

# UAVOS AP-10.1 AUTOPILOT

## DATASHEET

<b>Title</b>	<b>AP-10.1</b>
<b>Subtitle</b>	AUTOPILOT SET
<b>Document type</b>	Data Sheet
<b>Document number</b>	DS.UV.431329.AP101
<b>Revision and date</b>	R03 / 30-Mar-2021
<b>Product status</b>	Mass Production

This document applies to the following products:

<b>Product name</b>	<b>Product designation</b>	<b>P/N</b>
Navigation Computer	NAV	UV.431329.102.330
GNSS Receiver	GPS	UV01.431329.100.346
Onboard Telemetry Unit	OUT / 900 MHz	UV01.431329.100.310

Note: revised and supplementary data may be published later.

[www.uavos.com](http://www.uavos.com) [uavos@uavos.com](mailto:uavos@uavos.com)



# UAVOS AP-10.1 AUTOPILOT & CONTROL SYSTEM

The Automatic Control System (AP) provides the hardware and vehicle control abstraction layer for the host platform enabling fully autonomous operation. All flight systems including take-off, landing, navigation and mission execution can be instigated with a single keystroke. All diagnostics, flight mission planning and remote control can be achieved wirelessly.

A notable feature of the AP is its distributed architecture. Each component of the system has a dedicated microcontroller providing data and communication with other components within the CAN bus. This decentralized configuration helps to manage central processor loading by distributing routine management tasks across all system components. Additionally, there are no restrictions on the number of same-type modules connected to one system, enabling multiple redundancy on all levels. With nearly all payloads or ready-made third-party modules, entire systems can be connected to the AP.

## FLEXIBILITY & SCALABILITY

Thanks to the AP's distributed architecture, the system can be used in a wide variety of vehicles ranging from small quadcopter to full size converted piloted aircraft. The redundant layering provides basic functionality while ground control software is multi-platform and functions across multiple workstations in a both a wide or local area network configuration. Specific payloads/sensors can be integrated by scripting custom protocols through onboard Virtual Machines (VMs).

## COMPATIBILITY

The AP is compatible with almost any vehicle configuration (VTOLs, USVs, UGVs, etc.), including non-traditional aircraft concepts. The flight control algorithm relies on Total Energy Control System (TECS) for improved reliability and response to malfunction including automatic landing with engine failure, auto-rotation for helicopters and parachute deployment.

The AP is resilient against jamming and features precise dead-reckoning navigation in absence of a GNSS signal.



## FEATURES

- Proprietary ADAHRS designed & developed by UAVOS
- Compact and light weight in anodized enclosures
- Leading edge components and technologies
- Maximum field-proven altitude 25 km [82000 ft]
- Redundancy capability
- Automatic take-off and automatic landing
- AHRS linear accelerations compensation without GNSS
- Dead-reckoning, flight and navigation without GNSS
- Onboard wind speed and direction estimation
- VM on key nodes for user program extensions onboard
- Ability to run user code for UAV control onboard
- Software extensions and customization (SDK)
- Flight simulator
- GoogleEarth integration
- Industrial CAN interface
- Onboard equipment flexibility and expandability
- Real-time controls override through telemetry channel
- Interfaces for external high-precision IMU



# NAVIGATION MODULE TECHNICAL DESCRIPTION [UV.431329.102.330]



NODE FEATURES	
Backup battery, RTC for 2 weeks	
FRAM non-volatile high-speed memory	
Primary IMU (Gyro / Accelerometer / Compass / Pressure)	
Redundant IMU (Gyro + Accelerometer + Compass)	
Tracking device type - MEMS	
Precision Micro Barometer Module	
Industrial grade digital interfaces	
Reduced energy consumption	
100+ waypoints navigation	
Modes: auto / geofencing / follow / circle / guided / loiter / etc.	
Real time mission plan changing	
Dead-reckoning, flight and navigation without GNSS	

ADAHRS / IMU		
IMU orientation		any
Pitch & Roll error		< 0.5°
Heading error		< 0.5°
Horizontal Position Accuracy		2 m [6.5 ft] (GNSS available)
Navigation Drift (Dead-reckoning)		<10 m/min [<32 ft/min]
Altitude limit		50000 m [164000 ft]
Altitude Accuracy		2 m [6.5 ft]
IMU Sampling rate		400 Hz
Gyro range		±250, ±500, ±1000, ±2000°/sec
Accelerometers range		±2g, ±4g, ±8g, ±16g
Internal Magnetometer		3 axis
Magnetometer range		±8 Gauss
Magnetometer heading accuracy		1° to 2° degree
Magnetometer attitude compensation		Yes



CPUM INTERFACES <sup>1</sup>		
GPIO (3V) ports: (remappable on MCU as below):		
Counter (RPM sensor inputs, hall effect sensor, etc.)	12	
PWM (servo drives, etc.)		
Timing (strobe signals generator, etc.)		
Logic (binary signals, switches, triggers, etc.)		
1-Wire interface	1	
TTL UART interface	1	
RS-485 interface	1	
RS-232 interface	1	
S.Bus support		
CAN bus	2	
ADC		4 ch.

SAFETY & REDUNDANCY FEATURES		
Internal redundand IMU		Gyro / Accelerometer / Compass
External IMU data suppoort		Yes
Multiple CPU access		Unlimited via distribution
Online sensors diagnostics		Yes
Sensor failure tolerance		Yes
Anti-spoofing & anti-jamming		Yes
Smart return-home function		Yes, adjustable
Power reverse-polarity protection		Yes, self-recoverable
Dual Power Supply		Yes
On-board power monitoring		Yes
Automatic emergency response		Yes, Multi-scenarios

MECHANICAL / ENVIRONMENTAL	
Size (mm, H x W x L)	119x47x71.6 mm [4.6x1.85x2.81 in]
Weight	170 g [5.99 oz]
Enclosure Material	Grade 2024-T351 Aluminium Alloy
Environmental Qualification	Designed to comply MIL-STD-810H <sup>2</sup>
EMC/EMI Qualification	Designed to comply with CE
ESD Compliant	Designed to comply with CE
Temperature Range	-40°C to +60°C [-40 to +140°F]
IP Rating	Designed to comply with IP67
Humidity	Up to 90% RH, non-condensing
Shock / Vibration protection	Vibration-isolating suspension
Main Connector	SNC23-10/18P-6-B
Voltage Supply	7-27 V
Power Consumption	2W @ 12V

<sup>1</sup> Not all interfaces are available at the same time without extension IFC module.  
<sup>2</sup> Applicable only to certain parts of the standard.

# GNSS MODULE TECHNICAL DESCRIPTION [UV01.431329.100.346]

## GNSS PERFORMANCE

Receiver Type	72-channel concurrent GNSS receiver
Constellations	GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1 SAIF, GLONASS L1OF, BeiDou B1I, Galileo E1B/C
SBAS types are supported	GAGAN, WAAS, EGNOS and MSAS
Differential GPS (D-GPS) support	RTCM 10402.3
Acquisition cold / hot / aided starts	27 / 1 / 3 s (GPS & GLONASS)
Accuracy of time pulse signal	RMS 30 ns / 99% 60 ns
Frequency of time pulse signal	0.25 Hz...10 MHz
Altitude Limit	50000 m [164000 ft]
Velocity Limit	500 m/s [1640 ft/s]
Velocity accuracy	0.05 m/s [0.16 ft/s]
Heading accuracy	0.3 degrees
Nav. update rate Single GNSS	up to 18 Hz
Nav. update rate concurrent GNSS	up to 10 Hz
Navigation sensitivity	-167 dBm
Antenna beam width	160 degrees
CAN bus	1

## SAFETY & REDUNDANCY FEATURES

Multiple GNSS module in system	Supported
Internal redundant IMU	9-axis (Gyro \ Accel. \ Compass)
Internal redundant compass	Yes
Online sensors diagnostics	Yes
Sensor failure tolerance	Yes
Anti-spoofing and anti-jamming	Superior
Spoofing detection	Yes
Power reverse-polarity protection	Yes, self-recoverable

## ADAHRS / IMU

Built in IMU sensors	yes
Internal Magnetometer	yes
Roll, pitch, yaw range	Continuous unrestricted
Pitch & Roll error	< 1°
Heading error	< 1°
Horizontal Position Accuracy	2 m [6.5 ft] CEP (GNSS available)
Navigation Drift (Dead-reckoning)	<10 m/min [<32 ft/min]
Altitude Accuracy	2 m [6.5 ft]
IMU Sampling rate	400 Hz
Gyro range	±250, ±500, ±1000, ±2000°/sec
Accelerometers range	±2g, ±4g, ±8g, ±16g
Internal Magnetometer	3-axis
Magnetometer range	±8 Gauss
Magnetometer heading accuracy	1° to 2° degree
Magnetometer attitude compensation	Yes

## MECHANICAL / ENVIRONMENTAL

Size (mm, H x W x L)	84x16x50 mm [3.3x0.62x1.96 in]
Weight	67 g [2.4 oz]
Enclosure Material	Grade 2024-T351 Aluminium Alloy
Environmental Qualification	Designed to comply MIL-STD-810H <sup>2</sup>
EMC/EMI Qualification	Designed to comply with CE
ESD Compliant	Designed to comply with CE
Temperature Range	-40°C to +65°C [-40 to +149°F]
IP Rating	Designed to comply with IP67
Humidity	Up to 90% RH, non-condensing
Shock / Vibration	ISO 16750-1:2018
Main Connector	Amphenol PT02E8-4P
Voltage Supply	7-27 V
Power Consumption	0.2W @ 12V



## NODE FEATURES

Industrial CAN interface
Full constellation GNSS Receiver
Inertial Measurement Unit
Industry leading navigation sensitivity
Integrated antenna

The node accommodates the latest concurrent reception of GPS/QZSS, GLONASS, BeiDou and a passive built-in antenna. There is no need for HF cables to the antenna and receiver. There could be several GNSS devices connected to the same system, located on different sides of the UAV for reliability of navigation (f.ex. some VTOLs). In addition, GNSS module has redundant compass module (3-axis magnetic field sensor) which can be used as a source for the AHRS for the NAV node.

TELEMETRY MODULE TECHNICAL DESCRIPTION [UV01.431329.100.310]

RADIO SPECIFICATION	
Frequency range	902-928 MHz
Modulation type	2GFSK, 4GFSK, QPSK
TX power (adjustable)	100 mW – 2W
Maximum rate @-103 dBm sens.	up to 345 kbps @400 kHz bandwidth @1W
Telemetry baud rate	256 bps, compressed stream
Range with tracking antenna & amp.:	~200 km [124 mi] <sup>4</sup> in LoS
Range with tracking antenna:	~100 km [62 mi] <sup>4</sup> in LoS
Range with omni-antenna <sup>5</sup>	~50 km [31 mi] <sup>4</sup> in LoS
Telemetry	10 Hz with compressed stream
Operating modes	Point-to-Point, Point-to-Multipoint, Store & Forward Repeater, Peer-to-Peer
Sensitivity (@10 <sup>-4</sup> ) from / to	-114 dBm @57.6 kbps / -107 dBm @230.4 kbps
Forward Error Correction	Hamming, BCH, Golay, Reed-Solomon, Viterbi
Error Detection	32 bits of CRC, ARQ
Rejection: Adjacent Channel	57 dB
Rejection: Alternate Channel	65 dB

SAFETY & PROTECTION	
On-board power monitoring	Yes
Noise and interference	Quad filter stages provide extreme rejection
Anti-jamming / Interference immunity	Hopping frequency
Encryption (optionally)	128-bit AES Encryption <sup>3</sup>
Power supply reverse-polarity protection	Yes, self-recoverable

APPROVALS	
FCC Part 15.247 / IC RSS210	
FCC Part 15.90 / IC RSS119	
RoHS Compliant	

<sup>3</sup>AES encryption, 2W frequency hopping operation requires Export Permit.  
<sup>4</sup>Range depends on environmental conditions, electromagnetic environment and radio interference in the area of coverage.  
<sup>5</sup>At least 4.8 meters (A.G.L) mast is required to archive the stable range within LoS without tracking mast.

Rate (kbps)	Power	Sensitivity (dBm)	Bandwidth (kHz)	Regulatory
19.2	1W	-116	25	FCC / IC
56	1W	-113	60	FCC / IC
115.2	1W	-109	150	FCC / IC
172.8	1W	-108	180	FCC / IC
230.4	1W	-106	230	FCC / IC
276.4	1W	-105	230	FCC / IC
345	1W	-103	400	FCC / IC
19.2	2W <sup>3</sup>	-115	25	None
56	2W <sup>3</sup>	-110	60	None
115.2	2W <sup>3</sup>	-109	150	None
172.8	2W <sup>3</sup>	-108	180	None
230.4	2W <sup>3</sup>	-106	230	None
276.4	2W <sup>3</sup>	-105	230	None
345	2W <sup>3</sup>	-103	400	None

MECHANICAL / ENVIRONMENTAL	
Size (mm, H x W x L)	113.4x36.5x79.2 mm [4.46x1.43x3.11 in]
Weight	160 g [5.64 oz]
Enclosure Material	Grade 2024-T351 Aluminium Alloy
Environmental Qualification	Designed to comply MIL-STD-810H <sup>2</sup>
EMC/EMI Qualification	Designed to comply with CE
ESD Compliant	Designed to comply with CE
Temperature Range	-40°C to +60°C [-40 to +140°F]
IP Rating	Designed to comply with IP67
Humidity	5-95% RH, non-condensing
Shock / Vibration	ISO 16750-1:2018
Main Connector	SNC23-19/22P-6-B
RF Connector type	SMA
Voltage Supply	5-27 V
Power Consumption	2.4W @ 7V



The telemetry data and command line is transferred to the GCU through this node. Emergency RC is conducted through RMM. The onboard and ground modems make data self-arbitrating. The Modem has a single CAN and one an external antenna connector.

NODE FEATURES / CAPABILITIES	
Industrial CAN interface	
Virtual Machine	
Telemetry data processing	
Data self-arbitrating	
Antenna Tracking System support	
Autopilot controls	
Auxiliary CAN	
USB Interface (for GCU)	

INTERFACES	
CAN BUS	2
GPIO (3V)	12
ADC	1 ch
RS232 / USB	1