Zubax Myxa Datasheet

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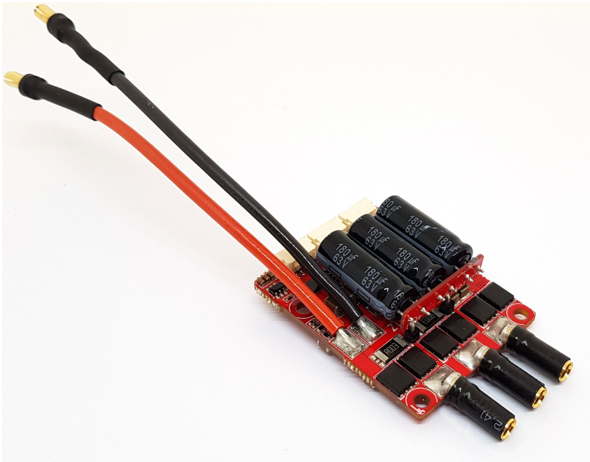
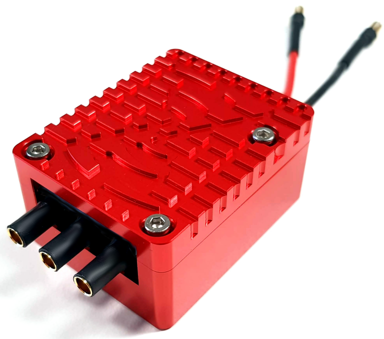
Overview

Zubax Myxa is a high-quality FOC ESC based on Telega motor control technology. Myxa is designed to support the propulsion systems of light unmanned aerial vehicles (UAVs), unmanned underwater vehicles (UUVs) and unmanned surface vehicles (USVs), and is compatible with almost all PMSM and BLDC motors. Myxa's state-of-the-art vector control algorithm makes it one of the most energy-efficient ESCs available.





Features

- Up to 850 W of continuous power output
- 13 – 51 V input voltage range (4 – 12S $LiCoO_2$ battery)
- Software-controllable 5 V, 0.5 A BEC (Myxa B only)
- Energy-efficient sensorless field-oriented control (FOC)
- Self-diagnostics and health status reporting
- External motor temperature sensor support for enhanced self-diagnostics
- Highly configurable (wide range of tunable parameters)
- Firmware updatable in-field via the CAN, UART and USB interfaces
- Regenerative braking and active freewheeling
- No soldering required for installation or use
- Low noise and high efficiency courtesy of the sinusoidal motor currents and high-frequency PWM
- Rich set of communication interfaces:
    - CAN bus interface:
        - UAVCAN compliant
        - Dual redundancy (Myxa B only)
    - USB Micro-B interface for control, management, and telemetry (GNU/Linux, Windows, macOS)
    - Industry-standard RC PWM input
    - UART

Applications

- Propeller drives for UAVs
- Pump and propeller drives for UUVs and USVs
- Fuel pump drives for jet engines and gas turbines

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1 Overview

Zubax Myxa is a high-quality FOC ESC based on the Telega motor control technology. Myxa is designed to support the propulsion systems of light unmanned aerial vehicles (UAVs), unmanned underwater vehicles (UUVs) and unmanned surface vehicles (USVs).

The controller provides up to 850 W of continuous power output and supports a wide range of operating voltages: 13 – 51 V (4 – 12S $LiCoO_2$ battery). Myxa is capable of being finely tuned to any motor-propeller combination for optimal dynamic response.

Myxa offers several control modes that make it suitable for a wide range of propulsion systems. It is fully UAVCAN-compatible and can be easily integrated into an end system using the two standard UAVCAN Micro connectors[1] on each CAN interface.

Ensuring high levels of system reliability, Myxa continuously measures and reports on all the critical performance parameters including the controller temperature, the motor temperature,[2] the instantaneous DC link voltage and the instantaneous DC link current.

The analog front-end of the phase current measurement circuitry is equipped with an automatic gain control (AGC), the status of which is displayed using a dedicated LED indicator.

For information on operating and tuning the device, please refer to the Telega reference manual.

1.1 Quality assurance

Every manufactured device undergoes an automated hardware verification process, the test logs of which can be viewed at `https://device.zubax.com/device_info`. To facilitate traceability and reduce the risk of counterfeits, every manufactured device stores a strongly encrypted digital signature in its non-volatile memory to identify its origin.

Additional information about product quality is available upon request from `support@zubax.com`.

1.2 Variants

Two types of Myxa are available:

- Myxa A – optimized for cost-sensitive applications
- Myxa B – optimized for mission-critical applications

Each Myxa is available in one of three variants, all of which provide conformal coating for the PCB:

- Bare PCB (variant 0) – suitable for embedding into tightly-packed systems
- Polyolefin transparent envelope (variant 1) – optimized for systems that have critical mass and dimension constraints but where some protection from the environment is needed
- Aluminum (variant 2) – suitable for systems with higher power demands where the enclosure provides an additional cooling capability for the power MOSFETs by acting as a heatsink

Variant	Enclosure	Mass, g	Dimensions, mm	Rated power, W	Redundant CAN	BEC	Oper.temp, °C
Myxa A0	Board-level	26	55 × 35 × 19	400	N/A	N/A	-20 – 70
Myxa A1	Polyolefin envelope	27	55 × 36 × 20	400	N/A	N/A	-20 – 70
Myxa A2	Aluminum enclosure	55	57 × 38 × 24	850	N/A	N/A	-20 – 70
Myxa B0	Board-level	26	55 × 35 × 20	400	DMR	5 V, 250 mA	-40 – 85
Myxa B1	Polyolefin envelope	27	55 × 36 × 21	400	DMR	5 V, 250 mA	-40 – 85
Myxa B2	Aluminum enclosure	55	57 × 38 × 24	850	DMR	5 V, 250 mA	-40 – 85

Table 1.1: Model comparison

[1] For more details refer to the UAVCAN specification.
[2] When connected to a motor thermistor.

2 Characteristics

2.1 Absolute maximum ratings

Stresses that exceed the limits specified in this section may cause permanent damage to the device. Proper operation of the device within the limits specified in this section should not be assumed.

Parameter	Min	Max	Unit
Supply voltage	-0.3	56	V
Phase current amplitude		65	A
DC continuous current		60	A
Operating temperature (device)	-40	85	°C
UART, RC PWM input voltage	-0.3	7	V
CAN H/L input voltage	-58	58	V

Table 2.1: Absolute maximum ratings

2.2 Environmental conditions

Parameter	Note	Min	Max	Unit
Operating temperature (device)	Myxa A	-20	70	°C
Operating temperature (device)	Myxa B	-40	85	°C
Storage temperature (ambient)		-40	50	°C
Operating humidity	Condensation not permitted	0	100	%RH
Operating altitude	Above mean sea level (MSL)		10	km

Table 2.2: Environmental conditions

2.3 Operational characteristics

Parameter	Note	Min	Typ	Max	Unit
Continuous DC power	Myxa A0/A1/B0/B1			400	W
Continuous DC power	Myxa A2/B2			850	W
Peak DC power, 30 sec	Myxa A0/A1/B0/B1			700	W
Peak DC power, 30 sec	Myxa A2/B2			1200	W
Supply voltage		13		51	V
Idle power consumption			0.3		W

Table 2.3: Power characteristics

Parameter	Min	Typ	Max	Unit
Temperature measurement range	-55		125	°C
Temperature measurement error	-6		6	°C
Switch on-state resistance		3.4	4	mΩ

Table 2.4: Inverter characteristics

Parameter	Min	Typ	Max	Unit
Bit rate	125		1000	Kbps
Differential output voltage, dominant	1.5		5.0	V
Bus power rail voltage	-0.1	5.0	5.5	V
Inter-connector current pass-through	-1		1	A
Connector resistance during device lifetime		30	50	mΩ

Table 2.5: CAN bus interfaces characteristics

Parameter	Min	Typ	Max	Unit
Low-level input voltage	-0.3	0	1.6	V
High-level input voltage	2.1	3.3	5.5	V
Low-level output voltage		0	0.5	V
High-level output voltage	2.8	3.3		V
Source/sink output current	-10		10	mA

Table 2.6: Dronecode debug port characteristics

Parameter	Note	Min	Typ	Max	Unit
Power output voltage		4.5	5	5.2	V
Power output continuous current	PTC fuse protected			0.1	A
Power output PTC fuse trip level	Operational temperature range	0.1		1.0	A
Low-level input voltage		-0.3	0	1.6	V
High-level input voltage	Except GPIO2	2.1	3.3	5.5	V
High-level input voltage	Only GPIO2	2.1	3.3	3.4	V
Low-level output voltage			0	0.5	V
High-level output voltage		2.8	3.3		V
Source/sink output current		-10		10	mA
RC PWM signal period		1	20	60	ms
RC PWM pull down resistance		15	20	25	kΩ

Table 2.7: Auxiliary port characteristics

Parameter	Min	Typ	Max	Unit
Constant voltage (CV) output	4.9	5	5.2	V
Constant current (CC) output	0.5	0.85	1.1	A
Continuous load current per interface			0.25	A
Continuous total load current (both interfaces)			0.25	A
Voltage ripple			100	$mV_{p\text{-}p}$
CV/CC mode switch delay		2		μs

Table 2.8: BEC characteristics (Myxa B only)

2.4 Reliability

Please contact Zubax Robotics for additional information about reliability and safety.

Parameter	Typ	Unit
Replacement life	8	year
Operational service life	10 000	hour
Mean time to failure (MTTF)	1 500 000	hour

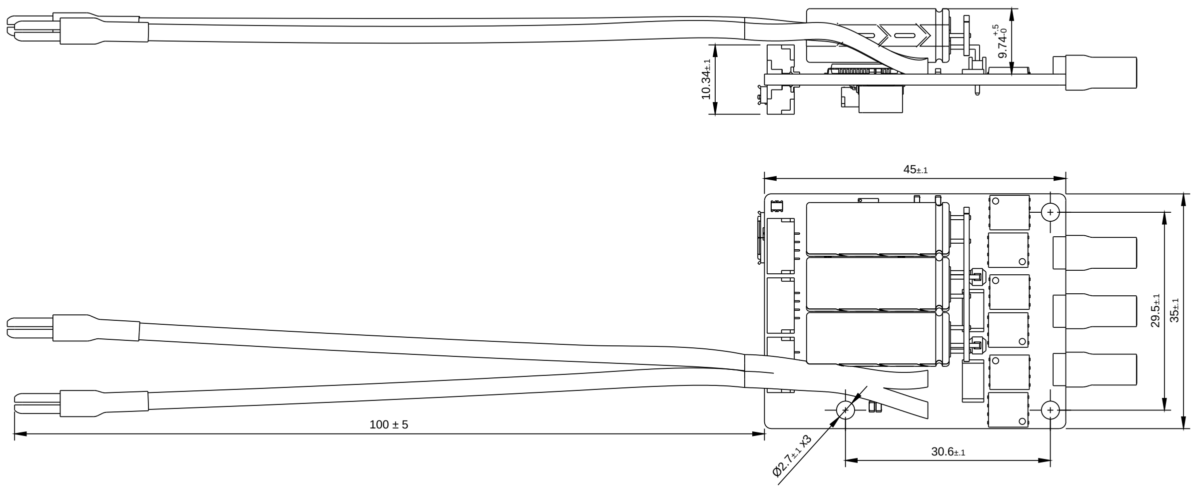
Table 2.9: Reliability

2.5 Mechanical characteristics

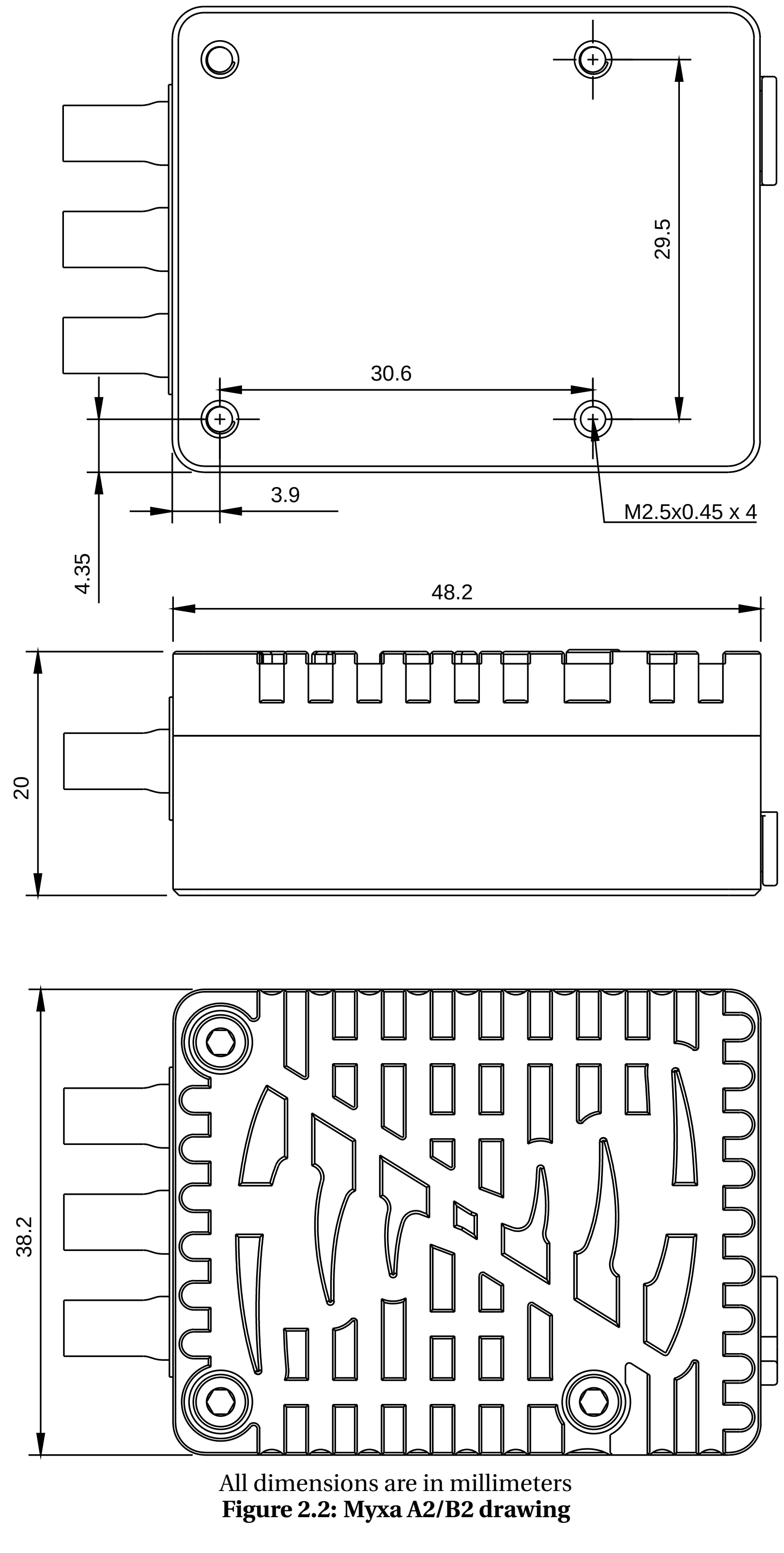
Regardless of the enclosure option, the PCB is always finished with conformal coating **Taerosol PRF 202** or equivalent. This provides the PCB strong protection against moisture, dust, and aggressive chemicals.

Parameter	Note	Myxa x0	Myxa x1	Myxa x2	Unit
Mass	Cables not included	26	27	55	g
Ingress protection	Conformal coating protects against liquid damage	IP04	IP44	IP54	
Mechanical load	Load per communication interface connector		3		N

Table 2.10: Mechanical characteristics



All dimensions are in millimeters
Figure 2.1: Myxa A0/B0 drawing



All dimensions are in millimeters

Figure 2.2: Myxa A2/B2 drawing

3 Functional description

3.1 Motor control

The description of the motor control functions of the device is provided in the Telega reference manual. This document focuses on the hardware-related aspects of the device only.

3.1.1 Motor selection considerations

When selecting a motor, it is important to consider its theoretical maximum rotational speed (RPM_{max}). This is derived from the motor's *motor velocity constant* (K_v), its *supply voltage* (V) and the controller's *voltage utilization factor* (F_{util}). The RPM_{max} is calculated as follows:

$$\mathrm{RPM}_{\max} = K_{\mathrm{v}} \times V_{\mathrm{supply}} \times F_{\mathrm{util}}$$

K_v is the ratio of the unloaded motor's rotational speed to its peak voltage[3] and its unit is *revolutions per minute per volt* (RPM/V) or *radians per volt second* $[\frac{\mathrm{rad}}{V \cdot s}]$.

F_{util} is a constant factor with a value between zero and one depending on the PWM type. BLDC motor controllers with a conventional trapezoidal or six-step commutation always have a factor of one. For Myxa, the F_{util} constant is 0.99.

Take, for example, selecting a motor with a K_v of 320 RPM/V being controlled by a Myxa running on a fully charged 10 S $LiCoO_2$ battery (i.e. 10 cells of 4.2 V). It would have a theoretical maximum RPM of:

$$\mathrm{RPM}_{\max} = 320 \times (10 \times 4.2) \times F_{\mathrm{util}} = 13\,306$$

In short, when selecting a motor for Myxa:

$$K_{\mathrm{v}} \geq \frac{RPM_{\max}}{V_{\mathrm{DCmin}}} \cdot F_{\mathrm{util}}$$

where RPM_{max} is the desired maximum speed of the motor under zero load; and V_{DCmin} is the minimum DC power supply voltage or the voltage of the fully discharged battery.

3.2 Power interface

3.2.1 Main power input

The main input power is provided via the 100 mm-long 1.5 mm^2 copper wires attached to the 3.5 mm gold-plated bullet male connectors. No other power inputs are required for the device to function.

3.2.1.1 Regenerative braking

While braking, the device transfers energy from the motor to the power supply network in a process known as regenerative braking. If the input impedance of the power supply network is high, the regenerative energy transfer may lead to the supply voltage increasing beyond the device's safe operating limits.

The internal resistance of traction batteries is generally sufficiently low to ensure safe absorption of the recovered energy. Problems may arise if the device is powered by a source where the input impedance is high, such as a laboratory power supply, for instance. In this case, it is advised to use an electronic load in CV mode connected in parallel with the power supply as a protection against overvoltage.

3.2.2 UAVCAN bus power

The device does not consume power from the UAVCAN bus. It can, however, be configured to deliver power to the UAVCAN bus as described in section 3.3.1.1.

[3] As measured across the coil wires.

3.2.3 USB power

The device can be powered via USB to update configurations as described in section 3.3.3.

The power stage is not supplied via the USB by design. If the device is powered via the USB and the main power is unavailable, the device will report a low-voltage power supply (LVPS) error.

The USB port is protected with an anti-backfeed diode which prevents current flowing from the device to the USB host. The device does not consume power from the USB interface if the main power is available.

3.2.4 Motor phase connection

The motor phases are connected to the female board-mounted 3.5 mm bullet right-angle connectors.

3.3 Communication interfaces

All the communication interfaces are available via dedicated connectors.

Connector name	Section	Connector type
CAN1 (2 connectors)	3.3.1	JST SM04B-GHS
CAN2 (2 connectors)	3.3.1	JST SM04B-GHS
Dronecode debug port	3.3.2	JST SM06B-SRSS-TB
USB	3.3.3	USB 2.0 Micro-B
Auxiliary	3.3.4	JST SM04B-GHS

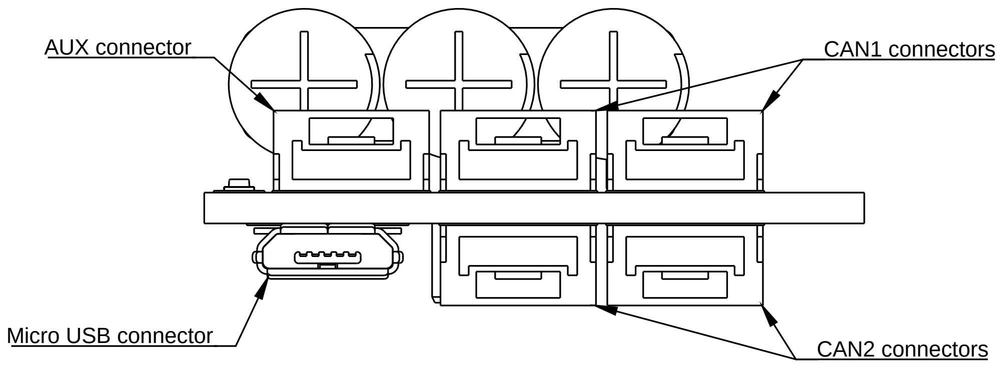


Figure 3.1: Front-side connector placement

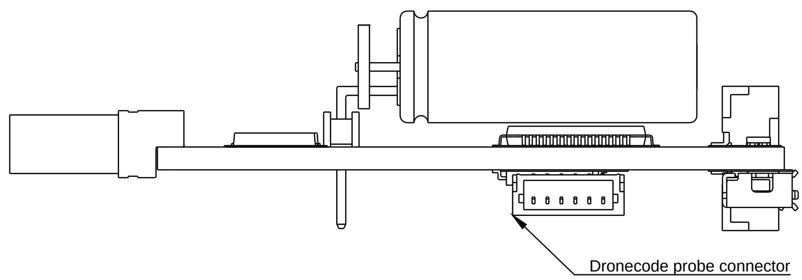


Figure 3.2: Dronecode debug port placement

3.3.1 CAN bus

The device is equipped with a single (Myxa A) or doubly-redundant (Myxa B) ISO 11898-2 CAN 2.0B interface. Each CAN interface has two standard UAVCAN Micro connectors[4] which are joined in parallel. Please note that the CAN bus must be terminated externally since it cannot be terminated internally by the device.

The secondary CAN bus interface (CAN2) can only be used with redundant CAN bus configurations. With non-redundant CAN bus configurations, only the primary CAN bus connectors (CAN1) should be used with the secondary CAN2 bus connectors being left unconnected. In the case of Myxa A, only the CAN1 interfaces are available; the CAN2 connectors are not installed.

[4] Refer to `http://uavcan.org` for more information on UAVCAN.

Pin no.	Type	Function	Comment
1	Power	Bus power supply	+5 V_{DC} nominal
2	Input/output	CAN high	
3	Input/output	CAN low	
4	Ground	Ground	

Table 3.1: CAN bus connectors pinout

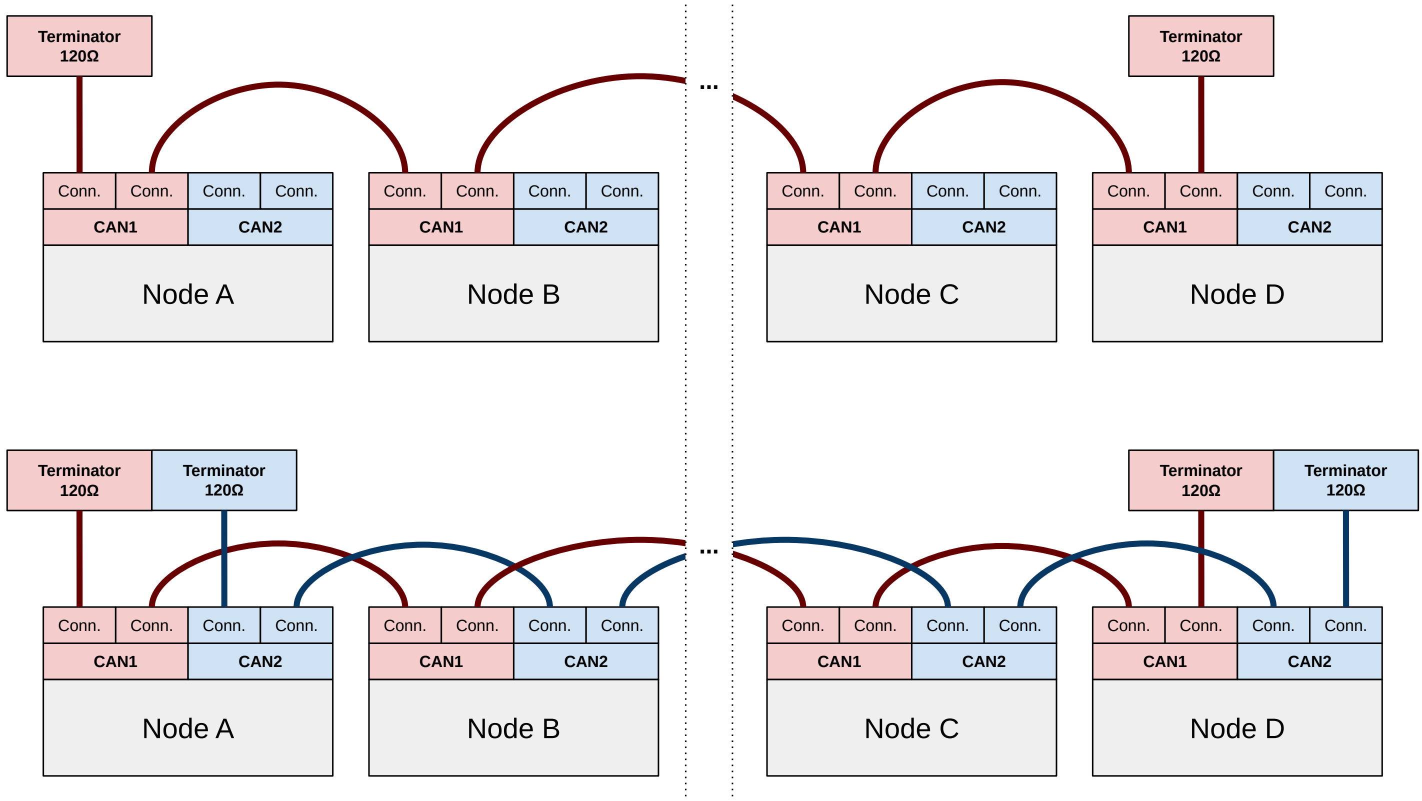


Figure 3.3: Connection of CAN nodes

3.3.1.1 *BEC output (Myxa B only)*

Myxa B does not consume power from the 5 V rail exposed via the CAN connectors but it can supply power to it if the BEC[5] power output is enabled.

Myxa B features one independent software-controllable BEC output per CAN interface. Each BEC output features an independent constant voltage, constant current (CV/CC) power source. Each output is protected from reverse current flow with ideal diodes so that the device is not back-powered from the bus if the main power is disconnected.

Long-term operation in constant current mode may cause the device to exceed its safe thermal envelope due to the increased heat dissipation from the embedded step-down converter and BEC current regulator.

BEC outputs for both CAN interfaces are controlled by a single software parameter. Please refer to the Telega reference manual for further information on configuring this feature.

3.3.2 Dronecode debug port

The device features a Dronecode debug port. This port accepts a standard Dronecode Mini debug connector (DCD-M)[6] and provides access to the serial interface which may be used to configure the controller. The Dronecode debug port is only accessible on unenclosed devices (Myxa A0/B0).

This interface uses the Popcop protocol to communicate with Kucher.[7] The default UART parameters are

[5] Battery elimination circuit.
[6] Refer to the Dronecode documentation for more information on standard connectors and communication interfaces.
[7] Kucher is the GUI software for Telega-based products.

115200-8N1.

Pin no.	Type	Function	Comment
1	Power	Power output	Unfused internal 5 V power rail. Not for production use.
2	Output	UART TX	
3	Input	UART RX	Pulled down with a resistor
4	Input/Output	SWDIO	Not for production use
5	Input	SWDCLK	Not for production use
6	Ground	GND	

Table 3.2: Dronecode Mini debug connector pinout

3.3.3 USB interface

Myxa features a full-speed USB 2.0 port with a standard CDC ACM interface providing driverless compatibility with all major operating systems (GNU/Linux, Windows, macOS). It accepts a standard USB Micro-B connector and will report the following properties to the USB host when connected:

- Vendor ID – $1D50_{16}$
- Product ID – $60C7_{16}$
- Vendor string – `Zubax Robotics`
- Device description string – `Zubax Robotics Telega`

If the USB interface is connected while the main power is unavailable, the device will operate in a degraded mode suitable for configuration and management activities only. In degraded mode, the power stage will be nonoperational and the BEC power output will be unavailable. As long as the main power remains disconnected, the device will report a low-voltage power supply (LVPS) error. The device will always report itself as a bus-powered USB device regardless of the availability of the main power.

The USB interface uses the Popcop protocol to communicate with Kucher[8].

The USB interface is not recommended for real-time motor control because electromagnetic interference from the power stage may render it unstable.

3.3.4 Auxiliary

Zubax Myxa is equipped with two GPIO pins that are available on the Auxiliary connector. While GPIO2 can only be used for GPIO purposes, GPIO1 can also be used to enable additional functions with software. These functions are: 1) the thermistor input; and 2) the RC PWM input.

Pin no.	Type	Function	Comment
1	Power	Power output	+5 V_{DC} power output with PTC fuse
2	Input/Output	GPIO1	RC PWM input or thermistor input
3	Input/Output	GPIO2	
4	Ground	GND	

Table 3.3: AUX connector pinout

3.3.4.1 Thermistor input

The PTC thermistor measures the motor windings' temperature. Myxa supports KTY84/130, KTY81/120 and KTY83/120 thermistors which should be connected directly between the GPIO1 and GND pins of the AUX connector; no additional components are needed.

Note that most commercially-available BLDC motors do not have an embedded temperature sensor and therefore require the end-user to install one. This is a relatively simple procedure that involves: 1) soldering extension wires to the thermistor; and 2) gluing the thermistor to the motor winding with epoxy resin.

Please refer to the Telega reference manual for additional information on this feature.

[8] Kucher is the GUI software used for Telega-based products.

3.3.4.2 *RC PWM input*

Zubax Myxa also supports the older analog RC PWM interface. Although this may be slow and prone to electromagnetic interference, it remains one of the most widely-used ESC interfaces in the industry.

The RC PWM input should be connected to the GPIO1 pin of the AUX connector and then configured in the firmware. Telega firmware is highly configurable when using the RC PWM interface. For a detailed description, please refer to the Telega reference manual or Myxa quick start guide.

3.4 LED indication

Myxa is equipped with four (Myxa A) or five (Myxa B) LEDs that indicate the status of the hardware and software. Their positions are shown in the figure 3.4 below.

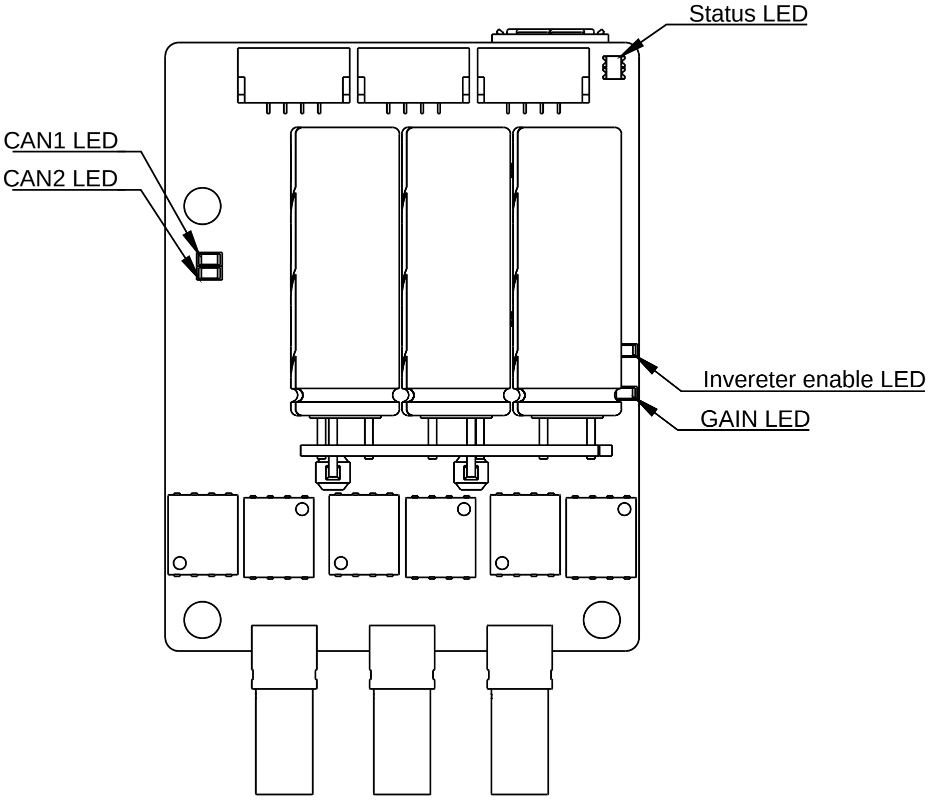


Figure 3.4: LEDs placement drawing

3.4.1 CAN LEDs

The CAN1 and CAN2 LEDs indicate the flow of data through the CAN buses. It blinks in **green** once if at least one CAN frame was successfully transmitted or received within the last 25 milliseconds. It remains constantly **green** when the CAN traffic on the bus rises above 40 frames per second.

Myxa A does not have a CAN2 LED.

3.4.2 Inverter-enabled LED

The Inverter-enabled LED indicates that the power stage is armed. When enabled, the LED will illuminate in **orange**.

3.4.3 Gain LED

The Gain LED reflects the status of the AGC of the phase current measurement circuit. When the LED is on, the gain is low; when off, it is high. The LED illuminates in **orange**.

3.4.4 Status LED

The Status LED indicates the current state of the device control logic.

3.4.4.1 Bootloader

During boot-ups and firmware updates, the LED will report a status as shown in table 3.4.

Color	Status	Description
Yellow	No application to boot	The firmware has not been flashed to the ESC or the firmware has been damaged.
Blue	Application being upgraded	The application is in the process of being upgraded.
Green	Boot canceled	The device firmware has not been properly signed.
Magenta	Ready to boot	The device has power but has yet to load the application.

Table 3.4: Status LED during boot

3.4.4.2 Normal mode

During normal operation, the Status LED will blink **blue**. If the device is incorrectly configured or the hardware is malfunctioning, the Status LED will blink **red**. A detailed description of the blinking pattern and the associated error states is provided in the Telega reference manual.

Note that the error codes can also be read via UART, USB, or CAN interfaces.