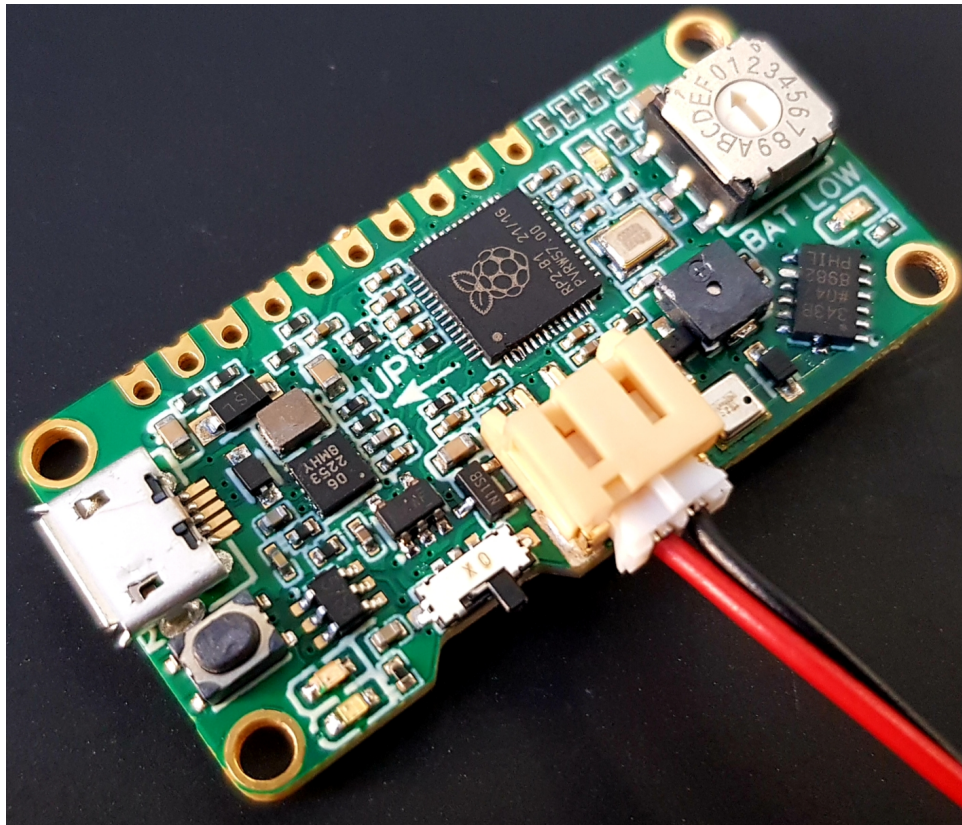


# ROCKIT REV.1 USER MANUAL

VERSION 1.6



DANINVENTS

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# 1 Disclaimer

In no respect shall DanInvents be accountable for any liabilities, claims, demands, damages or suits resulting from the use of Rokit and/or its related firmware. By using this circuit, you assume all risks associated with this product and its associated features. While the circuitry and firmware have been tested, they should be considered experimental and handled with caution.

# 2 Introduction

Rokit or Rocket Operation Computing Kit is a flight controller designed with rocketeers in mind. In a small package, it delivers accurate altitude and acceleration data, dual parachute deployment capabilities, and battery charging as well as fast data processing speed and data logging to a micro-SD card. Neat!

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	Specs
Dimensions (length, width, height) in mm	44, 22, 9
Mass in grams	5
Working voltage*	2.3 to 5.6 V
Current draw when idle	70 mA
Current draw when logging data	80 mA (200mA when beeping)
Current draw when moving a servo motor	400 mA
Maximum current output from 5V	2A (continuous)
Battery charging current	500 mA
Sampling rate	100 Hz
Altimeter range	Up to 9160 m
Accelerometer range (adjustable)	22.6 g
Maximum number of files	100
Maximum data logging time	5 min

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Table 1: The lower limit of the voltage range is set by the protection circuit of your lithium polymer battery. The battery power is typically cut off below 3V.

### 3 Layout

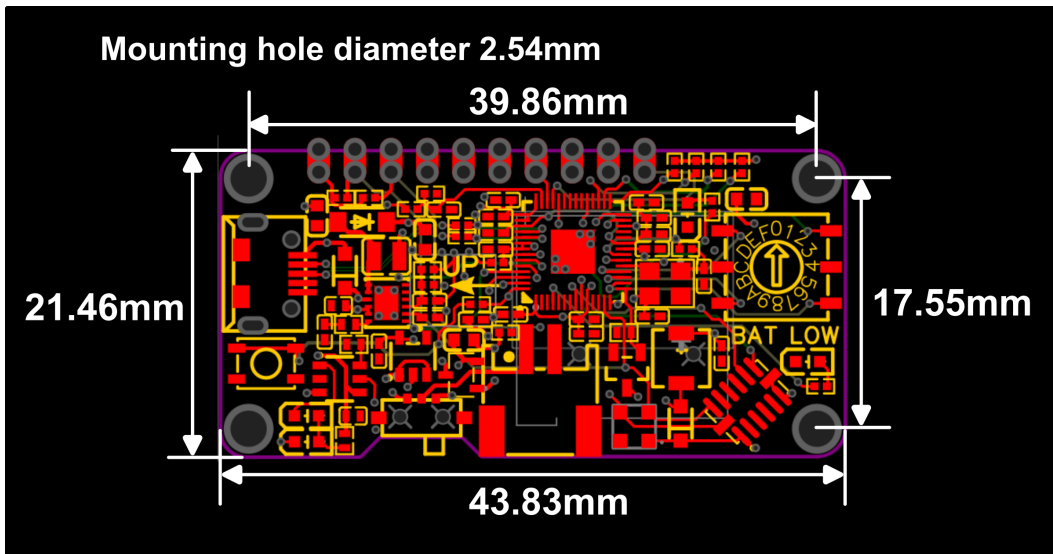


Fig.1. Rokit dimensions. The 2.54mm holes are grounded and can be used for probing the circuit.

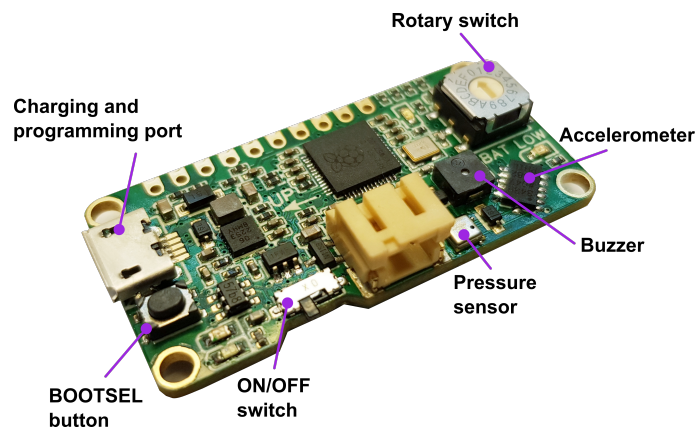


Fig.2. Top Rokit layout, the I2C pins as well as the servo signal pins operate at 3.3 V. Connecting these pins to a 5V signal source will destroy the microcontroller. For best data logging speed, use a class-10 microSD card.

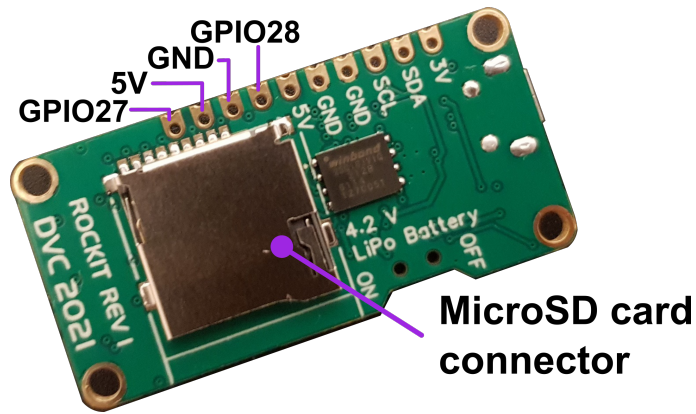


Fig.3. Bottom Rockit layout the general-purpose input/output pins (GPIO) 28 and 27 are used in the firmware to control servo motors 1 and 2 respectively. The I2C pins SDA and SCL corresponds to GPIO pins 10 and 11.

## 4 How does Rockit work?

### 4.1 Launch detection

In version 1.0 of the firmware, Rockit detects launch when the longitudinal acceleration is zero. This requires an acceleration transient, which might or might not occur.

Version 1.1 of the firmware solves this issue by setting an acceleration threshold of 1.5 g. This means that to detect launch Rockit must experience an upward acceleration of 1.5 g.

Version 2.1 of the firmware detects launch by measuring both altitude and acceleration. Altitude must be higher than 10 meters and there must be an acceleration of at least 2g for 100 ms for launch to be detected. For testing launch detection you can fool Rockit by first cupping your hands over the pressure sensor and sucking air out. Then rapidly move the acceleration forward (as indicated by the UP arrow) to fulfill the acceleration requirement. If you just want to test a deployment mechanism you could simply turn the rotary switch to position 3 and turning on the power (see table 2). Please check section 8 of this document to find the improvements of version 2.1 over other firmware versions.

## 4.2 Apogee detection

To detect apogee (position A of the rotary switch) the firmware constantly computes the difference between the current and the previous filtered altitude values. When the difference in altitude is negative four times in a row, a countdown starts to activate the servos.

# 5 How to use Rokit

## 5.1 Effect of sunlight on altitude readings

To avoid sunlight from interfering with altitude data, protect the pressure sensor from direct sunlight. One way to do it is by placing your Rokit in a container with opaque walls. Alternatively you can cover the circuit with tape or foam, just be careful not to cover the vent hole that there is on the surface of the pressure sensor.

## 5.2 Rokit power source

To work properly, Rokit needs an input voltage ranging from 2.3 to 5.6 V. The battery charging functionality is only safe to use with 1s (3.7 V nominal voltage) lithium-ion or lithium-polymer batteries.

Lithium-polymer batteries typically incorporate a protection circuit. When driving servo motors current spikes can trigger the overcurrent protection of your battery thus disabling it. To prevent this from happening at start up, Rokit includes soft-start circuitry. You can avoid this problem altogether by carefully choosing your servo motors and battery. Before a flight, test your Rokit to make sure that it can actuate the servo motors without the battery-protection circuit cutting off the power.

When connecting a battery, the polarity of the JST connector must be the same as indicated in the figure below where the black wire is ground.

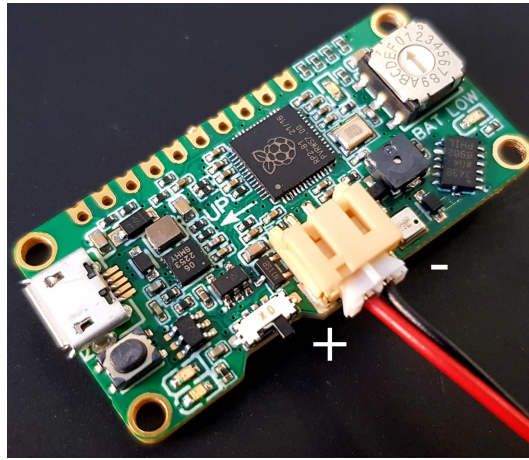


Fig.3. Mind your battery polarity! For rokit to work properly follow the wiring depicted in the image where red corresponds to the battery voltage and black to ground.

### 5.3 Choosing a microSD card

For best results, use a class-10 microSD card with a capacity of 16 GB or lower. MicroSD cards featuring capacities larger than 16 GB are not guaranteed to work. It might be possible to use an SD card with a capacity higher than 16 GB by first formatting the microSD card into FAT32 format.

### 5.4 Time and servo motor adjustment

To select an operating mode, with the device off turn the rotary switch to the desired position (see table 2) and switch on the device. When adjusting time and servo motor position, changes are saved automatically.

Both when changing the time and adjusting the servo motor position, the zero position corresponds to "0" ( $n = 0$ ) in the rotary switch and the end position to "F" ( $n = 15$ ).

Table 2. Mapping of the rotary switch functions.

Rotary switch position	Main function	Integer n
A	Automatic mode	n = 10
B	Timer mode	n = 11
C	Adjust deployment time for the automatic mode	n = 12
D	Adjust deployment time for timer mode	n = 13
E	Adjust servo 1 start position	n = 14
F	Adjust servo 1 end position	n = 15
0	Adjust servo 2 start position	n = 0
1	Adjust servo 2 end position	n = 1
2	Adjust servo 2 deploy time	n = 2
3	Testing of servo motors (firmware rev 2.1)	n = 3
4 to 9	Sleep mode	n = 4 to 9

#### 5.4.1 Time adjustment

To adjust the deployment time for servo motor 1 in the automatic or timer mode, turn the rotary switch to C or D. The green LED will start blinking indicating that you can now change this setting.

In automatic mode, the time adjustment follows the equation:

$$t_{servo1}(\text{seconds}) = 0.5 * n \quad n = 0, 1, \dots, 15$$

And in timer mode

$$t_{servo1}(\text{seconds}) = 1 * n \quad n = 0, 1, \dots, 15$$

The deployment time for servo motor 2 is adjusted in a similar fashion as in the automatic mode.

$$t_{servo2}(\text{seconds}) = 0.5 * n \quad n = 0, 1, \dots, 15$$

Note: The deployment time for servo motor 2 is  $t_{deploy} = t_{servo1} + t_{servo2}$ .



### 5.4.2 Servo motor adjustment

When adjusting the start and end positions of both servo motors, the orientation of the knob follows the relation:

$$angle(deg) = \frac{n * maxAngle(deg)}{15} \quad n = 0, 1, \dots, 15$$

Note: Depending on the servo motor maxAngle will be 90 or 180°.

### 5.4.3 Testing of servo motors

When you select position 3 of the rotary switch and turn on power servo motor 1 moves from its initial to its final position followed by servo 2 3 seconds later. After the test the Rockit goes into sleep mode.

## 5.5 Automatic mode

In the automatic mode (A), once launch has been detected and the rocket has reached apogee, servo motor 1 moves followed by servo motor 2.

## 5.6 Timer mode

In the time mode (B), once launch has been detected and a set amount of time has passed, servo motor 1 moves followed by servo motor 2.

## 5.7 Reading altitude

To find out the maximum altitude of your flight you can use data stored to the microSD card. If you are using version 2.1 of the firmware, you can also listen to the beeps from the buzzer or count the flashes of light from the LED that is next to the rotary switch. 5 minutes after launch is detected, Rockit beeps and flashes the altitude. For example, 5 beeps/flashes followed by 7 beeps/flashes means 57 meters.

# 6 Programming Rockit

Rockit comes already programmed, to implement an upgrade, follow these steps:

- Download the .bin file from GitHub containing the desired upgrade.
- Plug a micro-USB cable to Rokit.
- Hold the BOOTSEL button as you connect the other end of the micro-USB cable to your computer.
- Drag and drop the .bin file to the flash drive that is Rokit.
- Rokit is ready to use.

## **7 Firmware improvements of version 2.1 over the previous versions**

- Changed the way that launch is detected. Now the altitude must be greater than 10 m and the acceleration higher than 2 gs for over 100 ms. This improvement tackles the issue of false triggering due to vibrations.
- Modified the frequency at which the flight computer beeps, now it beeps less frequently before launch.
- Now the flight computer goes silent once launch is detected. After 5 minutes, the flight computer beeps and flashes the altitude. For example, 5 beeps/flashes followed by 7 beeps/flashes means 57 meters.
- Now the flight computer can rotate a servo 180 degrees (not yet tested as I don't own servo motors that rotate 180 degrees).
- When the rotary switch is set to a position between 4 and 9 the flight computer goes to sleep. This mode allows for quicker battery charging as compared to the other modes.
- Fixed a bug that made the piezo buzzer and the status LED stay on once launch was detected.
- The flight computer now waits for 10 seconds to allow the rocketeer to prepare for launch before the flight computer is armed. This avoids creating unnecessary files in your microSD card.
- Selecting the position 3 of the rotary switch allows you to test the servo motors. Servo motor 1 moves from its initial to its final position

followed by servo 2 3 seconds later. After the test the flight computer goes into sleep mode.

## 8 Firmware improvement of version 2.2 over the previous versions

Fixed the issue that prevented a servo motor from rotating 180 degrees. The new functionality has been tested to work with a MG90S servo motor.

```
//Servos
int servopin = 28;
int servo2pin = 27;
int zeroPos = 540; //These are the pulse widths for an MG90S servo motor
int extendedPos = 2580;
```

To modify the start and the end positions for a different kind of servo motor you will need to modify the zeroPos, and extendedPos variables. To do so you need to download the SparkFun\_MS5637\_Arduino\_Library, the Adafruit\_Sensor, Adafruit\_ADXL343, CircularBuffer, and pic/stdlib libraries.

I recommend using Arduino IDE rev. 1.8.19 to modify the code and upload the firmware to your flight computer.

Alternatively, you could also keep the current firmware and choose the start and end positions that work with your servo through the rotary switch settings.

## 9 Frequently-asked questions

**My flight computer gets very hot when I plug in the battery and nothing happens, what can I do?**

Disconnect the battery immediately! You have a battery with a wrong polarity (see section 5.2). Buy a battery with the right polarity or exchange the metal contacts of the JST connector by using a small flat screw driver (there are tutorials on how to do this online). Be careful when tampering with LiPo batteries! You can start a fire!

**My flight computer keeps beeping while charging the battery. How do I make it stop?**

Disconnect the circuit board from the USB cable and turn off the power. Rotate the switch to a position from 2 to 9 and plug the USB cable back in.

**My flight computer does not work. I turn it on and the LED stays green. What can I do?**

Make sure that you are using a micro SD card no bigger than 16GB. It is possible that micro SD cards with a capacity of 32GB also work. Double check that there are no more than 100 files in your micro SD card.

**Launch is not detected even when I tilt the flight computer, what is going on?**

In this case, you've got a flight computer with a firmware version other than 1.0. Now the acceleration threshold is 1.5 g and tilting the sensor does not trigger the flight computer. To simulate launch hit with your finger or against the table the edge of the flight computer so that the applied force is upwards (as indicated by the UP arrow).

**My servo motor does not move, what is going on?**

Make sure that you have properly configured the start and end positions of the servo motor. If the start and the end positions are the same the servo motor will not move.

**Why does the flight computer keep blinking even in the A and B modes?**

This means that the time delay for servo 1 and servo 2 are not configured. Please visit the section "time adjustment" of this manual.

**What is the difference between real-coded and complementary-coded flight computers**

Depending on the mapping of the positions of the rotary switch your flight computer is real or complementary coded. You will need different firmware depending on the coding of the rotary switch