**OU CO2 Bix3 (N925UA)**



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# Airframe System Description

The OU CO2 Bix3 is a fixed high wing pusher aircraft available from HobbyKing under the product name of Bix3, which is being modified to allow autonomous flight in addition to its default manual flight mode. The on-board autopilot is the Pixhawk (PX4) running the APM Plane software. The inertial measurement unit (IMU) and GPS is built into the Pixhawk. The OU CO2 Bix3 can maintain stable and safe flight in case of engine failure.



# Airframe System Specifications

**Wingspan**: 155cm

**Length**: 94.8cm

**Electronic Speed Controller**: 20A

**Flying Weight**: 890g

**Motor**: 2620-1400kv Brushless Outrunner

**Prop**: 8x4

# Communication System Description

A Taranis Radio Controller (X9D+) is used as the primary means of communication. The Taranis operates at 2.4GHz. The OU CO2 Bix3 is also equipped with a 5.8GHz transmitter to stream live video from the platform, this system is equipped with rotational helical antennas. Telemetry data is transmitted to a ground station using RFD 900+ modems (RFDesign) operating at 915 MHz.

# Sensor Package Description & Specifications

The sensor suite consists of a CO2 sensor, the K-30 Fast Response, purchased from co2meter.com. The sensor outputs its information to an Arduino teensy via I2C. The Sensor is connected to a GPS unit.

|  |  |
| --- | --- |
| Item | CO2 Engine® K30 FR\* Art. no. 030-8-0010 |
| Target gas | Carbon dioxide (CO2) |
| Operating Principle | Non-dispersive infrared (NDIR) |
| Measurement range | 0 to 5000 ppm vol |
| Accuracy | ±30 ppm ±3% of reading1 |
| Response timeT90 | 2 seconds @ 0,5 l/min tube gas flow, 20 sec diffusion time |
| Rate of Measurement | 2 Hz |
| Operating temperature | 0 to +50 °C |
| Operating humidity | 0 to 95% RH non condensed |
| Storage temperature | -30 to +70 °C |
| Dimensions (mm) | 5,1 x 5,7 x 1,4 cm (Length x Width x approximate Height) |
| Power supply | 5 to 14,0 VDC maximum rating (without reverse polarity protection) stabilized to +-5% over load and line changes. Ripple voltage less than 100mV.2 |
| Power consumption | < 600 mA peak, 70 mA average |
| Warm Up time to spec precision | 1 min |
| Life expectancy | > 3 years |
| Compliance with | RoHS directive 2002/95/EG Tested according; Immunity: EN 61000-6-1:2007, Emission: EN 61000-6-1:2007 |
| Serial communication | UART, Modbus protocol. Direction control pin for direct connection to RS485 receiver integrated circuit. |
| OUT 1 | D/A Resolution: 10 mV (10 bit) Linear Conversion Range: 0 to 10 V = 0 to 5 000 ppm Electrical Characteristics: ROUT < 100 RLOAD > 5 k |
| OUT 2 | D/A Resolution: 5 mV (10 bit) Linear Conversion Range: 0 to 5V = 0 to 5000 ppm Electrical Characteristics: ROUT < 100 RLOAD > 5 k |
| OUT 3 | Digital (High/Low) output, 700/800 ppm |
| OUT 4 | Digital (High/Low) output, 900/1000 ppm |

# Emergency Procedures

Emergency Assumption of Control

* If there is any question that the UAS is no longer flying its programmed mission, the PIC will take manual control of the aircraft and return it to the landing zone if able and land it under Remote Control
* There may be minor problems that do not require emergency assumption of control. In these cases, the PIC can direct an autopilot landing or manually land the aircraft.

Accident/Incident Notification

* If the UAS is lost the crew will attempt to locate the downed aircraft. If the crew needs help they will request help from the OU Department of Aviation SOF. If the aircraft is recovered the crew will fill out the flight log, recover the log file, and make repairs as needed. The crew will write a detailed description of the event for OU flight safety and the FAA using the OU SMS program’s hazard/incident report IAW the OU Department of Aviation SMS program. The PIC/flight crew will inform the OU SOF of any abnormalities. The crew will wait to hear from the manufacturer before re-launching the UAS airframe.
* If the UAS crashes and damages any property or anyone is injured the crew will assess the situation.
  + Maintain personal safety for all parties concerned
  + Care for or request medical care for any injured parties
  + Notify any applicable local law enforcement agencies
  + Notify the OU SOF; OU SOF will contact OU parties IAW the already established OU
  + Department of Aviation Safety/Operational Risk Management program.
  + The PIC as well as flight crew, working observers plus any eye witnesses will write down exactly what happened and be ready to file a report with the local law enforcement and FAA if so directed. At any rate the report should be given to the OU SOF.

OU CO2 Bix3 discrepancies will be written up in the OU maintenance aircraft forms. Information will be passed to the SOF and the manufacturer if necessary. Minor repairs can be made in the field and noted in the aircraft forms. It is in the nature of the aircraft for some parts to come off if a landing is harder than normal. If this occurs and there is no part damage the aircraft may be reassembled and flown.

Note these actions in the aircraft forms, so general wear can be tracked and greater understanding of the aircraft characteristics will be understood.

# Lost Link Procedure

The flight control system onboard the OU CO2 Bix3 aircraft is very advanced and able to handle loss of signal very well. The OU CO2 Bix3 has a flight plan loaded before launch but it can be changed midflight if required. At any time, the PIC can take control of the aircraft.

If Radio Control Signal is lost:

The OU CO2 Bix3 will automatically realize that it has lost the RC connection and will use the GPS to return to the launch location. It will do this by first rising or descending to the “return home height – 300 feet” as programmed in prior to launch. It will then move horizontally to be over the launch location. If the RC signal has not returned by this point, it will slowly descend to the ground.

If GPS Signal is lost:

The OU CO2 Bix3 uses GPS for flightpath and position holding stability. If the GPS signal is lost, the aircraft will stay in its current flight path using the gyroscopes, accelerometers, and altimeter. The pilot will resume control and fly it to the ground.

If Radio Control and GPS signals are lost:

If both signals are lost, the aircraft slowly descends to the ground at whatever location it is currently at.

# Lost Communication Procedures

When a mode change or altitude change ‘will’ occur in the OU CO2 Bix3, the PIC will announce the change to the Observer. Each Observer will respond in turn. Additionally, at any time, if an Observer sees an aircraft entering the COA flight space, they will notify the PIC who will then take control of the OU CO2 Bix3 and land as soon as possible. Each Observer is instructed to occasionally observe and communicate with the other Observers while performing their duties. Each Observer will respond in turn.

If at any time an Observer does not respond, the other Observers will visually locate the non-communicating Observer and report the status to the PIC, which will constitute a loss of communication. Lost communication between PIC and Observers necessitates termination of a flight.

# Launch/Recovery Procedure

The vehicle will be launched from the ground under PIC control. Recovery will be landing under PIC control.

# OU CO2 Bix3 Maintenance Log

**Tail Number: N925UA**

Created: February 01, 2017

Autopilot System

Hardware: Pixhawk PX4

Firmware: ArduPlane (3.33)

Ground Station

APM Planner 2 (Mac)

Firmware: v2.0.23-rc4

Telemetry

Radio control of vehicle

Taranis Radio Controller (X9D)

Operates at 2.4 GHz

Radio link for data

5.8GHz transmitter to stream live video

RFD 900+ Modem

Operates at 915 MHz

**Modifications**

**Date Modification & Notes**

# OU CO2 Bix3 Pre-Departure Checklist

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Packing List**

\_\_\_ Vehicle

\_\_\_ Batteries & LiPo bags

\_\_\_ Controller (Taranis)

\_\_\_ Laptop (Mission Planner)

\_\_\_ Vests and radios

\_\_\_ Extra props

\_\_\_ Tool box

\_\_\_ First aid kit

\_\_\_ Check lists and maintenance logs

\_\_\_ Inverter\*

\_\_\_ Extension cords\*

\_\_\_ Canopy\*

\_\_\_ Chairs\*

\*If going to KAEFS and using UAS trailer, these may not be needed

# OU CO2 Bix3 Flight Operations Checklist: 1/2

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Flight number: \_\_\_\_\_\_\_\_

Tail Number: N925UA

Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PIC: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Team: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Flight pattern: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Weather: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Objectives: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

COA/107: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

PRE-FLIGHT CHECKS

\_\_\_ Perform visual inspection of the vehicle – props not damaged, props tight, center of gravity,

orientation & connection of RF, GPS, data transfer antennas, mechanical check

\_\_\_ Review flight plan – verbal & on mission planner

\_\_\_ Check laptop (Mission Planner) and battery charge

\_\_\_ Turn on controller and check voltage

\_\_\_ Confirm Mission Planner running

\_\_\_ Vehicle at the launch point

\_\_\_ Connect battery in vehicle

\_\_\_ Connect telemetry (baud 57600, select serial link, confirm heartbeat)

\_\_\_ Confirm no Error Messages with Mission Planner

\_\_\_ Confirm GPS fix type

\_\_\_ Check battery voltage: Battery Nr. \_\_\_\_\_\_\_ Voltage \_\_\_\_\_\_\_\_\_

\_\_\_ Check sensors

\_\_\_ Test audio communications among participants

\_\_\_ Observers in location before take-off / good visual coverage

\_\_\_ Press the safety button on the vehicle until solid red – now live

\_\_\_ Check if all participants ready for flight

\_\_\_ Check the LED for status of the vehicle. Should see a blinking green light indicating GPS lock

\_\_\_ Arm motors & call clear prop

IN-FLIGHT CHECKS

\_\_\_ Takeoff, record takeoff time: \_\_\_\_\_\_\_\_\_\_

\_\_\_ Perform short pre-mission flight to verify controls are functioning

\_\_\_ Begin mission

\_\_\_ Complete mission

\_\_\_ Land, record landing time \_\_\_\_\_\_\_\_\_\_ Flight duration: \_\_\_\_\_\_\_\_\_\_\_\_

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# OU CO2 Bix3 Flight Operations Checklist: 2/2

Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_ Flight number: \_\_\_\_\_\_\_\_

Tail Number: N925UA

POST-FLIGHT CHECKS

\_\_\_ Notify observers and participants that mission complete

\_\_\_ Check battery voltage after landing: Battery Nr. \_\_\_\_\_\_\_ Voltage \_\_\_\_\_\_\_\_\_

\_\_\_ Disarm vehicle

\_\_\_ Disconnect battery

\_\_\_ Inspect vehicle

Remarks: