gives time for the sequence of pulses to conclude or for the user to release the transmit button as appropriate.

[7] Reverse DT Servo

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 DT SET position (as opposed to the DT TRIPPED position). If desired continue pressing and releasing the button to toggle servo direction – this is useful for setting up and/or testing the DT mechanism. Disconnect power to exit this endless loop.

APPENDIX: MORE ABOUT RDT

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.

During trimming flights it may be desirable to abort the motor run and at some stage later operate the DT servo. This may well save the model, as with the motor stopped speed drops off and a subsequent D/T does not then break the wings. However during competition flights, only a single transmission may be made to the model - *BMFA Rule 3.1.1 (a) (i)*. Thus the user has the option to configure this timer such that the RDT system operates on the D/T servo only for competition flights - or - on both the motor *and* the servo for trimming flights.

This ‘two stage’ abort idea works well with systems that issue a single trip pulse per transmission. However, some other systems issue a succession of pulses per transmission and this could create a problem. The first pulse received would stop the motor and very soon afterwards the next pulse would operate the DT – and that is guaranteed to rip the wings off the model!

So to accommodate such multi-pulse systems, in the ‘two stage’ abort situation the user can configure the timer such that after the first pulse has stopped the motor, any further pulses are ignored for a period of three seconds. This gives time for the sequence of pulses to conclude or for the user to release the transmit button as appropriate.
Clearly there is no issue with receiving multiple pulses if the timer is configured to trip the DT only – any subsequent pulses merely confirming the DT situation.

However, flyers using RDTs with a single trip pulse will configure the timer for single pulse use and as a result not suffer an enforced three second delay between stopping the motor and operating the DT – this could be vital in a situation where it would be preferable to rapidly stop the model by ripping its wings off rather than letting it proceed for a further three seconds (albeit unpowered) towards a hazard.

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 every few seconds to see if an RDT transmission is being made so there may be a delay between operating the transmitter and the receiver issuing a trip pulse. Again this is not an issue if a successful flight is being terminated after some minutes, but it may be more so if trying to stop the motor during a trimming flight.

There are also 'homebrew' RDT systems which utilize standard RC receivers, the 'Lemon' unit being a popular choice due to its small size, low weight and low cost. 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 form the 'host timer' systems previously described.

So to allow the E36 Timer to be used with these 'homebrew' systems a small adaptor module can be interposed between the receiver and the Timer's RDT input to convert the standard RC Servo protocol to match that of commercial 'host timer' RDT systems. The photograph below shows such an adaptor. These are also available from Forge Electronics if required.

It is shown with a standard Futaba receiver lead. Also the chip is shown mounted in a socket – this was to allow it to be removed for re-programming during the development phase and in final versions the chip will be soldered directly into the stripboard. It is considered that the demand for such conversion modules will be very low and therefore professional PCB versions would not be cost effective.

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 they don't use binoculars!

SAFETY

Consider familiarizing yourself with the timer operation using a servo in place of the ESC/ motor as previously described.

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 will begin to turn as soon as the button is pressed.

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!*

The 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.