OKO M1a.4 Initializer

The OKO Initializer M1 is a standalone initializer for usage on FPV Kamikaze type drones.

The M1 Initializer is intended to be attached to an igniter or electronic match. The OKO M1 Initializer's main function is to source a continuous current exceeding 500mA for a minimum 2msec duration after the detection of an impact. The M1 Initializer does not connect electrically to the drone.

The OKO Initializer is designed to maximize the safety to the operator while maximizing lethality for the target. The operator safety measures center around avoiding unexpected initialization by usage of a progressive state machine while allowing for very precise impact detection.

The state machine states must be traversed in sequence. States cannot be skipped unless overridden by the programming interface. The complete transition of all states terminates with the final discharge state. The state machine is presented as part of this document in Appendix A.

The OKO Initializer has an auto destruct function, which is time based and user programmable and is independent of the state transitions, meaning that after a certain time has expired, the device will issue the initialisation current irrespective of current state. The auto destruct timer is always started at power on and is only restarted if the device is powered off. There is no other way of restarting or stopping the timer. The auto destruct function is intended to prevent the capture and reverse engineering of the drone system as a whole, in the event that a kamikaze drone fails to reach its target or is brought down by enemy action.

Operational Sequence (states)

1) State 10 – immediately after Power ON,
    a. Green LED – Slow Blink. Red LED is OFF.
    b. If Yellow status LED displays the slow blinking pattern, this indicates a low battery condition; battery should be replaced to ensure proper detonation
    c. The initializer is in a wait state. The CPU is waiting to detect vibration induced by the drone motors.
    d. The state is exited if Motor Vibration is detected and exceeds a minimum threshold.
    e. The minimum Motor Vibration threshold for level 1 is programmable via P1/S1, allowing for fine tuning for Drone Frame size and Motor size.

2) State 20 – Motor Level 1 Detected
    a. Green LED – 2 Blinks then Pause. Red LED is OFF.
    b. The initializer has detected motor vibration. The CPU is waiting to detect a second, higher motor vibration, created typically from a drone in hover.

c. The state is exited if Motor Vibration is suddenly not detected, inwhich case it will return to State 10, or if Motor Vibration exceeds the level 2 threshold.

d. The minimum Motor Vibration threshold for level 2 is programmable via P2/S2, allowing for fine tuning for Drone Frame size and Motor size.

3) State 21 – Motor Level 2 Detected

a. Green LED – Medium Blink. Red LED is OFF.

b. The initializer has detected level 2 motor vibration. The CPU is waiting to detect flight. Flight is defined as a velocity measurement over time.

c. The magnitude of the velocity over time can be programmed via P21/S21. The larger the value the further the drone must travel before transitioning to Flight Detected status.

4) State 30 – Flight Detected

a. Green LED – blinking very fast rate, Red LED is OFF.

b. The initializer has detected flight meaning that the drone has accelerated to a given velocity and has travelled a minimum distance from the launch point. The CPU has started a programmable timer and is counting down.

c. The delay time can be programmed via T1.

Intermediate Actions

If enabled, the Initializer will return to State 10, if during State 20, State 21, or State 30 it detects that the Drone has stopped moving and has had its motors turned off. This is a preventive action as the drone has not flown far enough from base but has landed and had its motors turned off. This return to State 10 ensures that defective or accidentally crashed drones can still be recovered safely by friendly forces, without the risk of premature or wrongful detonation.

Note, this is only possible if Enabled via B0 (default) and if State 40 has not been entered.

IMPORTANT – returning to state 10 does NOT restart Ttot Timer (self destruct)

5) State 40 – Arming Cycle

a. Green LED blinking very fast rate, Red LED blinking very fast rate.

b. The timer after Flight Detection has expired and the Initializer is now charging the Discharge Capacitor and circuit. The CPU is reading a feedback loop and waiting for the circuit to reach a minimum of Varm Volts (default 6.0v).

c. The minimum voltage is programmable and if higher will increase the time of transition to the subsequent state. The upper limit is set to 14 Volts and is fixed.

6) State 50 – Armed, Ready for Impact

a. Green LED Off, Red LED blinking quickly

b. The Initializer is armed and ready and waiting for impact detection

c. The impact required can be set via P4/P5/P6.

d. The magnitude and window length can be set to very slight to very forceful impacts and are only limited by the g forces produced by the drone in flight which is a function of the operator – (we have never seen a drone in flight experience a g-force of 2g's – the minimum level)

Self Destruct

As mentioned previously the initializer includes a self destruct timer that is started at power on. This timer can be programmed from a minimum of 10 minutes to 300 minutes (6 hours). It is imperative to understand that the self destruct timer is not reset in any state and can only be restarted by powering off the device via the manual start switch.

Power On

The OKO M1 Initializer is equipped with a manual start switch. The manual start switch is a plastic tab that has a looped string attached to it. The manual start switch is engaged by removing the plastic tab from the unit. The plastic tab string is intended as a pull point so that the switch can be initiated by drone flight meaning the string is attached to the ground and the action of flight pulls the tab and closes the switch.

OKO strongly recommends not using this method. It has gone to great lengths to ensure that initializer function is not possible until the unit is well in flight and away from base.

OKO however does recognize that unfortunate past experiences may cause some personnel to insist on this method. As such, the method will work and it is possible to further enhance it's functionality by disabling certain parameters.

OKO recommends that the pull tab system be used to initially turn on the initializer from a distance (as a final step prior to drone lift off) by using the pull tab string or attaching an additional string to the pull tab. This also ensures that aside from the drone operator another observer is monitoring the initial activation sequence of the initializer, from the safety of a covered position.

Power-Off Safety

When opened, meaning the switch is depressed, the device has an active bleed of power to ground so as to eliminate any possibility of an accidental discharged from the charged capacitor. OKO would like to stress that the current design with active bleed to ground means that any charge remaining in the capacitor will be immediately dissipated, inactivating the capacitor.

Bypassing Initialisation States

Each state has a Boolean bypass flag (B0, B1, B2, B21, T1=0, B4) meaning that it is possible to go from power on to explosion without reaching any thresholds. This situation and setup should ONLY be used for test purposes and without an active device attached.

State 31, Await Free Fall is intended to be used only for "bomb drop mode", meaning once flight is detected, it will wait until free fall is detected (when an object reaches 0g's). Once it is detected, it will arm and fire on impact. To enable this feature, B3 must be enabled – and by default is disabled.

State 51 can be used to create a “Delay Before Firing” once impact has been detected. This delay can be adjusted with the T2 parameter. By default it is set to 0 milliseconds (no delay), and can be set to a maximum of 65535 milliseconds (65 seconds).

By Enabling Boverride, the Initializer will pass through states 34/35/36; using B34, Toverride, P3/S3, and BATlow. This is indended to be used for “booby trap mode”, meaning the device is placed in a non flight situation on the ground. For the first 10 seconds, the Initializer will report battery using the 3 blinks & pause pattern. If no RED LED is seen, the battery is OK. This feature can be skipped by enabling B34. LED’s are turned off and after time Toverride the device will be enabled and be sensitive to movement. Movement sensitivity can be adjusted via P3/S3. At this point, if the slightest of movements is detected, the battery drops under the low battery voltage (BATlow), or Ttot is reached, the initializer will arm and fire. Once initiated, there is no way to disable this mode.

The OKO M1 initialiser is intentionally extensively programmable allowing for operator and situation fine tuning. The device is programmed using an Android Application and a dedicated programming dongle via the USB connector. NOTE: the USB connector is not a real USB device and will not react if connected to a real USB port (phone, laptop etc.).

Additional Safety Features

The OKO M1 incorporates additional hardware protections to ensure that the firing discharge capacitor is not charged or discharged until all states have been achieved.

- A blocking transistor keeps any power from the step up inductor and diode until the Arming State 40 is reached.
- The firing or discharge of the device is both source and ground disconnected until state 50 meaning there is no electrical path to ground or to power until State 50.
- If power is removed by depressing the power switch, a transistor bleeds all power from the charge capacitor via a 100 ohm resistor to ground and keeps the positive side grounded until power is applied.

Appendix A

See State Diagram for Details