DELAY TIME POT

The delay time, the time after the motor is blipped, is adjustable, via the **DLY** pot, from 2 seconds (fully counterclockwise) to 33 seconds (fully clockwise) in second increments, after the "Start" pushbutton is pushed. Since there are ten positions marked (using reading glasses, perhaps…), this amounts to about 3½ seconds per position.

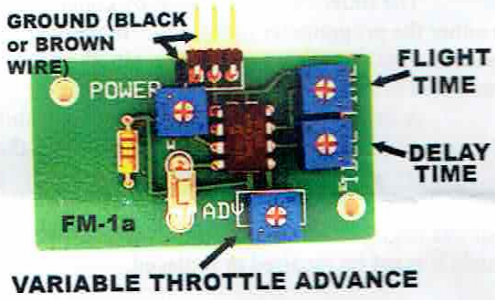
FLIGHT POWER POT

Varies power linearly from about 60% to 100% of maximum power.

FLIGHT TIME POT (approx)

(linear times, starting from fully counter-clockwise; about 30 sec per mark)

0	2:15 min:sec
1	2:43 min:sec
2	3:11 min:sec
3	3:40 min:sec
4	4:09 min:sec
5	4:36 min:sec
6	6:05 min:sec
7	5:33 min:sec
8	6:01 min:sec
9	6:30 min:sec



(The blackened quadrant of each pot is at the bottom when the pot is fully counterclockwise—although not shown in the picture above.)

FM-1a, Serial #7871-7890

After battery connection, the processor puts out a steady 1.0 ms pulse, for a minimum of 2 seconds (you should get a "beep" from the ESC, acknowledging a valid "off" throttle), and then waits for a push on the "start" button.

A second after the start button is pushed, the motor is momentarily advanced to full throttle to tell the ESC the range of throttles in use and to confirm to you that timing has begun. Then the dialed-in delay time begins, followed by the dialed-in flight time and flight power.

During the first 30 seconds of "flight" time, you may adjust the power level, which is very useful when first flying a model.

The processor uses the position of the "ADV" pot to determine the amount of throttle increase to use during the flight to compensate for decreasing battery voltage during the flight (from 0 to a maximum, in 15 increments).

Even after the "start" button is pushed, you can stop the motor by pushing the "start" button again, throughout the "flight" time. **Unplug** the battery for the next flight, even if you have enough charge left in it.

At the end of the flight time, power is reduced for one second and then the former power is restored for five seconds before the power is turned off (steady 1.0 ms pulse); after 30 more seconds, the output goes to 0 volts as an additional safety feature.

There are 16 different levels of throttle advance available within the 270° travel of the "ADV" pot, utilized at 30", 1', 2', 3', 4', and 5' flight time. You'll probably get the flattest power curve if you can use less than maximum power, and then use experiment to find the optimum advance.

Trouble-shooting a Premature Motor Shutdown

According to plan, every electric-powered flight should end with a one-second power-drop as a warning at the end of the programmed flight time, followed by five seconds of flight power, followed by motor shutdown. Any earlier motor shutdown is hazardous to the health of the airplane, at minimum, and must be corrected.

The **most likely** cause of a premature shutdown is by the ESC as it is protecting the battery when it senses an average battery voltage less than 3.1 volts per cell (or for whatever voltage for which it has been programmed). [Some ESCs do give you the option of choosing a power reduction rather than a motor cut-off at that point, and R/C fliers often use this.] Once the ESC shuts down the motor, it ignores the throttle instructions from the timer. And because the timer receives no feedback from the ESC, it will just continue its programmed throttle pulses, to the end of the "flight" – or until stopped by a push on the "start" button. Do push the start button!

An ESC may also be programmed to shut down the motor when it senses a too-large motor current (as in a nose-over) and, similarly, the timer will continue to provide throttle pulses until the start button is pushed or time is up or power is removed.

To test whether the ESC did shut down the motor, try disconnecting the battery for a few minutes and then seeing if the timer will restart the motor when the battery is reconnected. Stop it with the "start" button and determine why the battery got low. The cell voltages decrease throughout a flight and very rapidly under high currents, so it is no use to try to measure the voltages after the flight is over or to use the voltages provided by the charger. Instead, check to make sure a battery cell isn't failing or that you have an adequate battery for the prop load. (It is easy to monitor the battery voltage on the a test stand if you use one of the available power monitors. However, the current draw is always higher if the plane isn't moving because the prop has a high drag then.)

The **second most likely** cause of a premature motor shutdown is an intermittent electrical connection between the battery and the ESC or between the ESC's BEC and the timer. This is especially likely when a battery-ESC-motor-timer system has been working properly over many flights and suddenly begins to malfunction. Life inside a Stunter is a violent life, after all, and connections to the battery and to the motor are already stressed because of the high currents; the 5-volt BEC connection to the timer provides extremely low currents but sometimes the mechanical strength holding the parts together may decrease with time. All the connectors are gold-coated to minimize contact resistance, but a contact cleaner (e.g., Radio Shack) might be a good idea.

The **least likely** cause of a premature motor shutdown is the timer because its embedded program is not stressed electrically or thermally – and most of all, every failed timer I have checked is incapable of being programmed or starting the motor. (If you have an ESC which allows its BEC to be programmed for a voltage above 5 volts, that can damage the timer because it is rated for only up to 5.5 volts.)

For a failed timer (and I've delivered many thousands of un-failed timers), the embedded processor can't tell me what hurt it but the usual suspects are incorrect connections to the programmer (for the FM-9 system) or to the ESC (an offset connection, in particular, can reverse the positive and ground leads). I have seen at least one case of a timer that died from static electricity, but that is quite rare – but, again, it did **not** fail during the flight. And if the processor is going to fail from manufacturing defects, it is most likely to do so early in its life ("infant mortality") but almost certainly this will stop it from working at all.

In a few cases a timer has failed internally such that it not only doesn't work but it also provides a low resistance to the BEC voltage. So if a timer ever gets hot when connected to either the programmer or the ESC, consider it a failed member of your team and have it repaired or replaced.

If a timer loses its 5-volt power even momentarily during a flight, it will re-boot and provide only a throttle-off signal to the ESC, as at the beginning of the flight. If this is what happened, you can verify it by holding the model after it lands and push the start button!

As a safety feature, all of my timers will shut down the motor (and will absolutely not re-start until the battery is removed and re-connected) if the "start" button is pushed during the programmed "flight" time. This means that anything that electrically connects the same two pins (the two upper right-hand pins) during the flight will also shut it down. This has happened at least once when a flier mounted the timer on a carbon fiber (electrically-conducting) fuselage and flight loads made the connection. It is one more thing to check, though.

I don't know of **any** timer that has failed in flight. If a timer can start a motor run you can be confident that it will provide the programmed throttle pulses throughout the programmed flight time (unless reset with the start button). It is most important to realize that the ESC doesn't start or run the motor based on simple voltages. Instead, the ESC responds only to a signal that pulses to the supply voltage and lasts between about 0.001 second and 0.002 seconds (off to full throttle), at about 50 times a second. Anything else and the ESC won't run the motor! That is why a "timer" needs a computer chip and why the timer causing a motor shutdown (or sudden start-up!) is so unlikely.

Protecting the timer

The timer can be damaged by connecting it incorrectly to either the programmer or the ESC. In particular, if the connection to the ESC is offset by a pin, the +5 volts will be connected to the wrong pin.

A damaged timer is indicated by its inability to be programmed and, usually, a failure to even blip the motor. I.e., a failed timer won't even produce the "throttle off" signal required to initialize an ESC, let alone blip it or run it. The timer requires negligible current so if it ever gets even warm to the touch, it **must** be repaired or replaced.