AI VisionCube Kit

— 1.2km Ultra-Range・PiP Architecture・Multi-Target ID・Auto-Adhesive Tracking + Dynamic Memory Lock

User Manual

V1.3.0

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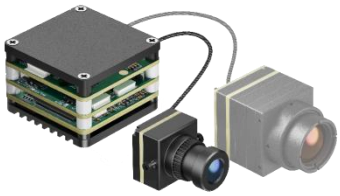
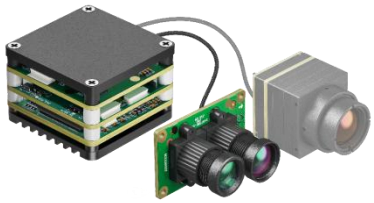
CONTENS

1. Product Overview

The AI VisionCube Kit is a revolutionary AI visual tracking system designed specifically for drones, integrating high-performance target recognition, dynamic tracking, and anti-jamming control. Through the fusion of deep learning algorithms and high-performance intelligent chips, drones equipped with this kit can achieve automatic target acquisition, stable tracking, and precise trackings in complex electromagnetic environments. This significantly reduces the operational threshold for pilots and greatly improves mission execution efficiency.



AI VisionCube S/ST



AI VisionCube D/DT

1.1 Core Features and Advantages

➢ 1.2km-Long-Range Recognition

Equipped with single/dual-camera collaborative algorithms and precision optical modules, automatically identifies human/vehicle targets at 1.2km range. Achieves 85% higher recognition accuracy than conventional AI systems, enabling beyond-visual-range operations in complex environments.

➢ Multi-Target Recognition

YOLOv7-optimized architecture simultaneously tracks 50+ dynamic targets within FOV. Supports self-training algorithm deployment for customized classification models in defense and surveillance scenarios.

➢ PiP Architecture

Dual-stream PiP technology combines global situational awareness (main view) with 8x digital zoom tracking (sub-view), allowing real-time environmental analysis and precision strike decision-making.

➢ Adaptive Lock-On Tracking

After identifying multiple targets, the drone can correct its heading. The intelligent crosshair adsorption algorithm will adsorb the tracked target to the central area of the screen, reducing the locking time to 0.5 seconds. This significantly reduces the micro-operation load on the pilot and increases the locking success rate to 92% in high-speed moving scenarios.

➢ Dynamic Memory Locking

Integrates temporal prediction models and Kalman filter algorithms to reacquire targets within 3s after occlusion/visual loss. Enhances tracking stability by 40% in dense foliage environments.

➢ Multi-sensor Compatibility

Switchable visible/thermal sensors with 9650 mV/lux·s D/T-high sensitivity and uncooled thermal imaging. Ensures 24/7 target ID capability from -20℃ to 60℃, defeating camouflage/thermal masking.

➢ Lightweight Integration

Modular design (<200g) supports BetaFlight open-source flight controllers. Achieves AI capability deployment within 5 minutes via plug-and-play installation, compatible with industrial drones to FPV racers.

➢ Target Re-locking Support

After locking a target, if you wish to change the target, you can toggle the corresponding channel's remote-control lever. An additional aiming reticle will appear in the VTX image. Use the RC direction stick to move the aiming reticle to the new target, and then lock it again.

➢ Expand Search Range

When the crosshair is not yet aligned with typical targets (e.g., people or vehicles) but you want to lock onto them quickly, simply toggle the corresponding channel on the remote control. Once activated, the drone's flight path will auto-adjust, and the crosshair will swiftly and precisely snap to the detected targets in the frame.

2. Working Principle

2.1 System Core Components

AI Image Processing Board: As the central control unit of the system, it acts like the "brain" of the system. It processes the image data captured by the high-definition camera in real-time, utilizing advanced AI algorithms for target detection and recognition. The system also features an automatic adhesive tracking function, where it can automatically attach and track a target, precisely locking onto the target's features. Additionally, it has memory tracking functionality, recording the target's movement characteristics and historical trajectory to provide more accurate data support for subsequent tracking.

High-Definition Camera: Provides high-quality image input and supports ultra -low-latency latency analog output(<60ms), ensuring both real-time video transmission and high-definition clarity. It also supports Picture-in-Picture (PiP) digital zoom, allowing the pilot to better identify target details, making the target features clearer for the AI image processing board to perform accurate recognition.

Flight Control: Receives target information and instructions from the AI module, and adjusts the drone's attitude based on this information in real-time. It facilitates a smooth transition from manual control by the pilot to autonomous target tracking mode. Furthermore, based on the memory tracking information from the AI image processing board, it adjusts the flight more stably and accurately according to the target's trajectory, ensuring consistent tracking.

2.2 Working Flow

Step 1: Target Pre-Setting & Monitoring

During flight, the pilot monitors the surveillance area using FPV (First-Person View) video. When a target (such as a human or vehicle) appears within the frame, the system automatically detects and identifies the target through its built-in model and adhesive recognition function. It quickly determines key features of the target and locks onto it stably. Additionally, the system uses the PiP mode to display a zoomed-in view, helping the pilot confirm target details and prepare for subsequent tracking. And AI Image Processing Board begins to store memory of the target, recording its initial position, appearance, and movement parameters.

Step 2: Signal Interference Monitoring & Mode Switching

When the target is within the maximum range of 1.2 kilometers, if there is interference in the target area (for example, the target emits interference signals, resulting in unstable remote control signals or even a risk of losing control), the pilot can manually switch to the AI tracking mode before the remote control signal is lost, activate the tracking system, and let the AI visual system with strong analysis and tracking capabilities take over the flight control commands, and continue to stably track by using the memorized target information.

Step 3: Autonomous Visual Tracking & Flight Control Takeover

Once AI mode is activated, the AI Image Processing Board relies on real-time image analysis, advanced target recognition algorithms, and the automatic adhesive recognition and memory

tracking features to continuously monitor the target's status. As the target moves, the system constantly matches the target's features in memory, ensuring accurate tracking even if part of the target's appearance changes. The flight control system continuously adjusts the drone's attitude based on the latest status of the target. The system ensures low-latency feedback (below 60ms) through simulated output, allowing the drone to stably track the target during flight. Even if the target moves quickly or is briefly obstructed, the memory tracking function helps maintain the lock.

Step 4: Flight Mission Execution

After AI Image Processing Board takes over, the drone calculates the optimal trajectory and flies towards the target area based on the memorized target path and real-time monitoring of the target's dynamics. Thru this process, the FC system continuously adjusts the drone's flight posture in real-time, based on the target data returned by the AI module, combined with memory information. This ensures that the crosshair in the center of the FPV video remains aligned with the target, ultimately achieving precise target tracking.

3. Technical Specifications

AI VisionCube Kit Technical Specifications					
Module Name		**AI VisionCube S**	**AI VisionCube D**	**AI VisionCube ST**	**AI VisionCube DT**
Photo					
Target Recognition Type		Default: Human, Vehicle	Default: Human, Vehicle	Default: Human, Vehicle	Default: Human, Vehicle
Target Detection Range		Vehicle: 450m, Human: 170m	Vehicle: 1200m, Human: 500m	Vehicle: 450m, Human: 170m	Vehicle: 1200m, Human: 500m
Min Target Tracking Pixel		16x16 pixels	16x16 pixels	16x16 pixels	16x16 pixels
Max Tracking Speed of Dynamic Target		60km/h	60km/h	60km/h	60km/h
Intelligent Adhesive Tracking		Supports crosshair fuzzy locking for close-range adhesive tracking	Supports crosshair fuzzy locking for close-range adhesive tracking	Supports crosshair fuzzy locking for close-range adhesive tracking	Supports crosshair fuzzy locking for close-range adhesive tracking
Trajectory Prediction & Memory Tracking		Supports trajectory prediction and feature memory tracking	Supports trajectory prediction and feature memory tracking	Supports trajectory prediction and feature memory tracking	Supports trajectory prediction and feature memory tracking
Max Target Recognition No.		50	50	50	50
Picture-in-Picture (PiP)		Supported	Supported	Supported	Supported
Input Voltage		DC 9~16V	DC 9~16V	DC 9~16V	DC 9~16V
Power Consumption		10W	10W	10W	10W
Operating Temperature		-20℃~60℃	-20℃~60℃	-20℃~60℃	-20℃~60℃
AI Image Processing	Computing Power of	TOPS*1	TOPS*6	TOPS*1	TOPS*6

Board	Main Controller				
	Communication Protocol	CRSF	CRSF	CRSF	CRSF
	Communication Method	UART	UART	UART	UART
	Video Output Format	CVBS	CVBS	CVBS	CVBS
	Supported Firmware	BetaFlight	BetaFlight	BetaFlight	BetaFlight
	Input Voltage	9~16V	9~16V	9~16V	9~16V
	Mounting Holes	25.5*25.5mm	25.5*25.5mm	25.5*25.5mm	25.5*25.5mm
	Size	38*38*29mm	38*38*29mm	38*38*29mm	38*38*29mm
	Weight	43.8g	43.8g	43.8g	43.8g
Visible Light Camera Module	Low Light Performance of Short-focal Camera	7341 mV/lux·s	9650 mV/lux·s	7341 mV/lux·s	9650 mV/lux·s
	Short-focal CMOS	1/2.8 Inch	1/2.6 Inch	1/2.8 Inch	1/2.6 Inch
	Short-focal FOV	69°(H)*42°(V)	72°(H)*45°(V)	69°(H)*42°(V)	72°(H)*45°(V)
	Short-focal Length	4mm	3.9mm	4mm	3.9mm
	Low Light Performance of Long-focal Camera	N/A	9650 mV/lux·s	N/A	9650 mV/lux·s
	Long-focal CMOS	N/A	1/2.6 Inch	N/A	1/2.6 Inch
	Long-focal FOV	N/A	26°(H)*15°(V)	N/A	26°(H)*15°(V)
	Long-focal Length	N/A	12mm	N/A	12mm
	Video Input Format	1920*1080@30hz	1920*1080@30hz	1920*1080@30hz	1920*1080@30hz
	Size	19*19*30mm	40.8*25*26mm	19*19*30mm	40.8*25*26mm
	Weight	13.6g	17.0g	13.6g	17.0g

Thermal camera	Pixel Pitch	N/A	N/A	12um	12um
	Response Band	N/A	N/A	8～14μm (LWIR)	8～14μm (LWIR)
	FOV	N/A	N/A	20.3°(H)×15.2°(V)	20.3°(H)×15.2°(V)
	Focal Length	N/A	N/A	9.1mm	9.1mm
	Video Input Format	N/A	N/A	384*288@25hz	384*288@25hz
	Size	N/A	N/A	26*26*32.85mm	26*26*32.85mm
	Weight	N/A	N/A	32.4	32.4

4. User Interface Definition and Wiring

4.1 AI VisionCube Kit Interface Diagram

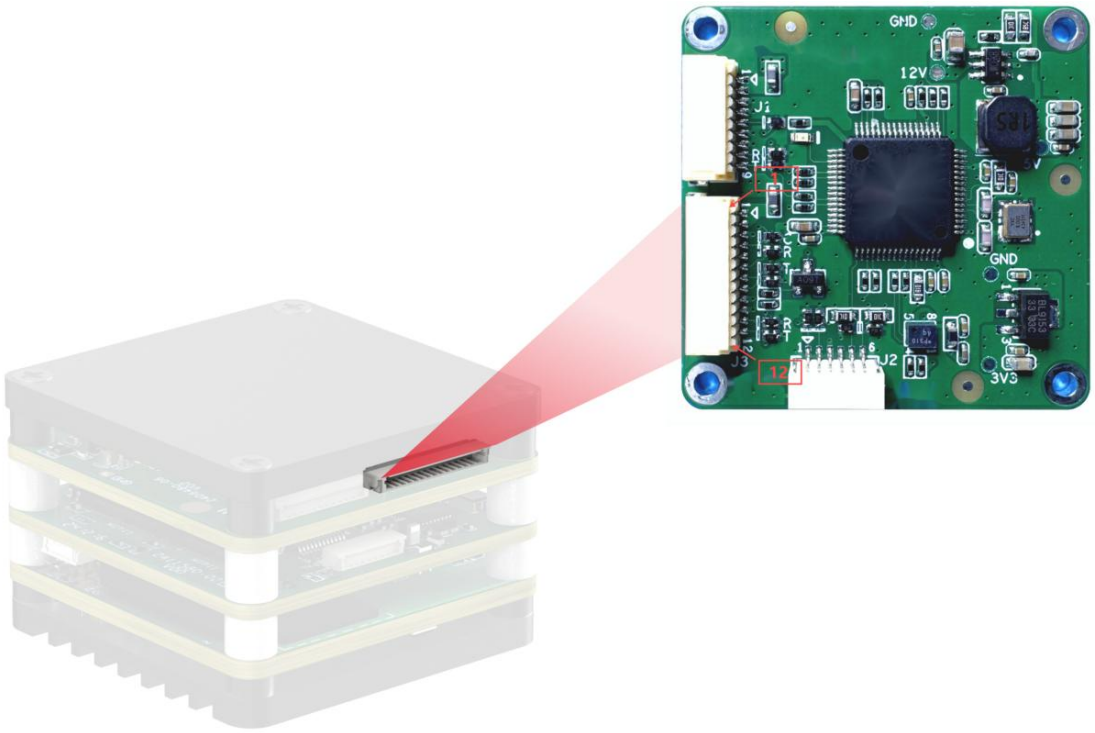


Fig 4.1 AI VisionCube Kit Interface Diagram

4.2 AI VisionCube Kit User Interface Definition Table

Interface No.	Definition	IN/OUT	Function
1	VCC	IN	9~16V Power Input
2	VCC	IN	9~16V Power Input
3	GND	GND	Power Input GND

4	VIDEO_OUT	OUT	Analog Video Signal Output
5	GND	GND	Analog Video Signal Output GND
6	UART3_RX	IN	Connect to FC UART TX
7	UART3_TX	OUT	Connect to FC UART RX
8	SBUS	IN	Reserved / No function
9	5V	OUT	5V power output
10	GND	GND	Power output GND
11	UART6_RX	IN	Connect to Receiver TX
12	UART6_TX	OUT	Connect to Receiver RX

Table 4.2 User Interface Definition Table of the AI VisionCube Kit

4.3 AI VisionCube Kit Wiring Diagram

This wiring example uses flight controller below as an example, the wiring interface between the AI VisionCube Kit and the flight controller is introduced. As defined in Table 4.2 and the physical interface position is shown in Figure 4.3, the port settings of the flight controller side connecting to the ELRS receiver are all set as UART1.

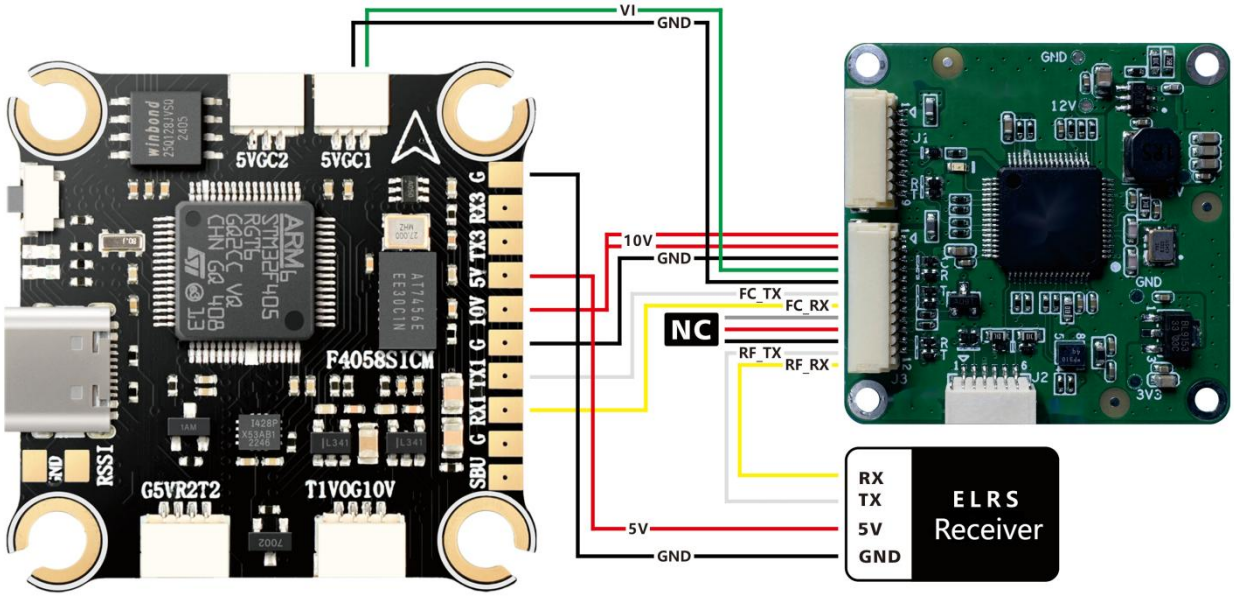


Fig 4.3 AI VisionCube Kit & FC Diagram

4.4 Camera Installation Angle

Note: During installation, maintain the camera's pitch angle at approximately 30° relative to the ground (or the drone’s horizontal plane).

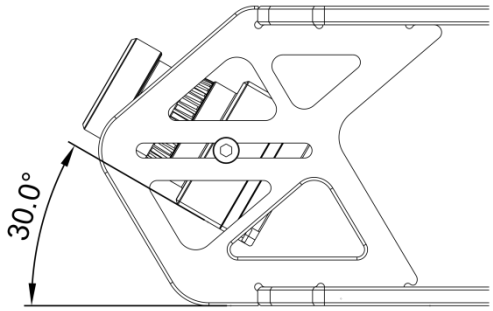
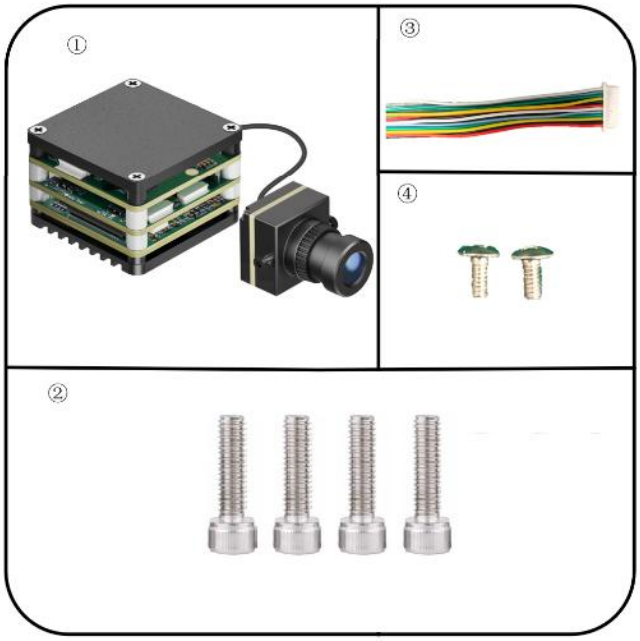


Fig 4.4 Camera Installation Angle

5. AI VisionCube Kit List

5.1 AI VisionCube S/ST Kit List

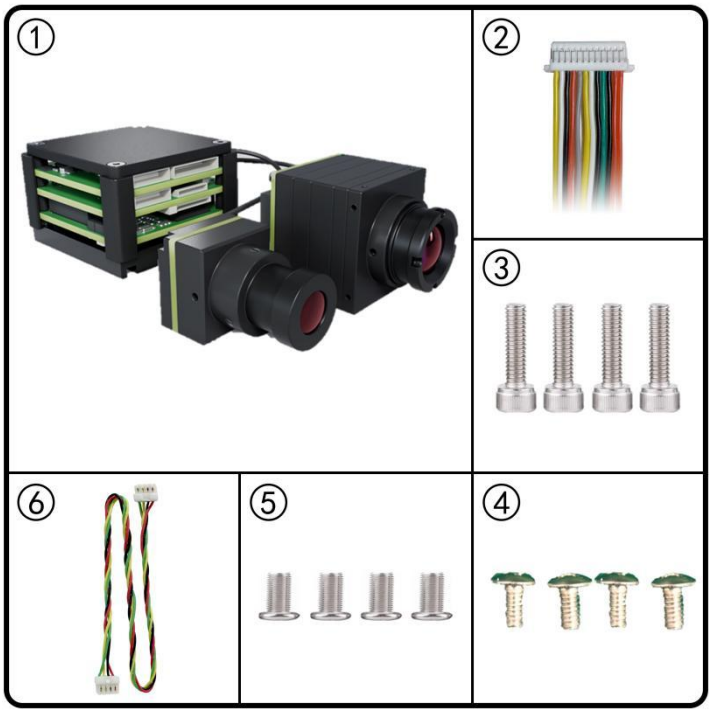


①: AI VisionCube S × 1;

②: Hexagon Socket Crew M2*6 × 4;

③: SH1.0-12PIN 15cm Ribbon Cable × 1 (used to connect the flight controller and the AI VisionCube kit);

④: Cross Slot Pan Head Screw M2*4 × 2.



①: AI VisionCube ST × 1;

②: SH1.0-12PIN 15cm Ribbon Cable × 1 (used to connect the flight controller & the AI VisionCube kit);

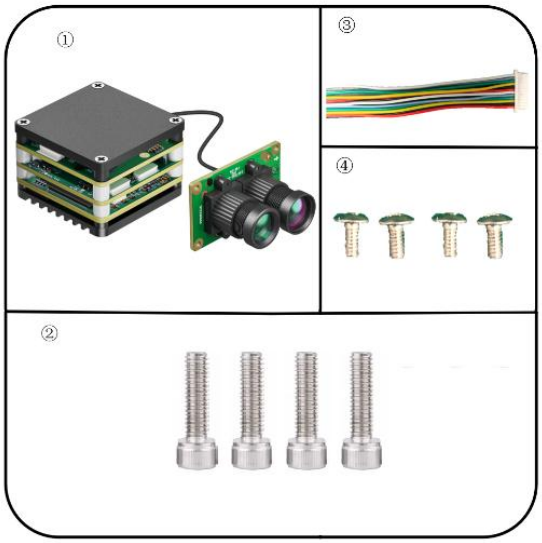
③: Hexagon Socket Screw M2*6 × 4;

④: Cross Slot Pan Head Screw M2*4 × 4;

⑤: Cross Recessed Pan Head Screw M1.6*4 × 4;

⑥: 4Pin Thermal Imaging Camera Connection Cable × 1.

5.2 AI VisionCube D/DT Kit List



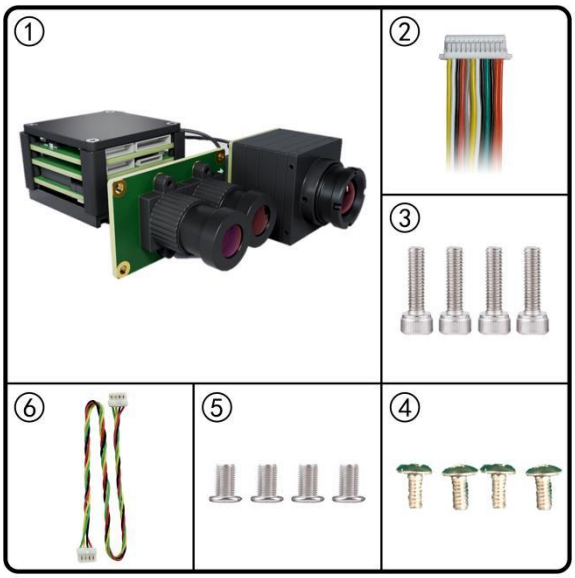
①: AI VisionCube D ×1

②: Hexagon Socket Screw M26 ×4

③: SH1.0-12PIN 15cm Ribbon Cable ×1 (for connecting the flight control and AI VisionCube)

④: Cross Slot Pan Head Screw M24 ×4

⑤: Screw X ×1 (for thermal imaging module installation)



①: AI VisionCube DT × 1;

②: SH1.0-12PIN 15cm Ribbon Cable × 1 (used to connect the flight controller & the AI VisionCube kit);

③: Hexagon Socket Screw M2*6 × 4;

④: Cross Slot Pan Head Screw M2*4 × 4;

⑤: Cross Recessed Pan Head Screw M1.6*4 × 4;

⑥: 4Pin Thermal Imaging Camera Connection Cable × 1.

6. Product Dimension and Installation

6.1 AI Image Processing Board Size

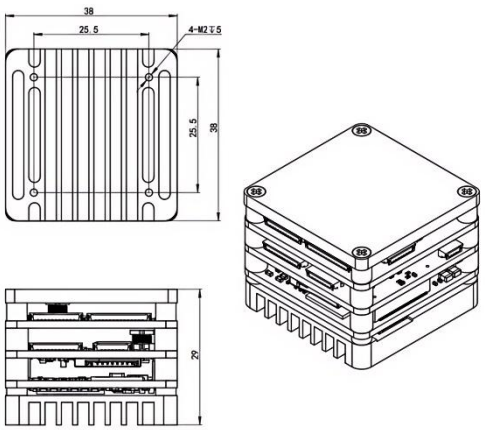


Fig 6.1 Size of the AI Image Processing Board

6.2 HD Visible Light Camera Module Size (AI VisionCube S/ST)

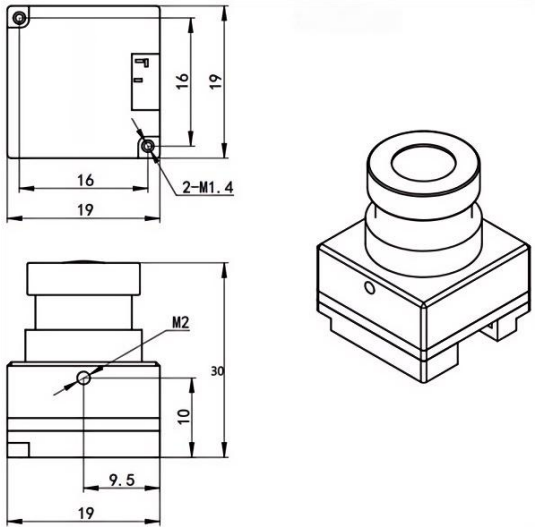


Fig 6.2 HD Camera (AI VisionCubeS /ST) Size (mm)

6.3 High-Definition Dual Visible Light Camera Module Size (AI VisionCube D/DT)

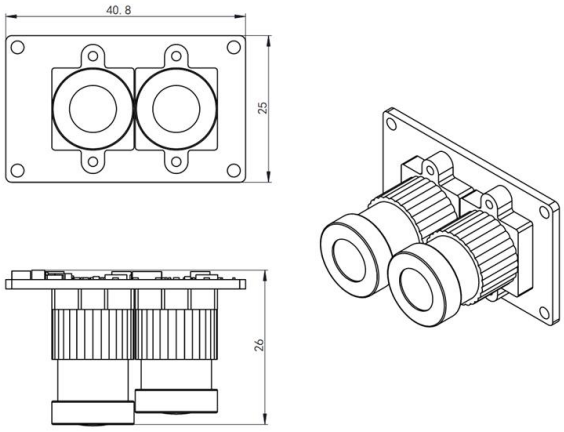


Fig 6.3 Size of High-Definition Camera (AI VisionCube D/DT)

6.4 Thermal Imaging Camera Module Size

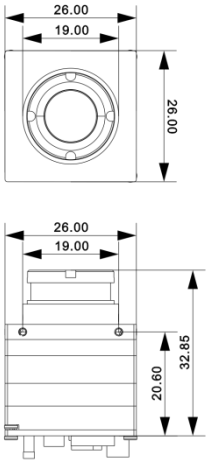


Fig 6.4 Size of Thermal Imaging Camera

7. AI VisionCube Kit Setting and Operation

7.1 Flight Controller Setting

This example takes the FC405/ICM42688 flight controller of HSAirforce as an example, and the firmware version of the flight controller is 4.4.2.

Step 1: Open BetaFlight, select the corresponding COM port, and then click "Connect", as shown in Figure 7.1.1.

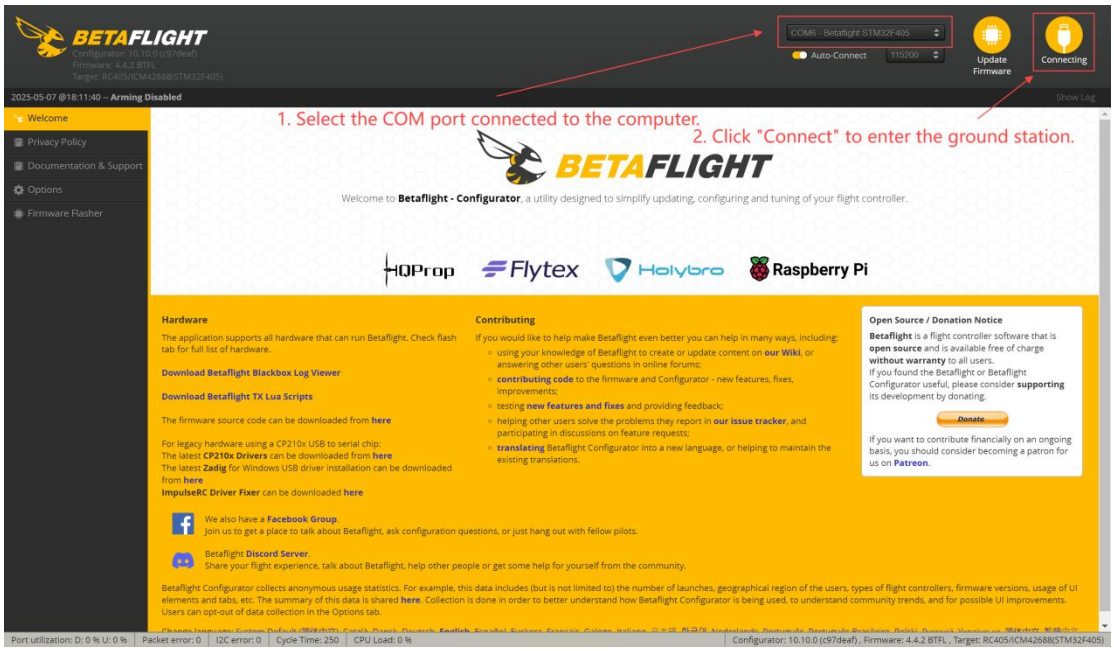


Fig 7.1.1 Connecting to BetaFlight

Step 2: Click the **Ports** on the left side of the ground station software. For example, if the flight controller's UART1 is connected to the AI module, enable the corresponding Serial Digital Receiver switch for UART1 in the software. After configuration, click "Save" or "Save and

Reboot" (the switch will appear yellow when enabled and gray when disabled). Refer to Figure 7.1.2 for visualization.

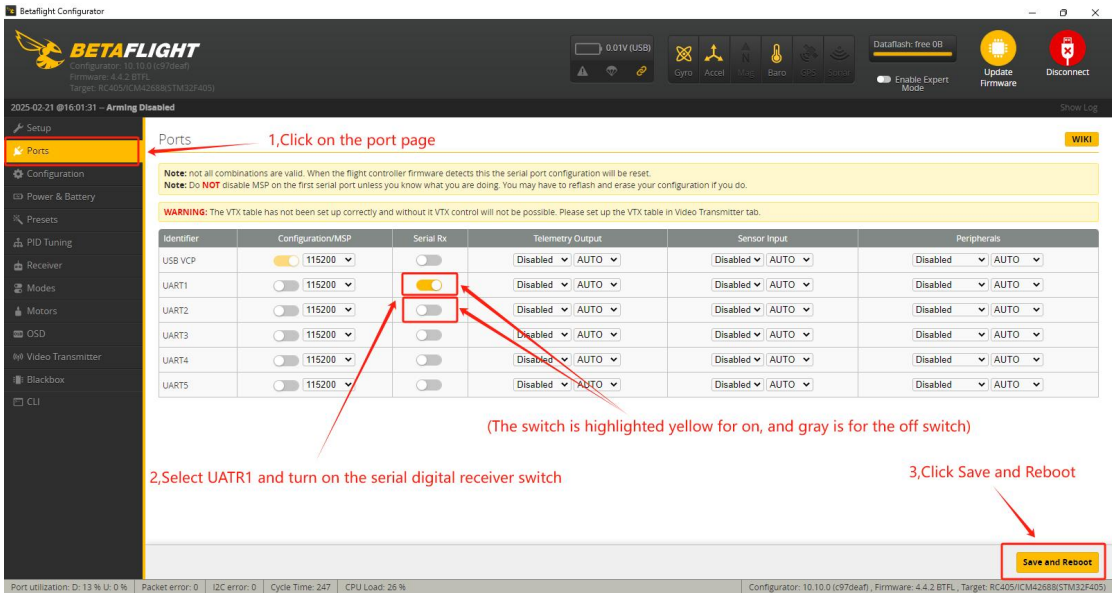


Fig 7.1.2 Flight Control Port Settings Serial Port

Step 3：Click on the PID Tuning option on the left side of the ground station. Scroll down the page to the Self-stabilization/Semi-self-stabilization option. Set the angle limit in this option to 75, and then click "Save", as shown in Figure 7.1.3 and Figure 7.1.4.

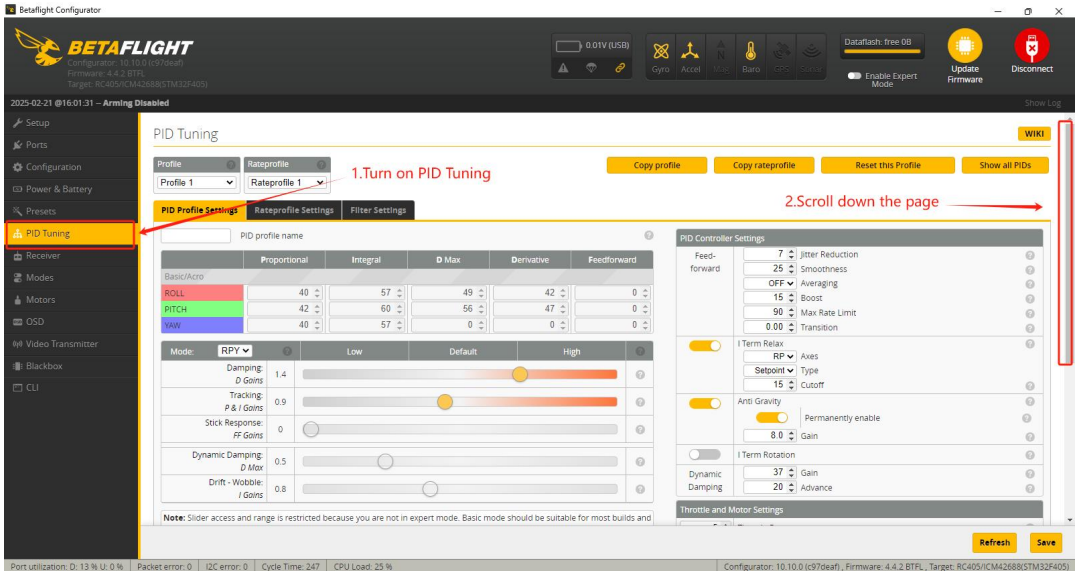


Fig 7.1.3 PID Control Interface Settings

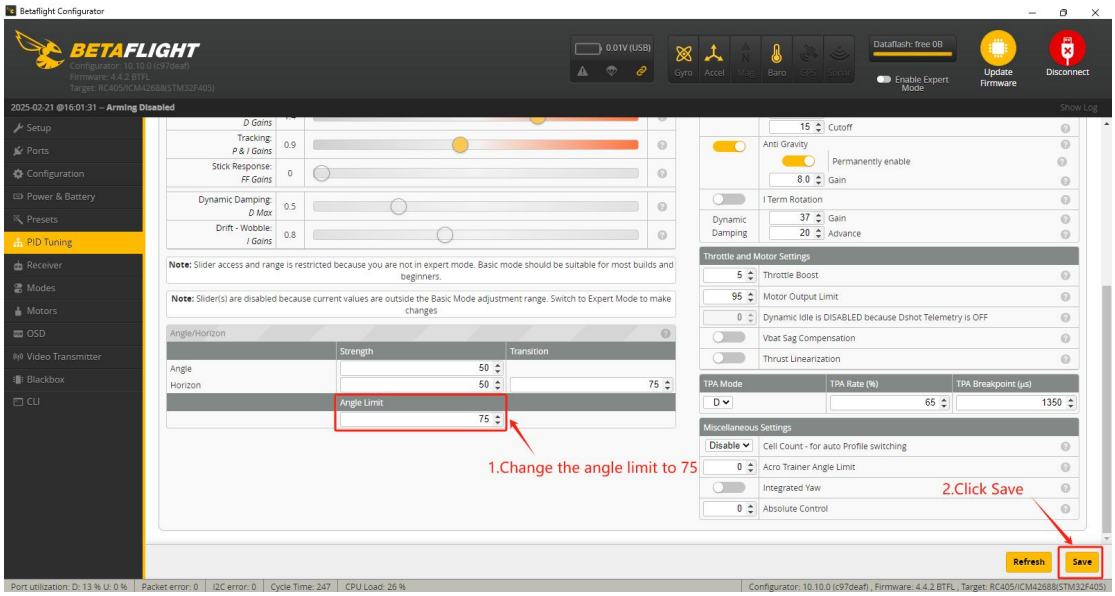


Fig 7.1.4 PID Control Interface Settings

Step 4: Click on the Modes option on the left side of the ground station. Set ARM as AUX1 (it must be AUX1 and cannot be changed), and set ANGLE as AUX6 or above the AUX6 (the functions of AUX2-AUX5 have already been occupied by the AI module), as shown in Figure 7.1.5.

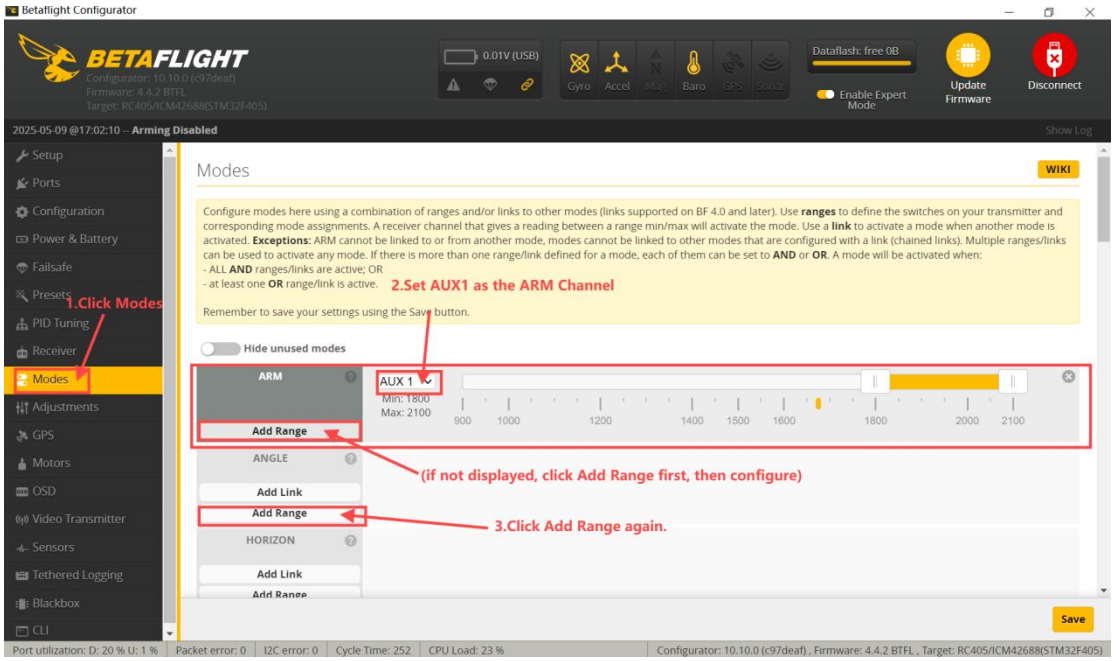


Fig 7.1.5 Flight Mode Configuration Interface

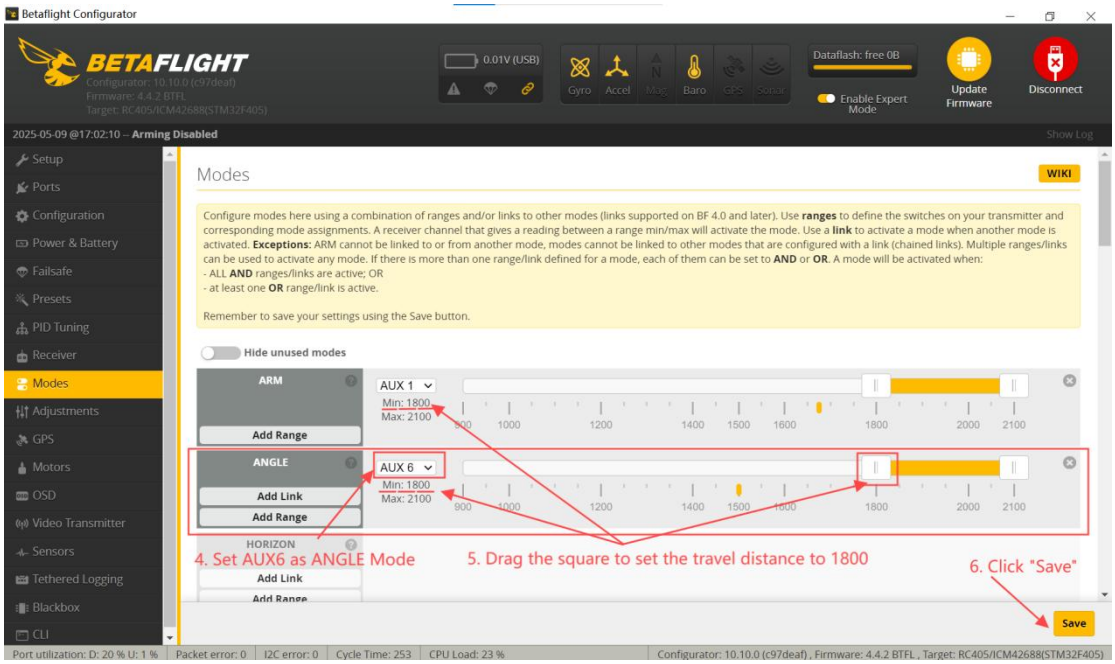


Fig 7.1.5 Flight Mode Configuration Interface

Step 5: Click on the Receiver option on the left side of the ground station:

① Make sure to change the serial digital receiver protocol to the CRSF protocol.

② Turn on the telemetry output switch and click "Save", as shown in Figure 7.1.6.

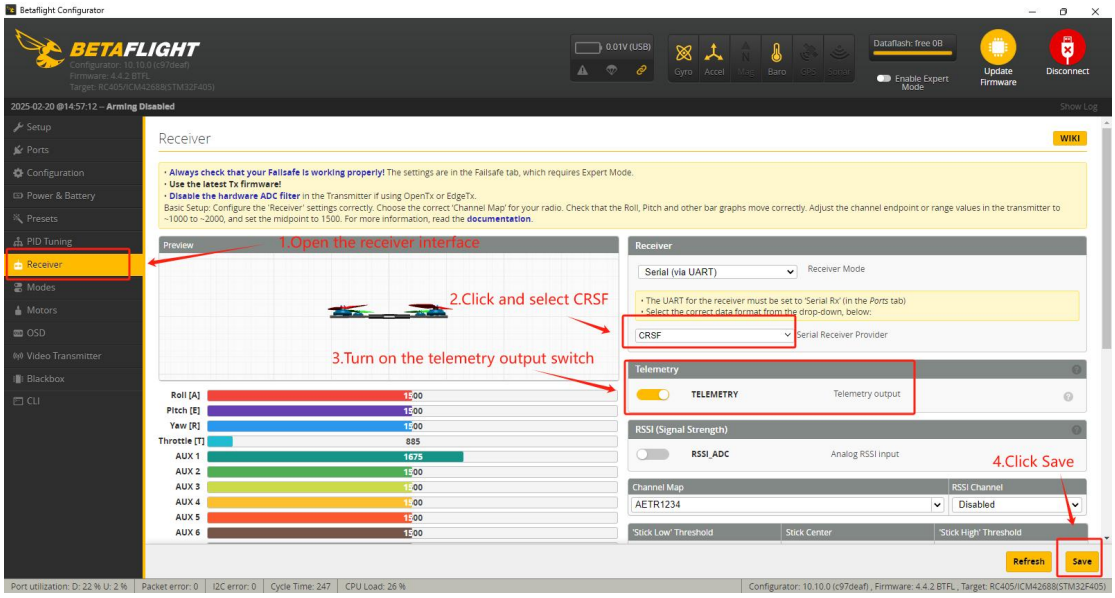


Fig 7.1.6 Flight Control Receiver Interface Settings

7.2 AI VisionCube Series Remote Control Channel Functions

7.2.1 Pre-Operation Notes

① Before operation, please first open the channel setting interface of the RC, set the corresponding channels according to the channel table in the following figure, and based on the individual operation habits of the pilot, set different channels to correspond with the corresponding channel switches of the RC.

② After completing the setup, power on the aircraft (ensure propellers are not installed) and perform a ground static test. If the channel configuration is successful, the word "TRACKING" will appear on the screen after target locking.

7.2.2 AI VisionCube Series Remote Control Channel Function Table

RC Channels	AI VisionCube S	
	Down Position	Up Position
CH5	Motors locked	Motors unlocked
CH6	/	Lock target
CH7	/	Expand target search range
CH8	/	Fine-tune locked target (using remote control joystick)
CH9	No function	
CH10	Drone enters manual mode	Drone enters stabilized mode

RC Channels	AI VisionCube D	
	Down Position	Up Position
CH5	Motors locked	Motors unlocked
CH6	/	Lock target
CH7	/	Expand target search range
CH8	/	Enables precise micro-adjustments to locked targets thru directional input from the remote control stick
CH9	Switch to wide-angle camera at down position	Switch to telephoto camera at up position
CH10	Drone enters manual mode	Drone enters stabilized mode

RC Channels	AI VisionCube ST	
	Down Position	Up Position
CH5	Motors locked	Motors unlocked
CH6	/	Lock target
CH7	/	Expand target search range

CH8	/	Fine-tune locked target (using remote control stick)
CH9	Switch to wide-angle camera at down position	Switch to telephoto camera at up position
CH10	Drone enters manual mode	Drone enters stabilized mode

RC Channels	AI VisionCube DT	
	Down Position	Up Position
CH5	Motors locked	Motors unlocked
CH6	/	Lock target
CH7	/	Expand target search range
CH8	/	Fine-tune locked target (using remote control stick)
CH9	Down position: Telephoto camera; Mid position: Wide-angle camera; Up position: Thermal imaging	
CH10	Drone enters manual mode	Drone enters stabilized mode

7.3 Precautions Before Use

- Strictly follow the electrical interface definitions to confirm the power supply voltage. Do not input a voltage outside the supported range, as it may damage the equipment.
- Before powering the module, confirm that the wiring is correct and ensure it is not reversed.
- When powering with a battery, check to ensure the battery is supplying power correctly.
- Check if the AI processing board and camera are installed securely.
- After powering on, ensure the display is normal.
- When the aircraft is not in the unlocked condition, after switching to tracking mode, observe if the lock frame appears in the center of the screen and locks onto the target, and ensure it can be unlocked normally.
- Check whether the stick of CH6 on the RC is in the down position. If not, you need to set it to the down position before unlocking.

7.4 Intelligent Tracking Operation Guide

➢ Target Locking & Initiating Tracking

a. **Real-time Picture Collaboration:** The pilot observes the target through the real-time high-definition picture (including the PiP function) transmitted back by the drone, adjusts the flight attitude, and aligns the crosshair at the center of the picture with the target to be tracked.

b. **One-Button Adhesive Locking:** Gently toggle the locking joystick of the remote controller. The AI algorithm automatically adsorbs the target and generates a tracking frame. The system

immediately takes over the flight control and initiates the tracking program.

c. Dynamic Attitude Compensation: During the tracking process, the drone calculates the target's movement trajectory in real time. Through dynamic attitude adjustment (pitch/yaw/roll), it ensures that the crosshair is always locked within the tracking frame, guaranteeing the tracking accuracy.

d. **Expand Search Range:** Set the stick corresponding to channel 7 of the remote controller to the high position, and the adsorption range of the target will be larger after the target is locked (turn it on before locking the target).

e. **Seamless Target Switching after Locking:** Set the stick corresponding to channel 8 of the remote controller to the high position, and cooperate with the pitch and roll joysticks to switch the target. After the selection frame is aligned with the target, set channel 8 to the low position, and the locking of the new target will take effect (turn it on after locking the target).

f. **Free Selection of Visual Perspectives:** Set the stick of channel 9 of the remote controller to the low position/middle position/high position for seamless switching of the corresponding camera (it can be turned on before or after locking the target).

g. **Multi-Flight Mode Options:** You can use Manual Mode and Self-stabilization Mode for flight control (mode switching is not allowed after locking the target).

- Tracking Termination and Status Reset

a. **Instant Cancel Mechanism:** Reset the remote controller lock lever, and the system will immediately cancel the tracking command, switching back to manual control mode.

b. **Attitude Takeover & Reset:** The pilot manually adjusts the aircraft to a stable state. After confirming that the video feed is normal, the target search and lock process can be restarted.

8. Disclaimer

8.1 The products of our company can only be used for civil purposes. It is strictly prohibited to directly or indirectly use them for the following content or in relation to the following:

a. Military combat-related purposes;

b. Weapon of mass destruction proliferation;

c. Terrorist activities.

8.2 The purchaser must ensure that their customers or end-users comply with the above requirements.

If the purchaser violates applicable export control or economic sanctions laws and regulations, we reserve the right to immediately suspend product delivery to the purchaser and terminate any related cooperation.