RADAR UAV-77

UAV Obstacle-Avoidance & Altimeter mmWave Radar System

— APPLICATION MANUAL —

【Identical hardware, distinct software.】

77GHz mmWave Radar | All-Weather Operation | IP67 Protection Rating

Max 100m Detection Range | 80° Field of View | 64 Target Tracking

±0.1m Ranging Accuracy | <1.5W Low Power | <150g Lightweight

Professional mmWave Radar Manufacturer

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I. Product Introduction

1.1 Product Overview

RADAR UAV-77 is a UAV obstacle-avoidance and altimeter radar system based on 77GHz mmWave FMCW waveform technology, designed for various medium-to-large unmanned aerial vehicles. Adopting a MIMO multi-channel array architecture, it provides 80° horizontal field of view and 30° elevation coverage, and can detect and track up to 64 dynamic targets in real time in complex environments, with a maximum detection range of 100 m (for targets with RCS ≥ 10 dBsm) and ranging accuracy better than ±0.1 m. The system supports all-weather operation, unaffected by light, fog, rain, snow, or sandstorm conditions, providing reliable environmental perception for the UAV and effectively improving flight safety and operational efficiency.

1.2 Key Features

- **✔ All-Weather Capability Unaffected by lighting conditions, it operates normally in harsh environments such as dense fog, heavy rain, sandstorms, and nighttime, ensuring continuous and safe UAV operation.**
- **✔ 360° Omnidirectional Perception Supports multi-radar networking fusion; data stitching achieves full spherical field-of-view coverage, eliminating detection blind spots.**
- **✔ Ultra-Lightweight Design Dimensions ≤ 70 × 65 × 18 mm, total weight < 150 g, suitable for the payload requirements of most small-to-medium UAVs.**
- **✔ Rich Interface Protocols Provides multiple communication interfaces such as CAN, UART, I²C, and SPI, flexibly connecting to mainstream flight-control platforms (Pixhawk / ArduPilot / PX4, etc.).**
- **✔ Functional Safety Assurance Designed in compliance with the ISO 26262 ASIL-D functional safety standard, with built-in fault self-diagnosis and redundancy verification mechanisms.**

1.3 Typical Application Scenarios

Application Field	Typical Use
Power Line Inspection	Autonomous inspection of high-voltage transmission lines; close-

	range tower obstacle avoidance
Logistics Delivery	Urban last-mile delivery drones; obstacle avoidance weaving through building clusters
Industrial Inspection	Chemical plants, wind farms, and bridge structure inspection
Agricultural Plant Protection	Farmland spraying operations; automatic avoidance of field trees / power lines
Emergency Rescue	Search and rescue at disaster sites; autonomous navigation in rubble areas
Urban Security	Traffic monitoring and public safety management; safe flight over crowded areas

II. System Functions

2.3 Early Warning Mechanism

Parameter	Specification
Warning Strategy	Dual criteria based on distance threshold + TTC (Time-To-Collision estimation)
Near-field Warning Distance	D ≤ 30 m (yellow warning, prompt to slow down or hover)
Danger Warning Distance	D ≤ 15 m (red alert, recommend emergency avoidance)
TTC Threshold	High-level alert triggered when TTC ≤ 3.0 s
Warning Output Method	Alarm frame sent via CAN bus (containing target ID / distance / bearing / speed)
Response Latency	From detection to alarm output ≤ 30 ms

2.4 Data Output Interface

Parameter	Specification
Physical Interface	6-pin waterproof connector (customizable)
Comm. Protocol 1	CAN 2.0B (500 kbps, extended frame, customizable ID)
Comm. Protocol 2	UART (115200 bps, 8N1)
PX4 / OrangePi Compatibility	UART / CAN, compliant with the corresponding communication protocol
Auxiliary Interface	I²C (for configuration/debug), SPI (for firmware upgrade)
Data Frame Content	Number of targets / Per target: distance (m), azimuth (deg), relative speed (m/s), RCS (dBsm), target ID
Output Period	30 ms / frame (~33 Hz refresh rate synchronized)

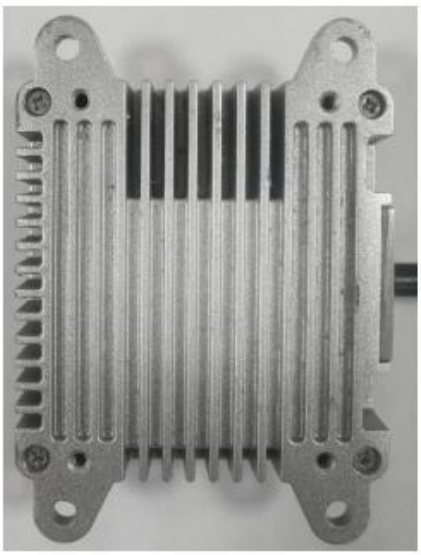
III. Specifications

Technical Specifications:

Category	Parameter	Technical Spec
RF Performance	Operating Frequency	77~79 GHz (center frequency 77 GHz)
	Modulation Waveform	FMCW linear frequency-modulated continuous wave
	Transmit Power	≤ 17 dBi EIRP
	Receive Gain	≥ 13.5 dBi (array combining gain)
	Bandwidth	500 MHz (corresponds to 0.12 m theoretical range resolution)
	Scan Period	≤ 35 ms (including signal processing and target output)
Detection Performance	Max Detection Range	100 m (RCS ≥ 10 dBsm) identifiable distance for

		wires/branches: 40 m
	Min Detection Range	≥ 0.2 m
	Horizontal FOV	80° (±40°)
	Elevation Coverage	±15°
	Range Resolution	0.12 m
	Range Accuracy	±0.1 m
	Relative Speed Range	±50 km/h
	Speed Resolution	0.25 m/s
	Simultaneous Tracked Targets	≤ 64
Electrical & Environmental	Operating Voltage	DC 7–30 V
Electrical & Environmental	Power Consumption	< 1.5 W (typical 1.2 W)
Electrical & Environmental	Operating Temperature	−40 ~ +85 °C
Electrical & Environmental	Storage Temperature	−40 ~ +85 °C
Electrical & Environmental	Protection Rating	IP67 (dustproof & waterproof)
Electrical & Environmental	Vibration Resistance	IEC 60068-2-6, 10~500 Hz, 2g
Electrical & Environmental	Shock Resistance	IEC 60068-2-27, 50g / 11 ms half-sine
Mechanical & Interface	Dimensions	≤ 70 × 65 × 18 mm (L × W × H)
	Weight	< 150 g (including connector)

Housing Material	Engineering plastic (PC + ABS) / metal bottom case
Mounting Method	M4 bolt fixing / 3M double-sided tape (optional)
Communication Interface	CAN / UART / I²C / SPI



IV. Installation Guide

4.1 Mounting Position Selection

Mounting Position	Applicable Description
Under the Fuselage	Mounted at the center bottom of the UAV, radar antenna facing down; suitable for altitude-hold cruise and ground obstacle avoidance.
Front / Rear of the Nose	Mounted on the front/rear end faces of the airframe; radar normal aligned with flight direction forward/backward; suitable for forward obstacle avoidance and path planning, enabling autonomous braking/reversing/detouring with the flight controller.

Both Wingtips	One unit on each side to form a dual-radar array, achieving over 180° horizontal coverage; suitable for complex urban environments or indoor flight, eliminating lateral blind spots.
Top-Facing Upward	For special scenarios (e.g., passing under bridges/canopy), radar mounted facing upward to monitor overhead obstacles.

4.2 Installation Steps

1. Ensure the mounting surface is clean and flat; remove oil and dust. If using adhesive mounting, wipe the surface with an alcohol pad.
2. Align the mounting bracket with the reserved holes and secure with M4 screws (torque 0.3 N·m), or attach 3M double-sided tape to the designated position.
3. Connect the CAN bus harness to the corresponding flight-controller interface (note: CAN_H / CAN_L must not be reversed); connect the power cable to the voltage output terminal.
4. Use the host PC software (or a UART debug terminal) to read the radar output frames and verify that target data is reported correctly.
5. Perform in-flight calibration: set up a target at a known distance, compare the radar measurement with the actual value for error, and adjust the mounting angle to compensate for offset if necessary.

4.3 Interface Pin Definition (modifiable per flight-controller type)

Pin	Definition	Description
Pin 1	CAN_H	CAN bus high line
Pin 2	CAN_L	CAN bus low line
Pin 3	VCC	DC power input
Pin 4	GND	Power ground / signal ground (common)
Pin 5	TX	UART transmitter (TTL level)
Pin 6	RX	UART receiver (TTL level)

V. Usage Precautions

Power Requirements	Must use a regulated DC 7–30 V supply. Never connect directly to a high-voltage battery (e.g., 48 V), otherwise the radar module will be damaged. Always disconnect power before wiring, and energize only after confirming correct polarity.
Installation Standards	The mounting surface should remain flat; avoid severe vibration that loosens bolts. No metallic obstructions (e.g., protruding screw heads, cables crossing) are allowed within ≥50 mm in front of the radar antenna, otherwise false-echo interference will occur.
EMC (Electromagnetic Compatibility)	Avoid installing the radar directly below the video-transmitter antenna or the telemetry radio within ≥15 cm, to prevent RF interference from degrading detection accuracy. When multiple radars operate simultaneously, stagger their transmit timing or assign different CAN IDs.
Environmental Limitations	Although all-weather operation is supported, detection range attenuates (drops by about 20%~40%) under heavy rain (>50 mm/h) or hail. It is recommended to reduce flight speed and shorten the operating radius in such extreme weather.
Routine Maintenance	It is recommended to inspect the radar surface for dust, water stains, or scratches every 50 accumulated flight hours; gently wipe with a soft dry cloth. Never clean with organic solvents.

END

This document is for reference only; the specific parameters are subject to the actual product and the factory inspection report.
For any questions, please contact the technical support department.

RADAR UAV-77

无人机避障、定高毫米波雷达系统

—— 应 用 手 册 ——

【硬件相同 软件算法不同】

77GHz 毫米波雷达 | 全天候工作 | IP67 防护等级

最大 100m 探测距离 | 80° 视场角 | 64 目标跟踪

±0.1m 测距精度 | <1.5W 低功耗 | <150g 轻量化

毫米波雷达专业制造商

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一、产品简介

1.1 产品概述

RADAR UAV-77 是一款基于 77GHz 毫米波 FMCW 波形技术的无人机避障、定高雷达系统，专为各类中大型无人飞行器设计。该系统采用 MIMO 多通道阵列架构，具备 80° 水平视场角与 30° 俯仰角覆盖能力，可在复杂环境中实时探测并跟踪最多 64 个动态目标，最大探测距离达 100m（针对 RCS ≥ 10dBsm 目标），测距精度优于 ±0.1m。系统支持全天候工作模式，不受光照、雾霾、雨雪及沙尘天气影响，为无人机提供可靠的环境感知保障，有效提升飞行安全性与作业效率。

1.2 核心特点

- ✔ **全天候工作能力** 不受光照条件限制，在浓雾、大雨、沙尘暴、夜间等恶劣环境下均能正常探测，确保无人机持续安全运行。
- ✔ **360° 全方位感知** 支持多雷达组网融合，通过数据拼接实现球形视场全覆盖，消除探测盲区。
- ✔ **极致轻量化设计** 外形尺寸 ≤ 70 × 65 ×18mm，整机重量 < 150g，适配绝大多数中小型无人机载荷需求。
- ✔ **丰富接口协议** 提供 CAN、UART、I²C、SPI 等多种通信接口，灵活对接主流飞控平台（Pixhawk / ArduPilot/PX4 等）。
- ✔ **功能安全保障** 遵循 ISO 26262 ASIL-D 功能安全标准设计，内置故障自诊断与冗余校验机制。

1.3 典型应用场景

应用领域	典型用途
电力巡检	高压输电线路自主巡检，近距离塔架避障
物流配送	城市末端配送无人机，建筑物群中穿梭避障
工业巡检	化工厂区、风电场、桥梁结构检测
农业植保	农田喷洒作业，田间树木/电线自动规避
应急救援	灾害现场搜救，废墟区域自主导航
城市安防	交通监控与公共安全管理，人群聚集区安全飞行

二、系统功能

2.3 预警机制

参数项	技术指标
预警策略	基于距离阈值 + TTC（碰撞时间预估）双重判据
近场预警距离	D ≤ 30m（黄色预警，提示减速或悬停）
危险预警距离	D ≤ 15m（红色告警，建议紧急避让）
TTC 阈值	TTC ≤ 3.0s 时触发高级别告警
预警输出方式	CAN 总线发送告警帧（含目标 ID / 距离 / 方位 / 速度）
响应延迟	从探测到输出告警 ≤30 ms

2.4 数据输出接口

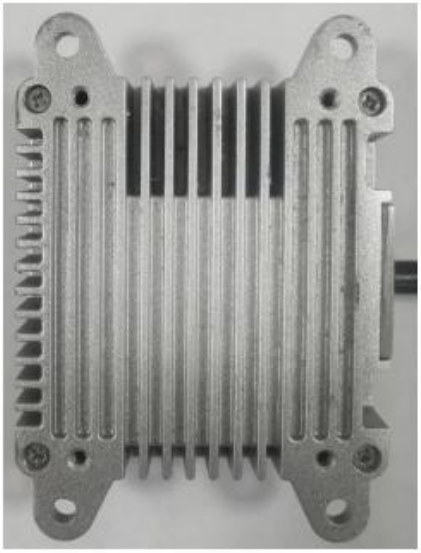
参数项	技术指标
物理接口	6 pin 防水插头（可自定义）
通信协议一	CAN 2.0B（500 kbps，扩展帧，ID 自定义）
通信协议二	UART（115200 bps, 8N1）
PX4/OrangPi 兼容	UART/CAN，满足对应通信协议
辅助接口	I²C（配置/调试用）、SPI（固件升级用）
数据帧内容	目标数量 / 每目标：距离(m)、方位角(deg)、相对速度(m/s)、RCS(dBsm)、目标 ID
输出周期	30 ms / 帧（~33Hz 刷新率同步）

三、规格参数

技术规格参数：

类别	参数	技术规格
射频性能	工作频段	77 ~79 GHz（中心频率 77 GHz）
	调制波形	FMCW 线性调频连续波
	发射功率	≤ 17 dBi EIRP
	接收增益	≥ 13.5 dBi（阵列合成增益）
	带宽	500 MHz（对应 0.12m 理论距离分辨率）
	扫描周期	≤ 35 ms（含信号处理与目标输出）
探测性能	最大探测距离	100 m（RCS ≥ 10dBsm） 电线/树枝可识别距离：40m
	最小探测距离	≥ 0.2 m
	水平 FOV	80°（±40°）
	俯仰覆盖	±15°
	距离分辨率	0.12 m
	距离精度	±0.1 m
	相对速度范围	±50 Km/H
	速度分辨率	0.25 m/s
	同时跟踪目标数	≤ 64 个
电气与环境	工作电压	DC 7-30V
电气与环境	功耗	< 1.5 W（典型值 1.2W）

电气与环境	工作温度	-40 ~ +85 ℃
电气与环境	存储温度	-40 ~ +85 ℃
电气与环境	防护等级	IP67（防尘防水）
电气与环境	抗振动	IEC 60068-2-6, 10~500 Hz, 2g
电气与环境	抗冲击	IEC 60068-2-27, 50g / 11ms 半正弦
机械与接口	外形尺寸	≤ 70 × 65 × 18mm（L × W × H）
	重量	< 150 g（含连接器）
	外壳材质	工程塑料（PC + ABS ）/五金底壳
	安装方式	M4 螺栓固定 / 3M 双面胶粘贴（可选）
	通信接口	CAN / UART / I²C / SPI



四、安装说明

4.1 安装位置选择

安装位置	适用说明
机腹下方	安装在无人机底部中央位置，雷达天线朝下，适用于定高巡航与地面避障场景。
机头前方/后方	安装在机身头部前后端面，雷达法线沿飞行方向向前/向后，适用于前向避障与路径规划场景，配合飞控实现自主刹车/倒车/绕行。
两侧翼梢	左右各安装一颗，组成双雷达阵列，实现 180° 以上水平覆盖，适用于复杂城市环境或室内飞行场景，消除侧向盲区。
顶部向上	特殊应用场景使用（如穿越桥洞/树冠层），雷达朝上安装用于上方障碍物监测。

4.2 安装步骤

6. 确认安装位置清洁平整，去除油污与灰尘；若使用胶贴方案，需用酒精棉片擦拭表面。
7. 将安装支架对准预留孔位，使用 M4 螺丝紧固（扭矩 0.3 N·m），或贴合 3M 双面胶至预定位置。
8. 连接 CAN 总线线束至飞控对应接口（注意 CAN_H / CAN_L 不可接反）；连接电源线至电压输出端。
9. 使用上位机软件（或 UART 调试终端）读取雷达输出帧，验证目标数据是否正常上报。
10. 进行实飞标定测试：设置已知距离的目标物，对比雷达测量值与实际值的误差，必要时调整安装角度补偿偏移。

4.3 接口引脚定义（可根据飞控类型修改）

引脚	定义	说明
Pin 1	CAN_H	CAN 总线高电平

Pin 2	CAN_L	CAN 总线低电平
Pin 3	VCC	DC 电源输入
Pin 4	GND	电源地 / 信号地共地
Pin 5	TX	UART 发送端（TTL 电平）
Pin 6	RX	UART 接收端（TTL 电平）

五、使用注意事项

电源要求	必须使用 DC 7-30V 稳压供电，严禁直接接入电池高压（如 48V），否则会烧毁雷达模块。接线时务必先断电操作，确认极性正确后再通电。
安装规范	安装表面应保持平整，避免剧烈震动导致螺栓松动。雷达天线前方 ≥50mm 范围内不得有金属遮挡物（如螺丝头凸起、线缆横跨等），否则会产生虚假回波干扰。
电磁兼容	避免将雷达安装在图传发射天线或数传电台正下方 ≥15cm 处，防止射频干扰影响探测精度。多雷达同时工作时需错开发射时序或分配不同 CAN ID。
环境限制	虽然支持全天候工作，但强降雨（>50mm/h）或冰雹天气下探测距离会有衰减（约下降 20%~40%），建议在此类极端天气下降低飞行速度并缩短作业半径。
定期维护	建议每累计飞行 50 小时后检查一次雷达表面是否有积灰、水渍或划伤，使用柔软干布轻轻擦拭即可，严禁使用有机溶剂清洗。

END

本文档仅供参考，具体参数以实物及出厂检测报告为准。
如有任何疑问请联系技术支持部门。