NaviTop

NaviTop models: C10 or PC10

PYPILOT CONTROLLER 10A* WITH CLUTCH OUTPUT by Navitop

Pypilot was imagined and designed by Sean D'EPAGNIER. Thanks to him for this fantastic boat autopilot.

* Motor current is the amount of amps drawn by the motor at maximum torque, allowing the rudder to move freely. It is not the current with the motor stalled.

This motor controller needs to be paired with a suitable autopilot computer such as **Tinypilot** or **OpenPlotter** running pypilot.

- Supports 12 or 24 volts (34v maximum)
- Can drive most existing autopilot drive units without electromagnetic clutch
- With pypilot, this controller allows you to adjust the acceleration/deceleration and speed of the motor
- Over-temperature, over-current (stall) detection
- Waterproof 4 pins connection to Raspberry Pi (tinypilot or openplotter) by serial communication 3.3 or 5.5V with galvanic isolation, prevent ground loops and other electrical problems.
- Pins to connect optional rudder feedback, optional port/starboard end of stops switches or proximity detectors 5V
- Voltage, current, temperature and rudder feedback
- Reverse polarity protection and fuse ATC 15A
- Intrinsic consumption about 5 mA (60 mW with 12V, 120 mW with 24V)
- Power and output with lever connection terminals Wago 32 amps for 4mm² conductors
- The controller's 5V DC power supply has been redesigned to be more robust and allow the pypilot computer (only with Pi Zero) to be powered. All 5V outputs are short-circuit protected. EMC has been improved with EMC filters including a common mode toroidal filter added to the power supply input.
- By powering the autopilot computer with this controller, they both function perfectly with a controller power supply between 9.5V and 34V
- PCB marinized with tropicalizing acrylic varnish
- open-source software based on Arduino installed (ISP connector).
- Optional 3 pins waterproof connection to rudder feedback sensor
- Optional 3 pins waterproof connection to rudder limit swiches
- Optional 4 pins waterproof connection to rudder proximity detectors requiring a 5V power supply
- Optional 90cm micro-USB cable to power a Pi Zero tinypilot computer (0.3A max)
- Dimensions :
  - PCB : 104 x 70 x 25 mm
  - Box : 133 x 98 x 34 mm with 4 fixing holes for 4mm screw (120 x 48 mm)

2 - Precautions for removing and replacing the cover

To remove and replace the cover, tilt the top of the cover while keeping the bottom of the cover pressed against the bulkhead.

3 – Power Supply and Motor connection – Power cable Sizing

For the controller's power supply and connection to the motor, use a cable with a sufficient cross-section, whenever possible, so that its electrical resistance does not exceed the internal resistance of the motor controller. The goal is to have the actuator operate as quickly as possible with minimal heat loss in the wires.

Strip 9 to 11 mm of insulation from the power and motor wires, then:

- Connect the + and – power wires to the WAGO + and – terminals marked "Power".
- Connect the motor wires to the Wago A and B terminals marked "Motor" on the circuit board. The two motor wires must be reversed if the driver corrections are made in the wrong direction.

4 - Motor Connection

The motor wires, striped between 9 to 11mm, connect to Wago terminals block marked “Motor”. These may need to be reversed if the autopilot makes corrections in the wrong direction.

5 - Serial Data Connection

Cable type 1	Cable type 2	Cable type 3	purpose	raspberry pin
Red	Brown	Black	+3.3v	1
Green	White	Brown	Rx to Tx	8
Blue	Blue	Green	Tx to Rx	10
Black	Black	Blue	0v, GND	6, 9

Note: wire colors of cable will be one of 3 possibilities depending on the manufacturing.

This serial data connection is galvanically decoupled. The + wire is used to power the controller's galvanic decoupling circuit, which can be powered by +3.3V (Pi) or even +5V if you want to connect the controller to an Arduino driver. The power consumption in the mA range allows for the use of a cable with thin wires.

This cable can be extended by more than 30 meters with telephone or Ethernet cable. If you are particularly concerned about interference, you could use a shielded cable, but this is rarely, if ever, a concern in practice.

If you connect the motor controller directly to a Pi, we recommend installing TVS diodes on the Pi side to limit potential surges that could be induced by a nearby lightning strike, especially if this cable is more than a meter long (see diagram of a simple tinypilot in the documentation tab of www.navitop.fr).

6 - Rudder travel limiter switches

With a powerful actuator, installing limit switches to stop the motor before it forces the mechanical rudder stops is the most reliable solution, even though these switches are optional with pypilot. They will be more reliable than a poorly calibrated rudder angle sensor whose rod can bend or detach. They are essential with certain hydraulic actuators for which current limiting with the servo.max_current setting does not effectively limit the force.

GND is the common wire for both switches. Connecting wire A or wire B to GND prevents any motor movement in the corresponding direction.

The connection on the PCB is labeled "End Stops." The square pad is GND, the second is End B, the third is End A, and the last pad is the +5V power supply, used only if you are installing proximity switches or Hall effect logic sensors requiring a 5V power supply.

In all cases, limit switches must be installed so that the electrical contact remains closed beyond their engagement threshold, preventing the motor from starting with the rudder beyond the adjustment threshold.

After connection, test to ensure that when the motor rotates in one direction, the limit switch corresponding to that direction stops the motor. If this is not the case, the End A and End B wires must be reversed.

Upon request, we can supply and solder a 3 or 4 pin waterproof connector for the optional limit switches (+5V = red, A = green, B = blue, GND = black).

7 - Motor Current Measurement and Limiting

All pypilot controllers are equipped with a motor current measurement function that allows you to determine the current drawn by the motor in amps using the servo.current variable, visible in the pypilot client (configuration page) or with the pypilot_scope script.

Important: The pypilot servo.max_current parameter must be set appropriately for the motor and the controller installed on the boat. Pypilot detects the end of travel by stopping the motor in one direction when the measured current (servo.current) exceeds the pypilot servo.max_current setting. If this current limiting setting is set too low, "OVERCURRENT_FAULT" messages will constantly appear and block the actuator from moving. If the value is too high, the actuator could continue to exert dangerous force with the rudder at full lock.

For tiller actuators, a setting of 3.5 to 7 amps is generally correct. For powerful hydraulic drives, higher values such as 12 to 20 amps should be used.

Using the pypilot_scope script can be useful to know the actual consumption curve of the motor during operation and at full throttle.

8 - Rudder Feedback

First, with pypilot, the rudder feedback is optional. It can be disconnected while underway and pypilot will continue to steer. It is generally used to report the rudder angle on a display and avoid relying on end-of-travel stop by intensity limitation. It also may be used by certain pilot algorithms to enhance steering, but the basic pilot algorithm does not require it. To be clear, corrections needed in moderate conditions are 10 or more times that of the errors due to integration from not knowing the rudder position, so the potential improvement in steering performance from rudder feedback is not huge.

A potentiometer with 3 wires can be connected to the controller. The potentiometer should range from 1k ohms to 100k ohms. Recommend 10k. You can also connect a Hall effect sensor 5v with analog output to these 3 wires.

The connection on the motor controller's PCB is labeled "Rudder." The square pad is GND, the middle pad is the measurement, and the last pad is the 5V supply. It is not critical for the voltage to increase or decrease with rudder angle, as the rudder sensor calibration controls the direction. To determine the color of the three corresponding wires, visually check their connection on the PCB.

NOTE: The labels on rudder sensor cables are inaccurate, and we strongly recommend checking the PCB for the function of the three wires to be connected to the sensor.

If connecting an existing rudder sensor with only two wires, a 1kΩ resistor must be added between the 5V pin and the measurement pin.

When the rudder feedback sensor is installed, you can check the rudder calibration page to read the value and make sure it is working.

The rudder feedback must be calibrated. You must manually turn the rudder to port range, starboard range, and center and press each button for each position. The order is not important, but once all 3 operations are complete, the scale, offset, and nonlinearity must be calculated. The "Rudder Range" field must be manually set to indicate the actual angle at each range position and to limit the autopilot movement beyond that position. It is possible to set the "rudder range" to say 35 degrees and calibrate the rudder by moving it to 35 degrees in each direction and later set it to 30 degrees to further constrain the range the autopilot can move the rudder. So, to be clear, the "rudder range" is for calibration and whatever the value is when the button is pressed, but in operation it specifies the maximum angle the motor controller can move the rudder to.

Note: It should also always be remembered that using the rudder angle sensor to limit the actuator travel may disable the autopilot if the rod connecting the rudder is accidentally bent or disconnected. Properly installed limit switches or a good adjustment of the current limiter can often limit rudder loads more reliably.

9 - Motor Temperature Sensor

Optional 10k NTC (2 wires) for temperature of the electric motor.

This is generally not needed because most motors will not overheat unless stalled for prolonged periods. It can be used to prevent the motor from overheating and burning out.

10 - JST connector for powering tinypypilot computer with Rapberry Pi Zero

This allows a tinypilot computer with a Pi Zero to be powered with 5V DC. The autopilot computer and the controller then function perfectly with a controller supply voltage between 9.5V and 34V.

Computers with larger Pis have excessive power consumption at peak which is incompatible with this power supply.

All Navitop computers (simple or with remote control) come with a 5V DC power cable pre-equipped with a JST connector to power them with this controller.

For those building their own ECU, the Navitop store offers a 90cm cable with a JST connector on one end and a micro-USB male plug on the other. This plug connects to the Pi Zero to power the computer.

11 - Connecting a 6mm² cable to the Wago terminal

For those building their own ECU, the Navitop store offers a 90cm cable with a JST connector on one end and a micro-USB male plug on the other. This plug connects to the Pi Zero to power the computer.

12 – Navitop 12-24V 15A Motor Controller Designations

- C10 : Pypilot motor controller 12-24V 15A by Navitop with case
- P10 : Pypilot motor controller 12-24V 15A by Navitop without case

Options:

- CS3R: Cable with 3-contact waterproof connector for rudder angle sensor
- CS3S: Cable with 3-contact waterproof connector for rudder limit switch contacts
- CS4: Cable with 4-contact waterproof connector for proximity detectors requiring a 5V power supply
- CUP: Micro-USB cable to directly power a Pi Zero from the controller's JST output 5V DC.