AheadX Taurus

Navigation Flight Control System

Installation Manual

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FOXTECH

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Contents

Introduction

TAURUS GNC(Micro Guidance Navigation Control System) is a highly integrated and high reliable new generation flight control system designed for industrial UAV, which is suitable for many types of aircraft such as Fixedwing, multicopter, VTOL etc.

TAURUS has adopted a four redundant IMU design and has designed a new data arbitration mechanism to achieve seamless switching of IMU data sources. We chose an industrial-grade MCU with a frequency of up to 400MHz to ensure efficient operation of the system. TAURUS uses MEMS sensors with a temperature compensation of -20 ° C ~ 65 ° C, all metal shielded shell, with excellent reliability.

TAURUS uses a two-layer extended Kalman filter, an improved L1 guidance law, and an ADRC controller as the core algorithm of navigation flight control, and has extremely high control precision.

TAURUS is equipped with cross-platform ground station software, which can run under Windows, Linux, MacOS, Unix, FreeBSD, iOS, Android and other operating systems, suitable for the application occasions which has high requirements for operating system reliability.

TAURUS uses ZDLink communication protocol with its own intellectual property, which can provide industry customers with an on-board, cross-platform PC-side communication protocol SDK development package, that allows industry users to integrate TAURUS into their own systems, and even maintain the original operation method.

Features and Application

-Integrated 4 redundant MEMS inertial measurement unit, three-axis magnetometer, barometric altimeter, airspeed meter, the GNSS module, performs temperature compensation of -20 to 65 for the MEMS inertial measurement unit and the three-axis magnetometer.

-Dual integrated navigation system. The two-stage 17-step extended Kalman filter is used to fuse the information of the inertial measurement unit, the three-axis magnetometer, the barometric altimeter, and the GNSS module, and automatically switch between the GNSS/INS and AHRS/DR navigation modes according to the presence or absence of satellite signals.
-Using the improved L1 guidance law and ADRC controller, the control precision and robustness of the system are improved.

-The built-in global geomagnetic model and the magnetic compass calibration algorithm enable TAURUS to complete the magnetic compass calibration with one click and take off immediately after satellite positioning.

-Powerful remote technical service, no matter where and when users can request AheadX official remote technical support via the Internet at any time.

-Supports up to 1800 waypoints and can plan up to 200 emergency landing points.

-It has a fixed-point, equidistant, isochronous shutter photo taking function, and records the POS data of the aerial photography point.

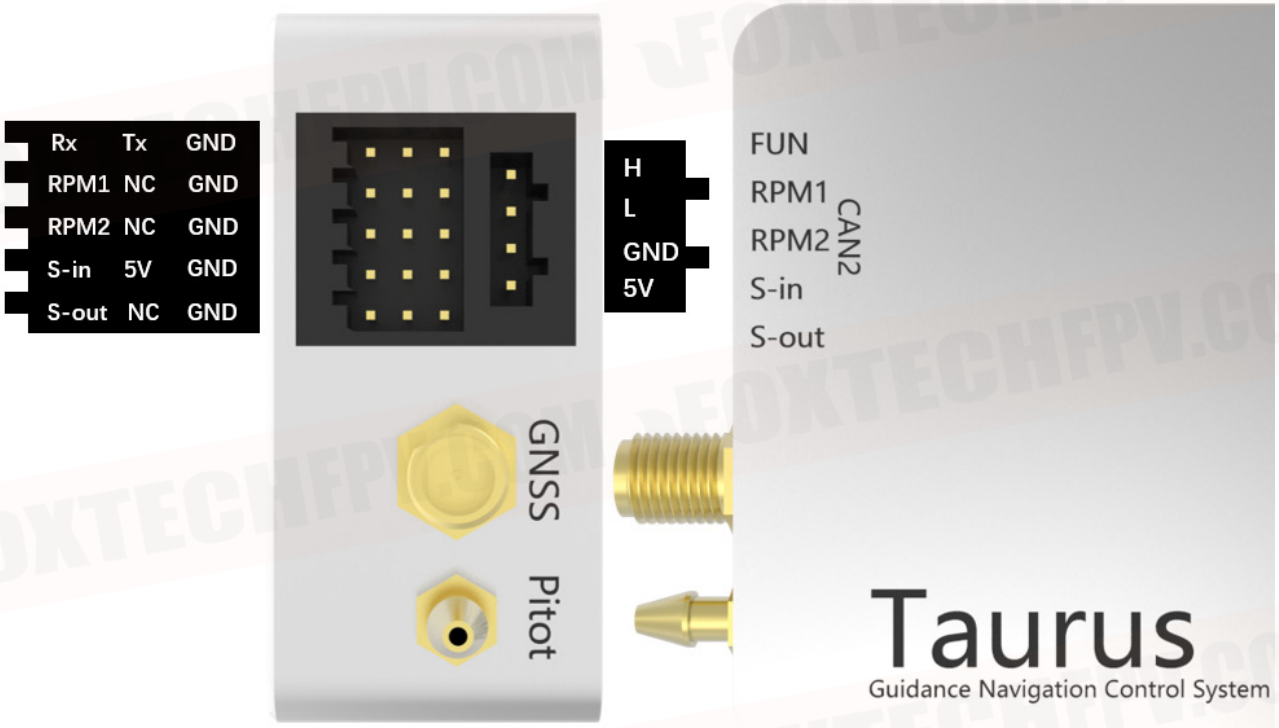
-Discretionary installation method. TAURUS has mounting angle correction and arm compensation function and can be mounted on the aircraft at any mounting angle and position.

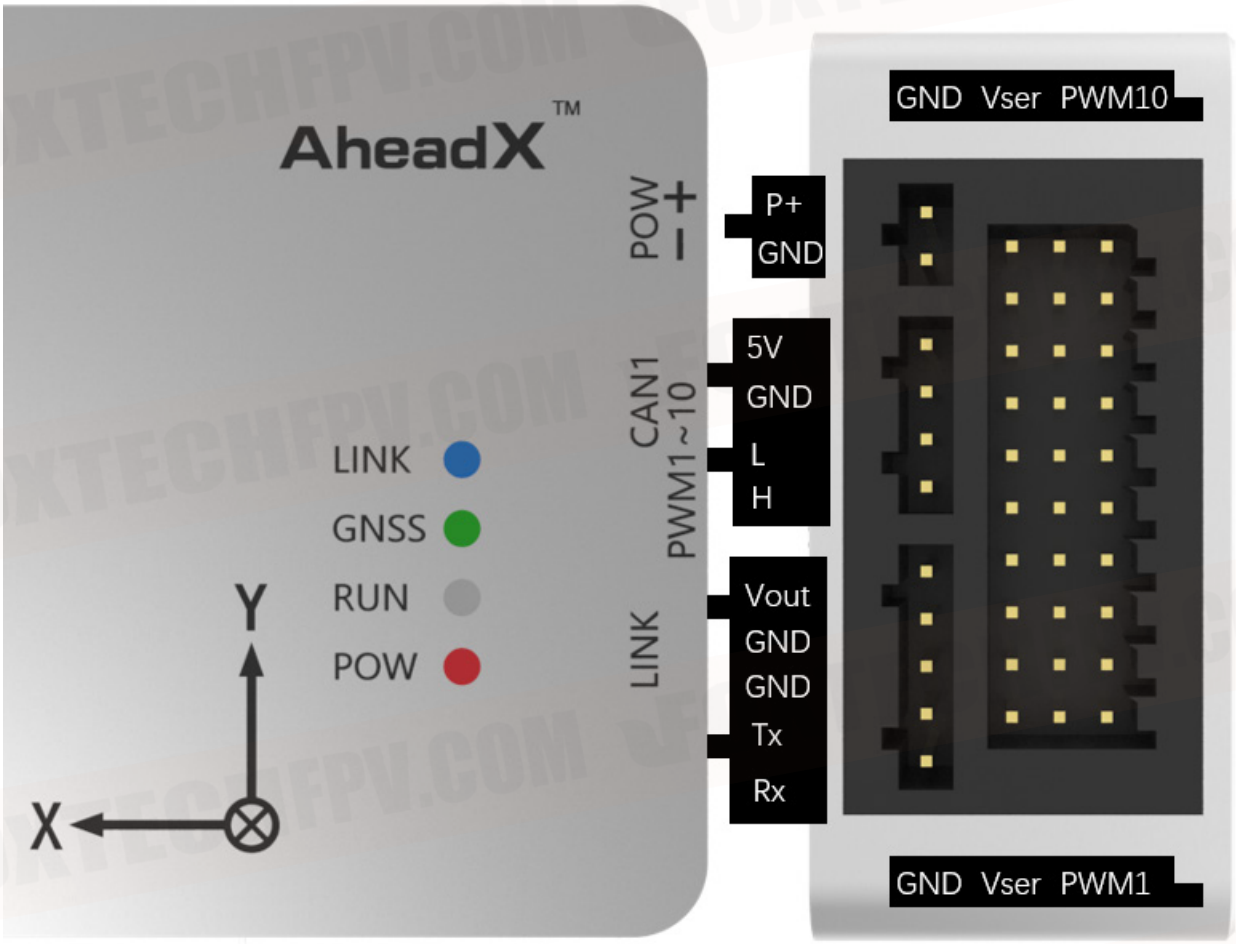
-Simulation training function. TAURUS can be used with AheadX's semi-physical simulation system to facilitate daily simulation training for drone drivers.

-Built-in black box data logging function, support for connecting external data recorders, recording up to 2000 hours flight data.

-Online upgrade function. Users can quickly get the latest version of firmware and ground station software via the Internet.Technical Parameters.

Technical Parameters





Item	Maximum	Standard value	Minimum	Unit	Remand
Weight		113		g	
Size		87 * 50* 23		mm	
Supply Voltage	53	25	7	V	
Consumption		1.5		W	
Working Temperature	65	25	-20	℃	
Attitude Precision		1		°	Dynamic, after GNSS positioning.
Angular Velocity Measurement Range	300		-300	°/s	
Accelerated Measurement Accuracy		80		mg	
Positional Accuracy		1		m	CEP
Speed Measurement Accuracy		0.1		m/s	
Speed Measurement Accuracy	10000		-400	m	
Airspeed Measurement Range	140		0	m/s	
Ground Speed Measurement Range	500		0	m/s	
Servo Control Channel		10		Line	
SBUS Input Access		1		Line	For remote control data link of backup.
SBUS Output Access		1		Line	
Servo Updating Frequency	400		50	Hz	
Remote Control and Telemetry		1		Line	RS232 level, need to close the built-in data link.
Voltage Monitoring Channel		2		Line	
Voltage Monitoring Range	58		0	V	
Engine Speed Monitoring Channel		2		Line	
Engine Speed Monitoring Range	65535		0	RPM	
CAN Communication Interface		2		Line	For smart battery, photoelectric pod and other equipment.
Communication Extension Serial Port		1		Line	For user equipment, external black box and other onboard equipment.

Installation and Connection of Flight Controller System

Self-provided Devices

You need to work with these devices:

UAV: VTOL.
Fixed wing
Multirotor

Radio: A radio device with RS232 port.

Auxiliary Control Joystick: It is recommended to use the AheadX A4RC01 auxiliary joystick; or a remote controller supporting SBUS output and with no less than 10 channels (for example: FUTABA T8FG/T14SG).
Ground station computer: A computer with a processor of i3 or above, memory of 2GB or above and hard disk space of 200M or above is recommended.

Cable

Interface Definition

Interface	Pin	
POW	P+: flight control power supply positive GND: ground	Description Supply voltage 7-53V
LINK	Vout: Radio power supply (the same as flight control power supply) GND: ground Tx: data transmission Rx: Data reception	Flight control communication serial por.
PWM1~10	PWM1~10: PWM signal output Vser: External power supply for the servo GND: ground	PWM signal output.
CAN1 CAN2	CAN_H: CAN signal H CAN_L: CAN signal L GND: ground 5V: 5V power supply output	Flight control CAN interface, 2 channels.
FUN	Rx: Data reception Tx: data transmission GND: ground	Extended serial port.
RPM1 RPM2	RPM1: Speed measurement signal 1 RPM2: Speed measurement signal 2 GND: ground	Speed monitoring.
S-in	S-in: Sbus input signal 5V: 5V power supply output GND: ground	S-Bus input interface, connect auxiliary joystick receiver.
S-out	S-out: Sbus output signal NC: Hanging GND: ground	S-Bus output interface, connect the servo.

Details of Device Connection

Flight Controller Power Supply:

-The flight control power input range is 7~53V.
-The flight control power supply will be output to the LINK radio at the same time, and the voltage is the same.
-The flight control 5V power supply output is only used for CAN interface expansion equipment and receiver (power does not exceed 2W).

Datalink:

-The TAURUS flight controller uses RS232 level for data communication.

-The LINK interface is used for data communication of same flight controller and firmware upgrade. The performance of data transmission equipment will directly affect the use of the entire set of drone equipment, please use reliable digital transmission equipment.

-When using this interface for flight control firmware upgrade, if the transmission bandwidth and bit error rate of the digital radio station cannot be guaranteed, please use the wired connection serial port to upgrade the firmware with the PC device directly. If the performance of the digital radio does not meet the requirement of the data transmission during the firmware upgrade, it may cause the upgrade process to stall or fail.

Connection of PWM Servo:

Fixed Wing PWM Servo Connection:
TAURUS flight controller supports 10 channels PWM servo/ESC input.

The output PWM control signal of the flight controller is not corresponding with the control amount of the remote control. The PWM signal is fully controlled by flight controller and the signal output sequence of the remote control needs not to be considered when connect it.

Before installing all ESC equipment, please use the remote controller to calibrate the throttle stroke. When calibrating the throttle stroke, use the default parameters of the throttle stick. The standard throttle stroke is 1100μs~1940μs, ensure the control consistency of the flight controller for each throttle. Failure to calibrate the throttle stroke will result in a power system control failure, and the resulting malfunction or accident is an artificial cause.
PWM1~PWM10 can be connected to the servo and fixed-wing ESC (or throttle servo) according to custom and certain rules.

Orange text, to which you need to pay more attention. should correctly record the servo and ESC connection number, it is useful for later parameter debugging.

It is strictly forbidden to use the flight control 5V power output to power the servo and ESC. If the fixed-wing ESC has a 5V output, it is forbidden to connect the 5V to the flight controller to avoid the voltage fluctuation causing the fault; and it is forbidden to use this output to power the servo, which may cause a flight accident due to insufficient power supply of the servo.

Connection example (for reference only):

PWM-1: left aileron;

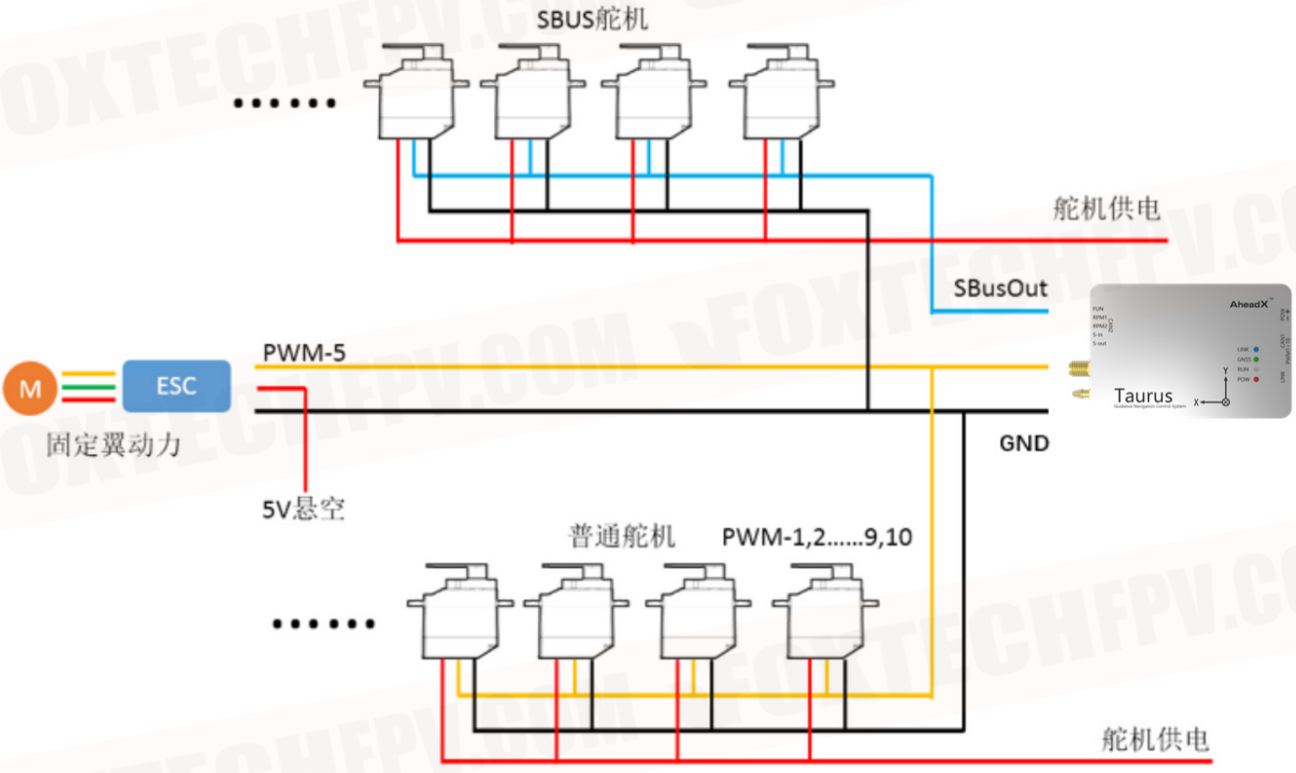
PWM-2: right aileron;

PWM-3: elevator;

PWM-4: rudder;

PWM-5: throttle;

PWM-6: Camera shutter.



Voltage Monitoring

The TAURUS flight control provides two voltage monitoring inputs, by default, flight control voltage and servo voltage are monitored respectively. Each has a voltage detection range from 0-58V. If the monitoring voltage exceeds the upper limit, which causes burning of the flight control, such case will be deemed as an artificial damage.

Speed Monitoring

Fixed wing: TAURUS-FW provides two speed monitoring signal inputs, usually used to monitor the speed of FixedWing power system. It needs that the ESC supports speed feedback signal output or using engine speed monitoring module.
This type of speed feedback uses 3.3V or 5V feedback signals, both compatible with the TAURUS flight controller.

· Mixing up voltage monitoring interface and speed monitoring interface may cause burning of the flight controller, which will be deemed as an artificial damage.
· When using single-engine, the speed monitoring must be connected to RPM1.

AuxiliaryJoystick

The TAURUS flight control supports connection and control of the remote control, which is used to assist in auxiliary control. There are two connection methods,Please chose the suitable method according to your control need.

1.The remote control receiver is connected via data link: the system supports using the "SBUS-to-USB" module to connect the joystick signal to the AheadX Space, and is sent to the flight control via the digital radio. The uplink frequency of the joystick data is 10Hz, and in the remote control mode the maximum can be increased to 20Hz, which basically meets the control needs of most drones. Avoid the problem that the transmission distance of the traditional remote controller is short and susceptible to interference.
2.The remote control receiver is directly connected to the flight control: TARUS supports the installation of the auxiliary rocker receiver on the aircraft, and the flight control directly collects the auxiliary joystick control information. The method has a short communication distance and usually loses control signals when it does not exceed 1 km. Therefore, this method is not recommended.

Through the S-in interface, the flight control can directly acquire the SBUS signal.

· BUS signal supports: SBUS (example R6208SB) SBUS_2 (example R7008SB) Please use low speed mode (70Hz), please avoid using high speed mode (140Hz).

CAN Bus Airborne Device

-It is used to connect the AheadX series avionics devices, including smart battery, external magnetic compass, height finder radar, gimbal/pod, smart light, etc.
-If many CAN bus airborne devices are used, please purchase the AheadX series CAN HUB/CAN POWER HUB.
-If a customized task load CAN communication is needed, please contact AheadX for customized development.

Standby Interfaces

The TAURUS flight controller reserves one communication extension interface FUN, uses 232 level for transparent transmission of task load control commands, or dual-redundancy GNSS equipment, using RTK function.

Detail of Device Installation

Due to the need to connect with other avionics, it will involve cable soldering or plug connection, the following notes must be kept in mind to ensure the reliability of the connection:
1.Extend the welding wire and use heat-resistant and tensile silver-plated cables as possible. Avoid core fracture, outer skin damage or excessive welding resistance as possible in any airborne environment.
2.The connectors with self-latching structure will be preferred as connection plugs and the key parts should be fastened or adhered to improve the connection reliability.

Indicator

单独状态		
	Power灯常亮	正常通电
	Run灯快闪	飞控运行正常
	GNSS灯慢闪	内置GNSS正在定位
	GNSS灯常亮	内置GNSS已定位
	Link灯快闪	接收到上行数据
组合状态		
	Power常亮、Run灯灭、GNSS、Link灯慢闪	升级模式

Installation of the Flight Control Device

Installation Environment

Electromagnetic Compatibility

Equipment that may interfere with the magnetic compass: engine, motor, gimbal, power supply conductor, magnetic screw, larger metal structure, etc.

a) Keep the engine as far as possible from the double interference of the magnetic compass and vibration;
b) The motor and the gimbal work will generate large magnetic field interference, which seriously interferes with the working stability of the magnetic compass;
c) The power supply conductor will generate an interference electromagnetic field when the current changes, causing unpredictable and serious interference to the magnetic compass operation;
d) Magnetic screws and larger metal structures will cause constant deflection disturbance to the magnetic compass.

No power supply wire, magnetic screw, etc. shall be present within 10cm around the flight control; no motor, gimbal or other magnetic motion equipment shall be present within 15cm; away from the engine 30cm or more.
If the electromagnetic interference around the flight control is serious and unavoidable, consider using an external magnetic compass

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May interfere with the PWM output and other control signals:

a) High-power radio transmitting equipment with poor shielding effect, electric power conductor magnetic equipment, etc.

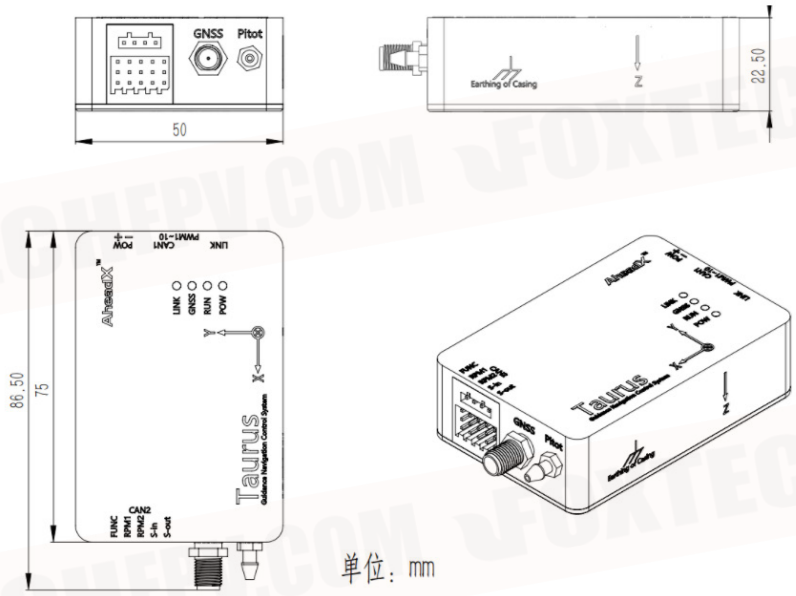
b) High-power radio transmitting equipment and its transmitting antenna with poor shielding effect. If the PWM control signal is interfered by electromagnetic fields, abnormal conditions such as rudder shaking may occur, resulting in hidden dangers.

Therefore, if the on-board electromagnetic environment is relatively harsh, consider adding anti-interference equipment such as magnetic rings and shielding nets.

Structure Interference

- the shock absorbing structure is to be installed, the vibration of the body may cause the flight control to follow the sway. During the movement of the shock absorbing structure, do not generate collision or other contact to avoid unpredictable motion interference.

-In the motion interference of sudden impact, the flight control cannot judge whether it is a flight motion or a structural interference, and the resulting flight failure is a human cause.



Installation of Flight Control Hardware

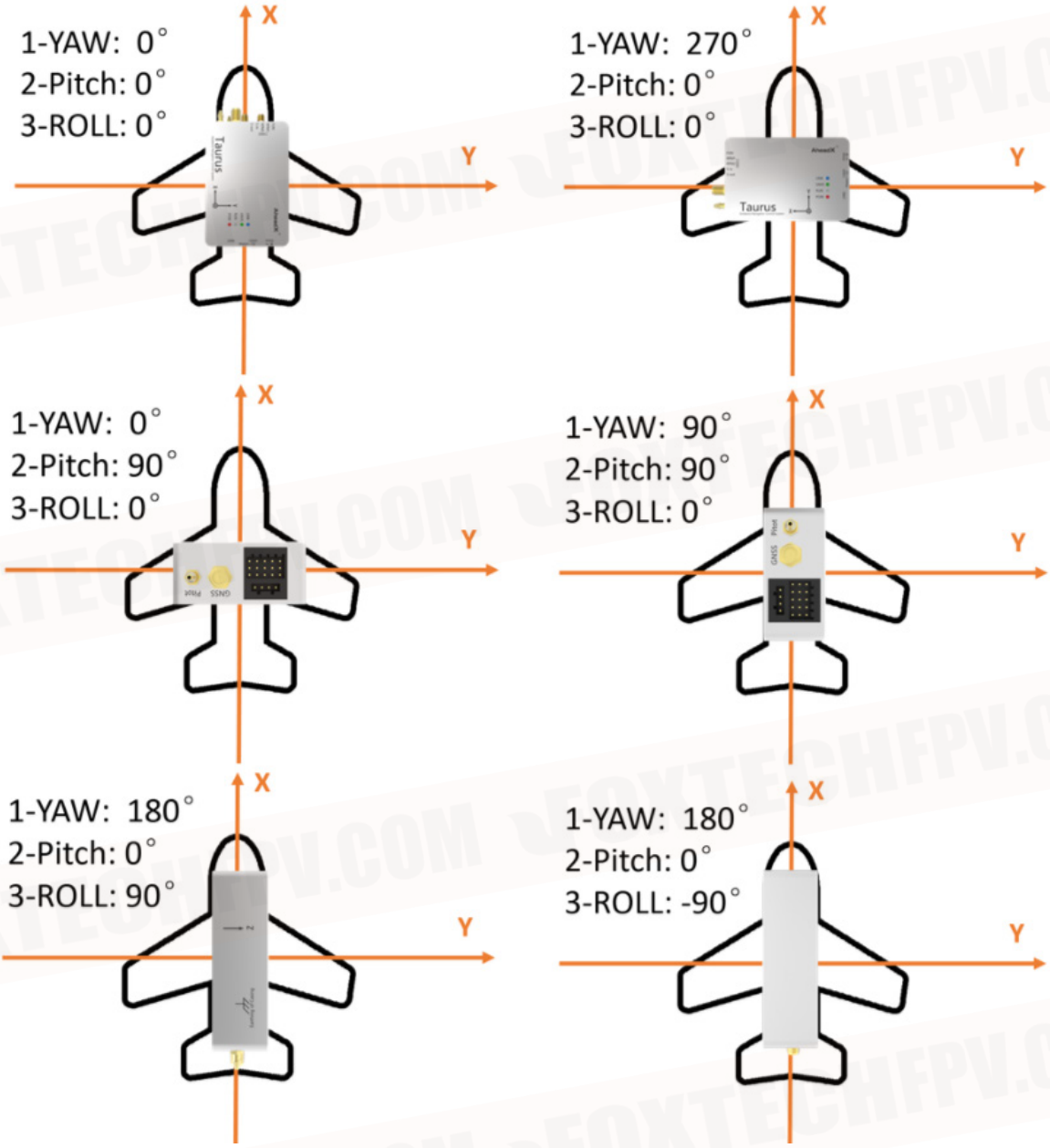
The TAURUS flight controller supports installation in any angle and the installation angle can be calibrated with a software, which make it easy to use.

The following precautions shall be kept in mind:

1.If the model permits, install the flight control device in the positive direction (The X forward arrow is pointing in the direction of the nose, and the Y forward arrow is pointing to the right) as possible so that no adjustment is required for the installation angle.
2.If an angle adjustment is required for installation, you must know the accurate installation angle as the calibration value of the software. Inconsistence between the value and the installation angle may reduce the flight effect and even cause a flight accident.
3.The adjustment of installation angle abides by the transformation principles of Euler angle and right- hand rule (when your thumb points to the positive direction of the rotation axis, the curl direction of your other four fingers represent the positive rotating direction). The airborne coordinate system is used as the reference coordinate and the coordinate system of the flight control device is used as the rotating coordinate system, which means each rotation is around the coordinate axis labelled on the casing of the flight control device.
4.The rotation parameter setting of the installation angle has a strict sequence (for detailed settings, see the chapter "Installation Adjustment" of the Parameter Adjustment Manual):
Rotate the YAW axis (rotating around Z axis and the parameter value can only be a nonnegative number ranging from 0 to 360);
Rotate the Pitch axis (rotating around Y axis and the parameter value ranges from -90 to +90);
Finally, rotate the Roll axis (rotating around X axis and the parameter ranges from -180 to +180).
5.A rotation of Euler angle may have more than one route, but has the same result and control effect. The setting method with the shortest route is recommended for convenient commissioning (That is, the absolute sum of all installation Angle adjustment parameters is the minimum).

To achieve more favorable measurement accuracy, the installation location of LEO shall be within 1m from the center of mass.

Common Installation Examples:



Mounting of GNSS Antenna

Installation Environment

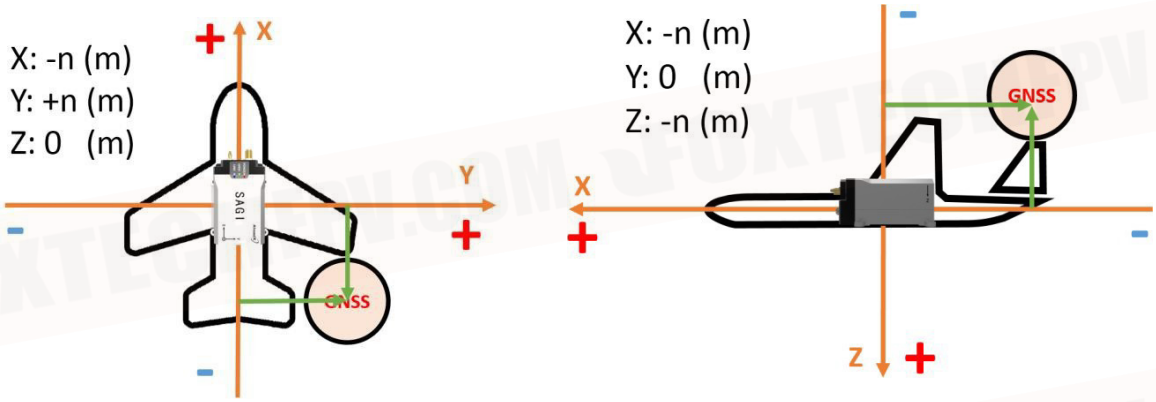
TAURUS supports GPS/GLONASS (or BEIDO) navigation system, but the associated GNSS antenna is a non- magnetic weak signal receiver, so any shelter or coating will affect the signal receiving quality. Under favorable conditions, it can receive the signal of 15-20 satellites.

Notes:

1.The feeder of GNSS antenna and the SMA plug of the flight control GNSS antenna interface shall be connected reliably, the antenna shall be led to the top of the UAV body and the signal receiving face (black plastic cover) of the antenna shall be parallel to the ground and installed upward, but not in the cabin or any other enclosed space. Otherwise, the signal quality will be significantly affected and the aircraft cannot perform accurate positioning.
2.The antenna surface shall not be covered by any metal materials such as copper foil or absorbing material such as carbon fiber.
3.The feeder of GNSS antenna shall be free of any significant bending.
4.The GNSS antenna is a weak signal receiving device, and shall be arranged far from a magnetic field or an electric field and therefore far from the engine, servo, large current connecting cable and radio or transmitter with radiating capacity.
5.If the self-purchased GNSS antenna is used, the magnet on the back of the GNSS antenna shall be removed to avoid interference to the flight control device.
Do not use a radio device with a frequency ranging from 1.2 to 1.6GHz.

Mounting Adjustment

GNSS measures the location and speed information of the mounting point of GNSS antenna, but the mounting locations of the GNSS antenna and Taurus are not the same, which will cause a lever arm effect and bring errors to the location and speed measurement. In some places with higher measurement requirements, a calibration of mounting location is needed by filling the coordinate distance of GNSS relative to the flight control device.



Installation of Airspeed Tube

1.The airspeed tube can be led into the joint of the airspeed tube of flight controller by a silicone hose. The hose shall be as short as possible and not squeezed or suspended in air after the installation.
2.If the hose is too long or has a variable inner radius, the airspeed pressure transmission will be lagged, which produce a measurement error, affect the flight quality and even threaten the flight safety. The hose of airspeed tube and the joint of the autopilot airspeed tube shall be connected reliably.
3.The airspeed tube projects out of the body and shall keep pointing to the right front. The air inlet shall be far from the fuselage surface as possible to ensure the airflow speed in the upstream direction will not be interfered by the body or power device, otherwise an inaccurate measurement of airspeed may occur and cause a flight accident.

Check after Installation

1.There should be no potential difference between the grounding of all avionics equipment.
2.The 5V of the flight control output can only be used for low-power avionics equipment. It is strictly forbidden to power the servo or high-power equipment.
3.The PWM output signal should be protected against interference. All signal cables must be connected correctly and reliably. There must be no solder joints or virtual connections.
4.Cables that are not used need to be strictly insulated from each other to avoid malfunctions such as short circuits caused by misconnections.
5.Cables should be bundled, cleaned, and avoid pulling, entanglement, interference to the flight control.
6.The structural connection must be firm and reliable. Use screw glue and other anti-loosening measures in key positions, and check the shock absorption structure frequently.The airborne installation and airborne environment must not have magnetic substances, strong electromagnetic interference, etc.
7.The environment of flight control installation should not have magnetic material, strong electromagnetic interference, etc.
8.Antenna can not be covered, antenna connection feeder can not have too much bending.

Including but not limited to the above situation, installation and checking of TAURUS flight control equipment and random accessories are not strictly carried out according to this manual, resulting in equipment performance degradation, failure, damage, damage, etc., are human causes, non-product quality problems. Zhidaon Technology does not assume any responsibility for direct or indirect damage caused by such circumstances.

Basic Tests

Hardware Connection Check

Aircraft Terminal

-System power supply: Please confirm the power supply to the flight control device has been properly connected and the power supply voltage is within the design range.

-Fixed wing: PWM output connection- Please confirm flight controller PWM 1-10 output channel have been connected to the servo and ESC and is consistent with the control allocation. It is recommended to use independent power supply for the servo to ensure sufficient power supply, avoid losing efficacy of key control systems such as flight control or servo.
-Connection of data-link: Please confirm that the external radio has been properly connected to the LINK port.
-Connection of the SBUS receiver: If an airborne receiver is used, please confirm it has been properly connected.

Ground Terminal

Data link connection: Please connect the ground terminal of the data chain to PC.

Connection of auxiliary joystick: If not use airborne receiver, please use the SBUS-to-USB module to connect the auxiliary joystick device.After confirmation, please start the power supply of the airborne avionics system and prepare to check the flight control and other auxiliary equipment.

Software Connection Check

Start the computer that is ready to run the ground station, start the ground station, select the flight control serial port and connect on the model management page. After the connection is succeed, synchronize the flight control parameters to the ground station and enter the ground station. The online map is automatically loaded if the network is connected. Switch to offline map if no internet.
Ground Station software connection
Start the computer that is ready to run the ground station, start the ground station, select the flight control serial port and connect on the model management page. After the connection is successful, synchronize the flight control parameters to the ground station and enter the ground station. The online map is automatically loaded under the network condition.
Pre-flight Checking

The AheadX Space V3 ground station provides a full pre-flight checking function. Refer to the AheadX Space V3 Ground Control Software Manual - Retrieve the pre-flight checking panel and follow the instructions tocheck each item.

Upgrade

-TAURUS is the VI generation of guidance navigation control system developed by AheadX. We will constantly enrich and increase the product functions and overcome the shortcomings, so a set of online upgrading software is provided for the flight control firmware upgrading.
-Upgrading the firmware requires connection to No.1 serial port of the flight controller. The firmware upgrading software supports two hardware connection methods, direct connection by serial port and connection through data-link.
-After the flight controller or the radio is connected to the computer, open the firmware upgrading tool, search the serial port and select the proper serial port and open it; Click "Read flight control information" to obtain the relevant information and firmware version of the Taurus; Click "obtain latest firmware" and download the firmware supporting the corresponding flight controller. The latest version and upgrading information will be displayed; Click upgrade to start the upgrading.
-After the upgrading is completed, restart the flight control device.

To avoid loss of parameters caused by an exceptional failure in upgrading, it is recommended to download the flight control parameters in batches before upgrading and export them to a file for saving.

Restoring method in case of exceptional failure in upgrading:
Go to the installation directory of the firmware upgrading tool, execute the file Enforcement.exe, reconnect the flight control serial port, manually select a flight control type, download the firmware and upgrade it.
If an incorrect flight control type is selected, the flight control device cannot operate normally after the firmware is updated compulsorily.

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