

## 25 款感知模块硬件规格书

Hardware Specification Document – 25-Series Perception Module

### 修订记录

| 版本    | 日期         | 修订原因 | 修订者                |
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|       |            |      |                    |
|       |            |      |                    |

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## 一、项目概述

### 1. 产品名称、型号

产品名称：感知模块

项目代号：XA2021-P-004（雷达部分）、XA2023-P-008（FPV 相机部分）

### 1.

Project Overview

1.1 Product Name & Model

Product Name: Perception Module

Project Code: XA2021-P-004 (radar section), XA2023-P-008 (FPV camera section)

### 2. 项目背景描述

在 24 款感知系统设计的时候，我们将摇摆雷、仿地雷达、前视 FPV 和下视 FPV 这几个模块融合成一个感知模块设计。减少了外部线束数量、结构外壳也减少，有效降低了成本，安装位置的选择也变的简单。但是由于开发时间的紧张和技术储备的有限，几个模块的融合也仅仅是外壳的合一，内部模块划分、通讯架构还是偏独立。这也就导致了 24 款的感知整体外形设计起来非常臃肿。

要想整个感知更加精简，新感知设计需要更程度的融合。于是在 25 款感知设计上，我们将原来的摇摆雷达和仿地雷达合并改成旋转雷达，将前视镜头和下视镜头合并成一个鱼镜头，将原来雷达部分的 CANFD 外部接口删减掉，所以信号统一合并到 FPV 的千兆网口上跟飞控进行通讯。

同时，居于公司降本目标和为了应对随时可能面临的制裁危机，我们也开始了全面的芯片国产化替代。

Project Background

During the design of the 24-series perception system, we physically merged the yaw radar, terrain-following radar, front FPV camera, and downward FPV camera into a single perception module. This reduced external harness count, shrank the structural enclosure, cut costs, and simplified mounting locations. However, due to tight schedules and limited technical reserves, the integration remained superficial—only the housing was unified; internal sub-modules and the communication architecture remained largely independent. The result was a bulky overall form factor.

To achieve a truly compact design, the 25-series perception module adopts deeper integration:

- The former yaw radar and terrain-following radar are combined into a single rotating radar.
- The front and downward cameras are replaced by one fisheye lens.

- The radar's external CAN-FD port is eliminated; all signals are consolidated and transmitted to the flight controller via the FPV camera's gigabit Ethernet port.

Simultaneously, in line with corporate cost-reduction goals and to prepare for potential sanctions, we have initiated a full-scale shift to domestically sourced chips.

### 3. 产品描述

围绕公司降本增效的目标，通过重新设计 FPV 相机并实现更强大的感知功能，提高 P 无人机的智能化程度。基于鱼眼 FPV 相机，使用 X5 平台的 VPAC、DMPAC、DSP、MMA 等视觉计算资源对环境进行感知，实现包括但不限于感知避障、地形预测、夜间自动补光、安全点引导降落等功能，充分提高 P 系列无人机感知环境的维度，实现更加智能化的植保作业。

全新的旋转雷达，可进行 360 度全方面扫描。不仅仅可以感知正前方的障碍物进行飞行避障和测算离地高度进行仿地飞行，还可以感知正上方的障碍物进行避障，较少炸机概率，提升作业安全

#### Product Description

Aligned with the company's cost-down & efficiency-up objectives, the redesigned FPV camera delivers enhanced perception capabilities and raises the intelligence level of P-series UAVs. Leveraging the X5 platform's VPAC, DMPAC, DSP, and MMA vision-compute resources, the fisheye FPV camera performs environmental perception that includes—but is not limited to—obstacle avoidance, terrain prediction, automatic night-time fill-lighting, and safe-point guided landing, thereby expanding the UAV's environmental awareness and enabling smarter crop-spraying operations.

The new rotating radar performs 360° omnidirectional scanning. It not only detects forward obstacles for flight avoidance and measures ground clearance for terrain-following flight, but also senses overhead obstacles, reducing crash risk and further improving operational safety.

### 4. 产品外观(Product Appearance)



图 1 产品外观示意图(Figure 1 – Product Appearance Diagram)

## 5. 系统架构(System Architecture)

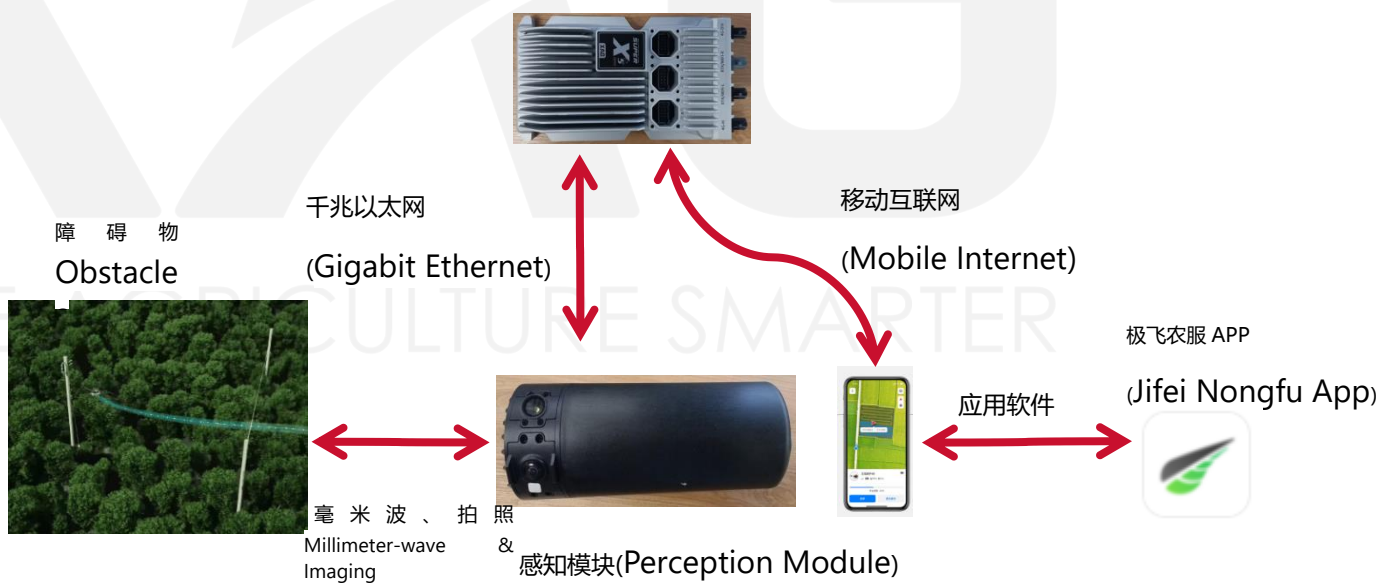


图 1 系统架构示意图(Figure 1 – System Architecture Diagram)

图 2 产品框图示意图(Figure 2 – Product Block Diagram)



### 三、产品功能(Product Functions)

描述产品所有功能点。(Description of all functional items.)

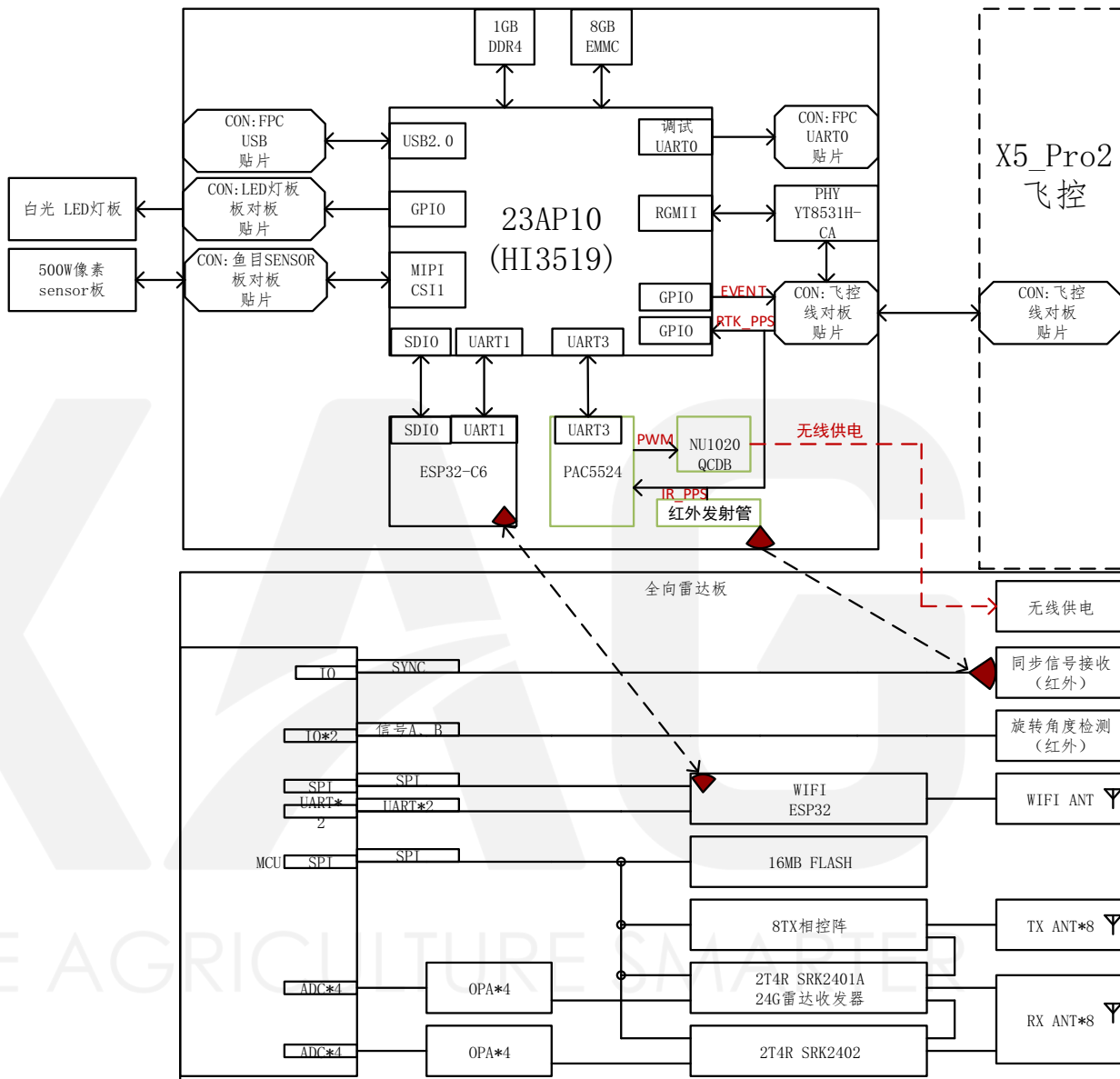
| No. | Function               | Description                                                                                                | Priority | Requirement Source | Notes |
|-----|------------------------|------------------------------------------------------------------------------------------------------------|----------|--------------------|-------|
| 1   | Fisheye Camera         | 5 MP, 4 mm focal length                                                                                    | 1        | User               |       |
| 2   | Ethernet Communication | 1000 M Ethernet                                                                                            | 1        | User               |       |
| 3   | Fill Light             | Auxiliary illumination for camera                                                                          | 1        | User               |       |
| 4   | Storage Function       | Stores captured images; uploads in real time via Ethernet and retains data on power loss                   | 1        | User               |       |
| 5   | Wireless Communication | Rotating radar exchanges data with FPV board wirelessly                                                    | 1        | User               |       |
| 6   | Rotating Scan          | Radar board can rotate 360° for scanning                                                                   | 1        | User               |       |
| 7   | Wireless Power Supply  | Provides power to omnidirectional radar                                                                    | 1        | User               |       |
| 8   | Serviceability         | FPV camera and radar sections can be detached individually for easy replacement and lower maintenance cost | 1        | Maintenance        |       |
| 9   | Obstacle Avoidance     | Detects obstacles in front and overhead for collision avoidance                                            | 1        | User               |       |
| 10  | Terrain Following      | Radar measures ground height for terrain-following flight                                                  | 1        | User               |       |
| 11  | Firmware Upgrade       | All internal modules can be upgraded via external Ethernet port                                            | 1        | Maintenance        |       |

| No. | Function                | Description                                                        | Priority | Requirement Source | Notes |
|-----|-------------------------|--------------------------------------------------------------------|----------|--------------------|-------|
| 12  | PCBA Auto-Test          | Dedicated test points on PCB for automated production testing      | 2        | Test               |       |
| 13  | Software Programming    | MCU main board supports software flashing via designated interface | 1        | R&D                |       |
| 14  | Hardware ID             | On-board ID circuit for hardware version differentiation           | 1        | Maintenance        |       |
| 15  | Technical Index Testing | All key specifications can be verified under lab conditions        | 1        | R&D                |       |

| 序号 | 功能项    | 说明                              | 优先级 | 需求类别 | 备注 |
|----|--------|---------------------------------|-----|------|----|
| 1  | 鱼眼相机   | 500W 像素，焦距长度 4mm                | 1   | 用户   |    |
| 2  | 以太网通信  | 1000M 以太网通信                     | 1   | 用户   |    |
| 3  | 补光灯    | 辅助相机照明                          | 1   | 用户   |    |
| 4  | 存储功能   | 可以存储相机拍照的图片，通过以太网实时上传，并具备掉电保存功能 | 1   | 用户   |    |
| 5  | 无线通讯功能 | 旋转雷达可以通过无线通讯和 FPV 板进行数据交互       | 1   | 用户   |    |
| 7  | 旋转扫描功能 | 雷达板可以旋转扫描探测                     | 1   | 用户   |    |
| 8  | 无线供电功能 | 给全向雷达提供电源供电                     | 1   | 用户   |    |
| 9  | 方便维修功能 | FPV 相机部分和雷达部分可方便拆分，可单独更换，降低维修成本 | 1   | 维护   |    |

|    |             |                          |   |    |  |
|----|-------------|--------------------------|---|----|--|
| 10 | 避障功能        | 可以检测正前方和正上方的障碍物，进行避障     | 1 | 用户 |  |
| 11 | 仿地功能        | 雷达可以检测底面高度，进行仿地飞行        | 1 | 用户 |  |
| 12 | 升级功能        | 可通过外部网口升级内部各单元模块的固件      | 1 | 维护 |  |
| 13 | PCBA 自动测试功能 | PCB 板设有相关测试点，方便生产进行自动化测试 | 2 | 测试 |  |
| 14 | 软件烧录        | MCU 主板能通过对对应接口实现软件烧录     | 1 | 研发 |  |
| 15 | 硬件识别码功能     | 板载硬件识别电路方便区分硬件版本         | 1 | 维护 |  |
| 16 | 技术指标测试功能    | 实验室条件下能实现各项指标测试          | 1 | 研发 |  |

#### 四、硬件框图



## 五、性能指标(Performance Specifications)

描述产品的所有性能指标(All performance indicators of the product are listed below.)

### FPV Camera Section

| No. | Parameter               | Specification                 | Note |
|-----|-------------------------|-------------------------------|------|
| 1   | Rated input voltage     | 24 V                          |      |
| 2   | Over-voltage protection | > 42 V                        |      |
| 3   | Operating current       | $\leq 1.5$ A                  |      |
| 4   | Stand-by current        | < 0.09 A @ 24 V               |      |
| 5   | Sensor format           | 1/2.7-inch CMOS               |      |
| 6   | Pixel count             | 5 MP                          |      |
| 7   | Chief ray angle (CRA)   | 15°                           |      |
| 8   | Sensitivity             | 2 800 mV / lux·s              |      |
| 9   | Field of view (FOV)     | Horizontal 90° / Vertical 60° |      |
| 10  | Image streaming         | 2592 H × 1944 V @ 30 fps      |      |
| 11  | Output interface        | 12-/10-/8-bit, 2-lane MIPI    |      |
| 12  | Output format           | RAW RGB                       |      |
| 13  | LED light               | White, power $\geq 4.4$ W     |      |

### Motor Driver & Wireless-Power Section

| No. | Parameter             | Specification                 | Note |
|-----|-----------------------|-------------------------------|------|
| 1   | ESC input             | 0.125 A @ 24 V                |      |
| 2   | ESC output            | Rated 0.6 A, max 1.5 A @ 15 S |      |
| 3   | Wireless-power output | $\geq 15$ W                   |      |

### Omnidirectional Radar Section

| No. | Parameter                              | Specification                                                        | Note                                                 |
|-----|----------------------------------------|----------------------------------------------------------------------|------------------------------------------------------|
| 1   | Operating frequency                    | 24.05 – 24.25 GHz                                                    |                                                      |
| 2   | Modulation                             | FMCW                                                                 |                                                      |
| 3   | Range (altitude $\geq 1.5$ m)          | 0.3 – 80 m                                                           |                                                      |
| 4   | Velocity range                         | $\geq 13.8$ m/s (min. 0 m/s)                                         |                                                      |
| 5   | Angular FOV                            | Horizontal $> 120^\circ$ / Vertical $> 20^\circ$                     | Accuracy guaranteed within FOV                       |
| 6   | Point-cloud refresh                    | $\geq 360$ Hz                                                        |                                                      |
| 7   | Range accuracy (altitude $\geq 1.5$ m) | $\leq 0.1$ m (within range & FOV)                                    | Degrades outside range                               |
| 8   | Velocity accuracy                      | $\leq 0.15$ m/s (within range & FOV)                                 | Degrades outside range                               |
| 9   | Angle accuracy (altitude $\geq 1.5$ m) | Horizontal $< 1^\circ$ / Vertical $< 2^\circ$ (within range & FOV)   | Degrades outside beam                                |
| 10  | Range resolution                       | Export version: $1 \text{ m} \pm 0.1 \text{ m}$ (within range & FOV) | Two targets separable with 1.5–2 $\times$ resolution |
| 11  | Velocity resolution                    | $3 \text{ m/s} \pm 0.1 \text{ m/s}$                                  |                                                      |

| No. | Parameter                                 | Specification                                                                                        | Note |
|-----|-------------------------------------------|------------------------------------------------------------------------------------------------------|------|
| 12  | Angular resolution                        | Horizontal $14.3^{\circ} \pm 1^{\circ}$ / Vertical $14.3^{\circ} \pm 1^{\circ}$ (within range & FOV) |      |
| 13  | Detection probability                     | $\geq 95\%$ (altitude $\geq 1.5$ m, RCS $< 10$ dBm <sup>2</sup> , within range & FOV)                |      |
| 14  | False-alarm rate                          | $\leq 5\%$ (altitude $\geq 1.5$ m, RCS $< 10$ dBm <sup>2</sup> , within range & FOV)                 |      |
| 15  | Single-antenna TX power                   | $\geq 25$ dBm                                                                                        |      |
| 16  | Phased-array TX power                     | $\geq 35$ dBm                                                                                        |      |
| 17  | Single-antenna TX gain                    | $\geq 12$ dBi (short antenna)                                                                        |      |
| 18  | Phased-array TX gain                      | $\geq 20$ dBi                                                                                        |      |
| 19  | RX antenna gain                           | $\geq 14$ dBi                                                                                        |      |
| 20  | Single-antenna pattern (-3 dB beamwidth)  | Vertical $20^{\circ} \pm 5^{\circ}$                                                                  |      |
| 21  | Phased-array TX pattern (-3 dB beamwidth) | Vertical $20^{\circ} \pm 5^{\circ}$                                                                  |      |

| No. | Parameter                             | Specification                         |
|-----|---------------------------------------|---------------------------------------|
| 22  | Rx antenna pattern (-3 dB)            | Vertical: $40^{\circ} \pm 10^{\circ}$ |
| 23  | Antenna count                         | Tx: 8 Rx: 8                           |
| 24  | Radar board power                     | Stand-by $\leq 6$ W                   |
| 25  | Encoder angle accuracy                | $\leq 1.5^{\circ}$                    |
| 26  | Radar board input voltage             | 10 V – 30 V                           |
| 27  | Wi-Fi data rate (radar ↔ motor board) | 2 MB/s                                |

| No. | Parameter                            | Specification | Note |
|-----|--------------------------------------|---------------|------|
| 28  | UART baud rate (radar ↔ motor board) | 230 400 bit/s |      |
| 29  | Debug UART baud rate (radar board)   | 921 600 bit/s |      |

| 序号              | 参数     | 规格                                           | 备注 |
|-----------------|--------|----------------------------------------------|----|
| <b>FPV 相机部分</b> |        |                                              |    |
| 1               | 额定输入电压 | 24V                                          |    |
| 2               | 过压保护   | > 42V                                        |    |
| 3               | 工作电流   | ≤1.5A                                        |    |
| 4               | 待机电流   | < 0.09A@24V                                  |    |
| 5               | 传感器尺寸  | 1/2.7 英寸 CMOS                                |    |
| 6               | 像素     | 500 万                                        |    |
| 7               | 主光角    | CRA: 15°                                     |    |
| 8               | 灵敏度    |                                              |    |
| 9               | 视场角    | 水平 90°<br>垂直 60°                             |    |
| 10              | 灵敏度    | 2800 mV/lux•s                                |    |
| 11              | 图像传输速率 | 2592H x 1944V @30fps<br>2560H x 1440V @30fps |    |
| 12              | 输出接口   | 12/10/8-bit 2Lane MIPI                       |    |
| 13              | 输出格式   | RAW RGB                                      |    |



|                        |                            |                                                              |                               |
|------------------------|----------------------------|--------------------------------------------------------------|-------------------------------|
| 14                     | LED 灯                      | 白光, 功率: $\leq 4.4W$                                          |                               |
| <b>电机驱动&amp;无线供电部分</b> |                            |                                                              |                               |
| 1                      | 电机驱动参数                     | 电调: 输入 0.125A@24V<br>输出额定电流 0.6A 最大 1.5A@15S                 |                               |
| 2                      | 无线供电功率                     | 输出功率: $\leq 15W$                                             |                               |
| <b>全向雷达部分</b>          |                            |                                                              |                               |
| 1                      | 雷达工作频率                     | 24.05Ghz~24.25Ghz                                            |                               |
| 2                      | 调制方式                       | FMCW                                                         |                               |
| 3                      | 测距范围(飞行高度 $\geq 1.5m$ )    | 测距范围:0.3m~80m                                                |                               |
| 4                      | 测速范围                       | $\geq 13.8m/s$                                               | 测速最小值为 0                      |
| 5                      | 测角范围(FOV)                  | 水平 FOV: $>120^\circ$<br>垂直 FOV: $>20^\circ$                  | 测角范围指: 范围内保证测角精度, 超范围角度误差会增加。 |
| 6                      | 点云刷新周期                     | $\geq 360Hz$                                                 |                               |
| 7                      | 距离测量精度 (飞行高度 $\geq 1.5m$ ) | $\leq 0.1m$ (测距测角范围内)                                        | 超距离范围的目标, 测距精度值会变大            |
| 8                      | 速度测量精度                     | $\leq 0.15m/s$ (测距测角范围内)                                     | 超距离范围的目标, 测速精度值会变大            |
| 9                      | 角度测量精度 (飞行高度 $\geq 1.5m$ ) | 水平测角精度: $<1^\circ$ (测距测角范围内)<br>垂直测角精度: $<2^\circ$ (测距测角范围内) | 超天线波束范围的目标, 测角精度值会偏差          |

|    |                                                                              |                                                                                              |                                                                  |
|----|------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------------------------|
| 10 | 距离分辨率                                                                        | 海外版: $1\text{m} \pm 0.1\text{m}$ (测距测角范围内)                                                   | 在满足 1.5 倍到 2 倍分辨率的条件下可对两个物体进行区分<br><br>超距离范围的目标, 测距分辨率会变大。       |
| 11 | 速度分辨率                                                                        | $3\text{m/s} \pm 0.1\text{m/s}$                                                              | 超距离范围的目标, 测速分辨率会变大                                               |
| 12 | 角度分辨率                                                                        | 水平角分辨率: $14.3^\circ \pm 1^\circ$ (测距测角范围内)<br><br>垂直角分辨率: $14.3^\circ \pm 1^\circ$ (测距测角范围内) | 1、在满足 1.5 倍到 2 倍分辨率的条件下可对两个物体进行区分<br><br>2、超天线波束范围的目标, 测角分辨率会变大。 |
| 13 | 识别率 (测距测角范围内, 飞行高度 $\geq 1.5\text{m}$ , 目标 $< \text{RCS} 10 \text{ dBm}^2$ ) | $\geq 95\%$                                                                                  |                                                                  |
| 14 | 误检率 (测距测角范围内, 飞行高度 $\geq 1.5\text{m}$ , 目标 $< \text{RCS} 10 \text{ dBm}^2$ ) | $\leq 5\%$                                                                                   |                                                                  |
| 15 | 单根天线发射功率                                                                     | $\geq 25 \text{ dBm}$                                                                        |                                                                  |
| 16 | 相控阵天线发射功率                                                                    | $\geq 35 \text{ dBm}$                                                                        |                                                                  |
| 17 | 单根发射天线增益                                                                     | $\geq 12 \text{ dBi}$ (短天线)                                                                  |                                                                  |
| 18 | 相控阵天线增益                                                                      | $\geq 20 \text{ dBi}$                                                                        |                                                                  |
| 19 | 接收天线增益                                                                       | $\geq 14 \text{ dBi}$                                                                        |                                                                  |

|    |                      |                                                                       |  |
|----|----------------------|-----------------------------------------------------------------------|--|
| 20 | 单根发射天线方向图(-3dB 带宽)   | 垂直面: $20^{\circ} \pm 5^{\circ}$<br>水平面: $120^{\circ} \pm 10^{\circ}$  |  |
| 21 | 相控阵发射天线方向图(-3dB 带宽)  | 垂直面: $20^{\circ} \pm 5^{\circ}$<br>水平面: $20^{\circ} \pm 10^{\circ}$   |  |
| 22 | 接收天线方向图(-3dB 带宽)     | 垂直面: $40^{\circ} \pm 10^{\circ}$<br>水平面: $120^{\circ} \pm 10^{\circ}$ |  |
| 23 | 发射天线目数               | 发射天线: 8<br>接收天线: 8                                                    |  |
| 24 | 雷达板功耗                | 待机功耗: $\leq 6W$<br>工作功耗: $\leq 12W$                                   |  |
| 25 | 码盘角度检测精度             | $\leq 1.5^{\circ}$                                                    |  |
| 26 | 雷达板输入电压范围            | 10V~30V                                                               |  |
| 27 | 雷达板与电机板间 WIFI 通信数据速率 | 2MB/s                                                                 |  |
| 28 | 雷达板与电机板间串口通信速率       | 230400bit/s                                                           |  |
| 29 | 雷达板调试接口串口通信速率        | 921600bit/s                                                           |  |

## 六、外部接口(External and Internal Interfaces)

### 1. 外部接口:(External Interface)

| 接口名称<br>Gigabit Ethernet & Power | 引脚序号<br>Pin | 引脚名称<br>Name | 引脚类型<br>Type | Level | Function | Note                     |
|----------------------------------|-------------|--------------|--------------|-------|----------|--------------------------|
| 感知模块                             | 1           | NC           |              |       |          | 原雷达<br>CAN_FD 改成<br>网口   |
|                                  | 2           | NC           |              |       |          |                          |
|                                  | 3           | LAN_DATA1_N  |              |       |          | 千兆网口，<br>接 FPV 相机<br>和雷达 |
|                                  | 4           | LAN_DATA1_P  |              |       |          |                          |
|                                  | 5           | LAN_DATA2_N  |              |       |          |                          |
|                                  | 6           | LAN_DATA2_P  |              |       |          |                          |
|                                  | 7           | LAN_DATA3_N  |              |       |          |                          |
|                                  | 8           | LAN_DATA4_N  |              |       |          |                          |
|                                  | 9           | LAN_DATA3_P  |              |       |          |                          |
|                                  | 10          | LAN_DATA4_P  |              |       |          |                          |
|                                  | 11          | PER_24V      | Power        | 24V   |          | 供电输入                     |
|                                  | 12          | GND          | GND          | 0     |          |                          |

### 2. 内部接口

| 插座名称 | 引脚序号 | 引脚名称            | 引脚类型 | 引脚电平 | 引脚功能 | 备注 |
|------|------|-----------------|------|------|------|----|
|      | 1    | SENSOR_I2C4_SDA | I/O  | 1V8  |      |    |
|      | 2    | GND             | GND  | 0    |      |    |
|      | 3    | SENSOR_I2C4_SCL | I/O  | 1V8  |      |    |
|      | 4    | IMU_SPI2_CLK    | I/O  | 3V3  |      |    |

|                                                        |    |                 |       |     |  |  |
|--------------------------------------------------------|----|-----------------|-------|-----|--|--|
| 鱼眼<br>sensor<br>接口<br>(Fisheye<br>Sensor<br>Interface) | 5  | GND             | GND   | 0   |  |  |
|                                                        | 6  | IMU_SPI2_CS     | I/O   | 3V3 |  |  |
|                                                        | 7  | MIPI_RX1_D0_P   | --    | --  |  |  |
|                                                        | 8  | IMU_SPI2_MOSI   | Out   | 3V3 |  |  |
|                                                        | 9  | MIPI_RX1_D0_N   | --    | --  |  |  |
|                                                        | 10 | IMU_SPI2_MISO   | IN    | 3V3 |  |  |
|                                                        | 11 | GND             | GND   | 0   |  |  |
|                                                        | 12 | GND             | GND   | 0   |  |  |
|                                                        | 13 | MIPI_RX1_D1_P   | --    | --  |  |  |
|                                                        | 14 | VCC_3V3         | POWER | 3V3 |  |  |
|                                                        | 15 | MIPI_RX1_D1_N   | --    | --  |  |  |
|                                                        | 16 | DOVDD_1V8       | POWER | 1V8 |  |  |
|                                                        | 17 | GND             | GND   | 0   |  |  |
|                                                        | 18 | DVDD_1V5        | POWER | 1V5 |  |  |
|                                                        | 19 | MIPI_RX1_D2_P   | --    | --  |  |  |
|                                                        | 20 | AVDD_2V8        | POWER | 2V8 |  |  |
|                                                        | 21 | MIPI_RX1_D2_N   | --    | --  |  |  |
|                                                        | 22 | GND             | GND   | 0   |  |  |
|                                                        | 23 | GND             | GND   | 0   |  |  |
|                                                        | 24 | GND             | GND   | 0   |  |  |
|                                                        | 25 | MIPI_RX1_D3_P   | --    | --  |  |  |
|                                                        | 26 | GPIO_C_IMU_INT1 | I/O   | 3V3 |  |  |
|                                                        | 27 | MIPI_RX1_D3_N   | --    | --  |  |  |
|                                                        | 28 | SENSOR1_RSTN    | I/O   | 1V8 |  |  |
|                                                        | 29 | GND             | GND   | 0   |  |  |

|                                                   |    |                |       |     |  |  |
|---------------------------------------------------|----|----------------|-------|-----|--|--|
|                                                   | 30 | GND            | GND   | 0   |  |  |
|                                                   | 31 | MIPI_RX1_CK0_P | --    | --  |  |  |
|                                                   | 32 | GPIO_A_FSYNC   | I/O   | 1V8 |  |  |
|                                                   | 33 | MIPI_RX1_CK0_N | --    | --  |  |  |
|                                                   | 34 | GPIO_B_FSYNC   | I/O   | 1V8 |  |  |
|                                                   | 35 | GND            | GND   | 0   |  |  |
|                                                   | 36 | GND            | GND   | 0   |  |  |
|                                                   | 37 | NC             | NC    | NC  |  |  |
|                                                   | 38 | SENSOR1_CLK    | Out   | 1V8 |  |  |
|                                                   | 39 | NC             | NC    | NC  |  |  |
|                                                   | 40 | GND            | GND   | 0   |  |  |
|                                                   |    |                |       |     |  |  |
| 补光灯板<br>接口 (Fill-<br>Light<br>Board<br>Interface) | 1  | LEDA           | Power | 3V  |  |  |
|                                                   | 2  | LEDA           | Power | 3V  |  |  |
|                                                   | 3  | LEDA           | Power | 3V  |  |  |
|                                                   | 4  | LEDA           | Power | 3V  |  |  |
|                                                   | 5  | LEDA           | Power | 3V  |  |  |
|                                                   | 6  | LEDA           | Power | 3V  |  |  |
|                                                   | 7  | LEDK           | Power | --  |  |  |
|                                                   | 8  | LEDK           | Power | --  |  |  |
|                                                   | 9  | LEDK           | Power | --  |  |  |
|                                                   | 10 | LEDK           | Power | --  |  |  |
|                                                   | 11 | LEDK           | Power | --  |  |  |
|                                                   | 12 | LEDK           | Power | --  |  |  |
|                                                   | 13 | NC             | NC    | NC  |  |  |
|                                                   | 14 | NC             | NC    | NC  |  |  |

|                                                                           |    |             |     |   |  |  |
|---------------------------------------------------------------------------|----|-------------|-----|---|--|--|
|                                                                           | 15 | TEM_ADC_CON | IN  | — |  |  |
|                                                                           | 16 | TEM_ADC_CON | IN  | — |  |  |
|                                                                           | 17 | GND         | GND | 0 |  |  |
|                                                                           | 18 | GND         | GND | 0 |  |  |
|                                                                           | 19 | GND         | GND | 0 |  |  |
|                                                                           | 20 | GND         | GND | 0 |  |  |
| 电机驱动<br>和无线供电接口<br>(Motor<br>Driver &<br>Wireless-<br>Power<br>Interface) | 1  | SH_A        |     |   |  |  |
|                                                                           | 2  | SH_A        |     |   |  |  |
|                                                                           | 3  | SH_A        |     |   |  |  |
|                                                                           | 4  | SH_A        |     |   |  |  |
|                                                                           | 5  | SH_B        |     |   |  |  |
|                                                                           | 6  | SH_B        |     |   |  |  |
|                                                                           | 7  | SH_B        |     |   |  |  |
|                                                                           | 8  | SH_B        |     |   |  |  |
|                                                                           | 9  | SH_C        |     |   |  |  |
|                                                                           | 10 | SH_C        |     |   |  |  |
|                                                                           | 11 | SH_C        |     |   |  |  |
|                                                                           | 12 | SH_C        |     |   |  |  |
|                                                                           | 13 | GND         | GND | 0 |  |  |
|                                                                           | 14 | GND         | GND | 0 |  |  |
|                                                                           | 15 | VSYS        | I/O |   |  |  |
|                                                                           | 16 | VCC_3V3     |     |   |  |  |
|                                                                           | 17 | HALL_1      |     |   |  |  |
|                                                                           | 18 | IR_LED      |     |   |  |  |
|                                                                           | 19 | HALL_2      |     |   |  |  |

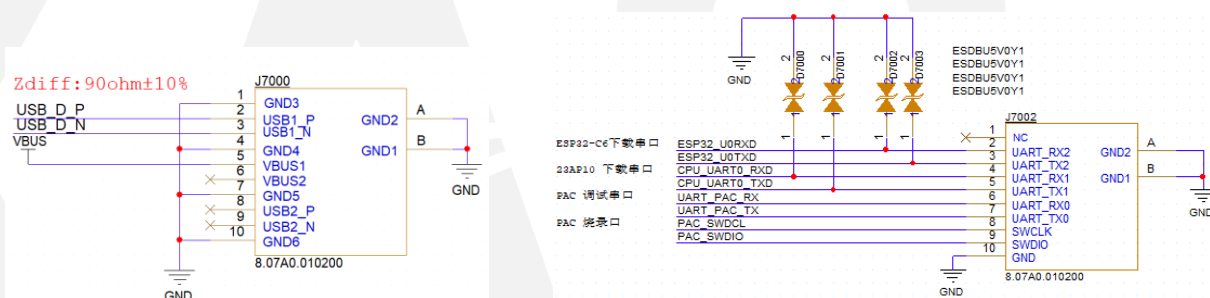
|  |    |               |  |  |  |  |
|--|----|---------------|--|--|--|--|
|  | 20 | WIFI_ANT3     |  |  |  |  |
|  | P1 | Wireless_OUT+ |  |  |  |  |
|  | P2 | Wireless_OUT+ |  |  |  |  |
|  | P3 | Wireless_IN-  |  |  |  |  |
|  | P4 | Wireless_IN-  |  |  |  |  |

### 3. FPV 主板调试接口

主控芯片固件下载调试 USB2.0 接口使用 FPC 连接器，及其它串口使用 FPC 连接器。如下图所示。

#### 6.3 FPV Main Board Debug Interface

Firmware download/debug is performed via a USB 2.0 FPC connector; additional UARTs also use FPC connectors as shown in the figure.



## 七、版本识别(Version Identification)

| 项目     | 当前硬件版本 | 配置方式 |
|--------|--------|------|
| 版本 1.0 | 01     | 电阻   |

Item

Current Hardware  
Version

Configuration Method

Hardware Version

V1.0

01 (resistor-coded)

## 八、工作条件(Operating Conditions)

| 序号 | 工作条件 | 要求 | 备注 |
|----|------|----|----|
|----|------|----|----|



|   |        |                                                          |  |
|---|--------|----------------------------------------------------------|--|
| 1 | 防护等级   | IP67                                                     |  |
| 2 | 工作温度   | -20°C~60°C                                               |  |
| 3 | 使用相对湿度 | 5%-98%                                                   |  |
| 4 | 存储温度   | -20°C~85°C                                               |  |
| 5 | 防静电    | 空气放电 $\geq \pm 15\text{KV}$ , 接触放电 $\geq \pm 8\text{KV}$ |  |

| No. | Condition                     | Requirement                             | Note |
|-----|-------------------------------|-----------------------------------------|------|
| 1   | Ingress protection            | IP67                                    |      |
| 2   | Operating temperature         | -20 °C to +60 °C                        |      |
| 3   | Relative humidity (operating) | 5 % – 98 %                              |      |
| 4   | Storage temperature           | -20 °C to +85 °C                        |      |
| 5   | ESD immunity                  | Air discharge: $\geq \pm 15 \text{ kV}$ |      |

## 九、规范要求(Regulatory Requirements)

1. 安全标准:EN60950-1;IEC60950-1
2. 电磁兼容性标准:EN55022 classB; EN60950-1
3. 接触放电 (ESD) 接触放电 $\pm 8\text{KV}$  IEC61000-4-2 (判据 B)

| Item | Standard / Test | Requirement             |
|------|-----------------|-------------------------|
| 1    | Safety          | EN 60950-1, IEC 60950-1 |

| Item | Standard / Test         | Requirement                          |
|------|-------------------------|--------------------------------------|
| 2    | EMC                     | EN 55022 Class B, EN 60950-1         |
| 3    | Contact discharge (ESD) | +8 kV per IEC 61000-4-2, Criterion B |

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FCC Compliance Notice:

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

This equipment should be installed and operated with a minimum distance of 20cm between the radiator and your body.

FCC Supplier's Declaration of Conformity

Brand name / model number: FRD2488\_25

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Suppliers Name(FCC): Pegasus Spray LLC

Suppliers Address (FCC): 18571 State Hwy 6Lewistown, MO 63452 United States

Suppliers Email Address: arthur@pegasusrobotic.com