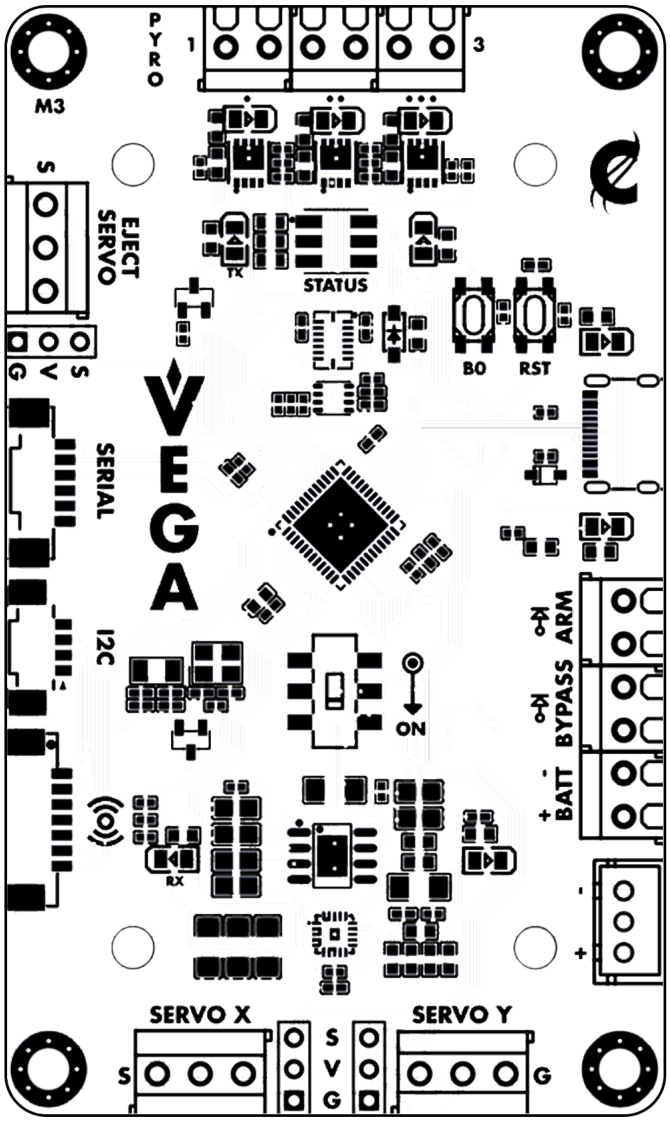
VEGA

FC-301



USER MANUAL

Please read before use

DISCLAIMERS

Safety

Flight computers are sophisticated pieces of technology that help rocketeers alike to fly their model rockets. Please ensure that you use the product enclosed properly with care and caution. Ensure it is properly secured onto the model rocket upright, perpendicular to the launchpad. Please take proper safety precautions when handling model rockets of any size.

Read the documentation carefully to ensure appropriate use of the flight computer. When launching model rockets, beware of your surroundings and ensure you follow protocols established by your local laws & regulations. Cosmic Aerospace Technologies is not responsible for any product misuse, which may lead to injuries after delivery. We are here to provide quality service for quality products, injuring yourself or others is a danger in the domain of model rocketry, and our products require fine-tuning after delivery. Make inspections and overviews before launch to ensure a safe flight.

WARNING

Do not install ejection explosives to the flight computer's pyrotechnic terminals until the day of launch or if there is a genuine use for it, otherwise, keep the pyrotechnic terminals free from explosives

Do not short the "ARM" terminal if not used. Only short the "ARM" terminal on the launch site or to test continuity without the use of pyrotechnics.

If you are using an external battery source other than 2S Li-ion, properly connect to the "BATT" terminal. Incorrect wiring will lead to reverse polarity and **cause shorts.** Follow the polarity on the silkscreen. If this happens, **replace the SS34 diode** underneath the terminal block with the spare.

Properly set your PID gains when using the thrust vector control on board the flight computer. Values are saved onto an EEPROM for use in flight.

Beware of unstable flights when first using TVC. It is not common for TVC rockets to be stable on initial launches, thus take proper safety precautions.

It is not recommended to use homemade rocket motors. Please use commercially available motors from (e.g. ESTES, AEROTECH).

Warranty

30 days warranty since delivery to the recipient.

Cosmic Aerospace Technologies does not refund products that are lost in flight or damaged by the consumer. Please be sure to launch in the open air and skies with a proper recovery system far from any buildings, homes or public areas such as public parks, streets and electrical wires. If you plan on high-altitude flights, we recommend implementing GPS capabilities.

Cosmic Aerospace Technologies offers repair services as well as design as layout to help you fix the board yourself[1].

Return & Refunds

If the item is damaged due to delivery, or is defective upon arrival you may request a refund:
cosmicaero.space/refund and we will contact you our e-mail:
orders**@cosmicaero.space**

Note that shipping labels will be paid by recipient for returns.

1 With the rise of Right to Repair, we believe that you own the product in full and have the right to fix any damaged components found on the board. More Information & documentation can be found on the Repair section of the website.

Useful Information & links

For more information on safety and regulations, please visit:

https://www.nar.org/ [National Association of Rocketry]

https://www.faa.gov/ [Federal Aviation Administration]

Please note that the information and resources given above may not be accurate to your location [Outside of the United States of America], thus you must be aware of your local regulations.

For information or questions regarding the flight computer itself, contact us:

E-mail: info@cosmicaero.space
Contact: https://cosmicaero.space/contact

Once again, thank you for using our product.

We really appreciate it.

Contents in the Bundle

1x Assembled FC-301 Vega board
- 4x M3 screw
- 4x Silicone shock absorber
- 4x O-rings
- 4x M3 nuts
- 1x Bottom Transceiver Board

1x Cosmic Tower Module (CTM)
- 1x Cosmic Tower PCB
- 4x Housing screw
- 1x CTM Housing

2x USB Type-C cable

2x 868-915 MHz Antenna

1x FTDI Programmer

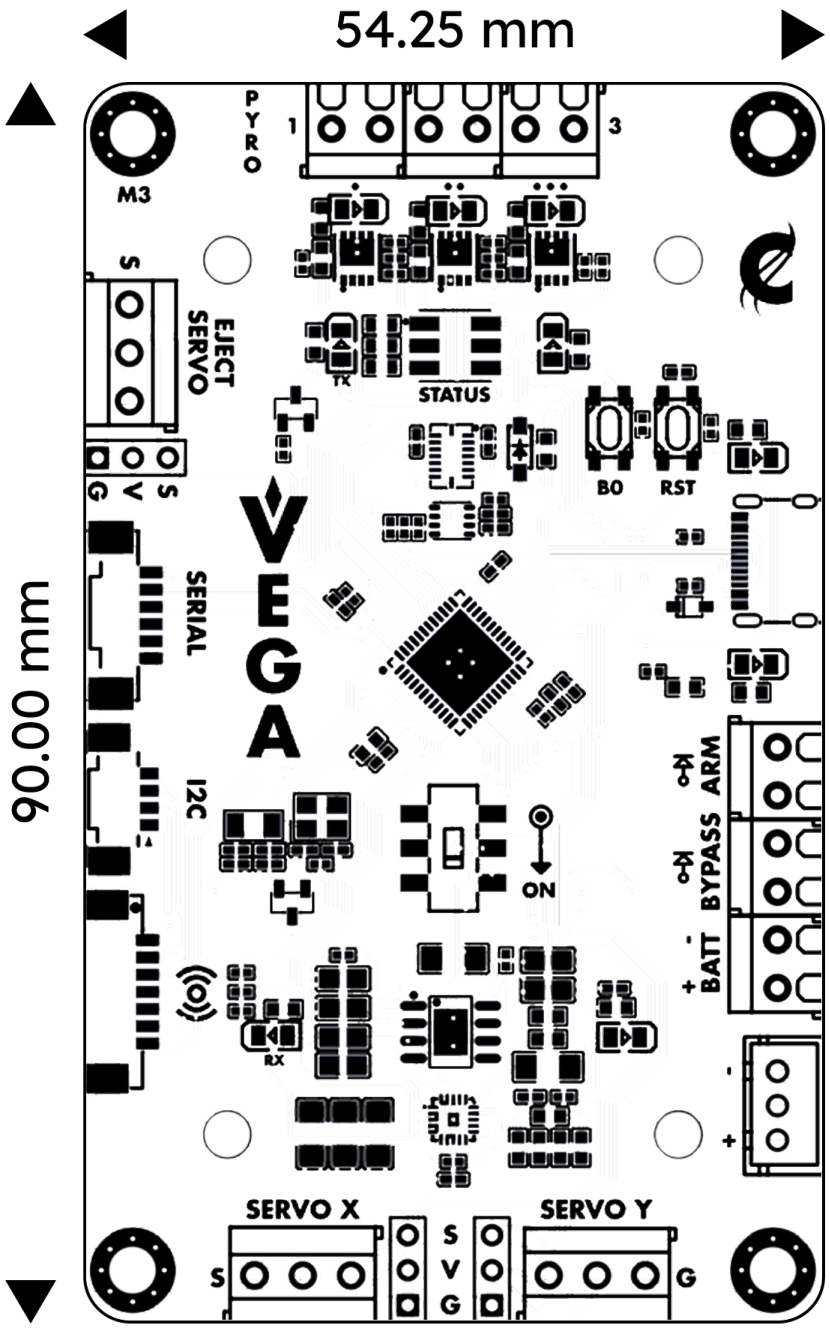
1x Philips screwdriver

1x Flathead screwdriver

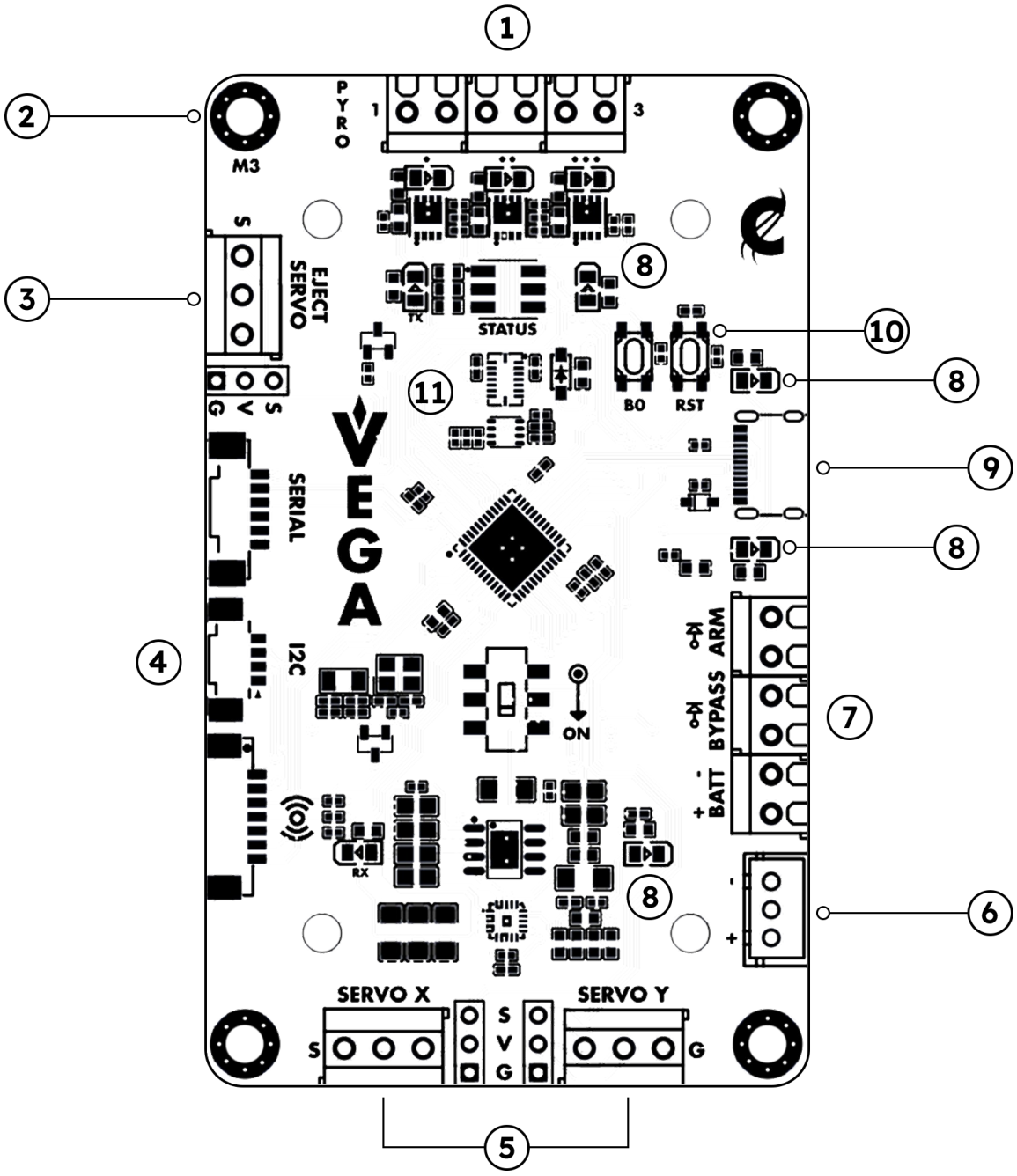
1x Spare SS34 diode

VEGA

BOARD OUTLINE

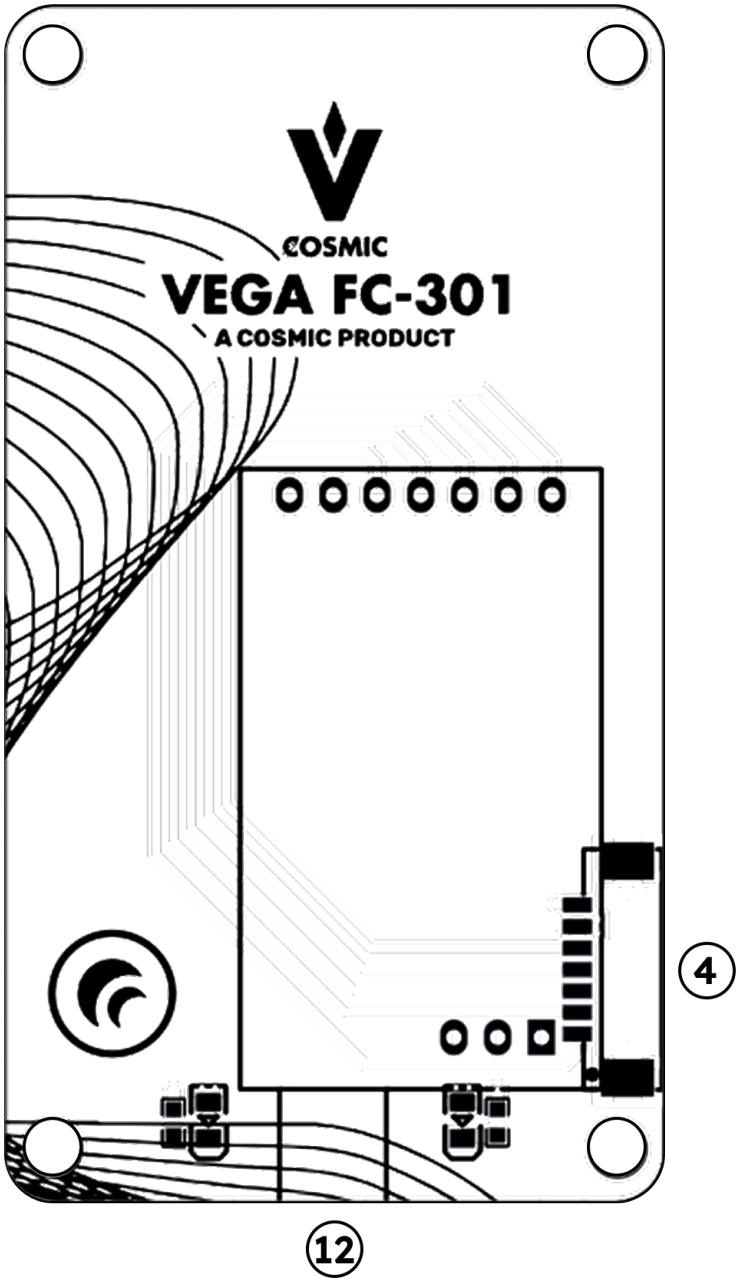


TOP BOARD
Overview



Identification numbers are listed in the sections below.

BOTTOM BOARD
Overview



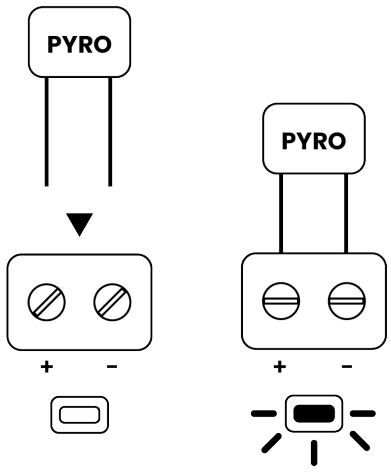
1 Pyrotechnic Terminals

WARNING

This section involves handling explosives which, if used incorrectly, may fatally injure your and others around you. Please beware of the dangers of pyrotechnics. YOU ARE RESPONSIBLE FOR YOUR SAFETY AND THE SAFETY OF OTHERS.

The Vega FC-301 has 2 types of onboard ejection system: mechanical and chemical. Pyrotechnic ejection is a chemical and more explosive method of ejection. The advantage over mechanical is its lightweight and small use of space on the rocket, however, pyrotechnic ejection is also known to not always function properly. Make sure the continuity indicators are bright green (when ARMED) before launch.

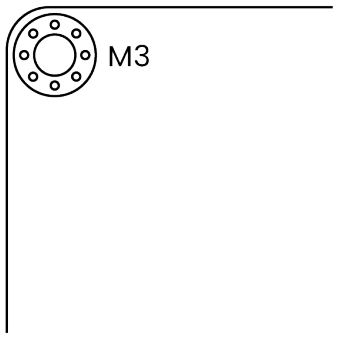
In order to use the pyrotechnic channels, insert the legs of the pyrotechnic onto any terminal. You may use 1 to 3 of the pyro channels, however note that a single pyro channel may not suffice for complete deployment.



Note: Pyrochannels 1-3 will only be active once the “ARM” terminal is shorted.

2 Mounting Holes

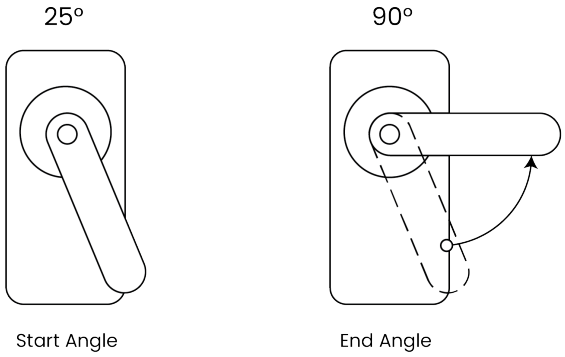
In order to mount the flight computer onto your rocket, you will need to either design a payload bay to hold all your electrical components or 3D print mounting brackets to hold the flight computer directly. Either way, it is recommended to properly screw the FC onto the either option through the use of screw holes.



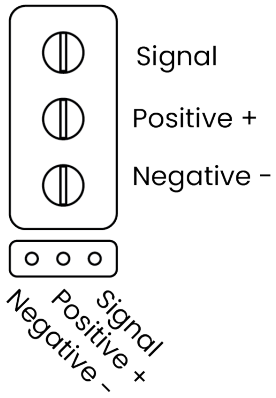
The screw holes on the flight computer are grounded and are standard to M3 screws only (not included).

3 Mechanical Ejection Terminal

As mentioned previously, you may use either a mechanical or chemical ejection. In order to use the mechanical ejection, you will be required to set the start angle and end angle of the servo using the Cosmic Tower. In the “Debug” tab, you can modify the “Start Angle” and “End Angle” to match your requirements for your mechanical ejection system.

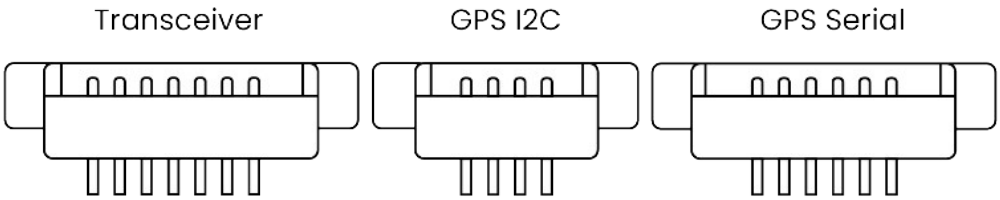


To connect your servo motor, a terminal block and header pins are available on the top left side of the flight computer. When the computer first boots up, it sets the servo angle to start. Remove the servo arm and let it set to the start angle and place the arm back to the desired location.



4 Peripheral MOLEX™ connectors

There are 3 MOLEX™ connectors located on the top board and 1 on the transceiver (bottom) board. The “Serial” and “I2C” connectors are for GPS communication (not included). The one below “I2C” is to connect the top board to the bottom transceiver board via the included 50 mm MOLEX™ connector. If you remove the connector, the board can no longer transmit or receive any data.



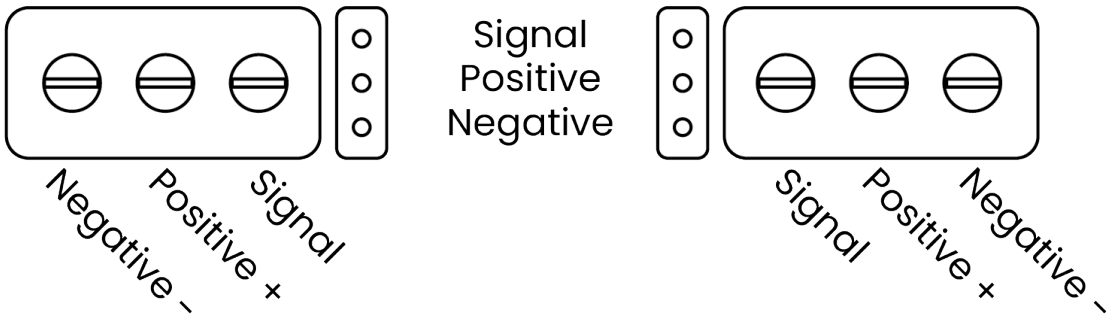
The GPS MOLEX™ connectors are specifically designed for the BN-880 GPS module which can be bought separately. If you happen to lose or damage the 50 mm MOLEX™ cable for the transmitter, you can purchase the item either through our website or MOUSER.com by searching “15134-0700” as the manufacturer part number (mfr. Part #).

5 Thrust Vectoring Terminals

Background

The VEGA FC-301 is T.V.C. compatible allowing your rocket to look like a “real” looking rocket. T.V.C. allows your rocket to be void of fins and can stabilize itself by automatically adjusting the thrust vector produced by your motor, generating torque about an axis(es), increasing or decreasing the corresponding pitch and roll of the rocket. In a perfect scenario, the rocket will go straight up, normal to the ground, meaning the reference point of the flight computer is Y = 90°.

To use the T.V.C. feature, assuming you have a T.V.C. mount which is adaptable to your rocket, connect 2 servo motors, plastic or metal gear (recommended), to your rocket. Servo motors have 3 wires, a negative, a positive and a signal line. Connect the servos according to the illustration below, where the left and right terminals are for X & Y respectively.



The most difficult part of T.V.C. is to fine tune the PID gain values to your rocket's specifications. Cosmic Tower allows you to input data surrounding your rocket's design by doing experiments on your rocket and will output a theoretical Proportional, Integrative and Derivative gain which you can copy and paste into the "Debug tab" and send to the Vega flight computer. However, it is recommended to also do your own calculations by hand and/or running Simulink for the most optimal outcome.

It is important to note that all values sent from the "Debug Tab" are saved onto the onboard EEPROM, meaning you will not need to upload the values every time you boot up the computer.

6 2S Li-ion Connector

The best way to power and use your flight computer for launch is using the 2S 3-pin connector. This connector is designed to properly insert the female connector of the 2S Li-ion battery without the hazard of inverse polarity. The 2S type is optimal as it can provide 7.4 volts while delivering an ample amount of current whenever needed. Although the FC does not draw as much current as RC planes or drones, having this option available can ensure that all the systems onboard are fed the proper amount of current. The onboard 5-volt and 3.3-volt regulators allow the conversion of 4 – 20 volts down to 5 or 3.3-volts as needed with above 90% efficiency for most applications.

It is important to note that the larger the amp hours of the battery, the larger the battery itself, thus be mindful of this when choosing your 2S battery. We recommend 450 mAh – 2000 mAh for the best size-to-weight ratio.

7 Peripheral Terminals

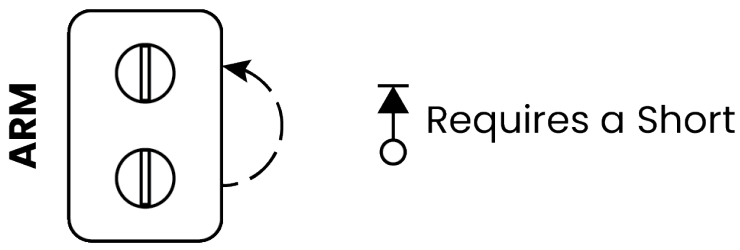
WARNING

Do not short the “ARM” terminal when debugging or directly handling the flight computer for testing. Only short on launch sites to reduce the chances of false discharges which can injure or kill.

The peripheral terminals located on the right side of the flight computer are in charge of arming the pyrotechnic channels, bypassing the switch and using an external battery other than the 2S Li-ion connector.

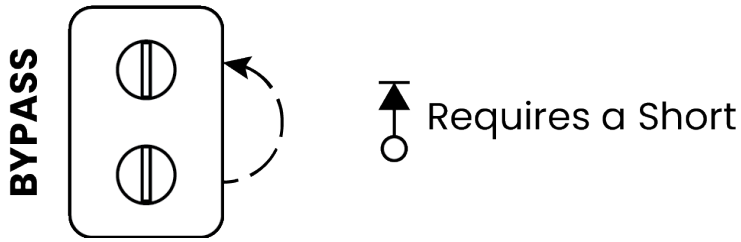
“ARM” TERMINAL

The arming terminal allows for current to pass from the battery to the pyro channels but not directly to ground. Arming this terminal also allows you to see the green continuity indicator lights located below each of the pyro channels. You can test the indicators by shorting the ARM terminals and placing metal tweezers across any of the pyro channels. **DO NOT USE PYROTECHNICS TO TEST CONTINUITY FOR THE SAKE OF TESTING CONTINUITY, USE A DEDICATED MULTIMETER.**



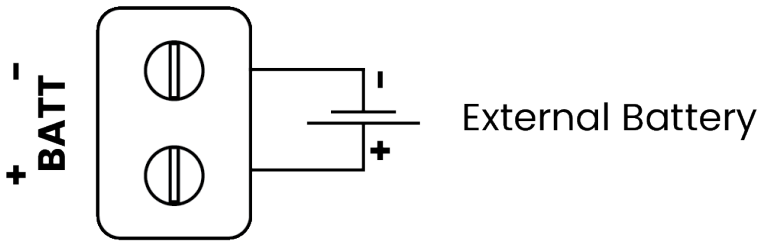
“BYPASS” TERMINAL

The “Bypass” terminal is another safeguard which prevents the rocket from only relying on the slide switch to power “ON” or “OFF”. It essentially *bypasses* the switch in order to keep power flowing to the flight computer without the worry of the switch turning on or off during flight. It is highly recommended to keep this switch shorted for flights, however, it is not needed when powering via USB-C.



“BATT” TERMINAL

The “BATT” terminal allows freedom to the user to use another form of powering the computer other than Li-ion. A common choice is a 9-volt battery, however, you will need to connect the proper terminals to the flight computer or else the SS34 diode underneath or other components on the board will be damaged and will need replacing. Furthermore, some 9 volt batteries may not be able to output enough current quickly to deploy the parachutes, unless using a mechanical ejection.



8 Light indicators

Light indicators are visual aids which can describe the current state of the rocket without needing hear from it or read the data being transmitted. The flight computer is equipped with 6 types of light indicators.

ON Light

This light will be lit automatically whenever there is power entering the flight computer as it is connected to all power inputs. This light is located right below the USB-C connector.

ERROR (PC13) Light

This light will blink in a Morse code like pattern which will indicate the error code it is running into. This light should stay off.

Transmit Lights

The TX lights, located on both sides of the main status lights will blink when sending data to the ground station or remain solid when in bootloader mode.

Receive Light

The RX lights located in the bottom half of the flight computer will blink red when receiving data from the ground station or serial monitor.

MAIN Status Light

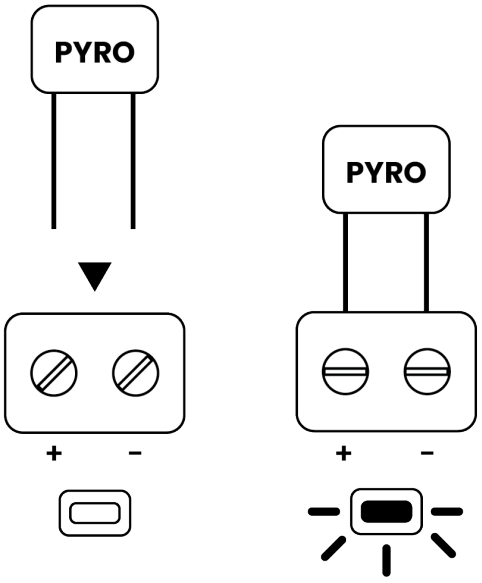
The main status light located between both transmission lights is an RGB SMD LED which can turn different colours depending on different states the main colours being:

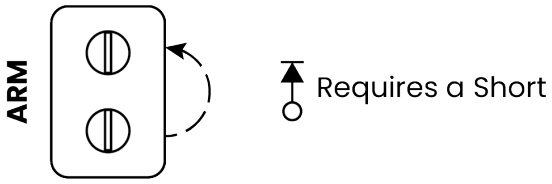
- Magenta for Launch Mode (Launch Detected)
- Red for Flight Mode (Awaiting Launch)
- Amber for Debug Mode (Awaiting debug packets)
- White for Apogee Detection & Ejection
- Flashing Red & White Locate Mode

This may vary with future updates

Continuity Indicators

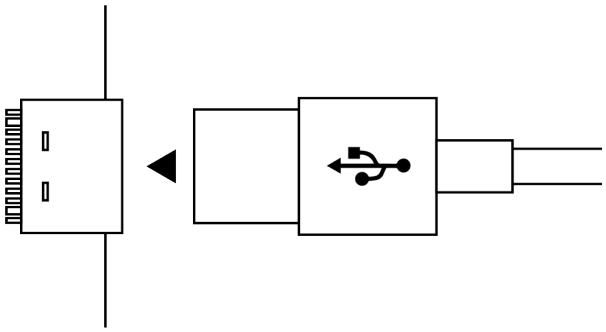
These lights are crucial for pyro ejection as they describe the flow of electricity as being continuous or not. You will be aware when you have continuity when the indicator underneath the pyrotechnic terminal is bright green. Discontinuity will result in the lights being off. This indicator will only work when the ARM terminal is shorted. **<u>Do not use</u> actual pyrotechnics when testing continuity.**





9 USB-C connector

The USB-C port is used to either update the firmware on the flight computer or to power the flight computer on. It is not recommended to test the T.V.C. servos using this as the power source unless the T.V.C. mount is empty and only for testing. Servos can draw a lot of current and may damage your PC's USB regulator unless rated for higher than 2 Amps.



Connect the USB Type-C into the flight computer and the other in your computer. Within the Cosmic Tower, you should find a binary file where you can upload it onto the flight computer using STMCubeProgrammer.

Updating Flight Software Firmware

Requirements:

- Vega FC-301
- USB-C cable
- Computer with the STMCubeProgrammer

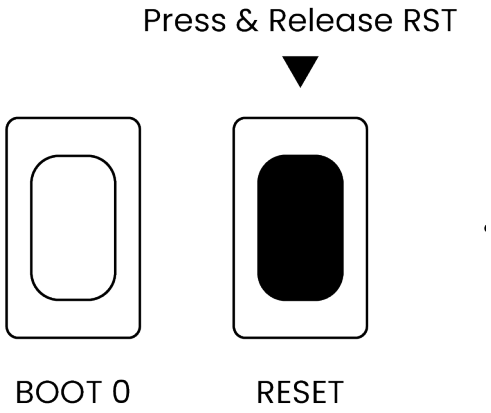
1. Connect the flight computer to a data port on your computer via the included USB-C cable or any other adaptable cable which can transfer data.
2. On the flight computer, put in “Bootloader mode” by pressing and holding the “B0” button and then pressing the “RST” button. Detailed instructions for the bootloader are in section 10.
3. Download the latest Vega firmware binary file on the Cosmic Tower.
4. On the top right, in the dropdown menu, select “USB”.
5. Under “USB configurations”, next to “Port”, press the refresh icon, there should be a “USB” that appeared.
6. Press the “Connect” button, the application should now be connected to the flight computer.
7. Enter the “Erasing & Programming” tab by clicking the second tab on the left side of the window of the application.
8. In “File Path”, find the location of the binary file where you saved the firmware and press “Open”.
9. Press “Start Programming”. End.

10 Boot 0 & Reset buttons

On the flight computer, there are 2 buttons labelled “B0” and “RST” located up and to the left of the USB-C connector. These buttons serve 2 purposes: resetting the flight computer and entering bootloader mode to upload new firmware. Refer to section 9 for updating the firmware on the flight computer.

Resetting

In order to reset the flight computer, simply press and release the “RST” button to. The FC should reboot after doing so.



Entering Bootloader Mode

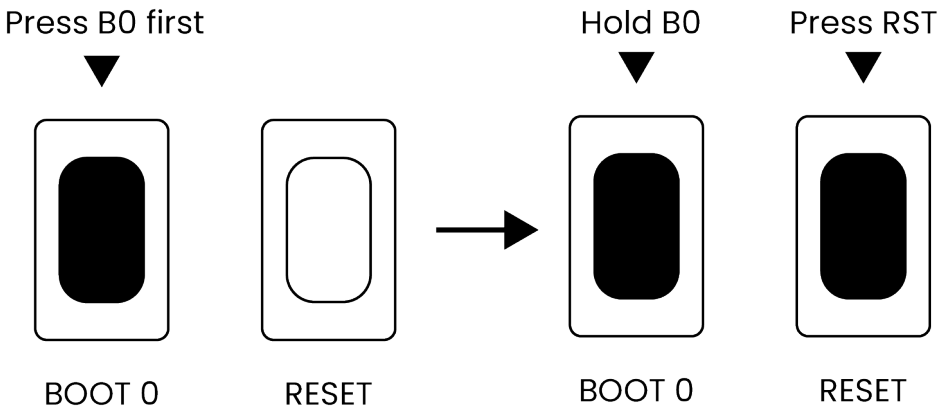
To upload new firmware onto the flight computer, you will need for the flight computer to be in “Bootloader” mode.

1. Hold down the “B0” button.
2. While having “B0” pressed down, press and release the “RST” button.

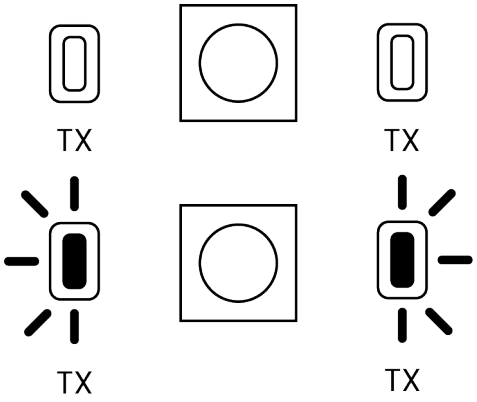
This will put your flight computer in DFU mode where it can overwrite the current firmware with the new one.

You can check your “Device Manager” and should be able to see “STM BOOTLOADER” under “Universal Serial Bus Devices”.

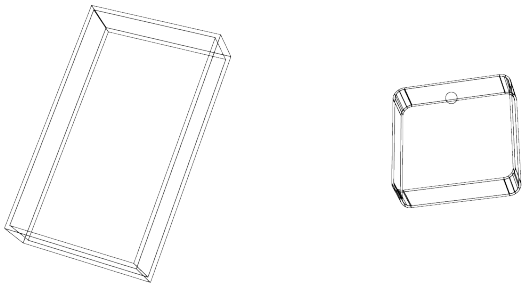
Steps Visualized



After entering “Bootloader Mode”, you will notice that the TX lights are solid white.



11 Sensors



On board the flight computer are 2 sensors: an inertial measurement unit and a barometric pressure & humidity sensor.

Inertial Measurement Unit (IMU) – BMI088

The BMI088 is a high performance 6-axis inertial sensor which can measure orientation and acceleration along the three axes. It is equipped with a 16-bit resolution for the triaxial gyroscope & accelerometer. Designed with precision and excellent with temperature stability and vibrations. - *Information provided by BOSCH*

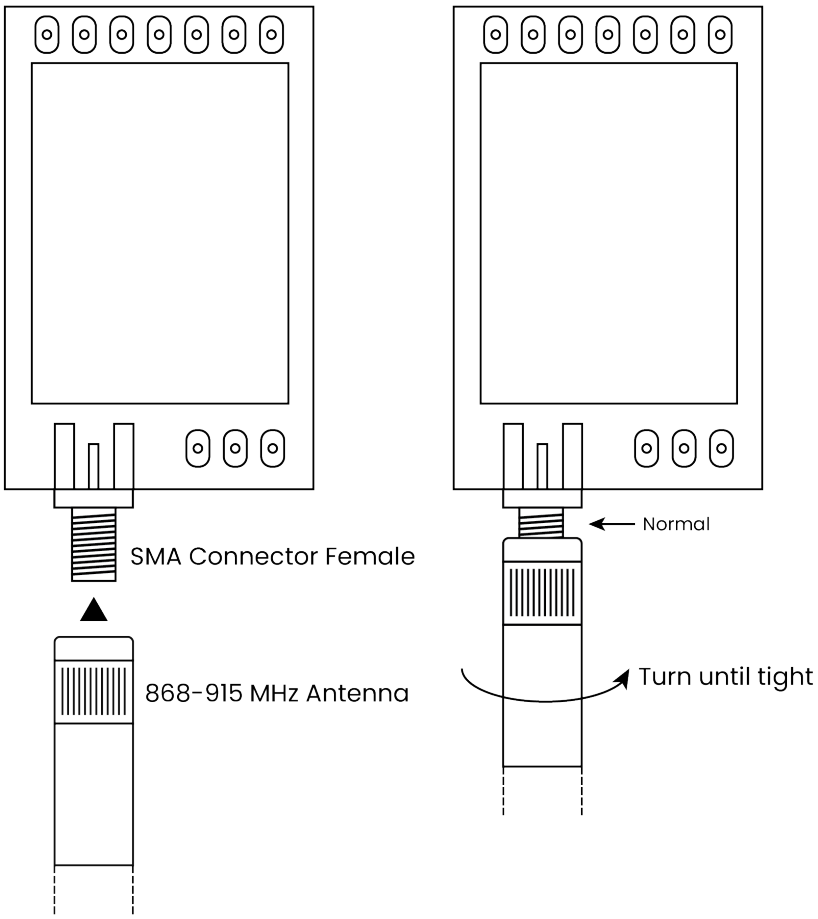
The IMU is in charge of providing the data for orientation and acceleration to the processor. The data is processed and calculated where it is used for launch detection, thrust vectoring control, current orientation and more.

Barometric Pressure, Temperature & Humidity Sensor – BME280

Used for precision altitude detection, displacement, humidity and temperature data, the BME280 can achieve the necessary data for parachute deployment and general data recovery information.

12 E220 Lora Module

The Vega FC-301 module is equipped with an E220-900T22D Lora Module from Ebyte. This allows for a limited long range communication between the Cosmic Tower and the flight computer. The bundle includes 2 868-915 MHz antennas but you can upgrade these whenever you want to reach the full potential. (e.g. Yagi)



Make sure the antenna from the flight computer and the Cosmic Tower module are always pointing the same direction, parallel to each other, for optimal range.

Sending Debug Values to the Flight Computer

1. Have the flight computer powered on.
2. Connect the Cosmic Tower Module (CTM) to the computer.
3. Open Cosmic Tower.
4. In the port tab, press the refresh button and select the available COM port. If you connected the flight computer as well, there will be another COM available. Disconnect the flight computer, refresh the COM and choose the remaining one.
5. Select a Baudrate above or equal to 115200.
6. Press Open.
7. You should be receiving data from the rocket. Now press the debug tab.
8. Toggle the switch from Flight mode to Debug Mode, the flight computer should enter debug mode after a few seconds.
9. Adjust the values as needed and press send, your flight computer should signal that it received it.
10. Switch back to Flight mode when finished.

It is recommended to connect the flight computer directly to the computer when sending debug packets and changing settings.