UM12672

MR-VMU-Tropic user manual

Rev. 1.0 — 5 November 2026 User manual

Document information

Information	Content
Keywords	MR-VMU-Tropic, i.MX RT1064, user manual, flight controller, PX4
Abstract	This document is the user manual for the MR-VMU-Tropic flight controller. It explains how to prepare and flash the firmware, and how to run the PX4 flight stack.

1 Introduction

The MR-VMU-Tropic is the flight controller (vehicle management unit) reference design of the NXP Mobile Robotics family. It is a PX4/NuttX autopilot built around an NXP i.MX RT1064 crossover MCU, providing the real-time flight-control and I/O functions of a drone or mobile robot. The board is intended as a validated flight controller starting point that customers can evaluate, reproduce, and adapt for their own vehicles.

The i.MX RT1064 is an NXP crossover MCU based on an Arm Cortex-M7 core with integrated flash and an on-chip real-time clock. It runs the PX4 flight stack on the NuttX RTOS and drives the motor outputs, sensor interfaces, and communication links required for autonomous flight and motion control.

This user manual describes the board hardware, how to prepare the firmware images, how to flash the board, and how to run the flight stack. The connector pinouts and onboard devices are documented in the Section 4. The hardware architecture is described in the MR-VMU-Tropic hardware architecture and reference design.

1.1 NXP Robotics Platform SDK and upstream open-source software

NXP embraces an open-source development model and participates in the communities behind the software used by this product. The NXP Robotics Platform SDK provides a curated and validated set of software components, tools, and documentation that have been tested together on this hardware platform.

NXP contributes improvements and fixes back to upstream repositories. Because contributions are made on a scheduled basis, the latest upstream code and the version included in the NXP Robotics Platform SDK may not always be identical. The SDK release is recommended for users seeking a tested and supported configuration, while advanced users may choose to work with the upstream project and its latest features.

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2 Finding the kit resources and information on the NXP web site

The information page for the MR-VMU-Tropic flight-controller reference design is on the NXP web site at https://www.nxp.com/design/design-center/development-boards-and-designs/MR-VMU-TROPIC. The information page provides overview information, documentation, software and tools, and a Getting Started tab with quick-reference information, including the downloadable assets referenced in this document.

The board design files and the latest hardware reference are published in the public NXP Robotics repository at https://github.com/NXP-Robotics/MR-VMU-TROPIC. The software, images, and build tooling are distributed through the NXP Robotics Platform SDK; follow the NXP Robotic Platforms SDK README to set up the SDK and obtain the assets.

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3 Getting ready

Before flashing and running the MR-VMU-Tropic, prepare the firmware images and the tools used to deploy them.

3.1 Firmware images

The firmware for the MR-VMU-Tropic is provided through the NXP Robotics Platform SDK, which builds and downloads the images inside a docker container. The SDK produces three artifacts for the board:

1. A bootloader image
2. The PX4 application firmware (a raw binary)
3. The PX4 firmware container that QGroundControl and the PX4 uploader accept

In addition, the SDK publishes a set of Zephyr sample images for board bring-up and peripheral checks.

Obtaining or building the images with the SDK is covered in the Deploy and Run Quick Start.

3.2 Tools

- A LinkServer-compatible debug probe (MCU-Link) for the initial bootloader programming over the Dronecode debug connector
- QGroundControl, or the PX4 command-line uploader, for routine PX4 application updates over USB
- A USB-C cable for the console and PX4 firmware uploads

The debug connector and USB-C port locations are shown in Section 4.3.

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4 Getting to know the hardware

Connectors, pinouts, and onboard devices of the NXP MR-VMU-Tropic, an open-source vehicle management unit (flight controller) built around the NXP i.MX RT1064 MCU. The board carries the Dronecode DS-009 connector set (telemetry, GPS, I^2C, CAN, and debug), two ESC headers, a GPS, and safety-switch port, a SPI port for an onscreen display, 100BASE-T1 Ethernet, a microSD slot, and a USB device port. All pin data below comes from the rev F schematic SPF-94468_F. The photos show a rev C board; the connector positions are the same.

Each card shows three things per pin: the function, the net name in the schematic and the i.MX RT1064 pad the signal ends up on. Parts in between, such as the CAN transceiver and the Ethernet PHY, are shown too. Pin 1 is the square pad.

4.1 Board overview

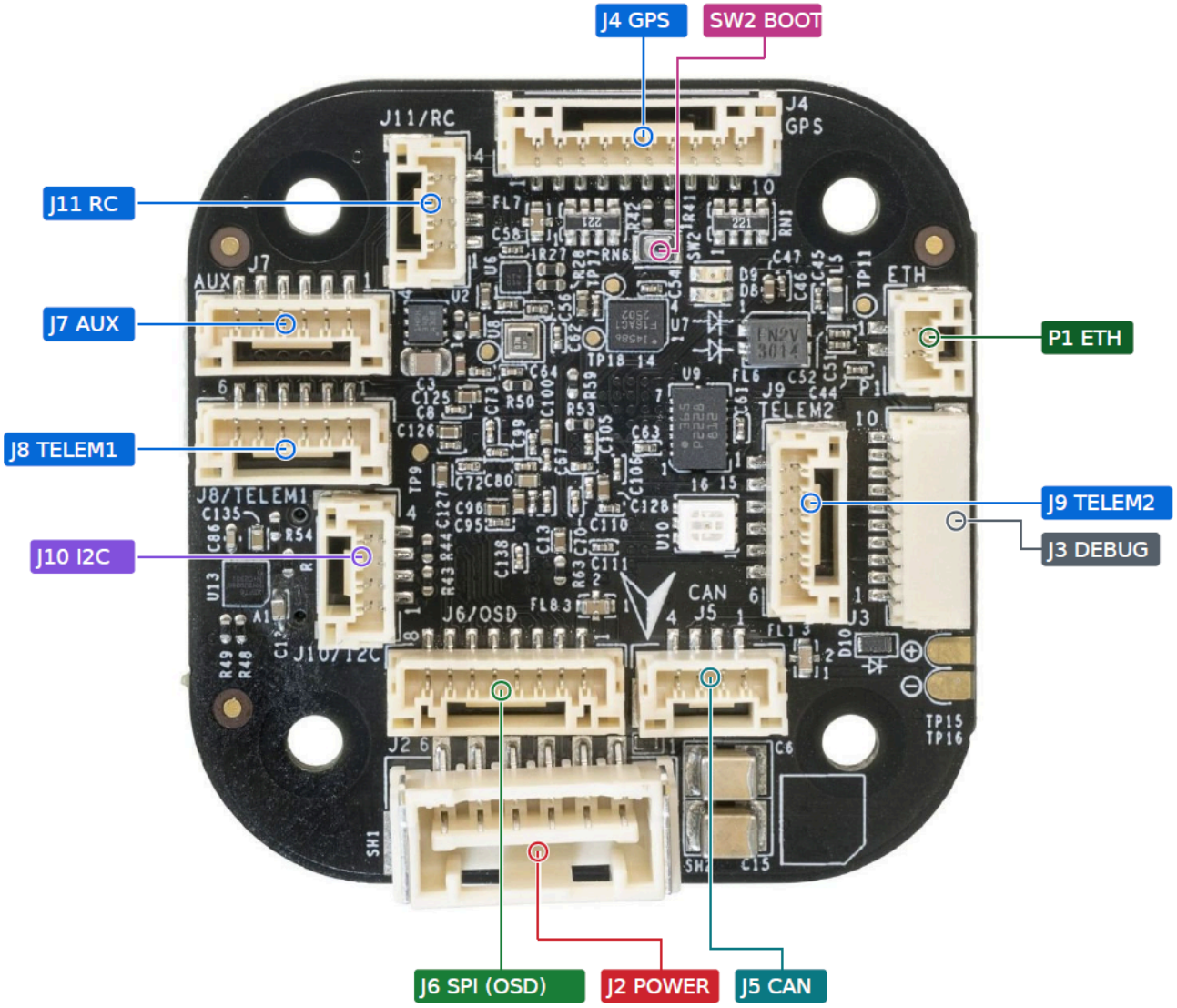


Figure 1. Board overview

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- J1 USB (bottom view)
- J12 PWM_B (bottom view)
- J13 PWM_A (bottom view)
- CN1 MICROSD (bottom view)

Bottom side with the two ESC headers, the USB-C port and the microSD slot:

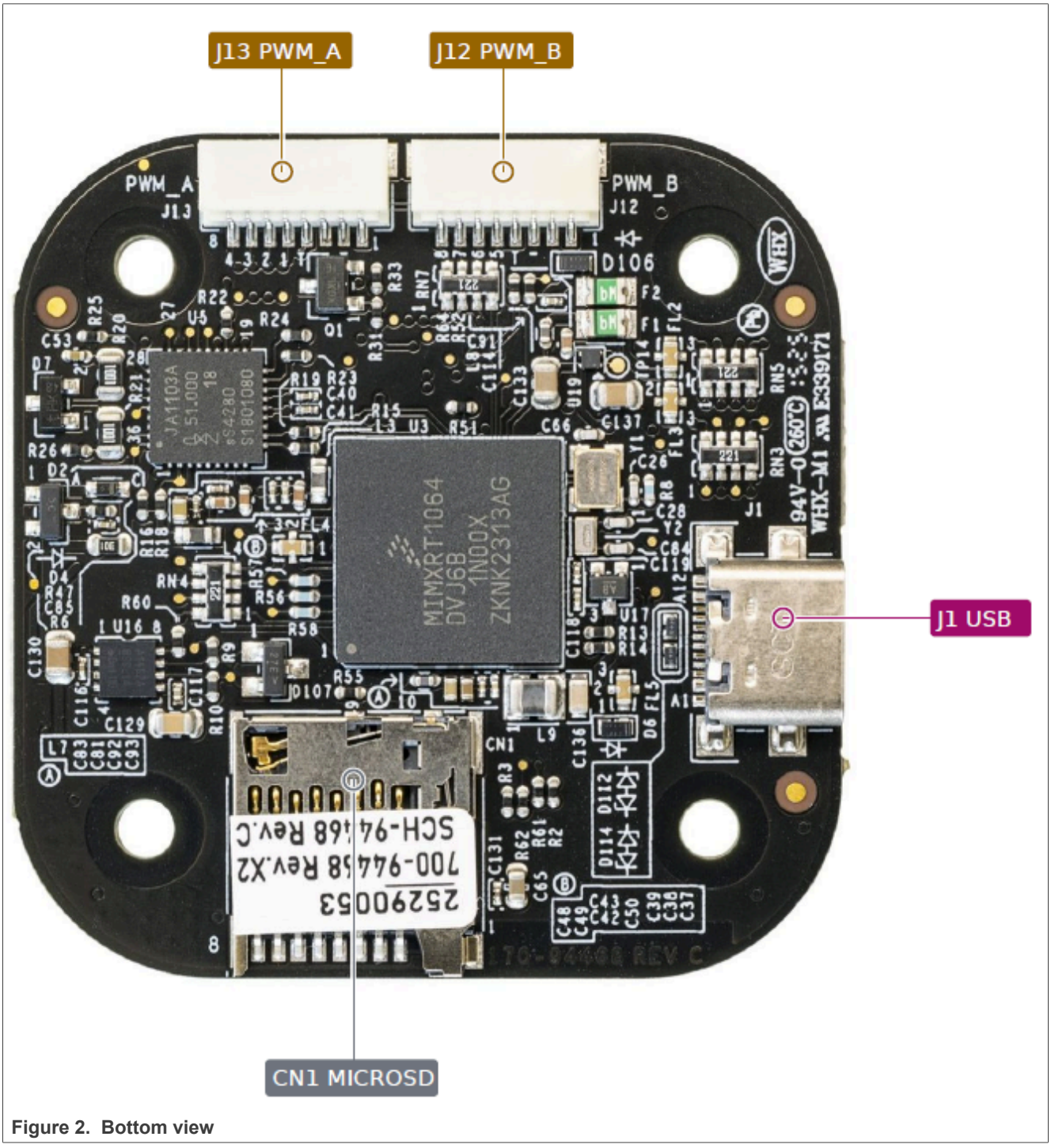


Figure 2. Bottom view

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4.2 Connector index

Reference	Function	Connector	Details
Main CN1 MICROSD	microSD card slot	microSD push-push, eight pins plus card detect	4-bit SD interface on the first SD host of the chip, used for logging; the card detect switch goes to a separate chip pin
Main J1 USB	USB 2.0 Type-C device port	USB Type-C receptacle (USB4110-GF-A)	Serial download port of the i.MX RT1064 boot ROM, and the port used for flashing; the board is always a USB device; VBUS can also power the board through protection switch U13
Main P1 ETH	100BASE-T1 single pair Ethernet	JST-GH 1x2, top entry	
Main J2 POWER	Power module input, 5 V plus battery monitor	Molex Clik-Mate 1x6 (5024430670)	
Main J3 DEBUG	SWD debug and console, DS-009 debug full layout	JST-SH 1x10	
Main J4 GPS	GPS module with compass, safety switch and buzzer	JST-GH 1x10 (BM10B-GHS-TBT), top entry	
Main J5 CAN	CAN FD (TJA1462)	JST-GH 1x4, top entry	
Main J6 SPI (OSD)	External SPI port, meant for an onscreen display board	JST-GH 1x8 (BM08B-GHS-TBT), top entry	
Main J7 AUX	Spare serial port with handshake lines	JST-GH 1x6 (BM06B-GHS-TBT), top entry	
Main J8 TELEM	Telemetry serial port 1 with flow control	JST-GH 1x6 (BM06B-GHS-TBT), top entry	
Main J9 TELEM	Telemetry serial port 2 with flow control	JST-GH 1x6, top entry	
Main J10 I^2C	External I^2C bus	JST-GH 1x4, top entry	
Main J11 RC	Serial radio control receiver port	JST-GH 1x4, top entry	
Main J12	Motor outputs	JST-SH 1x8	

4.3 Power and debug

4.3.1 Main J2 POWER

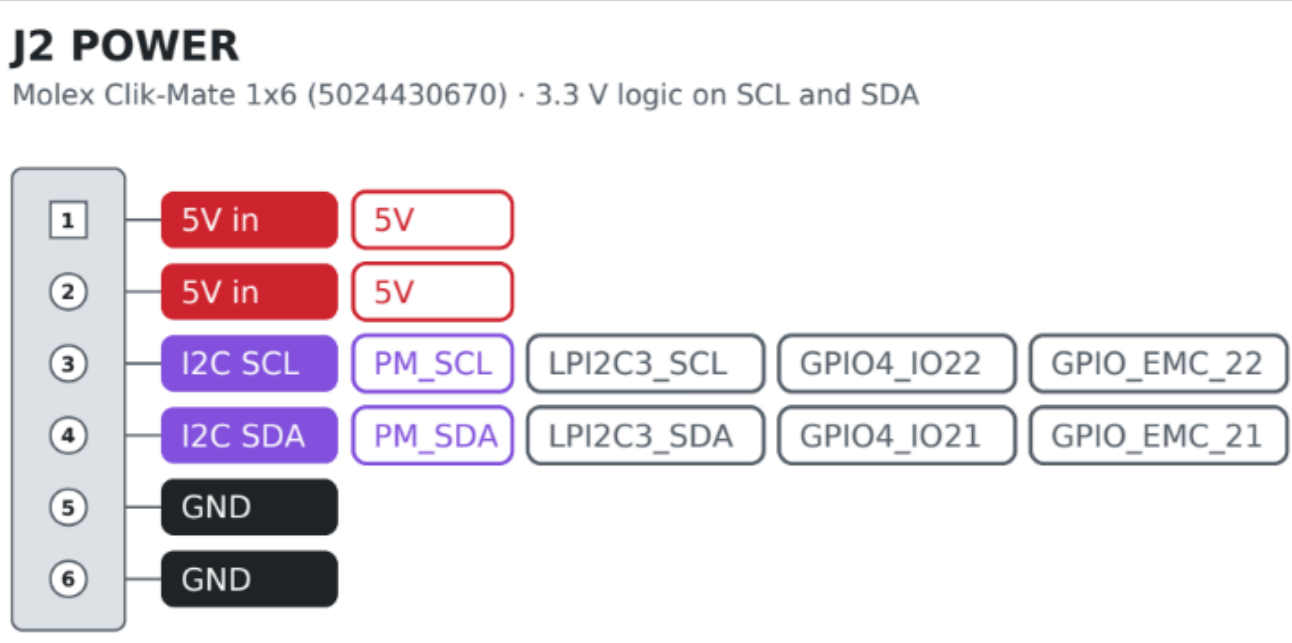


Figure 3. Main J2 POWER

This is the main supply of the board. The power module feeds 5 V into pins 1 and 2, and the board makes its own 3.3 V and 1.8 V from it. Pins 3 and 4 are an I^2C bus that reads voltage and current from the power module.

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Warning: *Feed only 5 V into pins 1 and 2. A higher voltage damages the board because there is no regulator behind this connector.*

4.3.2 Main J3 DEBUG

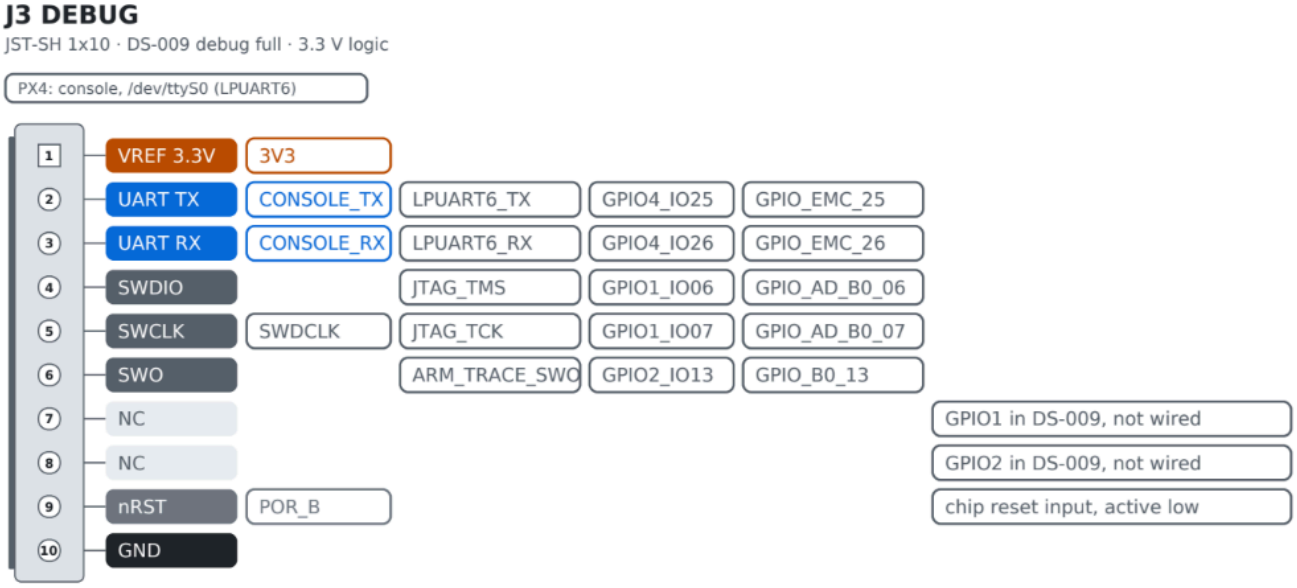


Figure 4. Main J3 DEBUG

Pin 1 is a 3.3 V reference output for the debug probe. Pins 2 and 3 are the serial console. Pins 4, 5, and 6 are the SWD lines of the i.MX RT1064. Pin 9 is the reset line of the chip, which is also pulled up on the board.

Warning: *Pin 1 is an output at 3.3 V, not a supply input. Use a debug probe that works at 3.3 V and never drive this pin.*

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4.4 Serial ports

4.4.1 Main J8 TELEM1

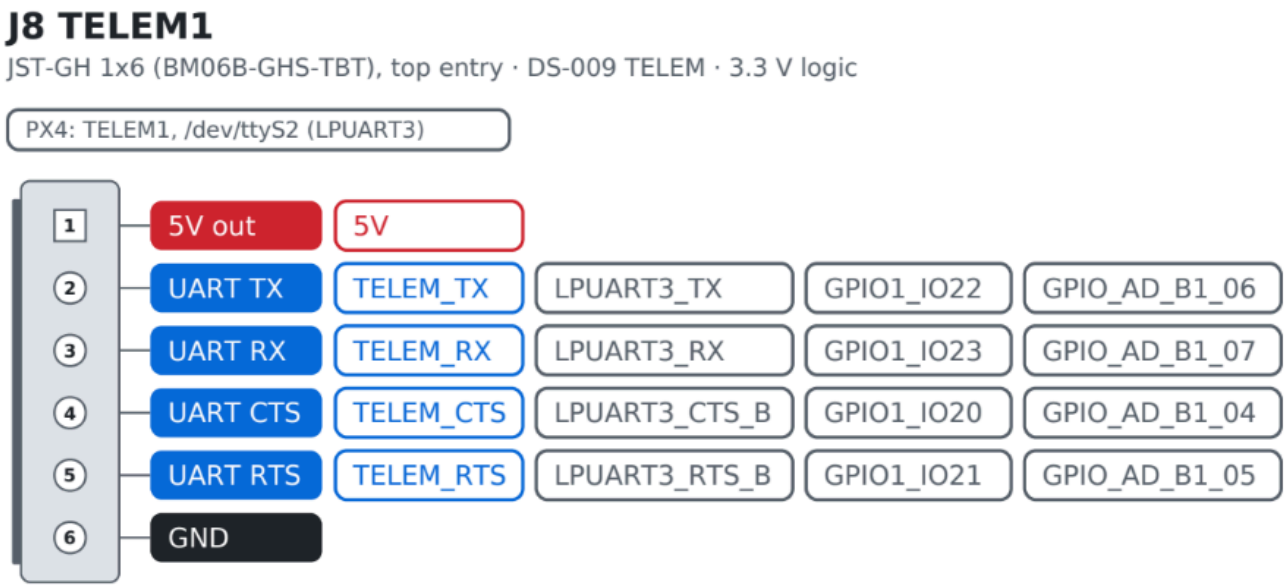


Figure 5. Main J8 TELEM1

Standard DS-009 telemetry layout: 5 V, TX, RX, CTS, RTS, ground. Pin 1 gives 5 V out through ferrite FL3.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

4.4.2 Main J9 TELEM2

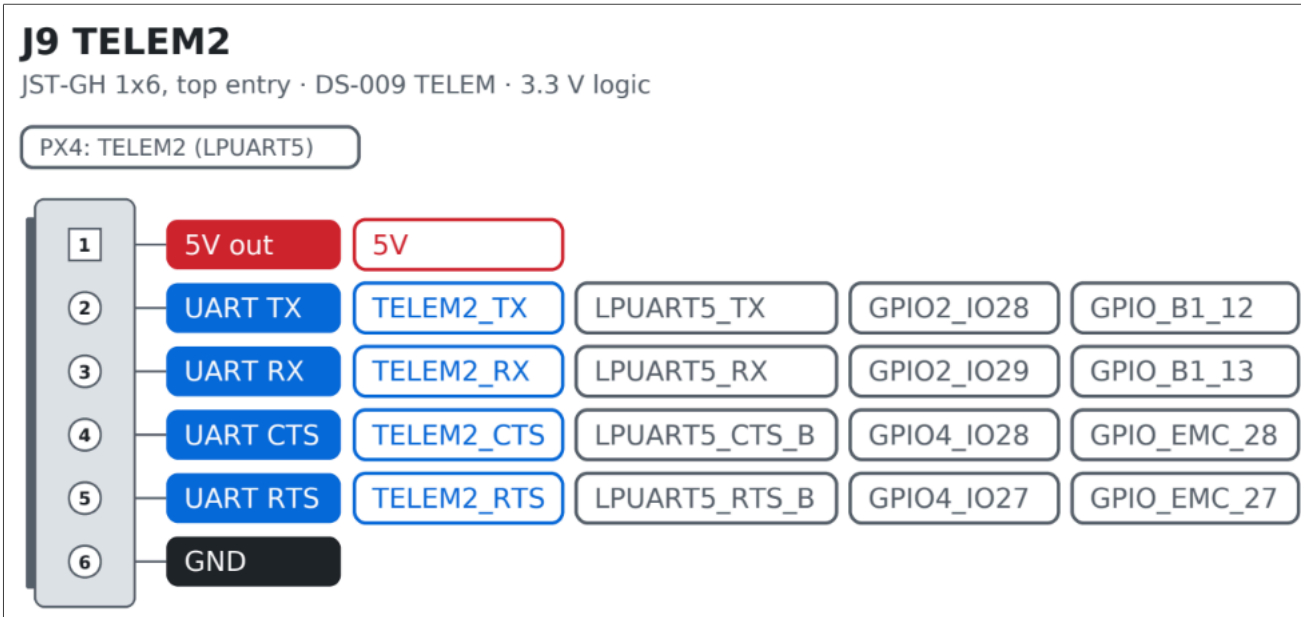


Figure 6. Main J9 TELEM2

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Same layout and same circuit as TELEM1, on a second serial port of the chip. Pin 1 gives 5 V out.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

4.4.3 Main J7 AUX

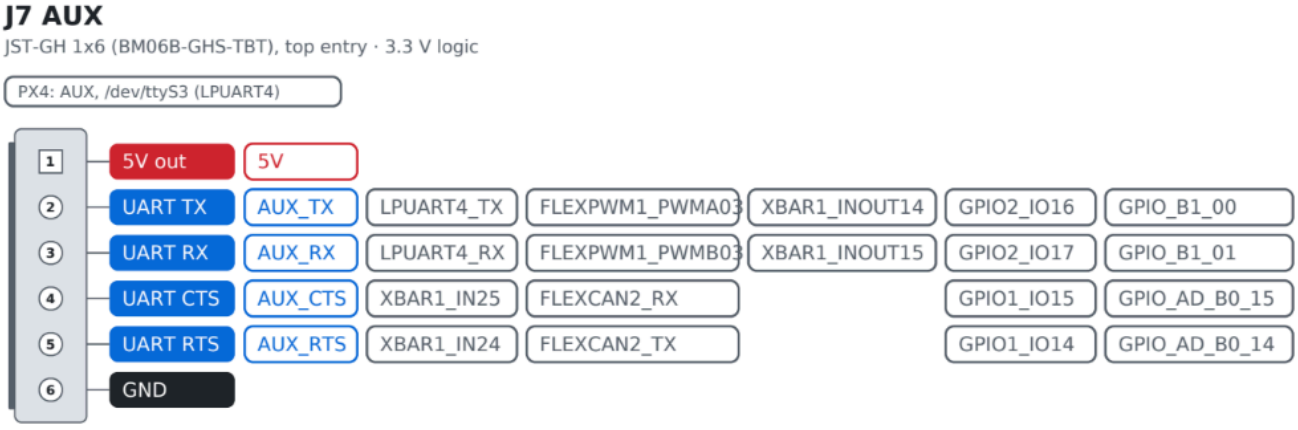


Figure 7. Main J7 AUX

Pin 1 provides a 5 V output. Pins 2 and 3 are assigned to LPUART4, which is used as the AUX serial port (/dev/ttyS3 in PX4). Pins 4 and 5 are labeled CTS and RTS in the schematic. However, these pins cannot be multiplexed to the LPUART4 hardware CTS and RTS functions and therefore cannot provide hardware flow control. If RTS/CTS flow control is required, it must be implemented in software using these pins as GPIOs.

The signal pins on this connector support several alternative functions through pin multiplexing. Pins 2 and 3 can be configured as PWM outputs using FlexPWM1 module 3, channels A and B. All four signal pins can support quadrature encoder or trigger functions through XBAR1, while pins 4 and 5 can instead provide a second CAN interface using FlexCAN2 with an external CAN transceiver.

Use of these alternative functions requires appropriate software and pin-multiplexing configuration and is left to the user.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

Note: *Confirm that the ESCs do in fact follow the BetaFlight connector standard, as there are many ESCs with variations on this pinout. Also note that wires are regularly soldered to pads on the ESC side.*

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4.4.4 Main J11 RC

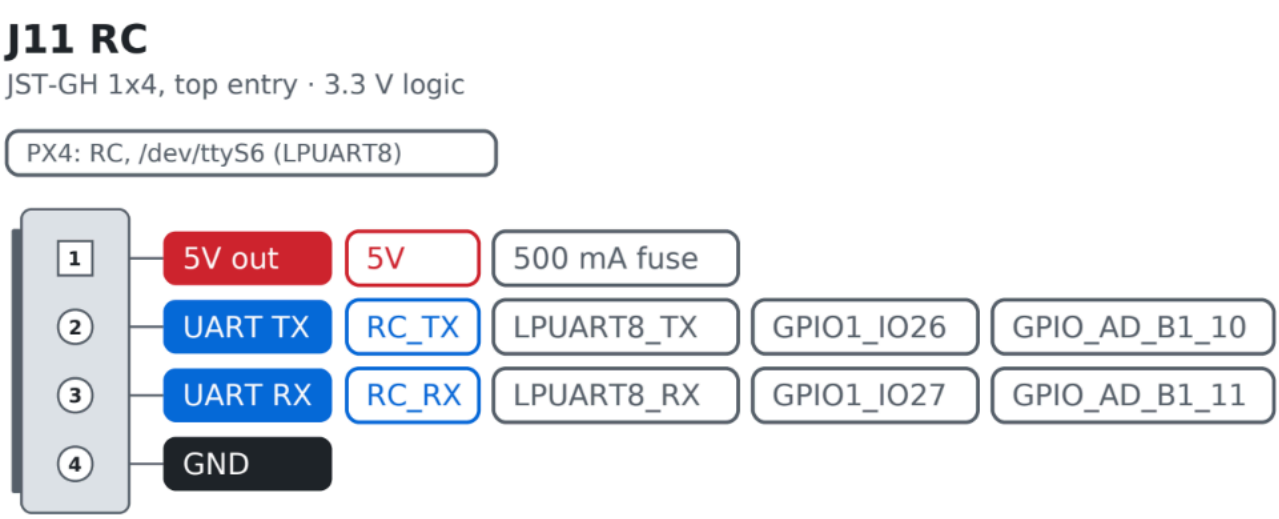


Figure 8. Main J11 RC

Serial port for a digital receiver, such as ELRS or CRSF. Pin 1 gives 5 V out through a resettable fuse, so a shorted receiver cannot pull down the board supply.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

4.5 GPS, I²C and CAN

4.5.1 Main J4 GPS

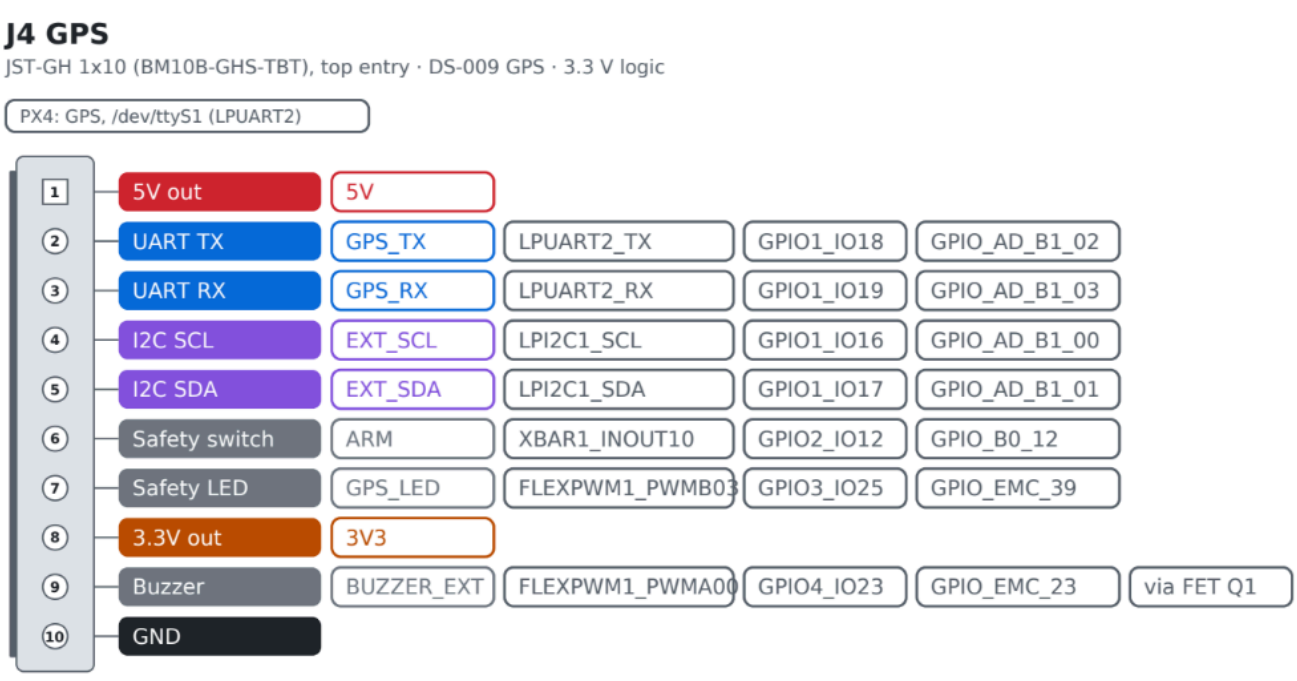


Figure 9. Main J4 GPS

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Pin 1 gives 5 V to the GPS module and pin 8 gives 3.3 V. Both are outputs. Pins 2 to 5 are the GPS serial port and the shared I^2C bus, the same bus as on the I^2C connector J10. Pin 6 reads the safety switch and pin 7 drives its LED. Pin 9 is the buzzer, switched to ground by FET Q1, so the board only pulls this pin low.

Warning: *Pins 1 and 8 are power outputs. Never feed power into them.*

4.5.2 Main J10 I^2C

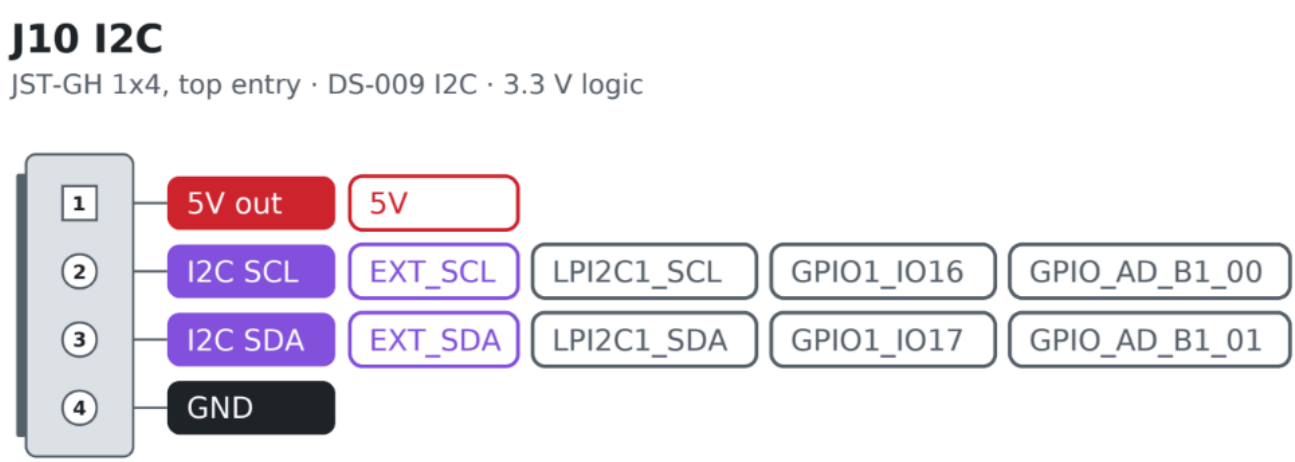


Figure 10. Main J10 I2C

The same bus as pins 4 and 5 of the GPS connector, so devices here share those addresses. Pin 1 gives 5 V out.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

4.5.3 Main J5 CAN

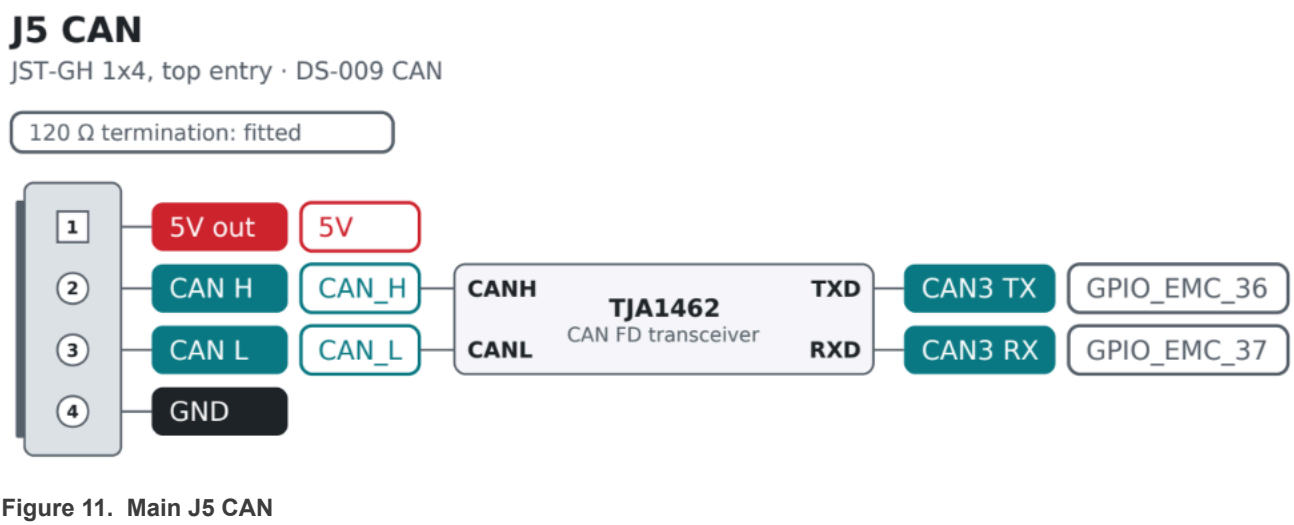


Figure 11. Main J5 CAN

The TJA1462 transceiver runs from 5 V and talks to the chip at 3.3 V. CANH and CANL together form the differential bus, TXD and RXD are the logic lines to the i.MX RT1064. The 120 Ω termination is fitted, so this port is one end of the bus.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

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4.6 Motors

4.6.1 Main J13 PWM_A

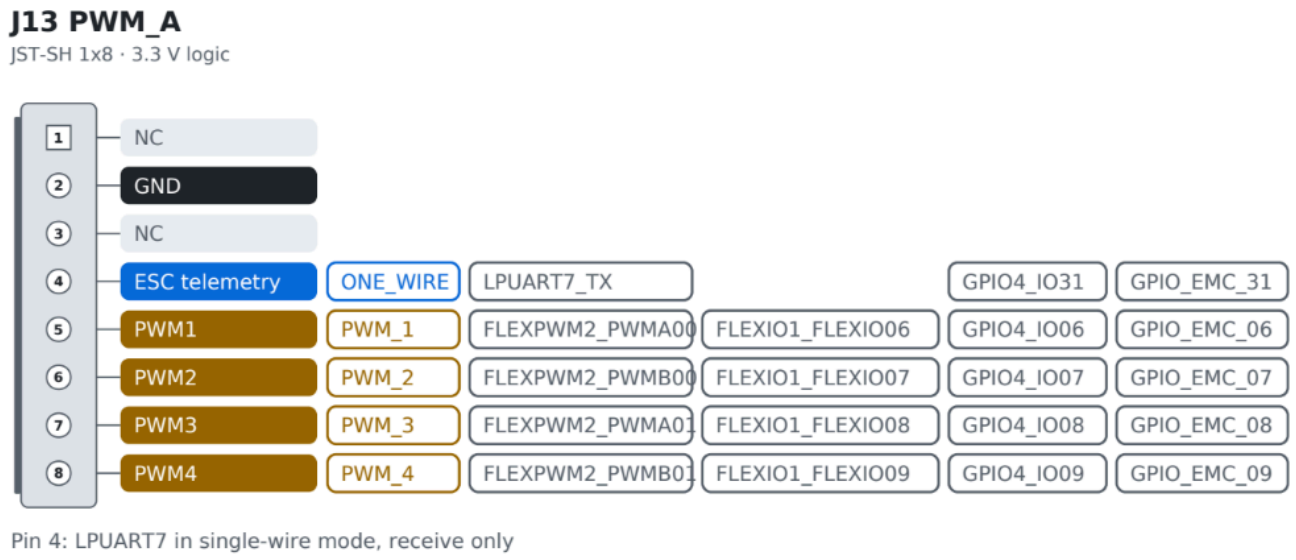


Figure 12. Main J13 PWM_A

Four motor signals for a four-in-one ESC. The pin order follows the Betaflight ESC connector standard, so a standard eight-pin ESC cable fits. The signals carry normal PWM or DShot. The same pads are also FlexIO1 pins, so DShot or other protocols can be bit-banged by FlexIO. Pin 4 is the ESC telemetry line, shared with the other ESC header. The ESCs send their UART telemetry (voltage, current, RPM, temperature) on this one wire, and the chip receives it on LPUART7 in Single-Wire mode. It is receive only. The chip never transmits here. Pins 1 (battery voltage) and 3 (current) of the Betaflight standard are not connected on rev F, so the board does not read battery voltage or current from the ESC.

Note: *This header has no 5 V pin. Many ESCs have a BEC that powers the flight controller, but this board does not use it. It gets its 5 V from the power module on J2 POWER.*

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4.6.2 Main J12 PWM_B

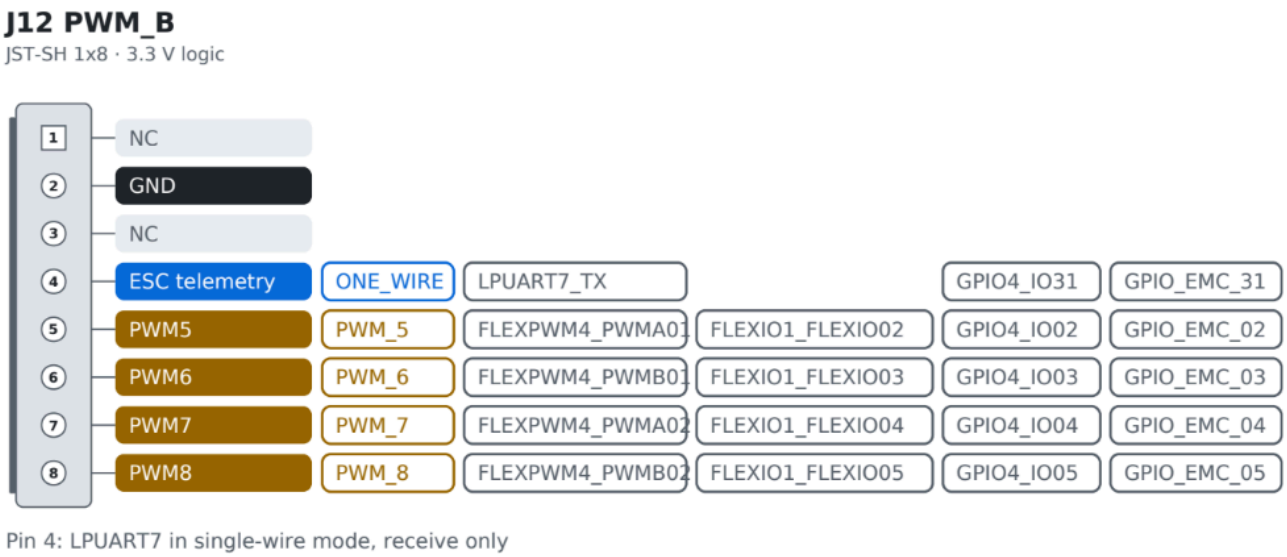


Figure 13. Main J12 PWM_B

Same circuit and same Betaflight pin order as PWM_A, for motors 5 to 8. The signals carry normal PWM or DShot. The same pads are also FlexIO1 pins, so DShot or other protocols can be bit-banged by FlexIO. Pin 4 is the same shared ESC telemetry line: LPUART7 in Single-Wire mode, receive only. Pins 1 (battery voltage) and 3 (current) of the Betaflight standard are not connected on rev F, so the board does not read battery voltage or current from the ESC.

Note: *This header has no 5 V pin. Many ESCs have a BEC that powers the flight controller, but this board does not use it. It gets its 5 V from the power module on J2 POWER.*

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4.7 SPI and Ethernet

4.7.1 Main J6 SPI (OSD)

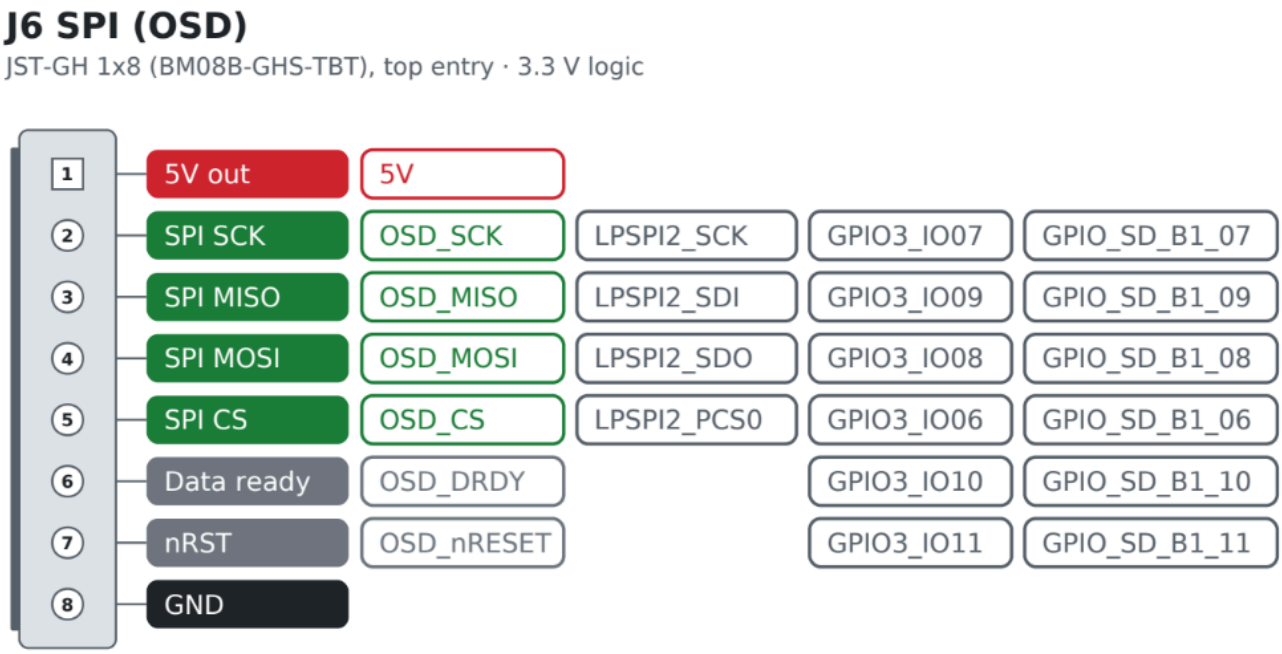


Figure 14. Main J6 SPI (OSD)

Pin 1 gives 5 V to the add-on board. The signal lines work at 3.3 V. Pin 6 is a data-ready input. Pin 7 is a reset output. This port is separate from the SPI bus of the onboard sensors.

Warning: *Pin 1 is a 5 V output. Never feed power into it.*

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4.7.2 Main P1 ETH

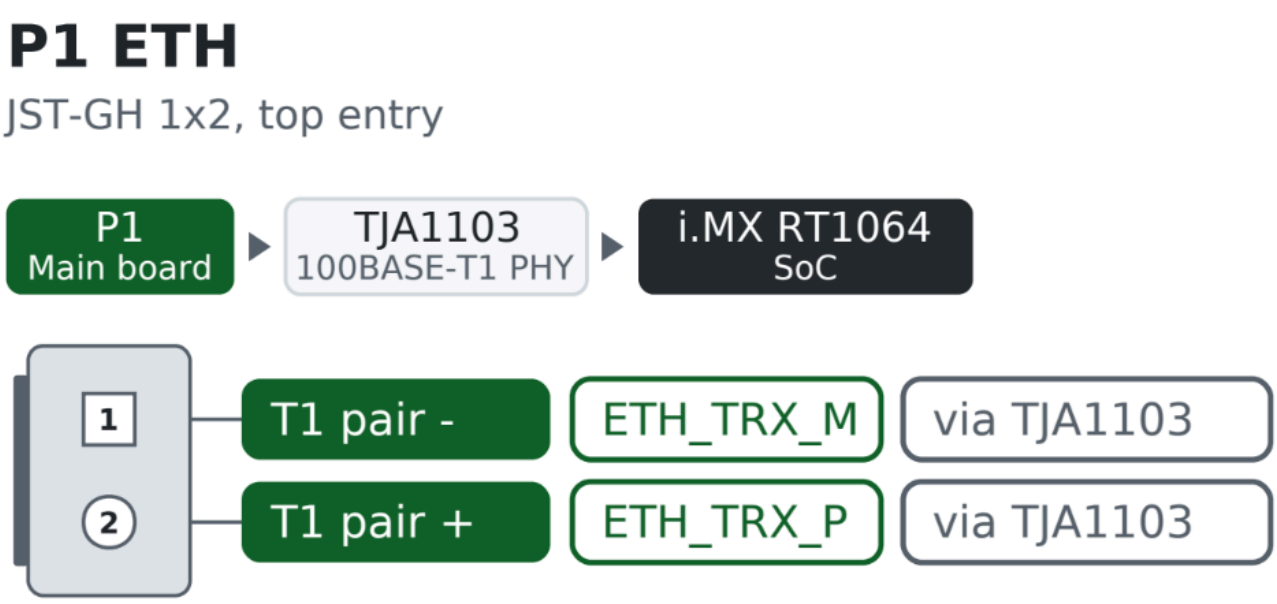


Figure 15. Main P1 ETH

Two wires carry send and receive at 100 Mbit/s. The TJA1103 does the physical layer and talks to the chip over RMII, so there is no direct link between these pins and a chip pad. Use a twisted pair and keep both wires the same length. The other end needs a 100BASE-T1 device or a media converter.

4.7.3 Main other connectors

Table 1. Main other connectors

Reference	Function	Connector	Notes
J1 USB	USB 2.0 Type-C device port	USB Type-C receptacle (USB4110-GF-A)	Serial download port of the i.MX RT1064 boot ROM, and the port used for flashing; the board is always a USB device; VBUS can also power the board through protection switch U13
CN1 MICRO	microSD card slot	microSD push-push, eight pins plus card detect	Four-bit SD interface on the first SD host of the chip, used for logging; the card detect switch goes to a separate chip pin

4.8 Buttons and switches

Table 2. Buttons and switches

Reference	Board	Function	Type	Notes
SW2 BOOT	Main	Boot mode button	Push button (NANOT 240 AS)	Holding this button while the board powers up pulls Boot mode 0 high and starts the serial downloader over the USB port; the second Boot mode pin is tied low on the board

4.9 Notes

- The connectors marked DS-009 on their card (TELEM1, TELEM2, GPS, I^2C, CAN and the debug port) follow the Dronecode DS-009 connector standard, so standard cables fit
- The two ESC headers (PWM_A and PWM_B) follow the Betaflight ESC connector standard, so a four-in-one ESC with a standard eight-pin cable fits; pins 1 (battery voltage) and 3 (current) are not connected on this board
- The board runs from 5 V on the power module connector J2, or from USB; every other 5 V pin is an output

Warning: *Never feed power into the 5 V pin of a JST-GH connector. Power the board through J2 or USB only.*

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4.10 Cheat sheet

All connector cards on one A4 landscape sheet: cheat sheet PDF.

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5 Configuring the hardware

The MR-VMU-Tropic is flashed in two stages: the PX4 bootloader is programmed once to the external QSPI flash with a debug probe, after which the PX4 application is updated over USB without a probe.

5.1 Chip fuse programming

This step is not required for EVK boards, as their fuses are already programmed.

A newly manufactured board, or any board containing a new unprogrammed processor, requires the device fuses to be programmed as part of initial bring-up. Fuse configuration and the associated programming procedure are covered in the programming boot configuration fuses on MR-VMU-Tropic application note.

5.2 Programming the bootloader (first time)

On a blank board, use a LinkServer-compatible probe (MCU-Link) on the Dronecode debug connector to program the bootloader, and optionally a first application image, to fixed offsets in the RT1064 QSPI flash region. This route is used for the initial bring-up and for recovering a bricked board.

5.3 Updating the PX4 application (routine)

Once the bootloader is present, the PX4 firmware is delivered as a `.px4` container and uploaded over USB, with no debug probe required. The board's PX4 bootloader accepts the upload when the board is reconnected. Both QGroundControl and the PX4 command-line uploader drive this automatically. This is the day-to-day update path.

5.4 Recovery

The QSPI flash can be fully erased with the debug probe before a clean reflash.

The exact LinkServer commands, flash offsets, PX4 upload steps, and the Zephyr sample images are listed in the Deploy and Run Quick Start.

5.5 Running the flight stack

The MR-VMU-Tropic runs the PX4 flight stack on the NuttX RTOS. Once the board is flashed, PX4 is configured and operated through QGroundControl in the same way as any other PX4 vehicle management unit: airframe selection, sensor calibration, radio and Flight mode setup, and parameter tuning.

The board's communication and actuation interfaces used by the flight stack – telemetry, GPS and safety, RC/ELRS inputs, CAN-FD/DroneCAN, 100BASE-T1 Ethernet, and the ESC outputs – are described in Section 4 and the MR-VMU-Tropic Hardware Architecture and Reference Design.

For the PX4 build, boot and usage details, see the PX4 documentation reference.

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6 Abbreviations

Table 3. Abbreviations

Acronym	Description
CAN FD	Controller area network flexible datarate
DShot	Digital shot (digital ESC control protocol)
ELRS	ExpressLRS (radio-control link)
ESC	Electronic speed controller
GNSS	Global navigation satellite system
GPS	Global positioning system
MCU	Microcontroller unit
OSD	Onscreen display
PX4	PX4 autopilot flight stack
RC	Radio control
RTOS	Real-time operating system
SPI	Serial peripheral interface
UART	Universal asynchronous receiver-transmitter
USB	Universal serial bus
VMU	Vehicle management unit

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7 References

[1] MR-VMU-Tropic product page — overview, documentation, software, tools, and ordering information
[2] MR-VMU-Tropic Hardware Overview — connectors, pinouts, and on-board devices
[3] MR-VMU-Tropic Hardware Architecture and Reference Design
[4] MR-VMU-Tropic Deploy and Run Quick Start
[5] PX4 documentation reference
[6] PX4 Autopilot
[7] MR-VMU-TROPIC board design and documentation

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8 Revision history

Table 4. Revision history

Document ID	Release date	Description
UM12672 v.1.0	05 November 2026	Initial version

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