UxV/35 Standard for UAV, UGV, and USV Boards

Datasheet

The Current UxV Landscape

In the US, small unmanned systems, encompassing ground (UGV), surface (USV), and aerial vehicles (UAV), including quadcopters and fixed-wing aircraft, are assembled from a common array of components.

These uniquely configured systems fulfill distinct purposes, from experimentation to deployment. However, scaling from single units, 10s, 100s, or 1,000s presents challenges due to the non-scalability of these components. Contributing factors include:

- Hand Soldering of module interconnections
- Fine Pitch connectors that require machine-crimped wires
- Incompatible connectors and form factors
- Lack of availability of version-controlled modules in volume
- Inability to assure software and firmware transparency

To mitigate these issues, standardization allows multiple vendors to contribute to the manufacture of scalable solutions.

- Small-scale production traditionally uses general-purpose, hand-assembled modules.
- Larger quantities often require custom-designed boards and systems to reduce cost, improve quality, and expedite production. The systems built in small volumes can bear the inconveniences and higher costs of these components, but as quantities rise, manufacturing standards such as ISO-9001 become essential.

Creating a UxV Standard

The components for these systems require a diverse skill set, including soldering, cable assembly, mechanical assembly, and configuration. The varying skill levels introduce different degrees of risk to the success of the final unmanned system.

These systems consist of multi-disciplinary components, such as electronic modules, wiring harnesses, and structural members. The UxV/35 standard proposes a modular assembly approach for unmanned systems that minimizes wiring and increases the success rate of assembly with components from multiple vendors. The goal is to bring order and interoperability to these common components. The UxV/35 standard enables multiple vendors to create modules that can easily plug together and function following project-specific configurations. These include, but are not limited to:

Flight controllers	**Motive means (motors)**	**User Interfaces**
Electronic speed controls (ESC)	**Communications**	**Enclosures & structures**
Power distribution	**Video systems**	**System testing**
Global orientation	**Payload systems**	**Local orientation**

Advantages of the UxV/35 Standard

Make Rapid Assembly Possible

In the PC/104 industry, an embedded computer can be assembled within minutes. Modules are unpacked, stacked, connected, powered up, and the operation begins. PC/104 is among the oldest American standards for embedded computing.

The objective of UxV/35 aligns with this precedent. The process involves unpacking a set of flight modules, stacking them as needed, and configuring their software. After installing the batteries, the flight can commence within minutes. Like the PC/104 example, scalability is assured through additional orders from a cooperative network of vendors.

Achieve Compatibility with Open-Source Controllers

The UxV/35 Standard, as outlined, is compatible with open-source flight and vehicle controllers such as ArduPilot and Betaflight.

Provide Scalability and Inter-Operability

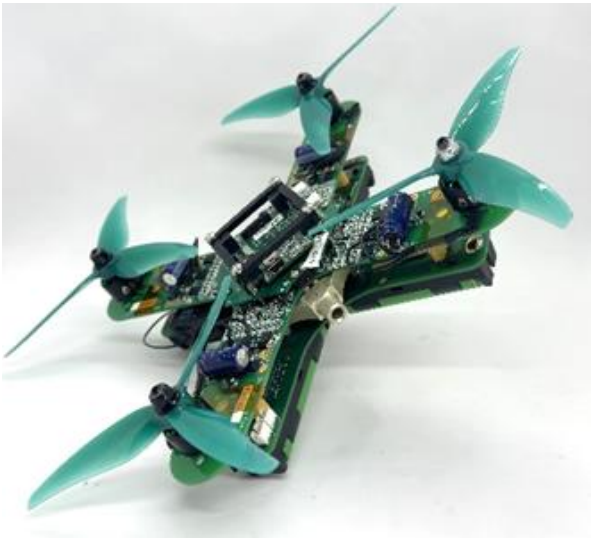
It facilitates interoperability between numerous vendors, spanning production volumes from single units to thousands.

Accommodate a Wider Range of Component Sources

It shifts the reliance on components from specific geographical locations by modifying connection pitches to accommodate a wider range of sources.

Enhance Reliability

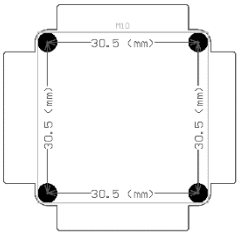
The precision design of the connecting pins between stacked boards ensures solid performance.



Example: Kairos UxV/35 Stack Manual Flight Drone

Defining the UxV/35 Standard

The UxV/35 bus is divided into 4 quadrants, located at the 4 corners of the 30.5mm square board (ad hoc industry standard). The four quadrants are assigned signal groups as follows:

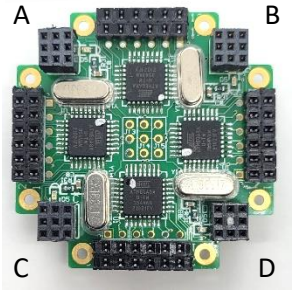


- A Servo Signals
- B I2C and General-Purpose Signals
- C Power and Power monitoring, Analogs, Safety
- D Serial signals

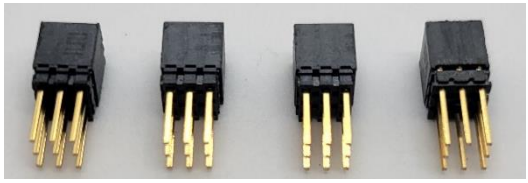
The groups are arranged on the board in the four corners. Each of the groups is assigned a letter in the range A – D. The groups are assigned as follows:

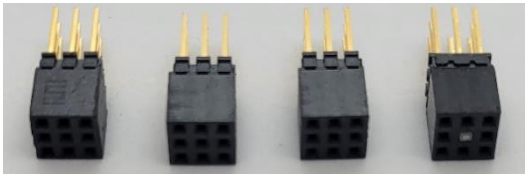
Group A	Upper Left
Group B	Upper Right
Group C	Lower Left
Group D	Lower Right

A	**B**
C	**D**



With Kairos assistance, Samtec developed a set of connectors based on a 2mm grid in a 3 x 3 pinning format. Groups A, B, and C use the full 9 pin load. Group D uses an 8-pin load. Without the middle pin, Group D becomes the key.





These connectors stack and nest forming a columnar bus of 9 pins. The concept is similar to PC/104. Samtec assigned these P/Ns:

Samtec P/N	Connector Type
ASP-232112-05	8-pin loaded, 2mm 3x3 format, center key
ASP-232112-06	9-pin loaded, 2mm 3x3 format

Each group is numbered 1 through 9, left to right starting in the upper left, and proceeding across and down. The group precedes the pin number when referencing a pin. The pins of the four groups are numbered as follows:

A1	**A2**	**A3**
A4	**A5**	**A6**
A7	**A8**	**A9**

B1	**B2**	**B3**
B4	**B5**	**B6**
B7	**B8**	**B9**

C1	**C2**	**C3**
C4	**C5**	**C6**
C7	**C8**	**C9**

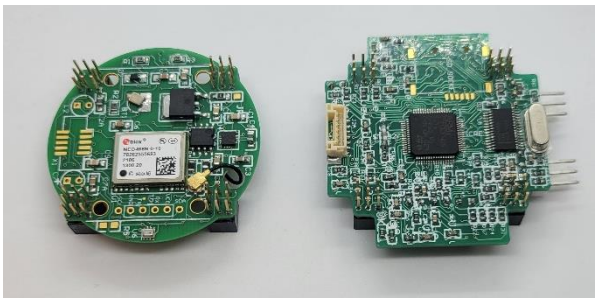
D1	**D2**	**D3**
D4		**D6**
D7	**D8**	**D9**

Each of the group's A-D are assigned signals that relate to the control and monitoring of unmanned ground, air, and surface vehicles. The group assignments are as follows:

A1 – Servo Output 1 Assigned to S1
A2 – Servo Output 2 Assigned to S2
A3 – Servo Output 3 Assigned to S3
A4 – Servo Output 4 Assigned to S4
A5 – Servo Output 5
A6 – Servo Output 6
A7 – Servo Output 7
A8 – Servo Output 8
A9 – SBUS Signal Serial Receive Channel E (input to FC)

B1 – Primary I2C Clock (SCL)
B2 – Primary I2C Data (SDA)
B3 – Secondary I2C Clock (SCL)
B4 – Secondary I2C Data (SDA)
B5 – GP1 Video In from Camera or Secondary SPI MISO
B6 – GP2 Video Out from Text Overlay or Secondary SPI MOSI
B7 – GP3 Serial Transmit Channel F (output from FC) or Secondary SPI SCLK
B8 – GP4 Serial Receive Channel F (input to FC) or Secondary SPI Chip Select #1
B9 – GP5 Serial Transmit Channel E (output from FC) or Secondary SPI Chip Select #2

C1 – Battery Voltage (3S or 4S) Battery +
C2 – Ground Battery -
C3 – Radio Signal Strength Indicator 0-3.3v (RSSI)
C4 – Analog Current Usage Indicator, 0-3.3v (Ain)
C5 – Return to Home
C6 – 3.3V generated from Battery input (1 amp)
C7 – Reset
C8 – Pause
C9 – +5V generated from Battery input (1 amp)



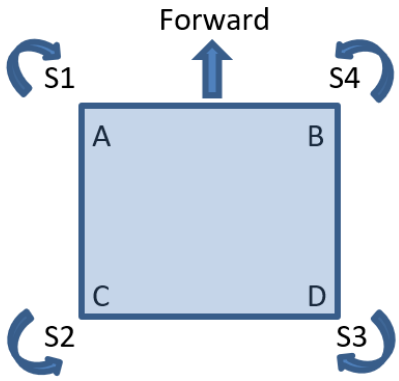
D1 – Serial Transmit Channel A (output from FC)
D2 – Serial Receive Channel A (input to FC)
D3 – Serial Transmit Channel B (output from FC)
D4 – Serial Receive Channel B (input to FC)
D5 – Pin not Present, used as Key
D6 – Serial Transmit Channel C (output from FC)
D7 – Serial Receive Channel C (input to FC)
D8 – Serial Transmit Channel D (output from FC)
D9 – Serial Receive Channel D (input to FC)

UxV/35 Suggested Assignment

Although autopilots for unmanned systems have significant configuration abilities (mostly I/O), these suggested assignments enable lower-skilled interoperability:

UAV - Quadcopter

S1	Forward Left Rotor, CW
S2	Rear Left Rotor, CCW
S3	Rear Right Rotor, CW
S4	Front Right Rotor, CCW
TxC/RxC	GPS
TxB/RxB	MAVLink
TxA/RxA	Commander/Swarm
I2CA	Baro, Compass



UAV – Fixed Wing

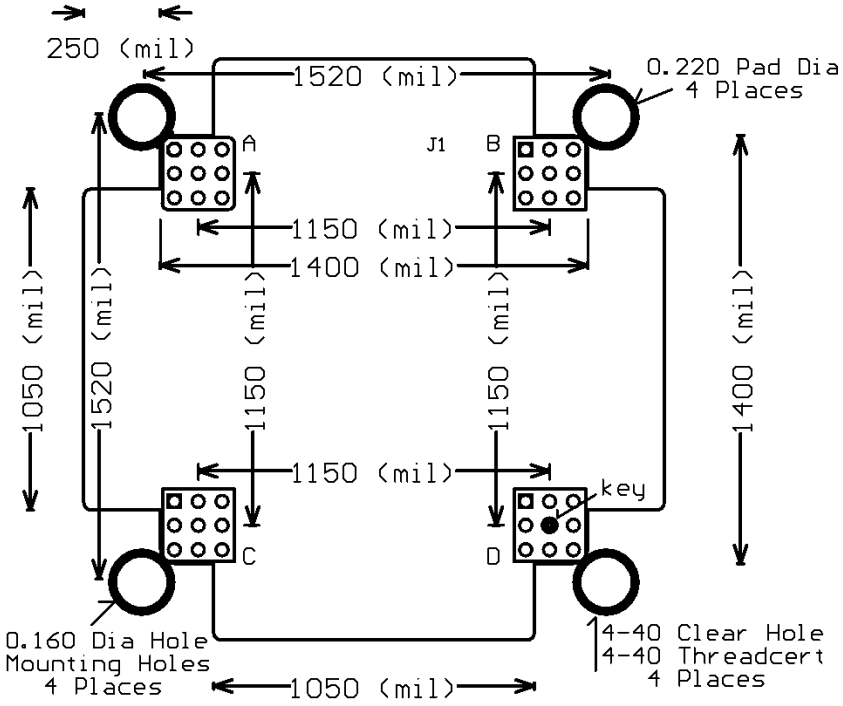
S1	Elevator
S2	Flaperon Right
S3	Flaperon Left
S4	Throttle ESC
TxC/RxC	GPS
TxB/RxB	MavLink
I2CA	Baro, Compass
TxA/RxA	Commander

UGV

S1	Steering
S2	Throttle
S3	Brake
S4	Transmission
TxC/RxC	GPS
I2CA	Compass
TxA/RxA	Commander

USV

S1	Steering
S2	Throttle
TxC/RxC	GPS
I2CA	Compass
TxA/RxA	Commander



Country of Origin

Kairos82nd uses the color of the PCB to assist in the determination of country of origin. One hundred percent of Kairos82nd UxV/35 components are manufactured in Salt Lake City, Utah. The PCBs are sourced and assembled locally. The firmware on these boards is source code managed by Kairos82nd or is available as open source.

All Kairos82nd UxV/35 boards that are Blue or Green indicate that the components used are sourced from domestic and global foundries. Any firmware is owned, managed, or controlled by Kairos82nd.

Any of our PCBs that are Red indicate that they may contain components from a country of origin is not acceptable for usage by the U. S. Government without a waiver.

All interoperability boards are Red because they can be adapted to 3rd party boards where Kairos82nd cannot manage the country of origin.

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