KAI Hardware Manual

Release 2.0/1.0

Embention Sistemas Inteligentes, S.A.

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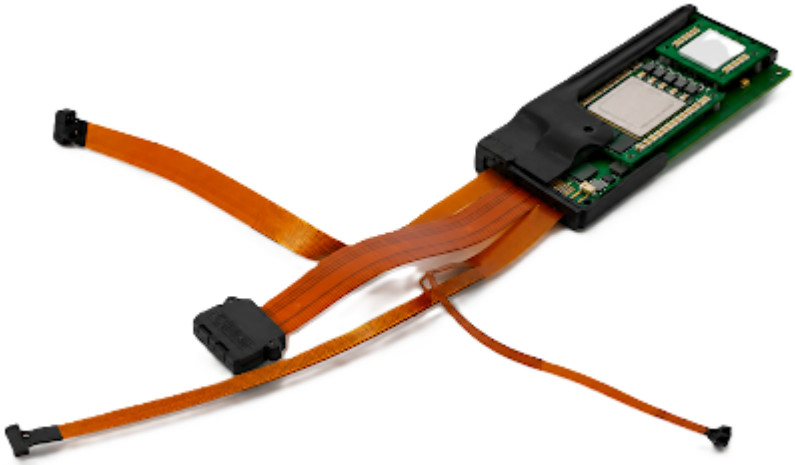
Scope of Changes

- Version 1.0
  - Added:
    - First version issued.

Introduction



Veronte Autopilot KAI

Veronte Autopilot KAI (Kinetic Artificial Intelligence) is a high performance **flight control system** with embedded artificial intelligence, designed for **Loitering Munition (LM)**, **Counter-UAS (C-UAS)** and **industrial** applications. In its **one-way autopilot** configuration, it is conceived as a single use unit for non-recoverable missions, with an operating life of up to 3 flights.

Veronte Autopilot KAI embeds RF positioning, computer vision and advanced APNT modules for operation in **GNSS-denied** environments. It also includes terminal guidance algorithms for **target selection and auto-follow**, enabling fully autonomous operation in environments where satellite navigation is degraded or unavailable.

The architecture is modular and decoupled, so the safety-critical flight control and payload activation core stays isolated from the non mission-critical tasks. It is divided into the **KAI FCC** and two independent **PNT** expansions. To adapt the unit to the operational threats, the **EW** environment and the budget of each programme, none of the expansions is mandatory, and they can be integrated in any combination or stacked together:

- **KAI FCC**: safety-critical flight control, internal sensors and I/O interfaces.
- **RF PNT**: GNSS, LEO satellite and 4G/LTE position triangulation.
- **Vision PNT**: computer vision for navigation and terminal guidance.

Veronte Autopilot software tools are specifically designed for the operation and configuration of the **Veronte Autopilot**. **Veronte Ops** is the software employed to operate the autopilot from a user-configurable interface, and the **PDI Builder** application permits configuring the autopilot and adapting it to the specific needs of the project.

Mission Domains

The same unit can be configured for different mission domains: - **Industrial Applications**: The compact system layout featuring the embedded computer vision system allows the system to be adapted to the most demanding autonomous vehicle applications. - **Loitering Munition**: focused on **GNSS denied environments**. It provides 100 % autonomous operation through all the mission phases, from take off and cruise to terminal impact, with vision-based navigation, user selectable impact angles, fly-by-camera control, silent approach modes, swarming and redundant warhead arming. - **C-UAS Interceptor**: focused on **point and track**. It provides high speed interception of agile threats, with Slew-to-Cue target handover from ground radar, AI threat neutralization and guidance laws optimized for high-g terminal manoeuvres.

For further information, see the Operation section of the present manual.

Main Features

- **Configuration**: Fully user-configurable payload, vehicle layout, control phases, control channels, etc.
- **Navigation**: Embedded advanced vision-based navigation (VMM, SLAM, VIO, etc.), RF positioning (LTE / 4G, LEO Satellite, GNSS), KAI FCC positioning (TRN, inertial navigation, etc.) are merged in an advanced sensor fusion for resilience against jamming and spoofing.
- **Guidance**: Beyond the standard waypoint navigation and fly-by-camera modes of the KAI FCC, the optional Vision PNT adds target selection and auto-follow, and Autonomous Target Engagement (ATE).
- **Telemetry**: Customizable telemetry and onboard log compatible with external datalink modules, with user-defined variables and recording frequency.

- **Interoperability**: **STANAG 4586** communication protocol for real time data sharing and cross-force mission handovers.
- **Internal sensors**: Magnetometer, internal IMU, temperature, etc.
- **External sensors**: radar, LIDAR, RPM, etc.
- **Payloads**: Secondary radios, satcom transceivers, camera gimbals, motor drivers, photo cameras, mission computers, pass through CAN tunnel, etc.
- **Automation**: User-selectable routines, activated on system events or periodically.
  - **Actions**: Phase change, activate payload, move servo, go to, onboard log, data wipe, etc.
  - **Events**: Waypoint arrival, inside/outside polygon, alarm, variable range, target lock, etc.
- **Diagnostics**: Autonomous pre-launch self-checks and continuous onboard health monitoring.
- **Security:** Hardware-bound AES-256 data encryption, secure datalink authentication protocols, redundant Safe & Arm mechanism, and pre-impact automated onboard data wipe.
- **Reliability:** High-integrity deterministic software developed under DO-178C standards and hardware compliant with DO-254.

Quick Start

This user manual covers the mechanical and electrical assembly of the **Veronte Autopilot KAI**.

Veronte Autopilot KAI is the main element of the flight control system. It contains all the electronics, sensors and processing capability required to execute the mission, handle the payload and run the embedded computer vision algorithms for GNSS denied navigation and target following.

A KAI-based flight control system contains the following elements:

- A **Veronte Autopilot KAI** installed in the vehicle to control. It executes the GNC algorithms in real time in order to accomplish the planned mission and handle the payload.
- **Veronte Ops** - Software dedicated to mission planning, configuration and operation. It allows the user to monitor the connected vehicle in real time, to interact with it and to replay previous missions for post-flight analysis.
- A **ground unit** linked between **Veronte Ops** and the **Veronte Autopilot KAI**, which supports manual and assisted control modes.

Basic Connection for Operation

1. Install the unit in the vehicle following the Hardware Installation section.
2. Connect the GNSS, LTE and LEO antennas to their corresponding ports.
3. Connect the unit to the computer through the Ethernet port.
4. Power the unit within the specified input voltage.

Warnings

- This user manual includes references to manuals for software applications. Select your software version to read them.
- Power out of range can cause irreversible damage to the system. Please read carefully the manual before powering the system.
- By default, **Veronte Autopilot KAI** is limited to **3 flights**. Once this limit is reached, the unit will not be able to restart. A **permanent license** is also available for industrial applications and for training / demo units.

Requirements

- A power supply able to deliver **18 to 34 V DC**.
- The corresponding antennas for the GNSS, LTE and LEO modules.
- A separate license to use **LEO** and **4G/LTE** positioning.
- A computer with the **Veronte** software applications installed.

Technical

Features

- **I/O Interfaces**
  - 2 x CAN FD buses
  - 2 x Ethernet
  - 1 x USB 3.0 (for Vision PNT board)
  - 8 x PWM
  - 1 x RS232
  - 1 x RS485 (for Vision PNT board)
  - 2 x Coaxial (with Vision PNT board)
- **Internal sensors**
  - 3-axis IMU
  - 3-axis magnetometer
  - Static pressure sensor
  - Pitot (dynamic pressure) sensor
- **Embedded processing**
  - High integrity flight control layer: deterministic engine developed under **DO-178C DAL B** and **DO-254 DAL B**
- **RF PNT** (only with the RF PNT expansion)
  - 2x GNSS receiver (Heading)
  - 1x 4G/LTE positioning
  - 1x LEO positioning
- **Vision PNT** (only with the Vision PNT expansion)
  - AI computer vision layer: vision-based navigation (SLAM), target following and real time decision making
- **Diagnostics**
  - Autonomous pre-launch self-checks
  - Continuous onboard health monitoring
- **Security**
  - Onboard AES-256 data encryption, bound to a unique hardware unit
  - Secure communications
  - Hash-protected configuration

    - Secure data wipe
- **Power**
    - 2 x 18 to 34 V DC input power supply
    - Redundant power supply
- **Protection**
    - ESD protection
    - Reverse polarity protection

Variants

The **Veronte Autopilot KAI** has 2 variants:

- **OEM**: bare PCBA, optimized to minimize weight. It is intended for applications requiring the maximum level of integration, allowing the unit to be embedded directly into internal bays or tightly constrained airframes.
- **Rugged**: fully enclosed configuration with a rugged coating that provides enhanced robustness against harsh environmental conditions, waterproof protection and anti-tamper security, which prevents unauthorized third parties from physically accessing the onboard electronics.

KAI FCC and PNT Expansions

The **Veronte Autopilot KAI** architecture is modular and decoupled, so that the safety-critical flight control and payload activation core is isolated from the mission-critical tasks. It is divided into the **KAI FCC** and two independent **PNT** (Positioning, Navigation and Timing) expansions, which can be integrated in any combination or stacked together:

- **KAI FCC**: safety-critical flight control layer developed under **DO-178C** and **DO-254**, internal sensors and I/O interfaces (see Features).
- **RF PNT**: it combines three RF positioning sources:
    - **GNSS**: satellite navigation receiver with **RTK** accuracy and anti-jamming and anti-spoofing capabilities. The system can integrate the **Septentrio G5 P6** (default option), **Septentrio G5 P8**, **Septentrio G5 P3H** or **U-blox X20** receivers. Other third-party receivers can also be integrated.

    - **4G/LTE**: internal cellular receiver with a programmable **eSIM** card for network based positioning.
    - **LEO**: PNT tracking module that receives location data from the cross-linked **LEO** satellite constellation. As the **LEO** satellites orbit much closer to the Earth than the GNSS constellations, their signal reaches the receiver up to 1000 times stronger, which allows the position reference to get through localized ground based jamming and spoofing arrays.

  It provides RF interfaces for direct wiring to external GNSS, 4G/LTE and LEO satellite antennas.

  > ⓘ **Note**
  >
  > **LEO** and **4G/LTE** positioning require a separate license.

- **Vision PNT**: up to 2 external optical cameras feed the internal high performance AI processing core, which runs the computer vision algorithms for autonomous target tracking and spatial positioning. It provides camera interfaces over **Ethernet**, **USB** or **MIPI**, and routes the live video as an **FPV** stream through the primary Ethernet bus to the platform telemetry datalink.

Standards

Item	Standard
Software	DO-178C DAL B
Hardware	DO-254 DAL B
Interoperability	STANAG 4586

Sensor Specifications

Accelerometers (3-axis each one)	
Specification	**IMU 1**
Range	±40 g
Maximum shock	2,000 g
Update Time	0.125 ms
In-run bias stability	13 µg

Gyroscopes (3-axis each one)	
Specification	**IMU 1**
Range	±480 °/s
Misalignment error	±0.1 °
Update Time	0.125 ms
Angular random walk	0.19 °/√h
In-run bias stability	2.3°/h

Magnetometers	
Specification	**Magnetometer 0**
Range	±800 µT
Sensitivity	50 to 13 nT

Magnetometers	
Specification	**Magnetometer 0**
RMS Noise	30 to 15 nT
Offset	-

Static Pressure	
Specification	**Sensor 1**
Range	25,000 to 125,000 Pa
Altitude range (ISA)	-1,800 to 10,360 m MSL (-5,900 to 34,000 ft MSL)
Band Error	±150 Pa
Resolution	±22 Pa
Update Time	0.5 ms to 2.0 ms
Bias	±7 Pa

Dynamic Pressure Sensor	
Specification	**Pitot**
Range	±60 inH_2O (±14,945 Pa)
Maximum airspeed at sea level (ISA)	300 kt (555 km/h)

Dynamic Pressure Sensor	
Specification	**Pitot**
Maximum airspeed at 34,000 ft (ISA)	490 kt (908 km/h) TAS, Mach 0.85
Band Error	±150 Pa
Resolution	±22 Pa
Update Time	0.5 ms to 2.0 ms
Bias	±7 Pa

> ⓘ **Note**
>
> The altitude and airspeed ranges listed above correspond to the internal pressure sensors. External sensors can be integrated to extend these ranges.

The following positioning sources are only available with the **RF PNT** expansion:

GNSS Receiver (RF PNT)	
Specification	**GNSS**
Constellations	GPS, GLONASS, Galileo, BeiDou, QZSS, NavIC
Bands	GPS: L1C/A, L1C, L1P(Y), L2C, L2P(Y), L5 · GLONASS: L1C/A, L2C/A, L2P, L3

GNSS Receiver (RF PNT)		
Specification		**GNSS**
		CDMA · Galileo: E1, E5a, E5b, E6 · BeiDou: B1I, B1C, B2a, B2I, B2b, B3I · QZSS: L1C/A, L1C/B, L2C, L5, L6 · NavIC: L5
RTK Support		Yes (via RTCM 3.x, CMR+, and native support for Galileo HAS - High Accuracy Service)
RTK Position Accuracy	Horizontal	0.006 m + 0.5 ppm
	Vertical	0.01 m + 1 ppm
SBAS Position Accuracy	Horizontal	0.4 m
	Vertical	0.7 m
Velocity Accuracy		0.05 m/s
Anti-jamming		AIM+ Premium Technology: Real-time monitoring, detection, reporting, and active mitigation of narrow-band, wide-band, and pulsed interference.
Anti-spoofing		AIM+ Premium Technology: Advanced spoofing detection and mitigation

> **Note**
>
> The specifications listed above correspond to the **Septentrio G5 P6** GNSS receiver, which is the default option. Optionally, it can be replaced by a **Septentrio G5 P3H**, a **Septentrio G5 P8** or a **U-blox X20** receiver.

4G/LTE Positioning (RF PNT)	
Specification	**4G/LTE**
Method	Terrestrial cellular network triangulation (multi-tower ranging)
SIM	Programmable eSIM
Satellite dependency	None

LEO Positioning (RF PNT)	
Specification	**LEO**
Constellation	LEO satellite
Signal power	Up to 1,000 times (30 dB) stronger than GPS
Coverage	Worldwide

> **Note**
>
> **4G/LTE** and **LEO** positioning require a separate license.

Mechanical Specifications

Variable	Value
Weight	190 g
Dimensions	127 mm x 53 mm x 15.3 mm
Operating temperature	-40 to 60 ºC -20 to 40 ºC (OEM units)
Storage temperature	-55 to 85 ºC
Launch acceleration	> 35 g

Electrical Specifications

Variable	Value
Voltage input	2 x 18 to 34 V DC
Power supply	Redundant
Protections	ESD Reverse polarity

Hardware Installation

Mechanical

Veronte Autopilot KAI has a high level of miniaturization, which allows it to be integrated into all kinds of vehicles, maintaining compatibility across fixed-wing, multirotor, helicopter, hybrid VTOL and USV platforms. It is available in an **OEM** variant, with the bare PCBA for the maximum level of integration, and in a **rugged** variant, fully enclosed with a rugged coating that adds waterproof and anti-tamper protection, with **190 g** as total weight.

Pressure lines

Veronte Autopilot KAI has two pitot pressure sensor inputs, which are in charge of determining both the dynamic pressure and the static pressure.

- **Pressure Intake**
  - Pressure intakes must be located in order to prevent clogging.
  - Do not install pressure intakes on the propeller flow.
  - Design pressure tubing path in order to avoid tube constriction.
- **Static Pressure**
  - It is not recommended to use inside fuselage pressure if it is not properly vented.
- **Pitot Tube**
  - Pitot tube must be installed facing the airflow.
  - It is recommended to install it near the aircraft's x axis in order to avoid false measures during manoeuvres.
  - The internal barometers allow a direct connection to the vehicle's pitot tube using standard **2 mm** tubing.
  - For low-speed aircraft it is recommended at least 6.3 mm tubes to prevent any rain obstruction.

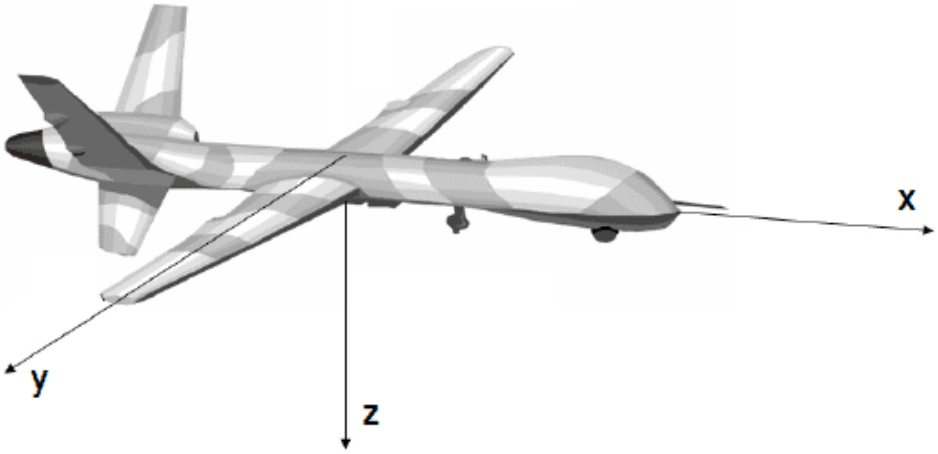
Location

The location of **Veronte Autopilot KAI** has no restrictions. It is only required to configure its relative position respect to the centre of mass of the aircraft and the GNSS antenna.

Orientation

The orientation of **Veronte Autopilot KAI** has no restrictions either. It is only required to configure axes respect to the aircraft by means of a rotation matrix or a set of correspondences between axes.

Aircraft coordinates are defined by the standard aeronautical conventions, shown in the following figure.



Aircraft Coordinates (Standard Aeronautical Convention)

Vibration Isolation

Although the **Veronte Autopilot KAI** rejects noise and high-frequency vibration modes with electronic filters, there may be situations where external isolation is needed. An optional Damping System can be ordered to reduce the aircraft vibrations to the KAI.

> ⓘ **Note**
>
> The user should take into account that wiring should be loose enough so that vibrations are not transmitted to the **Autopilot KAI**.

Electrical

Power

Veronte Autopilot KAI requires an input power supply in the **18 to 34 V DC** range and includes a **redundant power supply**, as well as **ESD** and **reverse polarity** protections.

> ⚠ **Warning**
>
> Power out of range can cause irreversible damage to the system.

Mating Connectors

The standard connector of the **Rugged** variant is a **Samtec** type connector. The following mating solutions are available to connect the KAI to the platform:

Solution	Description	Use
Standard flex	Flex cable, 31 mm width x 30 cm length Male-male connectors	KAI to board
Custom flex	Flex cable, 31 mm width Male to custom connector	KAI to vehicle
Breakout board	Board with female connector USB and RJ45 connectors 41.50 x 73.6 mm	KAI to standard connectors

Solution	Description	Use
Cable board	Board with male or female connector Futaba connectors Through holes for cables	KAI direct connection

The **custom flex** solution is adapted to each customer and platform, and is available for orders from **1,000 units**.

Software Installation

To install the required software and configure the **Veronte Autopilot KAI**, read the **KAI Software Manual**.

Operation

Veronte Autopilot KAI performs 100% autonomous flight control through all the mission phases, from take off and cruise to landing or terminal phase, allowing the operator to take manual control on pilot demand or to operate the vehicle in fly-by-camera mode at any time during the operation.

Flight Control

The flight control system provides a universal **GNC** architecture, compatible with any airframe and developed under the **DO-178C** and **DO-254** standards.

Its open architecture allows the definition of custom control laws, control phases, automatic routines and failsafes, so the system can be adapted to any mission profile or vehicle layout through model based design.

Types of operations

Veronte Autopilot KAI is a **dual-use** product: the same unit can be configured for industrial and for security applications, each one focused on a different core capability.

Industrial Applications

In **industrial** configurations, the miniaturized form factor and the embedded computer vision enable high autonomy across a variety of complex commercial applications, on **fixed-wing**, **multirotor**, **helicopter**, **hybrid VTOL** and **USV** platforms:

- **GNSS denied localization**: vision-based navigation to ensure mission safety and avoid signal loss during critical tasks.
- **Target tracking**: AI-driven algorithms for the high precision tracking of moving assets.
- **Integrated RTK precision**: centimeter-level positioning for precise navigation to the mission zone.
- **Moving vehicle operations**: autonomous takeoff and landing from ground or maritime mobile platforms.

- **Swarm coordination**: simultaneous control of multiple units with decentralized decision-making.
- **Fly-by-camera**: flight guided by the pointing direction of the camera or gimbal.

Loitering Munition

In **Loitering Munition** configurations, the unit provides 100 % autonomous operation in **GNSS denied environments**, optimized for **one-way** mission profiles:

- **GNSS denied navigation**: embedded **SLAM** technology to estimate the position from the images captured by the onboard cameras when the satellite navigation signal is degraded or unavailable, complemented with **4G/LTE** triangulated positioning and **LEO** positioning (**RF PNT**), and with the sensor fusion of the IMU, barometric and magnetic data. The architecture is hardened to detect and overcome **jamming** and **spoofing** attempts.

  The vision-based navigation operates in two modes:

  - **Pre-mapped area**: the system uses the loaded maps for positioning, without accumulated drift.
  - **Unmapped area**: the system employs **SLAM** (Simultaneous Localization and Mapping), keeping a drift rate below **1 % of the distance travelled**.
- **Terminal accuracy**: real time AI computation of the lead-pursuit trajectory, with user selectable impact angles for maximum effect on the target.
- **Camera guided control**: **fly-by-camera** mode in which the pointing of the onboard camera is translated into flight commands, so the airframe follows the camera focus.
- **Autonomous Target Engagement (ATE)**: neural network algorithms trained with pre-loaded threat libraries to automatically identify, classify and isolate specific tactical targets, without an active datalink or continuous operator input.

- **Tactical stealth**: specialised **silent approach** modes, including **communications silence** and **full stealth glide**, which reduce the acoustic and electromagnetic signatures during the final approach.
- **Swarming**: scalable architecture supporting synchronised multi-vehicle operations for coordinated saturation attacks.
- **Payload safety**: redundant warhead arming protocols to guarantee a controlled activation of the payload.

C-UAS Interception

In **Counter-UAS** configurations, focused on **point and track**, the unit is optimized for the high speed interception of agile threats, fusing aerospace grade reliability with AI driven neutralization:

- **Radar slaved navigation**: integrated **Slew-to-Cue** protocols for the real time target handover from ground radar, fusing the external telemetry with the internal sensors to maintain an accurate interception vector.
- **High dynamic GNC**: specialised guidance and control laws optimized for aggressive turns and high-g terminal manoeuvres, designed to survive launch loads above **35 g**.
- **AI threat neutralization**: high frame rate computer vision dedicated to identifying tactical signatures and to compute the autonomous lead pursuit of high speed moving threats. The **ATE** algorithms classify the threats against the pre-loaded libraries, so the interception can be completed without an active datalink.

Data Wipe and Encryption

All the configuration files, custom control logic and operational profiles stored in the onboard non-volatile memory are secured and hardware-bound with **AES-256 encryption**, so the configuration data remains unreadable even if the unit is physically captured.

Every data packet exchanged between the autopilot and the control station is encrypted in real time and validated with secure cryptographic handshakes across all the telemetry and command datalink channels, which prevents eavesdropping, man-in-the-middle data manipulation and adversarial command injection.

The **data purge** feature allows the instant wiping of the sensitive onboard data, such as the flight logs and the mission parameters. It can be triggered manually by the operator or automatically on pre-defined fail-safe conditions, such as a loss of link in a high-risk zone or a physical tampering attempt.

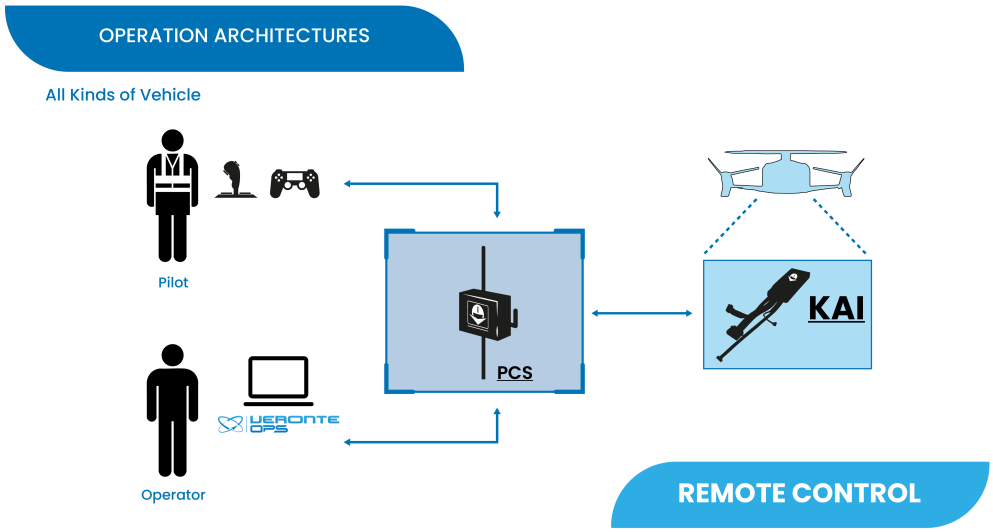
Operation Architectures

Veronte Autopilot KAI allows for a wide variety of communication and control solutions to adapt to each mission and platform specifications.

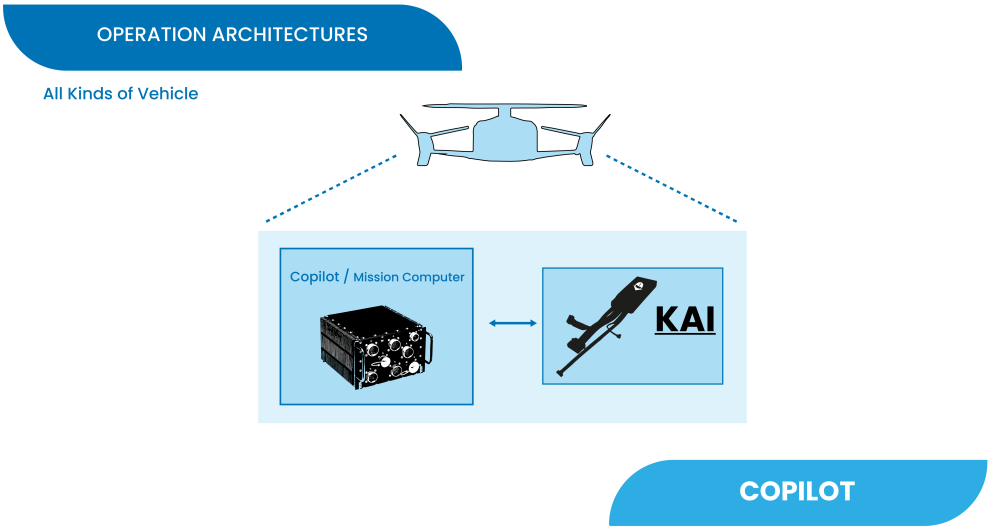
> **Tip**
>
> Most of the following diagrams can be used independently or combined, to create redundant systems or backup solutions.

Control Setups

Remote control: an operator commands the vehicle from the control station with **Veronte Ops**, while a safety pilot can take control at any time through a stick connected to the ground unit (**PCS**).

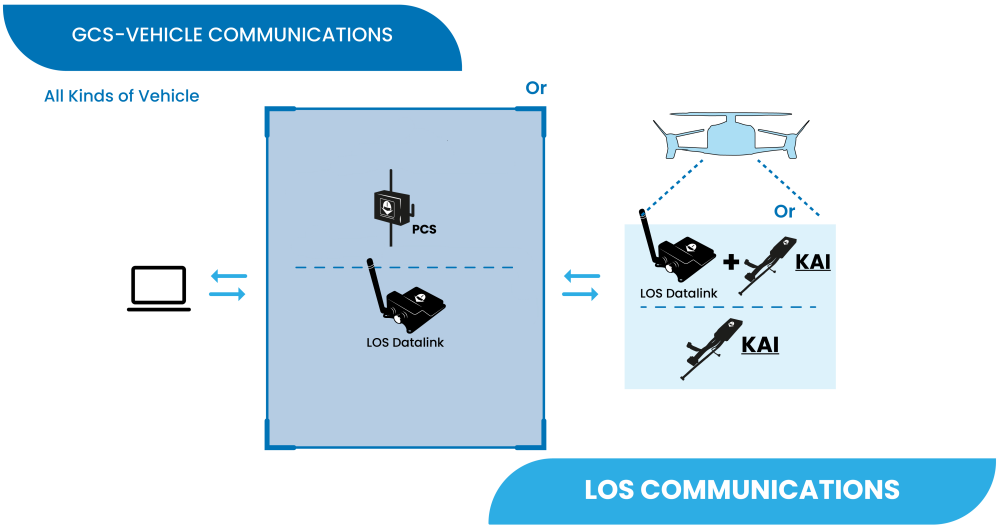


Copilot: the autopilot works together with an onboard mission computer, which handles the mission specific or advanced processing.

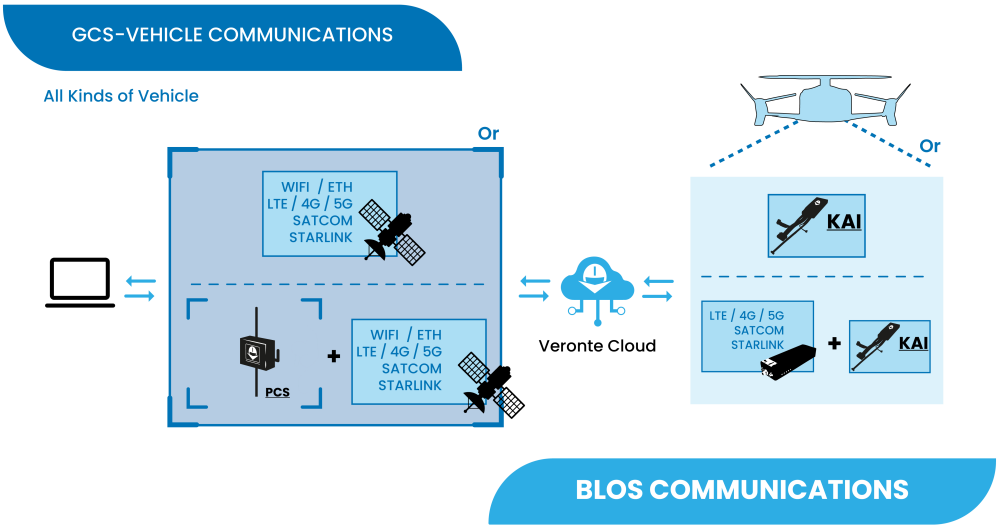


GCS-Vehicle Communications

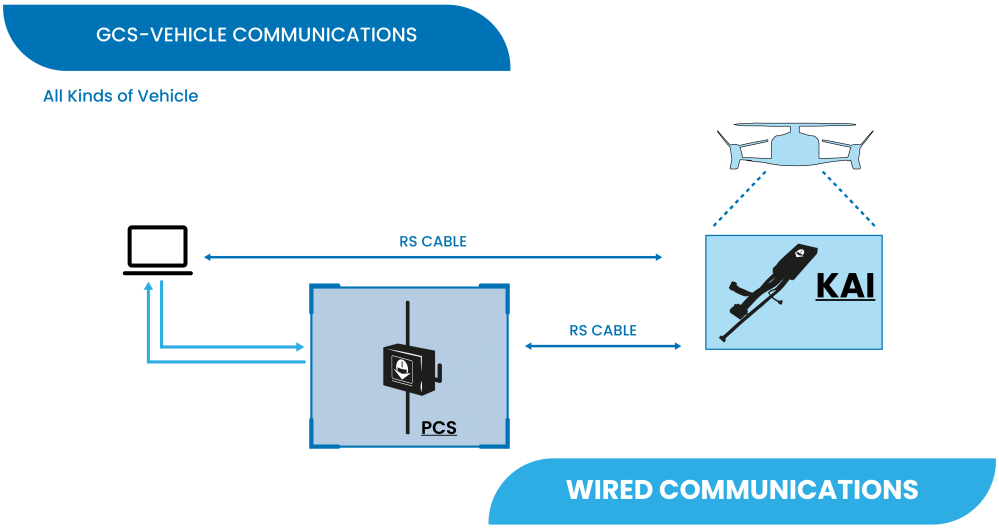
LOS communications: the control station (**PCS** or an external LOS datalink) links directly with the onboard unit.



BLOS communications: **Veronte Cloud** links the control station and the vehicle through external **LTE/4G/5G**, **Satcom** or **Starlink** modules. These methods can be used on both sides, switched or combined for redundancy.

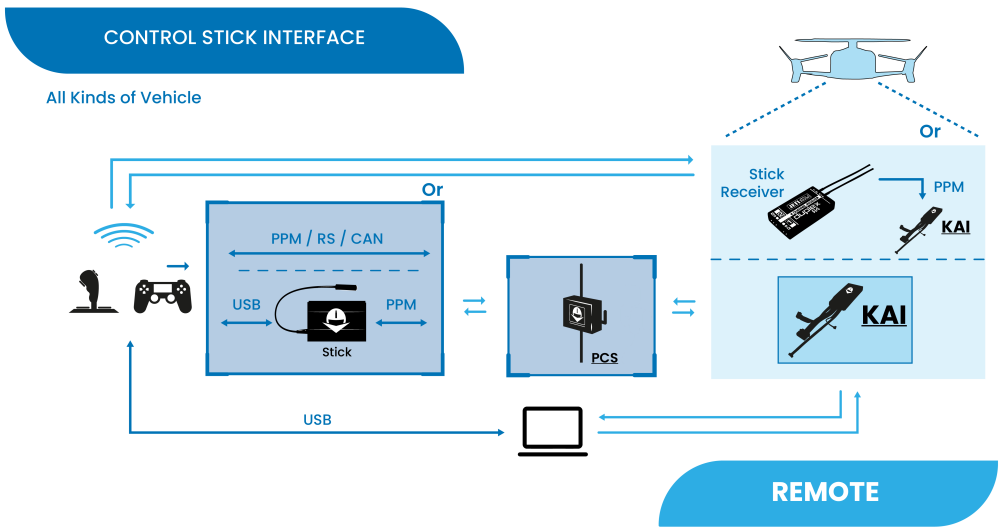


Wired communications: the control station is directly connected to the onboard autopilot by cable.

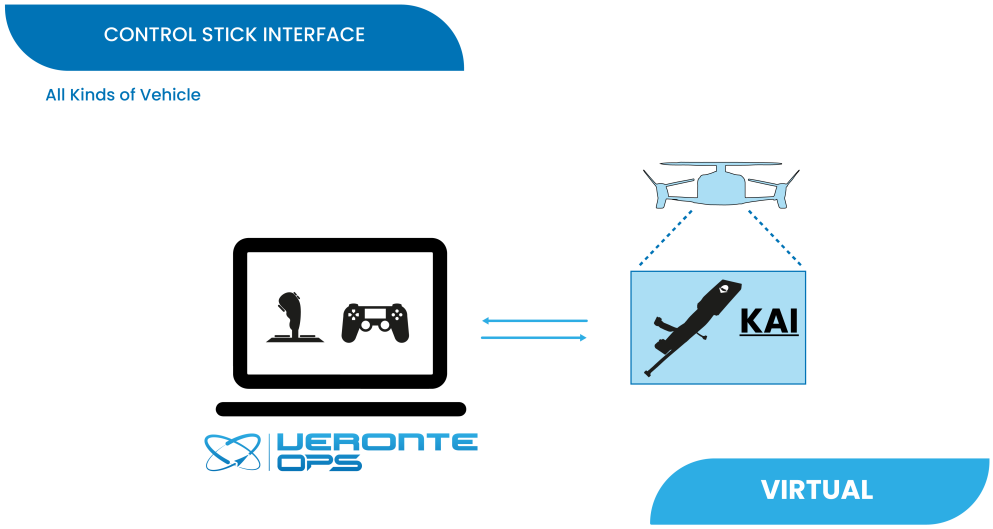


Control Stick Interface

Remote stick: the stick is connected to the control station via **PPM**, **RS** or **CAN**, either directly or through a **Veronte Stick** that converts **USB to PPM**. A stick receiver onboard provides a backup manual channel.

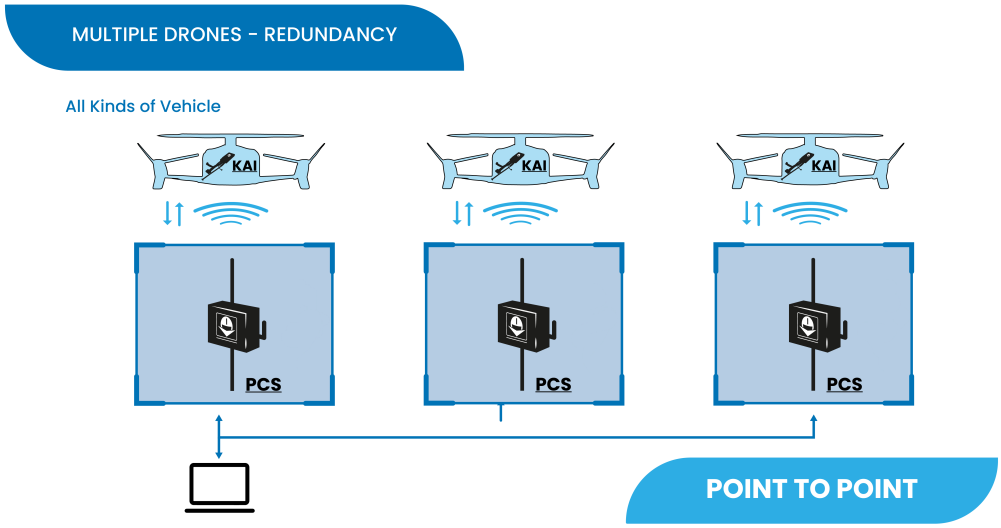


Virtual stick: any device able to provide control reference values through **RS232**, **RS485**, **ADC** or **CAN** can be used as a stick controller.

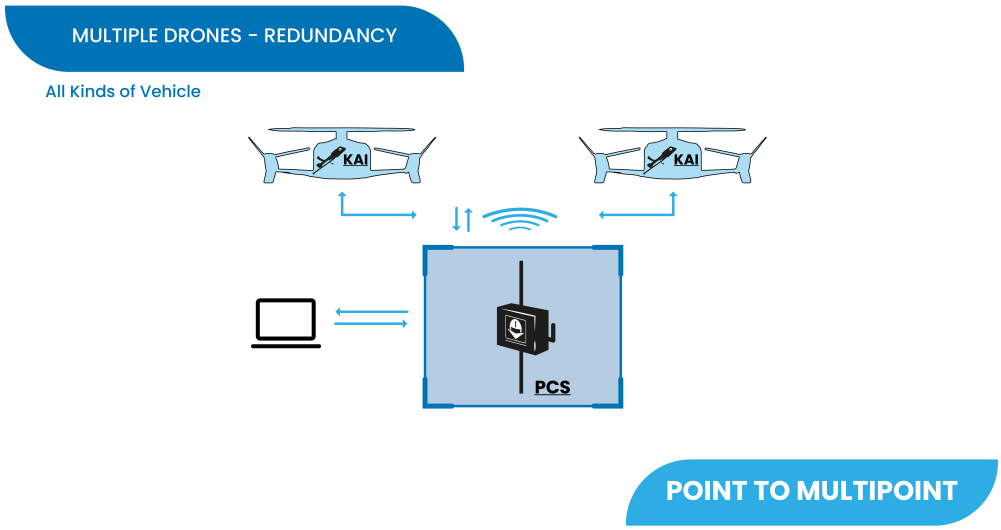


Multiple Vehicles and Control Stations

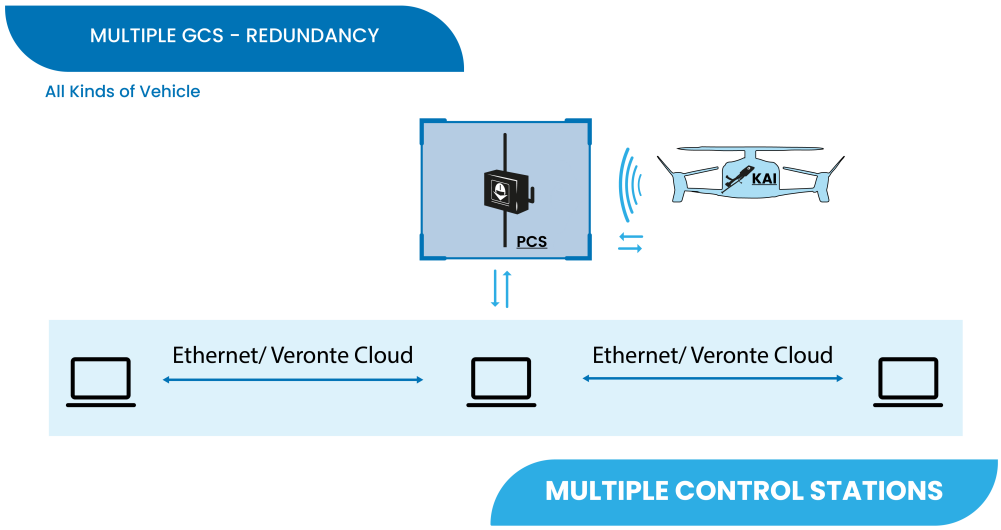
Point to point: standard multiplatform setup, with one ground unit per vehicle.



Point to multipoint: several platforms managed with a single radiolink.



Multiple control stations: for long range operations with several LOS stations, the PCs are connected through **Ethernet** or **Veronte Cloud**.



Operating Life

> **Important**
>
> By default, **Veronte Autopilot KAI** is limited to **3 flights**. Once this limit is reached, the unit will not be able to restart.
>
> A **permanent license** is also available for industrial applications and for training / demo units.

Maintenance

Preventive maintenance

Apart from cleaning, no extra maintenance is required to guarantee the correct operation of **Veronte Autopilot KAI**.

In order to clean **Veronte Autopilot KAI** properly follow the next recommendations.

- Turn off the device before cleaning.
- Use a clean, soft, damp cloth to clean the unit.
- Do not immerse the unit in water to clean it.

Software update

To update the software, an additional app is required: Veronte Updater.

Compatibles Devices

Veronte Autopilot KAI is compatible with a wide range of peripherals and external devices:

- **Payloads**: camera gimbals, cameras and other mission payloads.
- **External sensors**: altimeters, magnetometers and other navigation sensors that can be included in the sensor mix.
- **Mission computers**: connection through Ethernet, CAN FD or USB, with support for custom protocols.

Since **Veronte Autopilot KAI** is based on **Veronte Autopilot 1x**, both products have the same compatible devices. To know more, read the Compatibles Devices section of the **1x Hardware Manual**.

Integration examples

This section will present a number of examples of integration between the **Veronte Autopilot KAI** and external devices.

- Cameras

Cameras

Veronte Autopilot KAI processes the video stream of the onboard cameras in its **AI computer vision layer**, which performs the **vision based navigation** (SLAM), the **target selection and follow** and the **computer vision homing** during the terminal phase.

Two different TechNexion **FPD-Link III** cameras are used, each one dedicated to a different function:

- **TechNexion VLS-FPD3-AR0145-M-S78-IR**: camera for the **Visual Odometry (VO)**.
- **TechNexion VLS-FPD3-AR0234-C-S83-IR**: camera for the **Autonomous Target Engagement (ATE)**.

1. TechNexion VLS-FPD3-AR0145-M-S78-IR (VO)



TechNexion VLS-FPD3-AR0145-M-S78-IR

The **TechNexion VLS-FPD3-AR0145-M-S78-IR** is an enclosed **global shutter** camera with an **FPD-Link III** serial interface. Its high frame rate and ultra-short exposure make it suitable for capturing fast-moving scenes, which is why it is used for the **visual odometry**.

Specification	Value
Sensor	onsemi AR0145, 1/4.3" optical format, 1280 x 800 (1 MP), global shutter Pixel size 2.8 µm x 2.8 µm, monochrome
Maximum frame rate	115 fps (YUV422-UYVY) at 1280 x 800, 1280 x 720 and 640 x 480

Specification	Value
Output formats	YUV422-UYVY, RGB888, RGB565, RAW8, RAW10, RAW12
Interface	FPD-Link III (TI DS90UB953 serializer) FAKRA SMB jack, Z-Code
Supply voltage	10.8 to 26.4 V (Power over Coax)
Power consumption	≤ 1.4 W ≤ 0.6 W (standby)
Lens	S-Mount (M12) D-FOV 78° IR-cut filter at 650 nm
Dimensions and weight	29.5 mm x 29.5 mm x 28 mm, 45 g
Operating temperature	-30 to 70 ºC
Shock and vibration	15 G half-sine, 11 ms 1 Grms random, 5 to 500 Hz
MTBF	50,000 h

2. TechNexion VLS-FPD3-AR0234-C-S83-IR (ATE)



TechNexion VLS-FPD3-AR0234-C-S83-IR

The **TechNexion VLS-FPD3-AR0234-C-S83-IR** is an enclosed **global shutter** camera with an **FPD-Link III** serial interface. Its higher resolution provides the detail required for the **target selection and follow** and for the **computer vision homing** of the terminal phase.

Specification	Value
Sensor	onsemi AR0234, 1/2.6" optical format, 1920 x 1200 (2.3 MP), global shutter Pixel size 3.0 µm x 3.0 µm, colour
Maximum frame rate	60 fps (YUV422-UYVY) at 1920 x 1200 and 1920 x 1080

Specification	Value
	120 fps (YUV422-UYVY) at 1280 x 720 and 640 x 480
Output formats	YUV422-UYVY, RGB888, RGB565, RAW8, RAW10, RAW12
Interface	FPD-Link III (TI DS90UB953 serializer) FAKRA SMB jack, Z-Code
Supply voltage	10.8 to 26.4 V (Power over Coax)
Power consumption	≤ 1.5 W ≤ 0.1 W (standby)
Lens	S-Mount (M12) D-FOV 83° IR-cut filter at 650 nm
Dimensions and weight	29.5 mm x 29.5 mm x 28 mm, 45 g, aluminium enclosure
Operating temperature	-30 to 70 ºC
Shock and vibration	15 G half-sine, 11 ms 1 Grms random, 5 to 500 Hz
MTBF	50,000 h

2.1. Camera arrangement

Each camera is installed in the vehicle with a different orientation, according to its function:

- **VO camera (VLS-FPD3-AR0145-M-S78-IR)**, pointing to nadir: provides the images for the **vision based navigation**, from which the SLAM algorithm tracks the ground features to estimate the position of the vehicle in **GNSS denied** operations.
- **ATE camera (VLS-FPD3-AR0234-C-S83-IR)**, facing forward along the **x axis** of the aircraft: provides the images for the **target selection and follow** and for the **computer vision homing** of the terminal phase.

2.2. Wiring

Both cameras transmit the video and receive the power through a single **coaxial cable** with **FAKRA (Z-Code)** connectors, using **FPD-Link III** with **Power over Coax**. On the autopilot side, the FPD-Link III link is deserialized and delivered to the **MIPI** camera interface of **Veronte Autopilot KAI**.

> **Important**
>
> The Power over Coax supply must be within **10.8 to 26.4 V**. Use FAKRA Z-Code coaxial cables rated for FPD-Link III and keep the cable length within the limits of the serializer/deserializer link.

2.3. Installation recommendations

- Mount both cameras **rigidly** to the airframe. Any relative movement between the camera and the autopilot degrades the visual-inertial fusion.
- Keep the **field of view free of obstructions**, such as propellers, landing gear or antennas.
- Install the cameras **aligned with the aircraft axes** whenever possible, and configure the mounting offset in the software.
- Protect the cable routing from vibration, keeping the wiring loose enough so that vibrations are not transmitted to the camera or to the autopilot.

Troubleshooting

Maintenance mode

Maintenance mode is the main recovery mode that Veronte system puts at the user disposal. The main use of **maintenance mode** is to solve issues related to the current configuration, mainly related with communication or memory writing issues.

While in **maintenance mode**, **all communication channels are enabled** by default, so it is possible to connect to **Autopilot KAI** through any of its configuration interfaces, regardless of the current configuration. This allows re-establishing communications with the device in case they have been lost for any reason.

> **Tip**
>
> It is heavily recommended to always use **maintenance mode** to load a new configuration that is very different from the current one.

> **⚠ Warning**
>
> **Autopilot KAI** might enter in **maintenance mode** if a problem with the power supply is detected upon boot up (voltage or current is out of range).

How to enter in maintenance mode

To enter in **maintenance mode** by software, read the Maintenance Mode - Troubleshooting section of the **KAI PDI Builder** user manual.

Acronyms and Definitions

Acronyms

Acronym	Description
4G	Fourth Generation (mobile network)
5G	Fifth Generation (mobile network)
ADC	Analog to Digital Converter
AES	Advanced Encryption Standard
AI	Artificial Intelligence
APNT	Assured Positioning, Navigation and Timing
ATE	Autonomous Target Engagement
BLOS	Beyond Line Of Sight
BVLOS	Beyond Visual Line Of Sight
CAN	Controller Area Network

Acronym	Description
CAN FD	Controller Area Network with Flexible Data-rate
CDMA	Code Division Multiple Access
CMR	Compact Measurement Record
DAL	Design Assurance Level
DB9	D-subminiature 9-pin connector
DC	Direct Current
DO-178C	Software Considerations in Airborne Systems and Equipment Certification
DO-254	Design Assurance Guidance for Airborne Electronic Hardware
eSIM	Embedded Subscriber Identity Module
ESD	

Acronym	Description
	Electrostatic Discharge
EW	Electronic Warfare
FCC	Flight Control Computer
FPV	First Person View
GCS	Ground Control Station
GLONASS	Global Navigation Satellite System (Russian)
GNC	Guidance, Navigation and Control
GNSS	Global Navigation Satellite System
GPIO	General Purpose Input/Output
GPS	Global Positioning System
HAS	High Accuracy Service (Galileo)
I/O	Input/Output
IMU	

Acronym	Description
	Inertial Measurement Unit
IR	Infrared
ISA	International Standard Atmosphere
KAI	Kinetic Artificial Intelligence
LEO	Low Earth Orbit
LIDAR	Light Detection and Ranging
LM	Loitering Munition
LOS	Line Of Sight
LTE	Long Term Evolution
MIPI	Mobile Industry Processor Interface
MJPEG	Motion JPEG (Joint Photographic Experts Group)
MP	Megapixel
MSL	Mean Sea Level
NavIC	Navigation with Indian Constellation

Acronym	Description
OEM	Original Equipment Manufacturer
PC	Personal Computer
PCBA	Printed Circuit Board Assembly
PCS	Pole Control Station
PDI	Parameter Data Item
PNT	Positioning, Navigation and Timing
PPM	Pulse Position Modulation
PWM	Pulse Width Modulation
QZSS	Quasi-Zenith Satellite System
RF	Radio Frequency
RJ45	Registered Jack 45
RMS	Root Mean Square
RPM	Revolutions Per Minute
RS	

Acronym	Description
	Recommended Standard
RS232	Recommended Standard 232
RS485	Recommended Standard 485
RTCM	Radio Technical Commission for Maritime Services
RTK	Real Time Kinematic
SATCOM	Satellite Communications
SBAS	Satellite Based Augmentation System
SIM	Subscriber Identity Module
SLAM	Simultaneous Localization And Mapping
STANAG	Standardization Agreement (NATO)
TAS	True Airspeed
TC	Telecommand

Acronym	Description
TM	Telemetry
TRN	Terrain Relative Navigation
UART	Universal Asynchronous Receiver-Transmitter
USB	Universal Serial Bus
USV	Unmanned Surface Vehicle
UVC	USB Video Class
VO	Visual Odometry
VIO	Visual-Inertial Odometry
VMM	Visual Map Matching
VTOL	Vertical Take-Off and Landing
YUV	Luminance (Y) and chrominance (U, V) colour encoding

Contact Data

For support-related inquiries, customers have access to a dedicated portal through the Joint Collaboration Framework. This platform facilitates communication and ensures traceability of all support requests, helping us to address your needs efficiently.

For other questions or general inquiries, you can reach us via email at sales@embention.com or by phone at (+34) 965 115 421