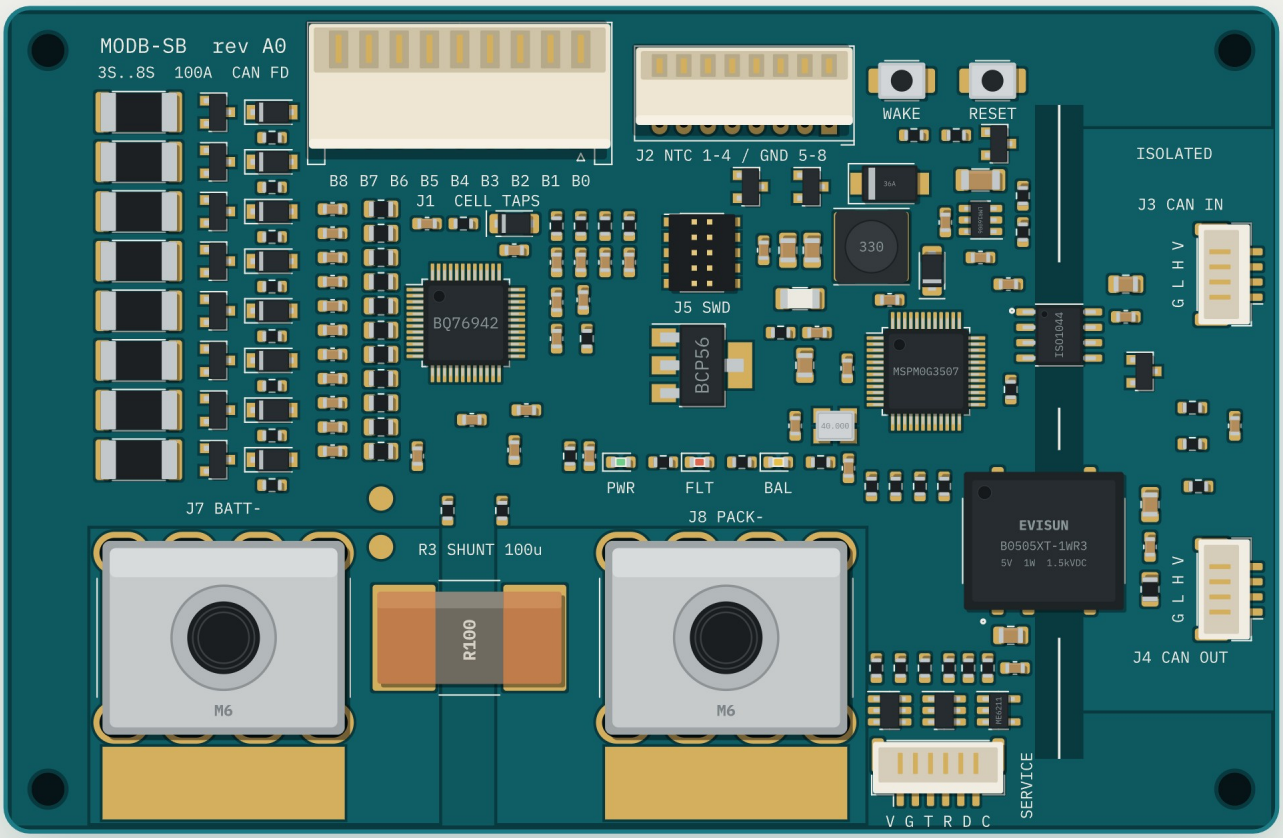
> SMART BATTERY MANAGEMENT · 3S–8S

MODB-SB

Monitoring BMS module for drone and drone-dock battery packs. Measures, balances and reports. Never disconnects the pack.

Every cell, the pack current and five temperatures, published to the flight controller, dock or ground station over isolated CAN FD and DroneCAN.



Rev A0 KiCad placement render · shown with optional M6 terminals and external balancing

3–8S	**100 A**	**±5 mV**	**CAN FD**	**16**	**<10 µA**
series cells · Li-ion or LiFePO4	continuous · 150 A burst	cell voltage, typ at 25 °C	isolated · DroneCAN	modules per bus, stackable	ship-mode draw

MEASURE · BALANCE

- Cell voltage, pack current and 5 temperatures, continuously
- ±300 A current range on a 100 µΩ, 25 ppm/°C shunt
- Passive balancing at 62 mA, or 170 mA with the external stage
- SoC and SoH computed on board

REPORT · INTEGRATE

- Galvanically isolated CAN FD with DroneCAN; CAN 2.0B compatible
- Parallel packs and series-stacked modules on one bus
- Fault detection and reporting, 32-event fault log
- 105 × 68 mm, parts 7.25 mm above the board

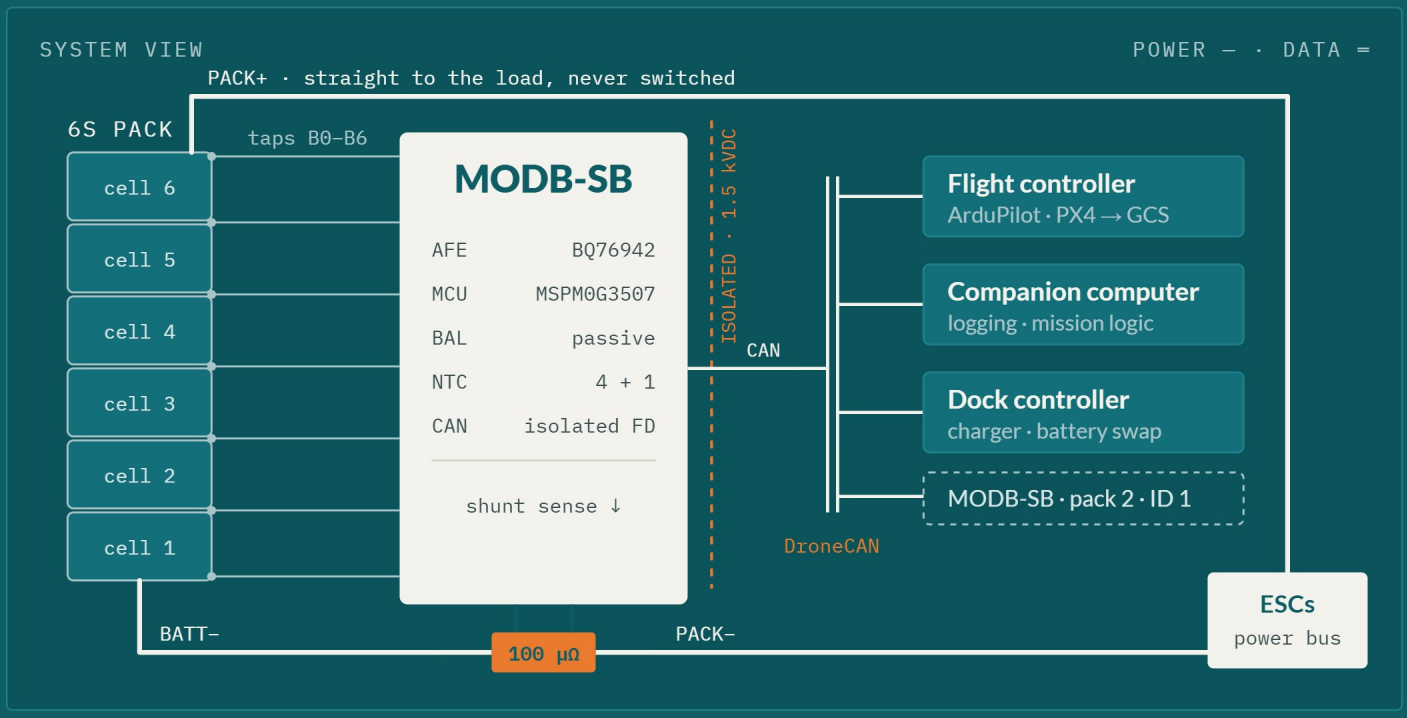
APPLICATIONS

- Multirotor and VTOL packs
- Drone docks and battery-swap stations
- Dual- and multi-pack airframes
- Series packs beyond 8S

> § 02 / WHY MODB-SB

A drone battery is eight cells, not one voltage.

Most flight controllers read one pack voltage and one current from a power module. A weak, hot or drifting cell shows up only as sag under load, usually late in the flight. MODB-SB sits on the pack, watches every cell and puts that data on the CAN bus the aircraft already uses.



01

Monitors. Never disconnects.

No power MOSFETs, relay or contactor in the pack path. A BMS that opens the power path in flight turns a cell warning into a crash. MODB-SB detects and reports each fault; the flight controller decides whether to land, return or carry on.

02

Isolated from the airframe.

The CAN side has its own isolated 5 V supply and ground behind a 4 mm barrier. Ground offsets between packs, ESC returns and the flight controller stay off the bus, and modules at different pack potentials share it.

03

Speaks DroneCAN.

Battery data goes out as standard DroneCAN battery messages, which ArduPilot and PX4 already read. Classic CAN 2.0B and CAN FD run on the same transceiver.

IN FLIGHT

The flight controller sees the weakest cell, not the average, and can trigger failsafes on it.

ON THE DOCK

The dock reads SoC, cell spread and temperatures before it charges. Balancing runs while the pack sits.

ACROSS THE FLEET

SoH and the fault log live on the pack, so packs are retired on data rather than guesswork.

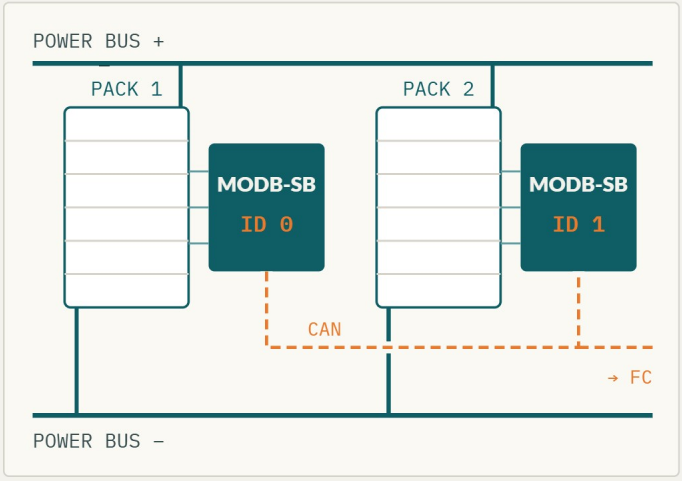
> § 03 / STACKABLE ARCHITECTURE · ISOLATED CAN

One bus for every pack on the aircraft.

Each MODB-SB is a node on an isolated CAN bus, with a node ID set by four solder jumpers (16 per bus). Two connectors carry the bus in and out of every module, so packs daisy-chain without a hub. Stack them side by side for more capacity, or end to end for more voltage.

Parallel packs

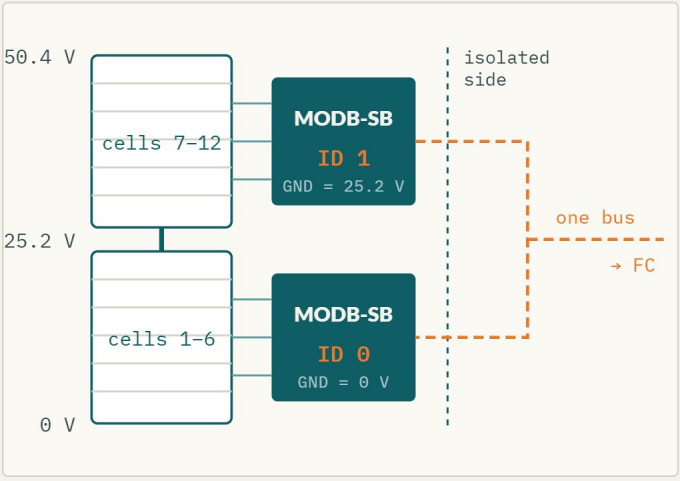
MORE CAPACITY



Dual-battery airframes and swap docks. Every pack reports its own cells, current, SoC and SoH under its own ID, so the flight controller or dock sees each battery separately.

Series modules

MORE VOLTAGE



Beyond 8S, stack segments end to end: two 6S modules make a 12S pack. Each module is referenced to its own segment, and the isolated CAN side lets both share one bus despite the 25 V offset.

Daisy chain and termination

J3 CAN IN → J4 CAN OUT



Only the two ends of the bus are terminated: close TERM on the last module, leave it open on the rest.

PHYSICAL LAYER

- TI ISO1044 isolated transceiver: CAN FD data phase up to 5 Mbit/s, 3 kVrms rated
- Isolated 5 V generated on board (1 W, 1.5 kVDC); nothing is powered from the harness
- Nominal bit rate 250 k, 500 k or 1 Mbit/s; 40 MHz crystal clocks the CAN FD timing
- Split termination 2 × 62 Ω + 4.7 nF, closed by solder jumper
- TVS on CANH/CANL; transceiver tolerates ±58 V bus faults

PROTOCOL

- DroneCAN battery messages, read natively by ArduPilot and PX4
- Runs on CAN FD or classic CAN 2.0B framing
- Node ID 0–15 from jumpers JID0–JID3 on the back of the board
- Faults reported on the bus within 100 ms (design target)
- Configuration and commands over CAN or the service port

> § 04 / SENSING · STATE ESTIMATION · BALANCING · POWER

Knows the state of every cell.

Sensing

TI BQ76942 AFE

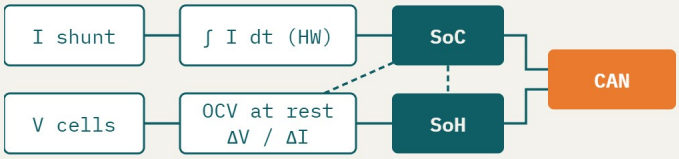
±5 mV	±300 A	2.93 ms	5
cell voltage, typ 25 °C	current range	current sample period	temperature points

Every tap reaches the AFE through its own 20 Ω / 0.22 µF filter; taps can be plugged in any order. Pack current is read across a 100 µΩ, 25 ppm/°C shunt with Kelvin sense lines, so shunt drift over a 60 °C swing stays near 0.15 %. Four external 10 kΩ NTCs cover the cells and a fifth sensor sits on the shunt.

VOLTAGE	up to 8 cells, plus the stack
CURRENT	charge and discharge, one shunt
TEMPERATURE	4 cell NTCs, shunt sensor
CHARGE	hardware coulomb counter

State of charge and health

ON-BOARD FIRMWARE



SoC is coulomb counted by the AFE's hardware integrator, which accumulates shunt current continuously. When the pack rests, the count is re-anchored to the cells' open-circuit voltage for the configured chemistry, and to 100 % at end of charge, so counting error does not build up over flights.

SoH tracks two things: usable capacity, measured from the charge counted between rest points against the rated capacity, and cell resistance, from the voltage step when the load changes. Both travel with the pack.

Cell balancing

PASSIVE · PER CELL

internal	62 mA
+ external	170 mA

typical per cell at 4.2 V; the external stage adds to the internal path

The AFE bleeds high cells through the 20 Ω tap resistors. For large packs or short dock turnarounds, a build option fits an external stage (NPN + 22 Ω, 1 W per cell). Balancing starts on its own above a set cell voltage and cell-to-cell difference, or on command; firmware limits internal balancing to 3 cells at once to keep the AFE cool.

Power modes

DRAW FROM PACK · 6S

MODE	CURRENT	WAKES ON
Active	22–36 mA	always on, CAN live
Light sleep	≈ 10 mA	CAN activity
Deep sleep	< 100 µA	pack current, service port
Ship	< 10 µA	WAKE button

Active draw includes the isolated CAN side, which stays powered so the bus is always live. Ship mode shuts down the AFE and every regulator.

Fault detection and reporting

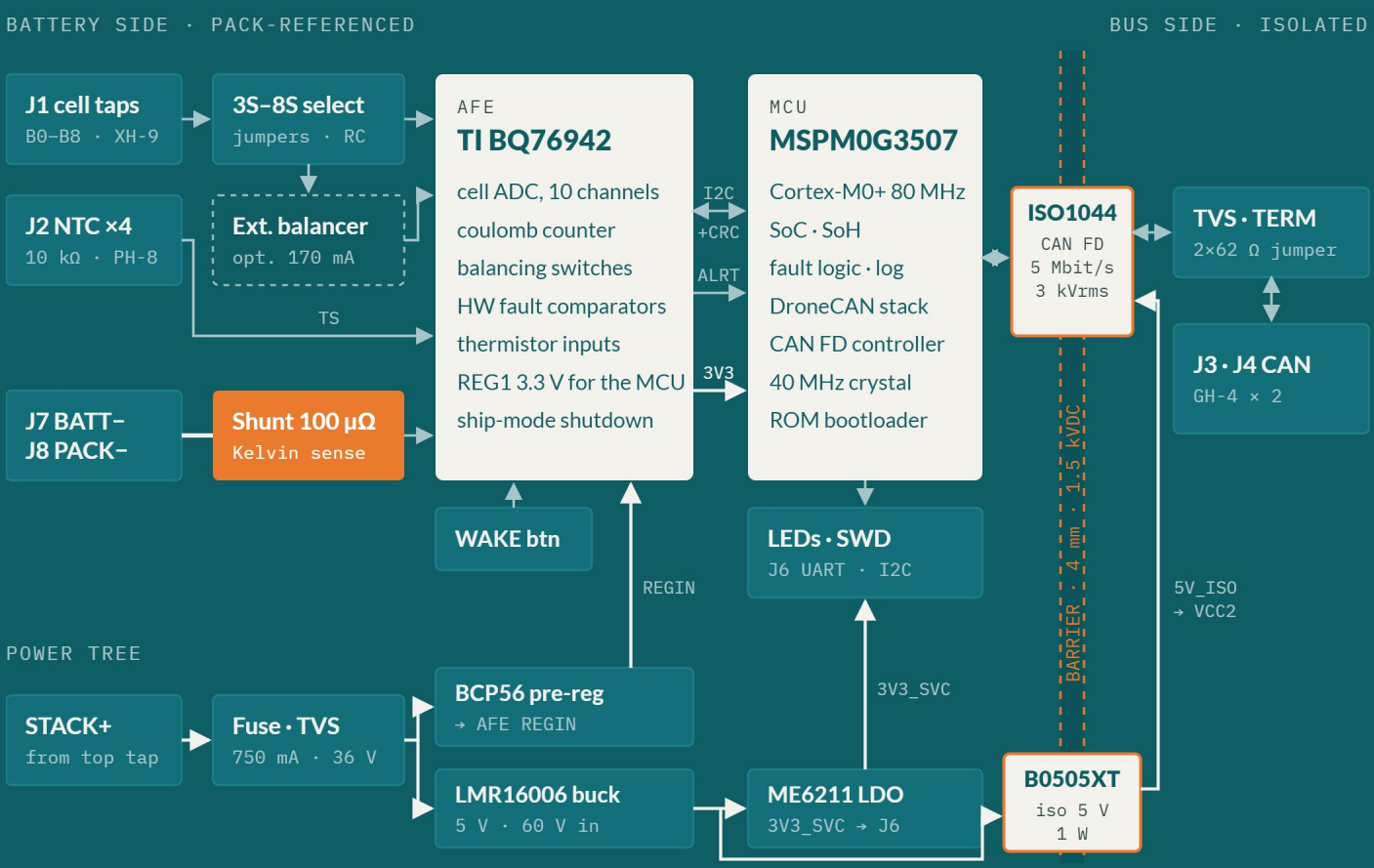
DETECT · REPORT · LOG

Cell over-voltage Cell under-voltage	**Over-current** charge and discharge	**Short circuit** in discharge	**Over- / under-temp** cells and shunt

Each fault has its own threshold and delay, set in firmware. The AFE's hardware comparators catch fast events; the MCU reports every fault on CAN and lights the FLT LED. A cell-count setting that does not match the wired pack is flagged too. The last 32 events are kept in high-endurance flash for readout over CAN or the service port. Nothing is disconnected: acting on a fault is the host's decision.

> § 05 / FUNCTIONAL BLOCK DIAGRAM

Two domains, one 4 mm barrier.



Core silicon

FUNCTION	PART	WHY THIS ONE
AFE	**TI BQ7694202**	3–10S monitor, hardware coulomb counter, integrated balancing, I2C with CRC
MCU	**TI MSPM0G3507**	Cortex-M0+ 80 MHz, 128 KB flash, 32 KB RAM, CAN FD controller
CAN	**TI ISO1044**	Isolated CAN FD to 5 Mbit/s, 3 kVrms, > 4 mm creepage
ISO PSU	**B0505XT-1WR3**	1 W, 1.5 kVDC, 7.25 mm SMD body
BUCK	**TI LMR16006X**	60 V input, 0.6 A, 700 kHz
SHUNT	**HoLRS1575**	100 µΩ, ±25 ppm/°C, 7 W

Design notes

- Powered from the tap harness: the top cell tap feeds the board through the fuse and TVS. No separate supply wire.
- Only the transceiver and the isolated DC-DC cross the barrier. Battery ground is Kelvin-tied at the shunt.
- Current path planned as wide pours on both 2 oz outer layers of a 4-layer board. PACK+ never touches the board.
- Parts chosen from JLCPCB and LCSC stock, with alternates in the BOM.

> § 06 / ELECTRICAL SPECIFICATIONS

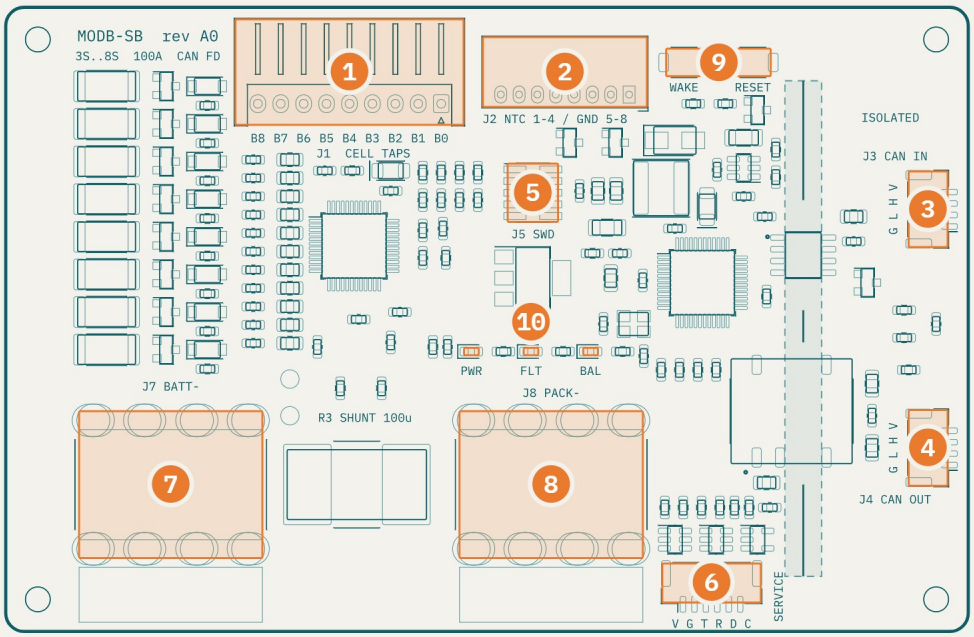
Specifications

Preliminary, rev A0. Values are design figures from the component datasheets, to be replaced by measured data after prototype tests. 6S Li-ion at 25 °C unless noted.

PARAMETER	CONDITIONS	MIN	TYP	MAX	UNIT	NOTE
ABSOLUTE MAXIMUM RATINGS						
Stack voltage, top tap to B0		–	–	36	V	design limit, TVS stand-off
Pack current, continuous	BATT− → PACK−	–	–	100	A	
Pack current, burst	duration TBC	–	–	150	A	
Isolation, bus side to battery side	1 min	–	–	1500	VDC	isolated DC-DC rating
CAN bus voltage	CANH, CANL to GND_ISO	−7	–	12	V	TVS stand-off; transceiver ±58 V
ESD, connector pins	IEC 61000-4-2 contact	–	–	±8	kV	design target
RECOMMENDED OPERATING CONDITIONS						
Series cells	jumpers + firmware	3	–	8	S	Li-ion or LiFePO4
Stack voltage		8	–	33.6	V	min: AFE regulator headroom
Ambient temperature		−20	–	65	°C	design target
Modules per CAN bus		–	–	16		
MEASUREMENT						
Cell voltage error	25 °C	–	±5	–	mV	
Current range		−300	–	300	A	reported in 10 mA units
Current resolution	single sample	–	76	–	mA	
Current offset	after calibration	–	±76	–	mA	
Current error	> 10 A, averaged	–	±1	–	%	target
Shunt temperature coefficient	100 µΩ, 7 W part	–	–	±25	ppm/°C	
Current conversion period		–	2.93	–	ms	
Temperature inputs		–	4 + 1	–		10 kΩ NTC, B 3380 K
BALANCING						
Internal balancing current	4.2 V cell	49	62	76	mA	
Internal channels active at once	firmware limit	–	–	3		
External balancing current	option, 4.2 V cell	–	170	–	mA	22 Ω, 1 W per cell
SUPPLY CURRENT FROM THE STACK · 6S, 25.2 V						
Active	CAN live	22	–	36	mA	
Light sleep	wake on CAN	–	10	–	mA	
Deep sleep		–	–	100	µA	
Ship mode		–	–	10	µA	
COMMUNICATION AND I/O						

> § 07 / INTERFACES · CONFIGURATION

Connectors on the edges, settings on the back.



1. **J1 · Cell taps** — XH 2.5 mm · 9-pin
2. **J2 · Thermistors** — PH 2.0 mm · 8-pin
3. **J3 · CAN in** — GH 1.25 mm · 4-pin
4. **J4 · CAN out** — GH 1.25 mm · 4-pin
5. **J5 · SWD** — 1.27 mm · 2×5
6. **J6 · Service port** — GH 1.25 mm · 6-pin
7. **J7 · BATT−** — M6 or solder pad
8. **J8 · PACK−** — M6 or solder pad
9. **SW1 · 2 · Wake, reset** — push buttons
10. **D5–7 · Status LEDs** — PWR · FLT · BAL

Pinouts

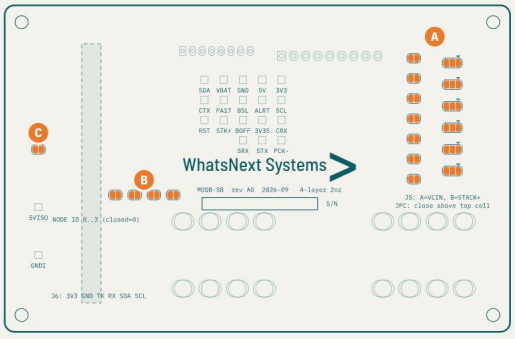
PIN 1 FIRST · ORANGE = KEY SIGNAL

	1	2	3	4	5	6	7	8	9	10
J1 · Cell taps	B0	B1	B2	B3	B4	B5	B6	B7	B8	
J2 · Thermistors	NTC1	NTC2	NTC3	NTC4	GND	GND	GND	GND		
J3 · J4 · CAN	GND_ISO	CANL	CANH	VBUS*						
J6 · Service	3V3	GND	TX	RX	SDA	SCL				
J5 · SWD	3V3	SWDIO	GND	SWCLK	GND	–	–	–	GND	nRST

B0 is cell 1 negative. NTC: 10 kΩ, B 3380 K. J6 is UART0 (bootloader port) and I2C1, 3.3 V at up to 250 mA, not isolated. *J3/J4 pin 4 stays open unless the 0 Ω link R52 is fitted, and the pin order is not the Pixhawk DS-009 order: use a matching harness. J7/J8 take an M6 terminal (120 A, test builds) or a soldered cable on a 20 × 12 mm pad.

Bottom side

VIEWED FROM BELOW



A cells · B node ID · C termination

Solder-jumper settings

+ MATCHING FIRMWARE SETTING

A	JS3	JS4	JS5	JS6	JS7	JS8	CLOSE
3S	B	·	·	·	·	·	JPC3–9
4S	A	B	·	·	·	·	JPC4–9
5S	A	A	B	·	·	·	JPC5–9
6S	A	A	A	B	·	·	JPC6–9
7S	A	A	A	A	B	·	JPC7–9
8S	A	A	A	A	A	B	JPC8–9

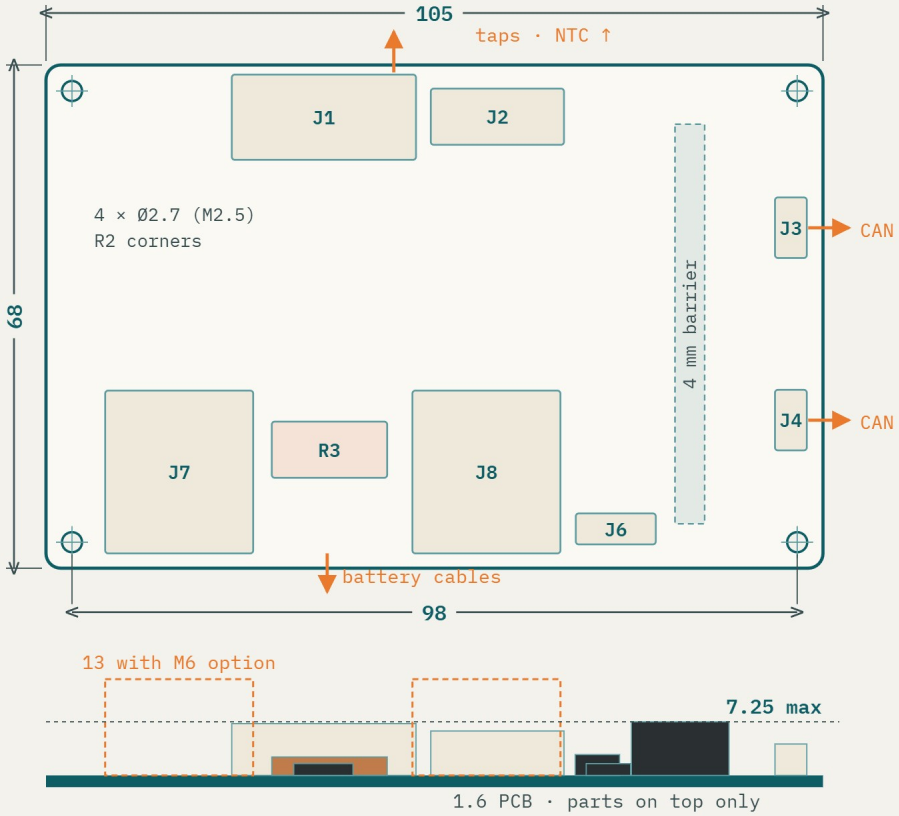
A cell (VCIN) · **B** top cell (STACK+) · · open. Wire B0 up to BN; leave higher taps empty.

B · JID0–JID3 form the 4-bit node ID; a closed jumper is a 0.

C · TERM closed adds the 124 Ω split termination. Close it on the last module only.

> § 08 / MECHANICAL · INTEGRATION · ORDERING

Built to live on the pack.



Dimensions in mm, top view. Connector outlines from the rev A0 placement.

Physical

Outline	105 × 68 mm
Height	parts 7.25 mm above the PCB · 13 mm with M6
PCB	4-layer, 1.6 mm, 2 oz outer
Mounting	4 × M2.5, 98 × 61 mm pattern
Mass	≈ 40 g, estimate
Coating	conformal-coat compatible
Parts	top side only; jumpers and test pads below

Telemetry on CAN

	TARGET RATES
Pack current	10 Hz
Cell and stack voltages	≥ 1 Hz
Temperatures, 5 points	≥ 1 Hz
SoC, SoH, capacity left	with cell data
Balancing status	with cell data
Faults	on event, ≤ 100 ms target
Fault log, 32 events	on request

DroneCAN battery messages, rates configurable. Settings and fault log over CAN or the service port.

Integration in five steps

FIRST POWER-UP

01 Set the cell-count jumpers and the matching firmware setting.

02 Wire BATT− to the pack negative, PACK− to the load and charger. PACK+ bypasses the board.

03 Plug in the cell taps, in any order, and the NTCs.

04 Set the node ID. Close TERM on the last module only.

05 Connect CAN. The pack appears on DroneCAN.

BUILD OPTION	STANDARD	ALTERNATIVE
Power connection	soldered cables on 20 × 12 mm pads · 7.25 mm tall	M6 terminals, 120 A · 13 mm tall
Balancing	internal, 62 mA per cell	external stage fitted, 170 mA per cell
Cell count, node ID, termination	solder jumpers, set at integration (page 07)	

If the battery layer is in your way, write to us.

Rev A0: schematic and placement complete, routing next. Prototype samples and measured data follow.

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