DroneNet

Compact Multi-protocol to 5 Port Ethernet Bridge

Datasheet

Applies to:
MPN: BB-DRN-B-1

September 2024
Board revision B

Contents

1 General Information

1.1 Functionality and Features of DroneNet

DroneNet is a collaboration between BotBlox and the Ardupilot project. At present, DroneNet ships with open-source firmware from the developers of Ardupilot.

This firmware is very new, and **many of the possible features possible on DroneNet remain unimplemented**.

As of 15 September 2024, DroneNet can achieve the following functionality.
- Serial to Ethernet
- CAN to Ethernet
- CAN device configuration

For the latest updates regarding development, please see the links below.

https://ardupilot.org/copter/docs/common-ethernet-adapters.html
https://firmware.ardupilot.org/AP_Periph/latest/BotBloxDroneNet/

DroneNet is a compact, embeddable multiprotocol to ethernet switch bridge that allows various protocols to be seamlessly converted into ethernet and bridged into an ethernet switch network. DroneNet achieves this by combining a STM32 microcontroller with a manageable ethernet switch chip.

This allows for the integration of older or lower bandwidth devices into an ethernet network without the use of bulky media convertors.

DroneNet is designed to provide upgradability for next generation UAVs and USVs to use 10/100Mbps ethernet, while still leveraging hardware that uses older communication protocols like CAN and USART.

DroneNet contains 1 x CAN, 1 x USART, 1 x RS485, 1 x USB, 3 x GPIO/PWM and 5 x 10/100BASE-T Ethernet ports in a compact (44.5mm x 44.5mm), rugged, embeddable form factor, allowing for seamless network integration. The hardware contains all the necessary physical layer transceivers circuitry for the CAN, RS485 and USB ports, as well as full galvanic isolation and magnetics for each of the five ethernet ports.

DroneNet shares the same dimensions and mount hole locations as our older 5 port ethernet switches, SwitchBlox and SwitchBlox for Ardupilot, allowing for easy mechanical compatibility between different models.

DroneNet currently ships with firmware provided from the Ardupilot project. This is currently a work in progress with features being added over time.

1.1.1 Features

- 5 x 10/100BASE-T
- 1 x CAN/CAN-FD port
- 1 x 3.3V USART port
- 1 x RS485 port *(unimplemented as of 15 September 2024)*
- 3 x GPIO/PWM pins *(unimplemented as of 15 September 2024)*
- 5V input voltage
- 44.5mm x 44.5mm size
- Vibration resistant, positive locking JST GH connectors for ports and power
- Automatic MDI-X crossover and polarity correction on the 5 10/100BASE-T ports
- Auto-negotiation on the 5 10/100BASE-T copper with connected devices to achieve maximum speed
- Inband STM32 for layer 3 routing *(unimplemented as of 15 September 2024)*

1.1.2 General Information

Voltage Input	5V DC (4.75V to 5.5V)
Supported Protocols	10BASE-T, 100BASE-TX, CAN-FD, USART, RS-485, USB2.0
Weight	14 grams
Size	44.5mm x 44.5mm x 8mm
Operating Temperature	-10 to +70°C
Storage Temperature	-45°C to +125°C

Table 1: General Information

1.1.3 Power Consumption Information

Networking (All 100BASE-TX ports networking, no STM32 firmware):
1.35 Watts *(270mA at 5V)*

Realistic maximum (All ports networking, reasonable estimated STM32 power consumption): 2 Watts (400mA at 5V)

Absolute theoretical maximum (All ports networking, full STM32 power consumption):
4 Watts (800mA at 5V)

1.1.4 General Operating Instructions

DroneNet is designed for use in industrial environments, operating from a pre-regulated input voltage between 4.75V to 5.5V (5V nominal).

As an unmanaged switch, DroneNet requires no configuration to work, and will begin operating as an unmanaged ethernet switch once powered from a nominal 5V supply.

1.1.5 Typical Applications

- Serial to ethernet bridge
- CAN to ethernet bridge
- UAV telemetry expansion and logging via ethernet
- USB to ethernet bridge
- RS485 to ethernet bridge
- Ethernet to GPIO/PWM output

1.2 Safety Information

- This device is fully functionally tested prior to shipment however in-application testing prior to integration is recommended.
- This device is provided as an electronic circuit board, and requires integration into chassis for full ingress protection.
- Do not use this product in wet environments without integrating into a chassis.
- Do not operate this product beyond the rated temperature and voltages.
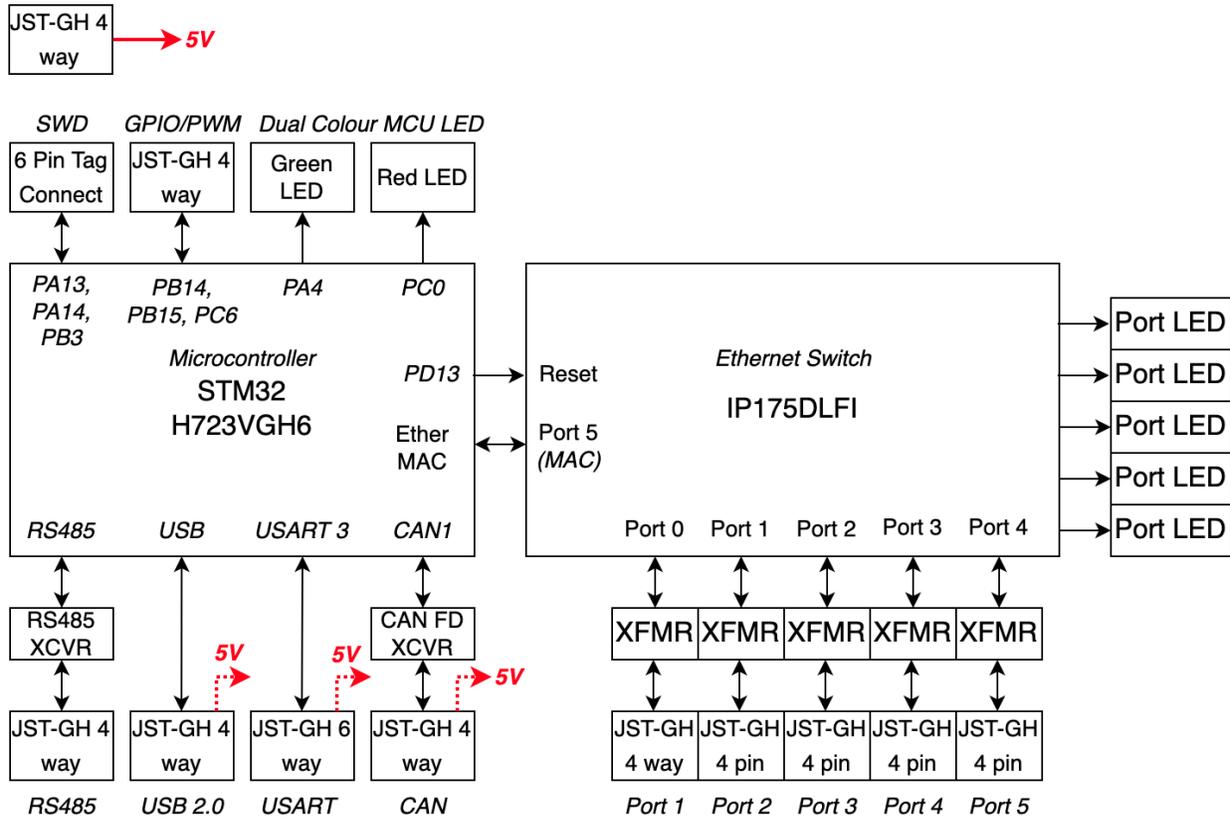
1.3 Block Diagram

Figure 1: DroneNet Block Diagram

1.4 Included Equipment

The product includes the following:
1 x DroneNet Board
4 x 4 way JST GH to RJ-45 cable, 0.2 meters (SKU: BB-RJJST1-4-0.2)
5 x 4 way JST GH to Tinned Leads, 0.2 meters (SKU: BB-TLJST1-4-0.4)

1.5 RoHS Compliance

The BotBlox DroneNet complies with the RoHS (Restriction of Hazardous Substances Directive).
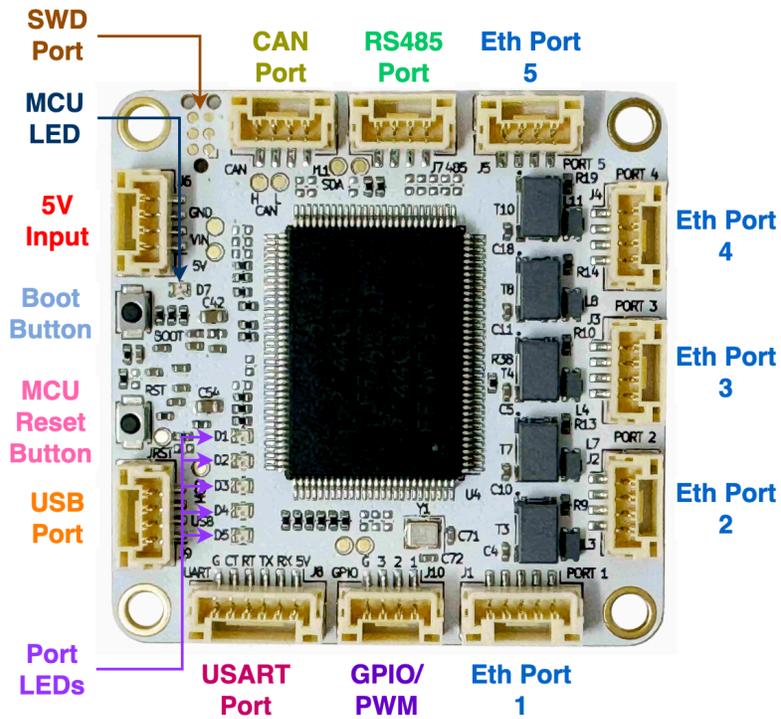
2 Hardware Interfaces

2.1 Board Map

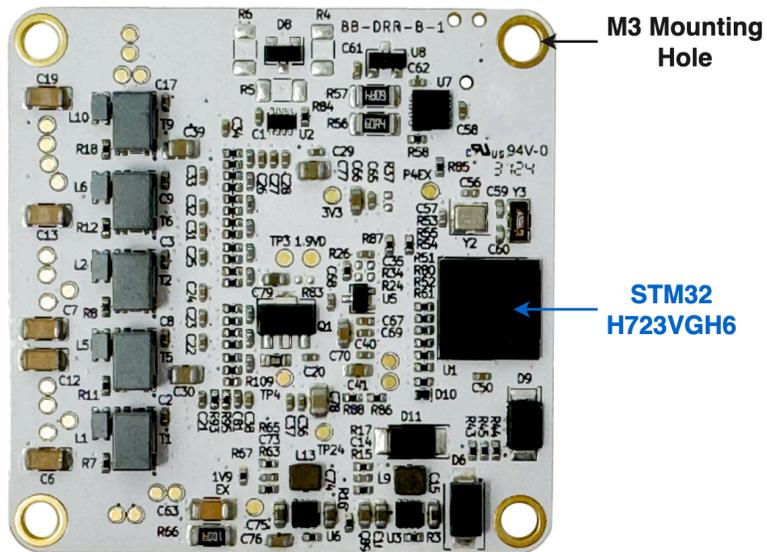*Figure 2: DroneNet Board Map (front)*

Figure 3: DroneNet Board Map (back)

2.2 Powering DroneNet

There are four methods to power DroneNet. The UART and USB are power supply OR'ed, meaning you can simultaneously supply the board from the USART port, USB port, and either the 5V input or CAN port. The 5V input and CAN port are not power supply OR'ed, so care should be taken when supplying both of these rails at the same time. The 5V rail on the CAN port can be output to power downstream devices.
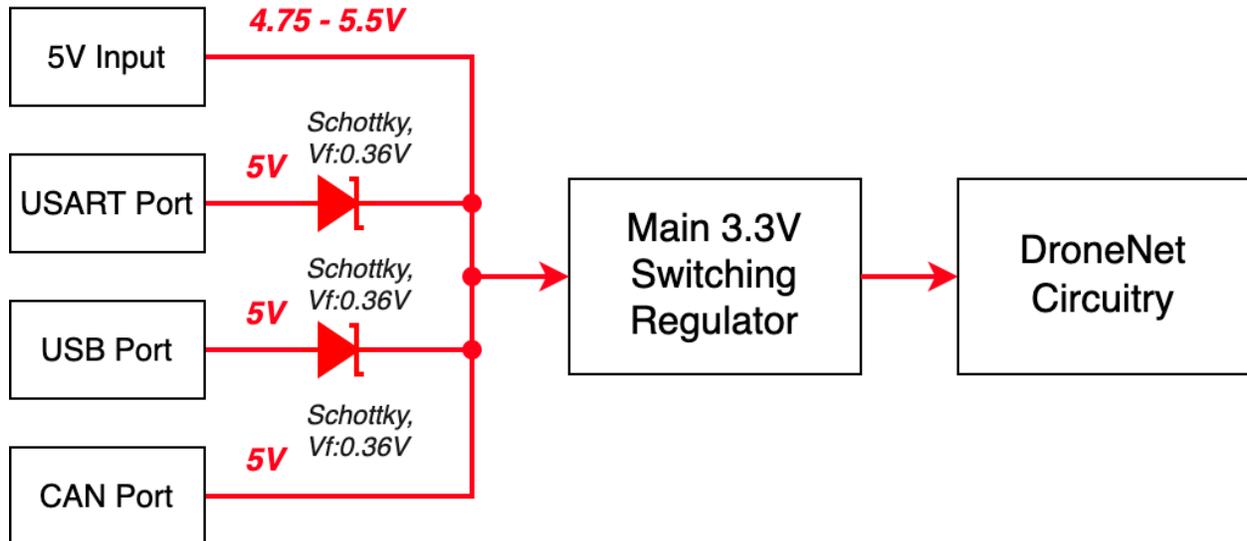

Figure 4: An illustration of the four power supply methods on DroneNet

2.2.1 Powering from 5V Input

There is a 5V input which can be used to power DroneNet. This accepts a 4.75V to 5.5V input. This input has some limited overvoltage and reverse protection (up to 10V), but it is not suggested to use a voltage that has the potential to exceed 5.5V for time periods longer than 500ms.

This input is designed for connection to a clean 5V rail, such as a BEC circuit output. More detail on the pinout of this connector can be found in Section 2.3 Connectors and Pinouts.

2.2.2 Powering from USART port connector

The USART port on DroneNet is designed for direct connection to the Telemetry ports on the CubePilot carrier board. A direct connection between DroneNet and the Telemetry port on the CubePilot carrier board will power DroneNet.

Note that you should be aware of the maximum current output limitations on the carrier board you are using. For the standard CubePilot carrier board, TELEM1 has a current limit of 1.5A while TELEM2 shares a 1.5A output with GPS, UART, I2C and other 5V peripherals. This is within the realistic maximum current draw of DroneNet is around 400mA.

More detail on the pinout of this connector can be found in Section 2.3 Connectors and Pinouts.

2.2.3 Powering from CAN port connector

The CAN port on DroneNet shares the same pinout as the CAN port on the CubePilot Carrier board, and thus can also be used to power DroneNet.

More detail on the pinout of this connector can be found in Section 2.3 Connectors and Pinouts.

2.2.4 Powering from USB port connector

There is a USB port on DroneNet that can be used to power the board. This port is designed to be connected to a USB 2.0 host, thus the 5V line from this port can be used to power DroneNet.

More detail on the pinout of this connector can be found in Section 2.3 Connectors and Pinouts.

2.3 Connectors and Pinouts

2.3.1 5V Input

A four pin JST GH connector can be used to supply input voltage to the board.

The voltage input has the following features:
- Voltage input can range from 4.75V to 5.5V
- Transient overvoltage protection up to 10V
- Transient reverse polarity protection down to -10V

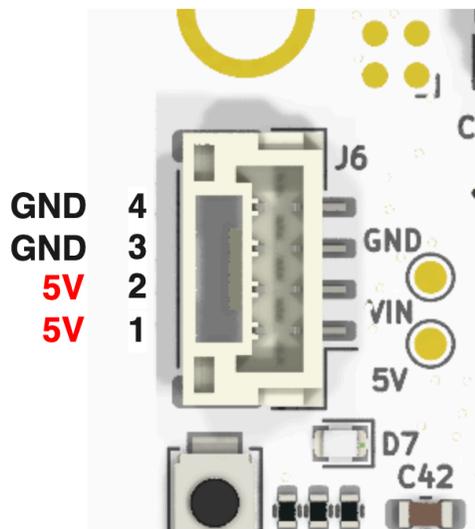The pinout of the voltage input connector is shown in figure 5.

Figure 5: 5V input header pinout

Table 2 shows the part numbers for the connector, mating housing and crimps for the 5V input.

Connector on board	Mating header	Crimp used	Wire used
BM04B-GHS-TBT(LF)(SN)	GHR-04V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 2: 5V Input connector part numbers for connector, housing and crimps
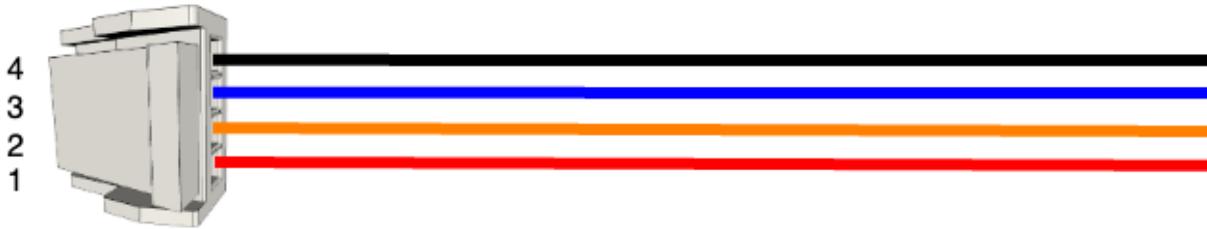

Figure 6: The cable supplied with DroneNet for the 5V power line. SKU: BB-TLJST1-4-0.3

2.3.2 USART Port

A six pin JST GH connector provides access to the USART port on the board. This pinout is shown in figure 7 below.
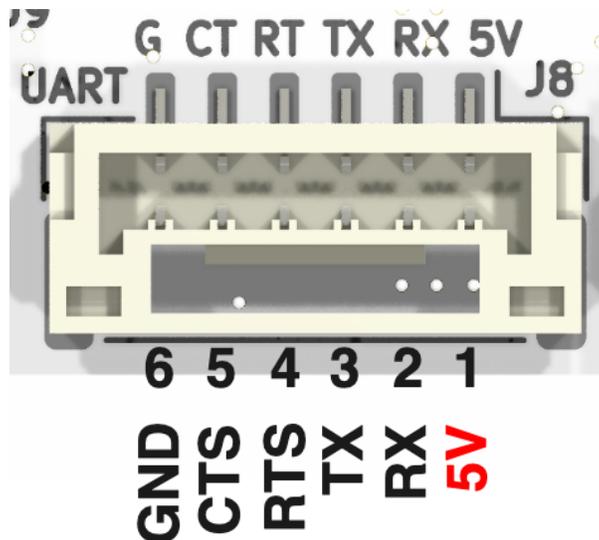

Figure 7: The pinout of the onboard USART port on DroneNet

The pin mapping used on the USART port on DroneNet follows the mapping of the TELEM port on the CubePilot carrier board, however the positions of RX and TX and mirrored with respect to the positions on the CubePilot carrier board. The same is true of CTS and RTS. This is done to allow this port to be directly connected to a TELEM port without needing the RX/TX and RTS/CTS lines to be swapped.

The swapping over of the lines allows the use of an off-the-shelf, 6 pin JST GH to JST GH cable, rather than requiring a crossover cable. The relative pin mapping between DroneNet and CubePilot is summarised in table 3. This cable is currently not supplied with DroneNet.

Connector Pin Position	Signal on DroneNet	Signal on CubePilot Carrier Board
1	5V (input)	5V (output)
2	RX (input)	TX (output)
3	TX (output)	RX (input)
4	RTS (input)	CTS (output)
5	CTS (output)	RTS (input)
6	GND	GND

Table 3: USART port pinout on DroneNet and TELEM port pinout on the CubePilot carrier board

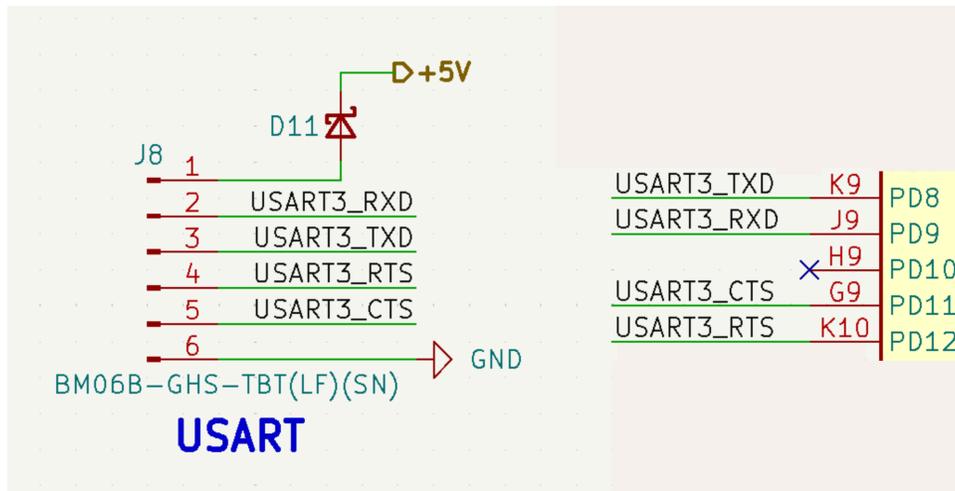The schematic of the USART port on DroneNet is shown in figure 8.

Figure 8: The schematic section of the USART port on DroneNet

The USART port is a 3.3V, unprotected, unisolated port on DroneNet, however the four pins used for the UART port on the onboard STM32H723VGH6 are 5V tolerant. Table 4 shows the part numbers for the connector and associated parts (mating housing and crimps) for the USART port.

Connector on board	Mating header	Crimp used	Wire used
BM06B-GHS-TBT(LF)(SN)	GHR-06V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 4: USART port connector part numbers for connector, housing and crimps

2.3.3 USB Port

A four pin JST GH connector provides access to the USB2.0 port on DroneNet. This pinout is shown in figure 7 below.
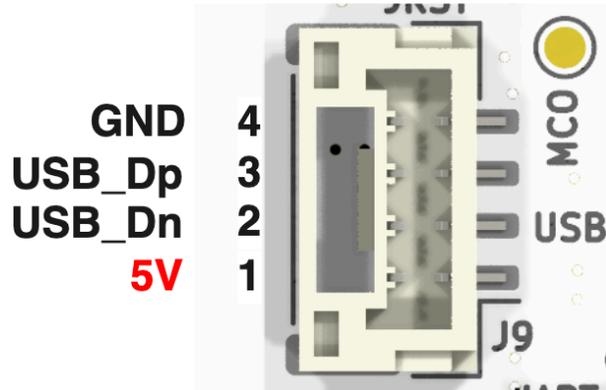

Figure 9: The pinout of the onboard USB 2.0 port on DroneNet

The USB port is a USB 2.0 (480Mbps) high-speed/full-speed device/host/OTG controller on the onboard STM32H723VGH6, however due to only USB_Dp and USB_Dn being present on the board, USB OTG is not possible on DroneNet.

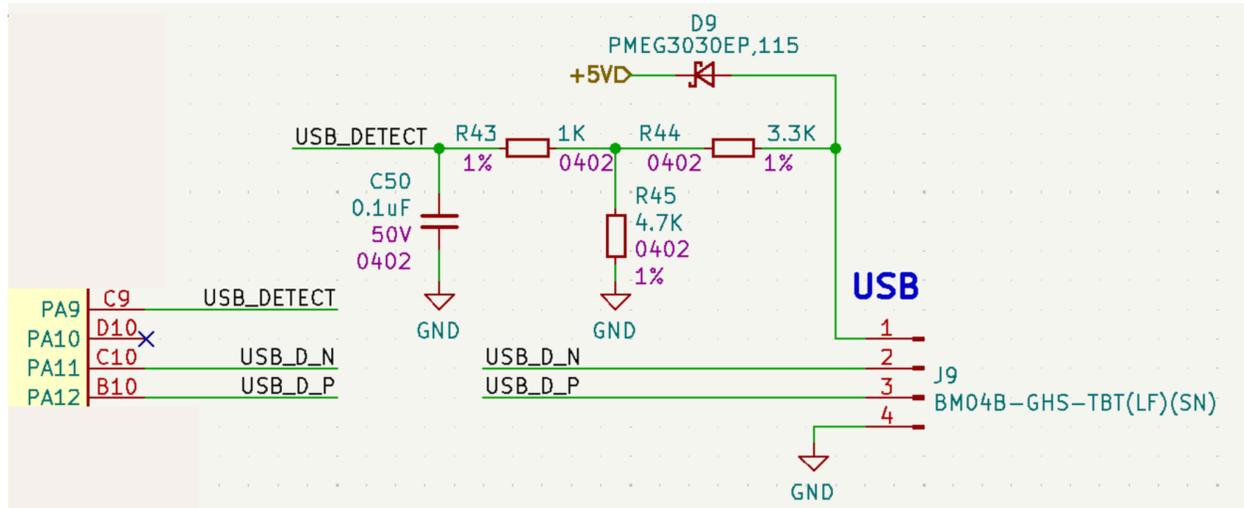The schematic for the USB3.0 section on DroneNet is shown below.

Figure 10: The schematic section of the USB port on DroneNet

Table 5 shows the part numbers for the connector, mating housing and crimps for the USB port.

Connector on board	Mating header	Crimp used	Wire used
BM04B-GHS-TBT(LF)(SN)	GHR-04V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 5: USB connector part numbers for connector, housing and crimps

2.3.4 CAN Port

A four pin JST GH connector provides access to the CAN port on DroneNet. This pinout is shown in figure 11 below.
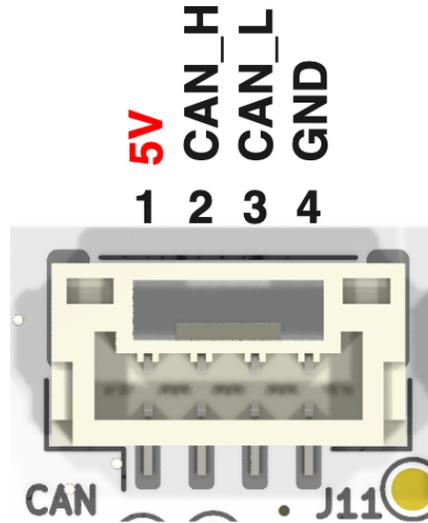

Figure 11: The pinout of the onboard CAN port on DroneNet

The CAN port is CAN, FD-CAN and TT-CAN capable. It is transient protected, 5V level and unisolated. The schematic for the CAN section on DroneNet is shown below. The bus is terminated by default with a split termination.
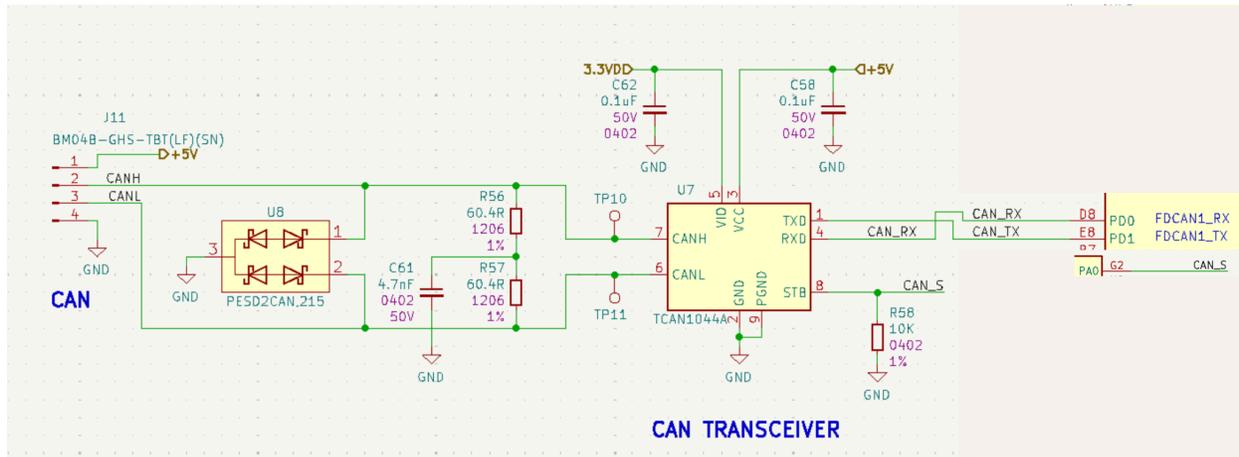

Figure 12: The schematic section of the USB port on DroneNet

Table 6 shows the part numbers for the connector, mating housing and crimps for the CAN port.

Connector on board	Mating header	Crimp used	Wire used
BM04B-GHS-TBT(LF)(SN)	GHR-04V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 6: USB connector part numbers for connector, housing and crimps

2.3.5 RS485 Port

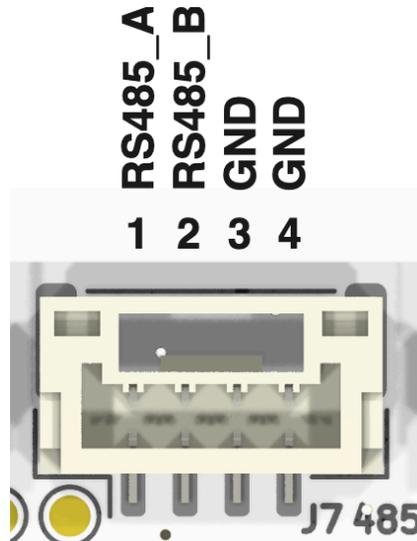A four pin JST GH connector provides access to the RS485 port on DroneNet.

Figure 13: The pinout of the onboard RS485 port on DroneNet

The RS485 port is, unisolated, two-wire, half-duplex and can achieve speeds up to 500 kbps with the following bus protections:

- Max bus voltage up to ±16V
- ±12-kV IEC 61000-4-2 Contact discharge
- ±15-kV IEC 61000-4-2 Air gap discharge
- ±4-kV IEC 61000-4-4 Fast transient burst

The schematic for the RS485 port on DroneNet is shown below.
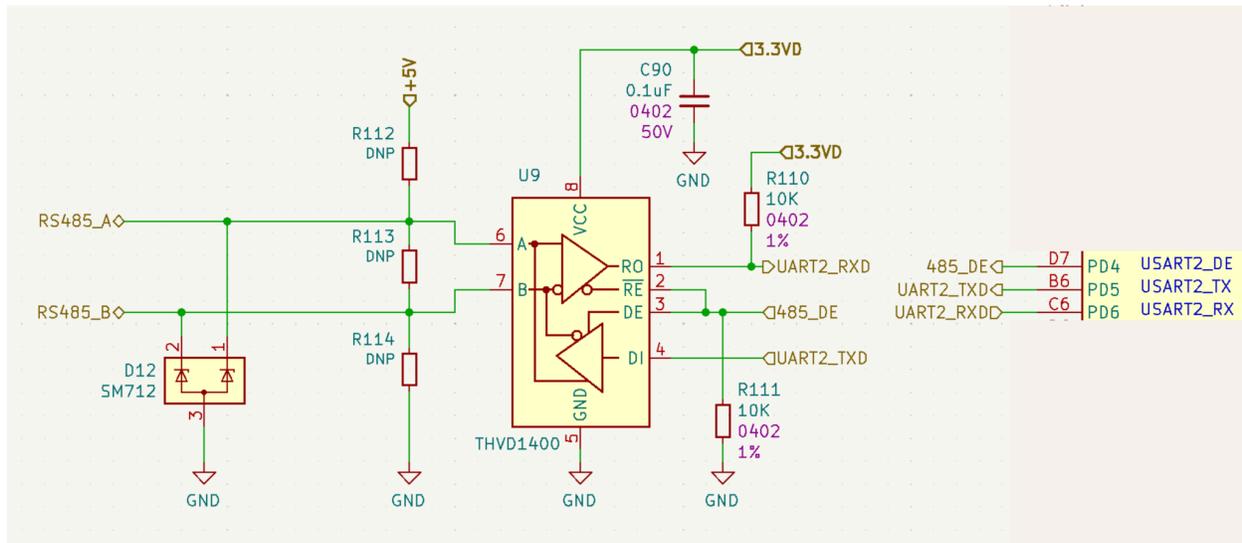

Figure 14: The schematic section of the RS485 port on DroneNet

By default, the line driver is unterminated, but it can be terminated by populating a 120Ω, 1206 resistor in the R5 location, as shown in figure 15 below. An example of such a resistor is the RMCF1206JT120R.
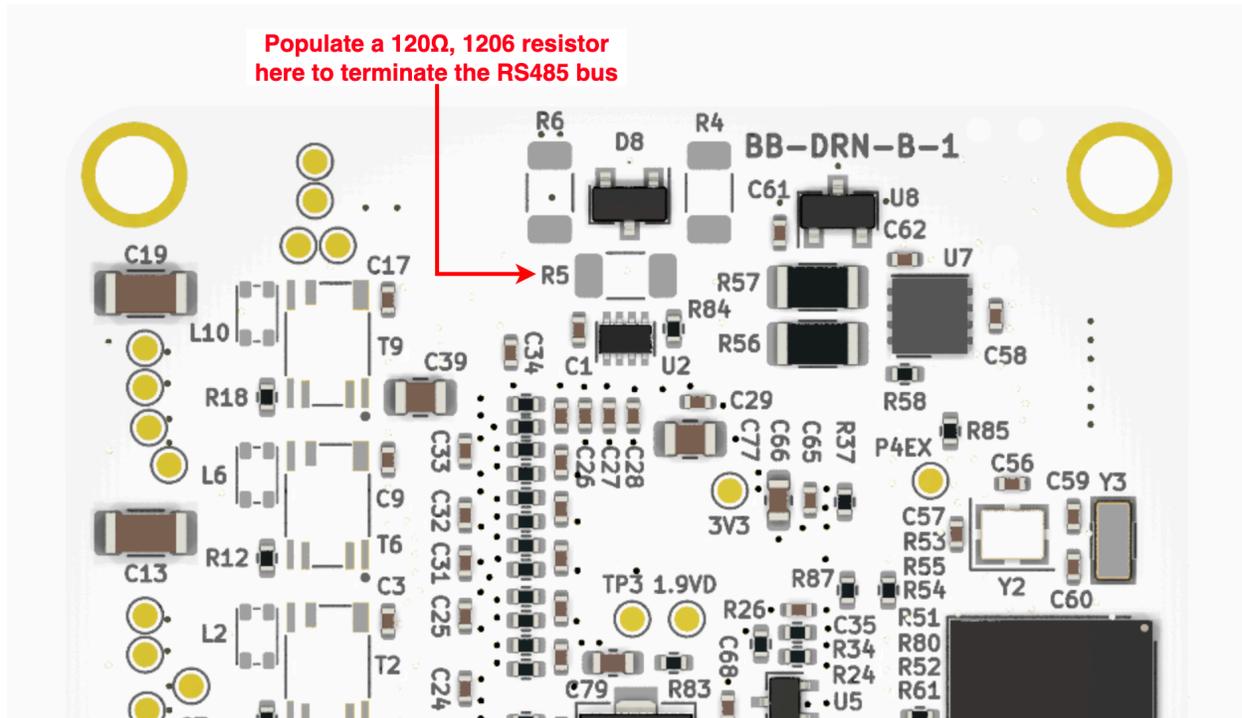

Figure 15: The location that a resistor needs to be installed into to terminate the RS485 bus

Table 7 shows the part numbers for the connector, mating housing and crimps for the RS485 port.

Connector on board	Mating header	Crimp used	Wire used
BM04B-GHS-TBT(LF)(SN)	GHR-04V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 7: RS485 connector part numbers for connector, housing and crimps

2.3.6 GPIO/PWM Port

A four pin JST GH connector provides access to a GPIO/PWM port on DroneNet. This pinout is shown in figure 16 below.
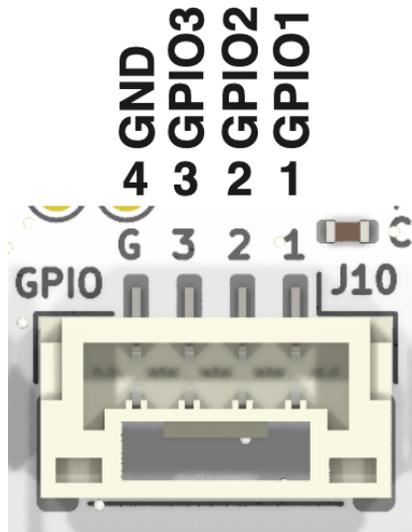
Figure 16: The pinout of the onboard GPIO port on DroneNet

This port consists of three direct connections to GPIO pins on the onboard STM32H723VGH6. These pins are input, output and PWM capable and thus can also be used to output PWM signals to drive various devices such as servos. These pins provide the user the ability to implement integrations of simple peripheral devices with DroneNet. All pins are 5V tolerant.

The schematic for the GPIO port on DroneNet is shown below.
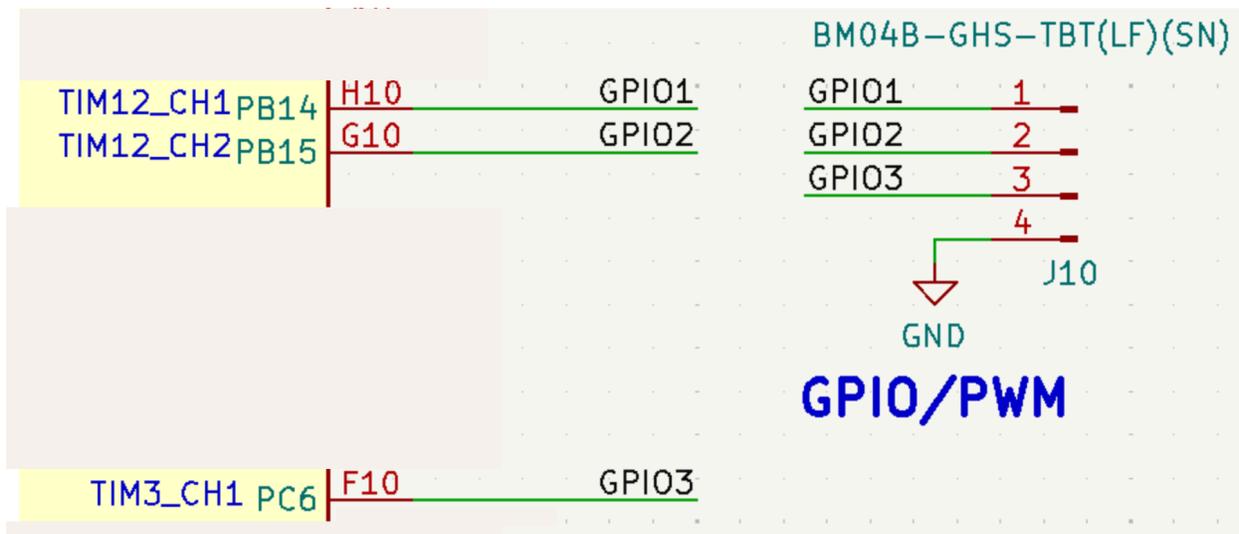

Figure 17: The schematic section of the GPIO port on DroneNet

Table 8 shows the part numbers for the connector, mating housing and crimps for the GPIO/PWM port.

Connector on board	Mating header	Crimp used	Wire used

| BM04B-GHS-TBT(LF)(SN) | GHR-04V-S | SSHL-002T-P0.2 | UL1061, 28AWG |

Table 8: GPIO/PWM connector part numbers for connector, housing and crimps

2.3.7 Ethernet Ports (four pin)

Four of the ethernet ports (ports 2-4) on DroneNet use a four pin JST GH connector. The pinout on all these connectors is identical, and shown in the image below. Each ethernet port is rated to 1500 VRMS (2.1kV) of isolation between the port and the power supply, as required by the IEEE 802.3 standard.
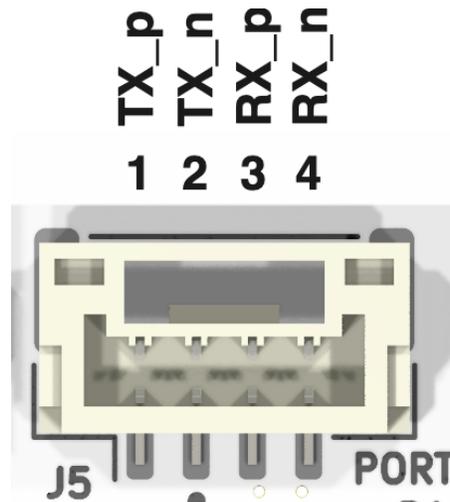
Figure 18: The schematic section of the GPIO port on DroneNet

The pinout of the ethernet ports on DroneNet matches the pinout used on SwitchBlox for Ardupilot, thus the same cable is used on both boards. The cable used is shown in figure 18.
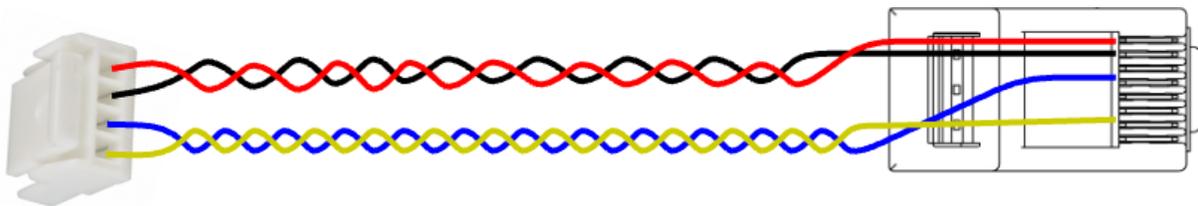

Figure 19: The cable supplied with DroneNet for the 4 pin ethernet ports. SKU: BB-RJJST1-4-0.3

All ethernet ports support 10BASE-T and 100BASE-T, and support auto-negotiation, auto-MDIX and auto-polarity swap.

Table 9 shows the part numbers for the connector, mating housing and crimps for the four-pin ethernet ports.

Connector on board	Mating header	Crimp used	Wire used
BM04B-GHS-TBT(LF)(SN)	GHR-04V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 9: Four-pin ethernet port connector part numbers for connector, housing and crimps

2.3.8 Ethernet Ports (five pin)

One of the ethernet ports (port 1) uses a five pin connector instead of a four pin connector. This ethernet is functionally identical to the other four ports, however an unconnected pin is present between the RX and TX signals. The five pin connector matches the pinout as used on ethernet ports on CubePilot and Herelink devices. Thus, the addition of a five pin ethernet port on DroneNet allows easy connection to CubePilot devices with a simple 5 pin JST GH to JST GH cable. The pinout of the connector is shown below.
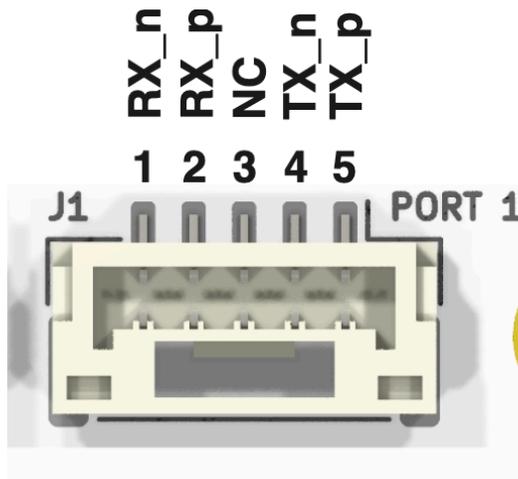
Figure 20: The pinout of the Port 1 on DroneNet

This ethernet port supports 10BASE-T and 100BASE-T, and supports auto-negotiation, auto-MDIX and auto-polarity swap.

Table 10 shows the part numbers for the connector, mating housing and crimps for the five-pin ethernet port.

Connector on board	Mating header	Crimp used	Wire used
BM05B-GHS-TBT(LF)(SN)	GHR-05V-S	SSHL-002T-P0.2	UL1061, 28AWG

Table 10: Five-pin ethernet port connector part numbers for connector, housing and crimps

2.3.9 SWD Port

An SWD port is used to program the STM32H723VGH6 on DroneNet. It is a segger 6 pin footprint on the board, designed to be used with Tag Connect 6 pin needle adapter. The pinout of the footprint is shown in figure 17 below.
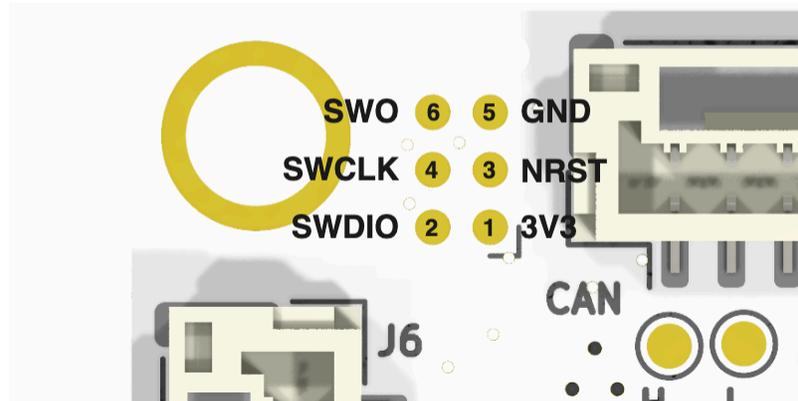

Figure 21: The pinout of the SWD on DroneNet.

A guide on how to program DroneNet using this port can be found at the link below.

https://forum.botblox.org/t/how-do-i-flash-botblox-boards-with-firmware/244

2.5 Buttons and LEDs

2.5.1 Port Activity Indicators

There are five port LED indicators on DroneNet, one corresponding to each port (please refer to the board map for the location).

Each LED is a dual colour, green/red LEDs, which allows the LED to show the port speed through colour. The table below details the colour and activity behaviour of each LED.

Link speed	Activity	LED Colour	LED Behaviour
10BASE-T	No activity	Green	Solid on
10BASE-T	Activity	Green	Blink
100BASE-T	No activity	Red	Solid on
100BASE-T	Activity	Red	Blink

Table 11: Port activity LED indicator behaviour

2.5.2 Microcontroller LED

There is a dual colour (green/red) on DroneNet that is connected to two GPIO pins on the STM32H723VGH6. Pin PC0 is connected to the anode of the red LED, while pin PA4 is connected to the anode of the green LED.

2.5.2 Power Indicator LED

There is currently no power LED on DroneNet. This will be fixed in future versions of the board.

2.6 Switching Fabric

The ethernet switch fabric on DroneNet has the following specifications.

Switch forward architecture	Store and forward
Fabric bandwith	Non-blocking, 100Mbps on all ports simultaneously is supported
# of MAC Addresses	2K
Ports 1-5 Capability	10/100BASE-T (Autonegotiation, auto MDI/MDIX, auto-polarity)

Table 12: DroneNet switch fabric capabilities

2.5 Ethernet Interfaces

2.5.1 5 x 10/100BASE-T Ethernet Ports

There are 5 copper ethernet ports on DroneNet that can operate in 10BASE-T and 100BASE-T.

A sixth ethernet port is a MAC port that operates in RMII mode; this connects to the MAC port on the onboard STM32H723VGH6, allowing direct access to the network for the STM32.

2.5.2 Auto negotiation

All five 10/100BASE-T ports support auto negotiation by default, and will automatically negotiate with any connected device to achieve the highest possible link speed based on the connected device's capabilities.

2.5.3 Auto-MDI/X

The 5 ports support Auto-MDI/X by default, meaning the ports will automatically determine whether or not they need to cross over between its pairs. This means that an external crossover cable is not required when using these ports.

3 Software Interfaces

3.1 Ardupilot Firmware

DroneNet currently ships with the Ardupilot firmware preloaded. Information on this firmware can be found at the link below:

https://ardupilot.org/copter/docs/common-ethernet-adapters.html

3.2 BloxOS Firmware

A distribution of BloxOS will be developed for DroneNet to add smart network management and layer 3 routing features. At present this, this is not yet released.

3.3 Custom Firmware

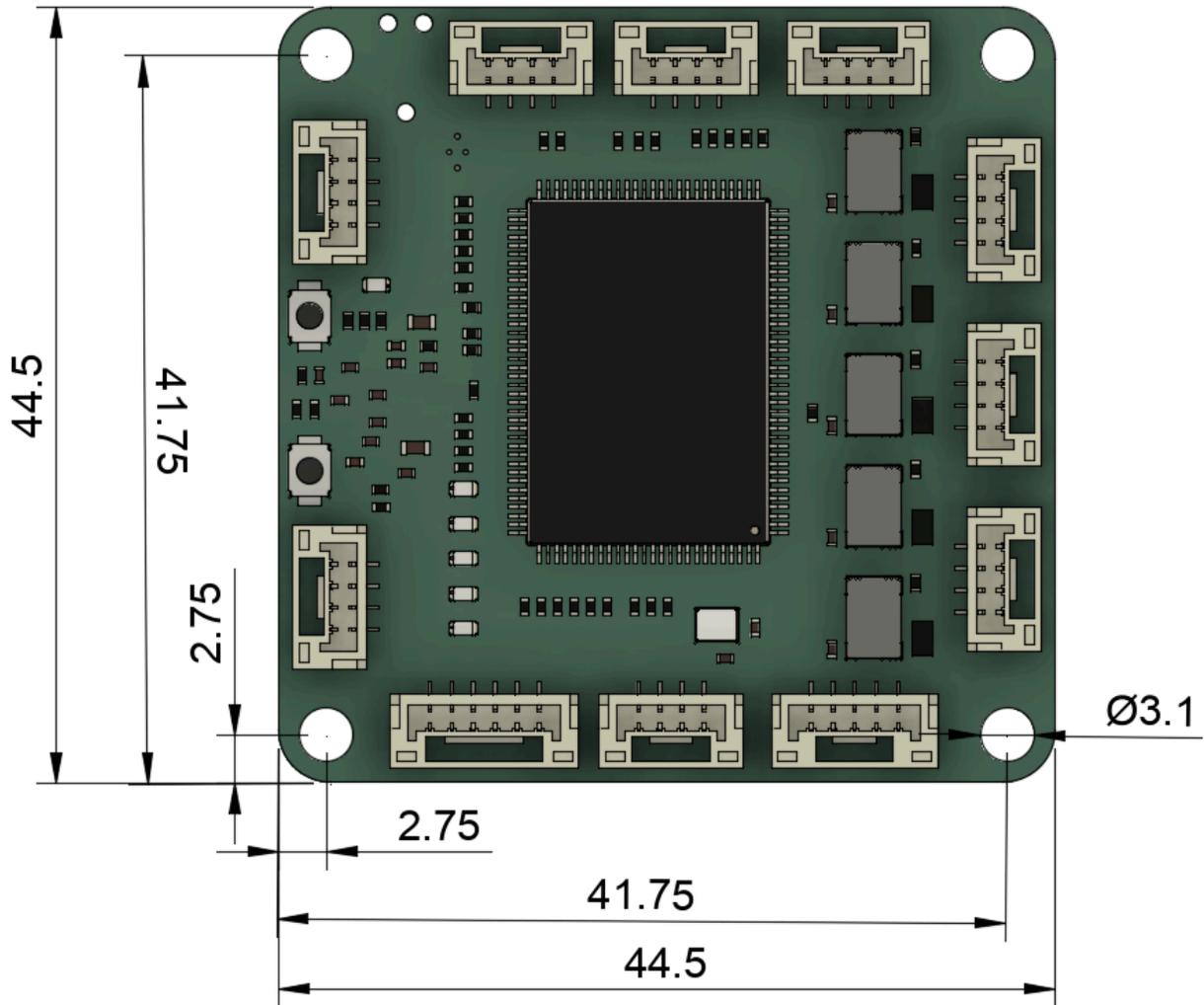Custom firmware for DroneNet can be developed by the end user.

4 Mechanical drawing

Figure 13. DroneNet mechanical drawing, viewed from the top

3D CAD can be found at the link below.

https://grabcad.com/library/dronenet-bb-drn-b-1-1

5 Datasheet Changelog

Date	Datasheet Version	Author	Notes
13/09/2024	B_A	Josh Elijah	Initial release
19/09/2024	B_B	Josh Elijah	Updated temperature range to reflect reality

6 Contact

If you have any questions regarding this product, please contact us:

info@botblox.org
4 Pavilion Court 600 Pavilion Drive,
Northampton Business Park,
Northampton,
England
NN4 7SL

7 Certificate of Conformity

The full text of the Certificate of Conformity of this product is available at the following web address. https://botblox.io/documentation/