UG10154

MR-CANHUBK344 Hardware Manual

Rev. 1.0 — 1 April 2025 User guide

Document information

Information	Content
Keywords	MR-CANHUBK344, S32K344, FS26, SE050, TJA1103, TJA1443, TJA1463, TJA1153, CANHUBK3
Abstract	Hardware notes describing package contents, instructions, open issues, fixes, and limitations.

1 Introduction

MR-CANHUBK344 board is an evaluation board designed for mobile robotics applications and is based on Arm® Cortex®-M7 core S32K344 general-purpose automotive microcontroller featuring the latest in safety, security, and software support.

While targeted to mobile robotics applications, the board can certainly be used for multiple purposes where automotive lockstep cores are desirable:

- A primary small vehicle controller.
- A safety domain controller.
- A high specification "CAN FD node" board.
- Bridging between 100Base-T1 and multiple CAN physical interfaces.
- Potentially, as a BLDC motor controller.

Special notes on processor:

While the dual-core lockstep (DCLS) S32K344 is installed on this board, the same board may support an S32K324 where the Cortex-M7 cores operate independently as a dual independent core device. Also, the S32K35x (240 MHz/3 core) is also installed in the same footprint with minor modifications. Both these ideas require manual rework to a board to replace the processor.

MR-CANHUBK344 includes one 100Base-T1 Automotive Ethernet and populates all six of the CAN FD ports available on S32K344. The features set it provides are suitable for a wide variety of other applications. One example is experimenting with tunneling CAN over Ethernet using the IEEE 1722 protocol. A software example is available for this on the NXP webpage for the device.

The 6 CAN ports are connected to three distinct types of NXP CAN PHYs, and allow for direct comparison between standard CAN FD, CAN FD/SIC (signal improvement CAN), and CAN FD/SCT (Secure CAN Transceivers)

Also on board is the SE050 Secure element with NFC (Near Field Communication) and UART, SPI, I^2C, PWM, and other GPIO accessible on DroneCode standard JST-GH connectors. In addition to the published S32K design studio example software application as an IEEE 1722 CAN over Ethernet bridge also look for open source NuttX RTOS, NuttX/PX4 and Zephyr RTOS support on this board for general-purpose applications in their respective open source repositories.

- https://github.com/apache/nuttx
- https://github.com/PX4/PX4-Autopilot
- https://github.com/zephyrproject-rtos/zephyr

NXP HoverGames contest uses these and other boards, which are intended to work together. You find other code examples, additional links, and “Engineering Notebook” style documentation specific to the Mobile Robotics team at the following gitbook URLs:

- https://nxp.gitbook.io/hovergames/
- https://nxp.gitbook.io/mr-canhubk3

1.1 Abbreviations

Table 1. Abbreviations

Term	Description
IEEE 1722	Layer 2 transport protocol working group for time-sensitive streams
100BASE-T1	Full-duplex single twisted-pair Ethernet
BEC	Battery Eliminator Circuit (power rail for servos and ESCs)

Table 1. Abbreviations...*continued*

Term	Description
BLDC	Brushless DC (motor)
CAN	Controller Area Network 1Mbps “classical CAN”, although may sometimes be inclusive of CAN FD
CAN FD	CAN Flexible Data rate (up to 8 Mbps)
CAN SIC	CAN FD using Signal Improvement CAN PHY
CAN SCT	CAN FD using Secure CAN Transceiver
ESC	Electronic Speed Controller
FMU/VMU	Flight/Vehicle Management Unit
IMU	Inertial Measurement Unit (Combination of accelerometer, Gyro, Magnetometer)
JTAG	Joint Test Action Group, interface commonly used for software debugging KB 1024 bytes
MAC	Media Access Control, a MAC address is a so-called physical address
Mbps	Million bits per second (10^6 bits/s)
NFC	Near Field Communication
PCB	Printed Circuit Board
RTK GPS	Real Time Kinematic Global Positioning System (Precision GPS Module)
SDK	Software Development Kit

2 Main components

This compact board includes components that are briefly described in this section. More detailed documentation on each of these individual components is available on their respective NXP.com webpages online.

2.1 S32K344

This compact board includes components that are briefly described in this section. More detailed documentation on each of these individual components is available on their respective NXP.com webpages online.

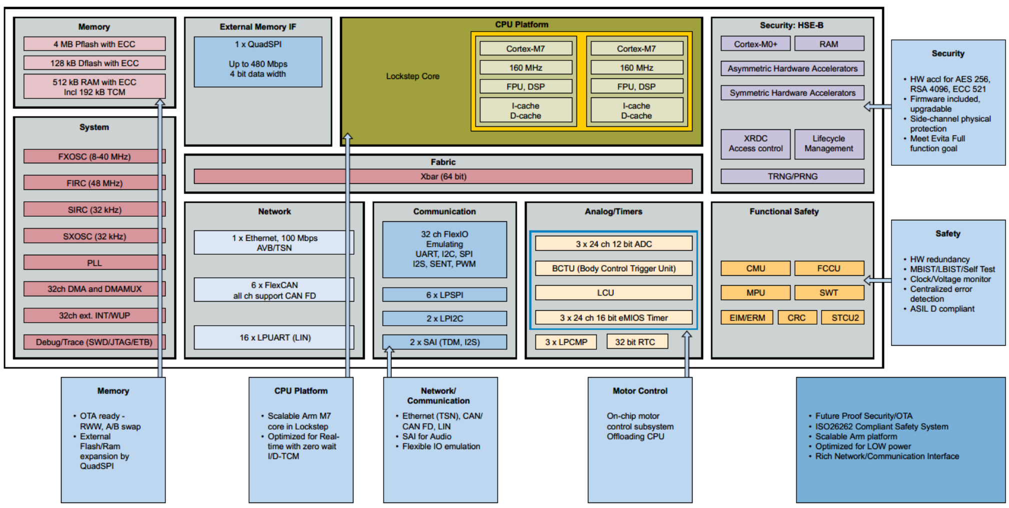

Figure 1. Block Diagram of S32K344 chip

The S32K344 is an Automotive General Purpose MCU of NXP Semiconductors. Figure 1 gives the block diagram of this chip. The software discussed in this document is running on the Lockstep Arm® Cortex®-M7 embedded in this chip.

2.2 FS26

FS26 is the ‘*Safety System Basis Chip with Low-Power Fit for ASIL D’* of NXP Semiconductors. Figure 2 gives the block diagram of this power supply chip. This part is sophisticated and is capable of additional complex configurations than implemented here, however in this design it primarily allows for a compact power supply design and high input voltage.

Normally the FS26 is connected through SPI to the S32K344 and implements a challenger window watchdog. Sending challenges to the through SPI S32K344 as the window watchdog when the response is invalid or not during the timing window the FS26 resets the S32K344 MCU. In the included sample code, the challenge watchdog functionality has **not** been implemented. Instead, during startup of the S32K344, the sample application sends a request to the FS26 to *disable the watchdog* functionality, therefore avoiding resetting the S32K344 while running sample applications.

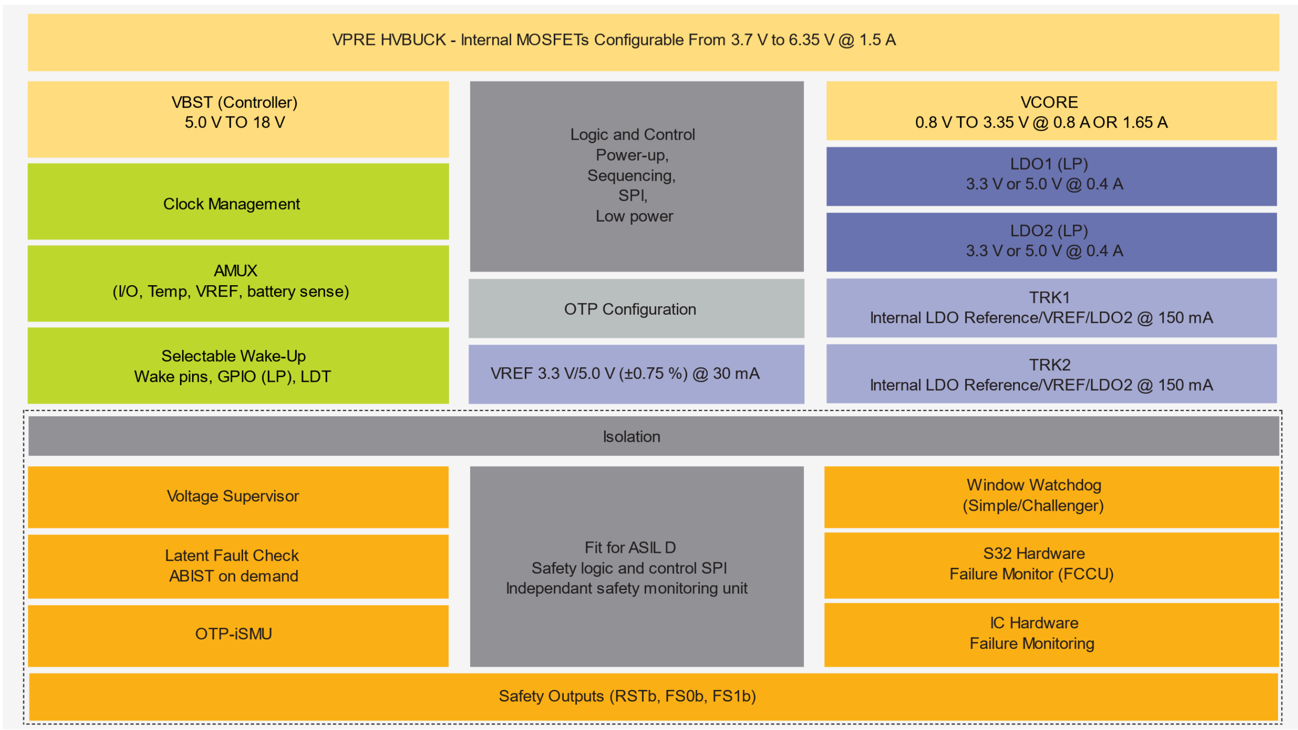

Figure 2. FS26 PMIC Block diagram

2.3 Note on PMIC and board power up sequence

The FS26 onboards PMIC by default implements a challenger window watchdog that resets the S32K344 MCU continuously if the challenge is not handled in software.

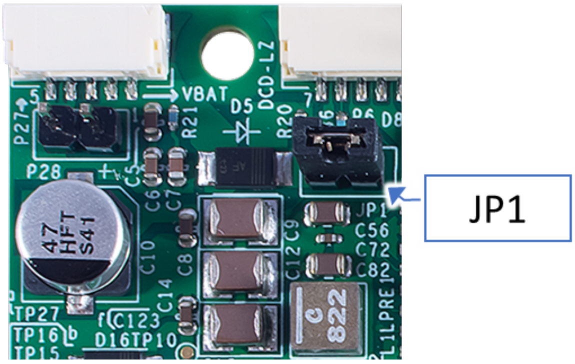

Figure 3. Jumper JP1 for FS26 debug mode

To avoid this, the FS26 must be put into Debug mode. This is done by removing the JP1 and then supplying exactly 12.0 V on P27 or P28 and then inserting the JP1 jumper.

Now, the reset LED D24 should no longer blink and the S32K344 will not be reset continuously by the FS26.

3 Board connections

The MR-CANHUBK344 board includes various connectors to permit access to the on-chip interfaces. The intended application space is mobile robotics, which mostly defined the DroneCode JST GH connectors and pinouts. Where an interface did not have a formal DroneCode standard, a typical derivative pinout was used. To support power input directly from a battery, a wide input voltage range is supported from 5 V to 40 V. The 100Base-T1 2-wire Automotive Ethernet interface uses the latest TJA1103 Ethernet Phy. Also included is a SE050 secure element for authentication into the system and also an NFC interface into the board.

3.1 Evaluation board block diagram

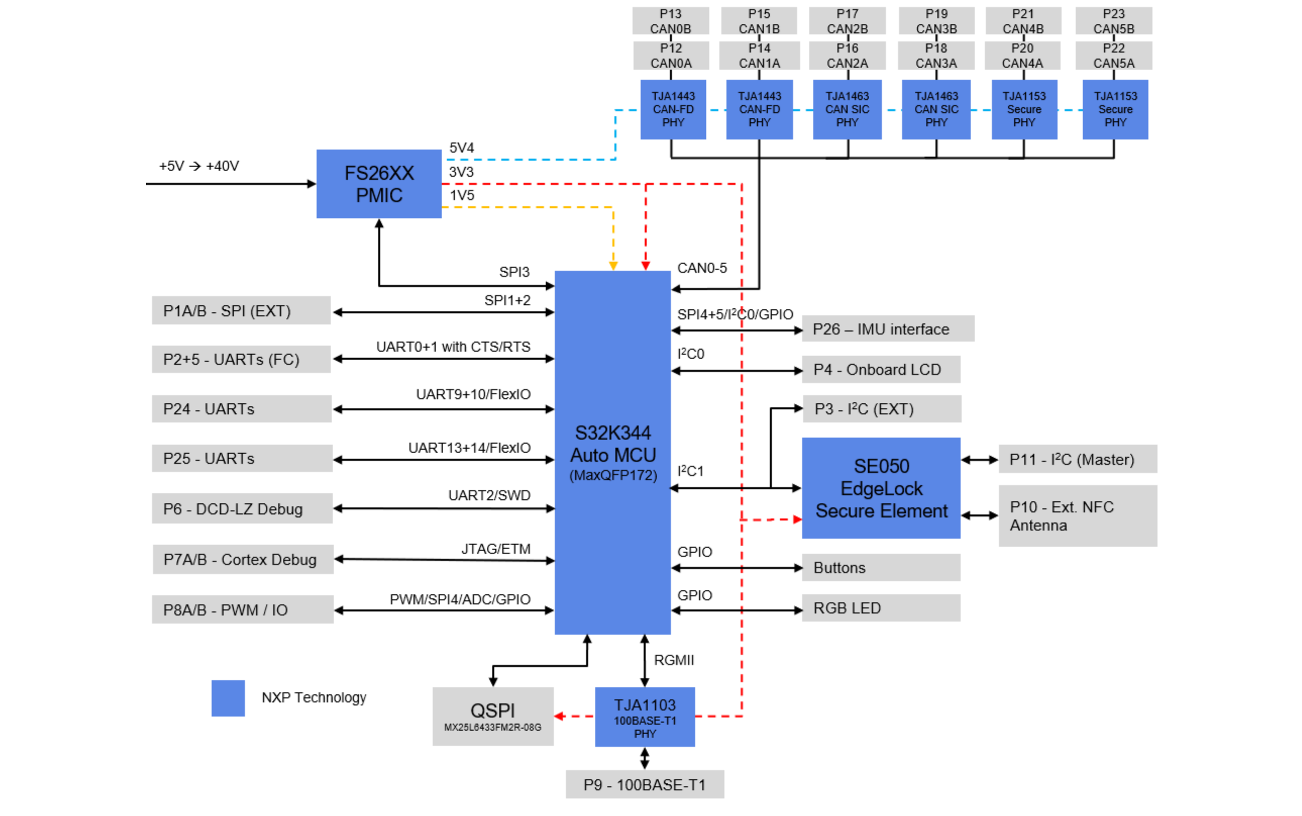

Figure 4. Evaluation board block diagram

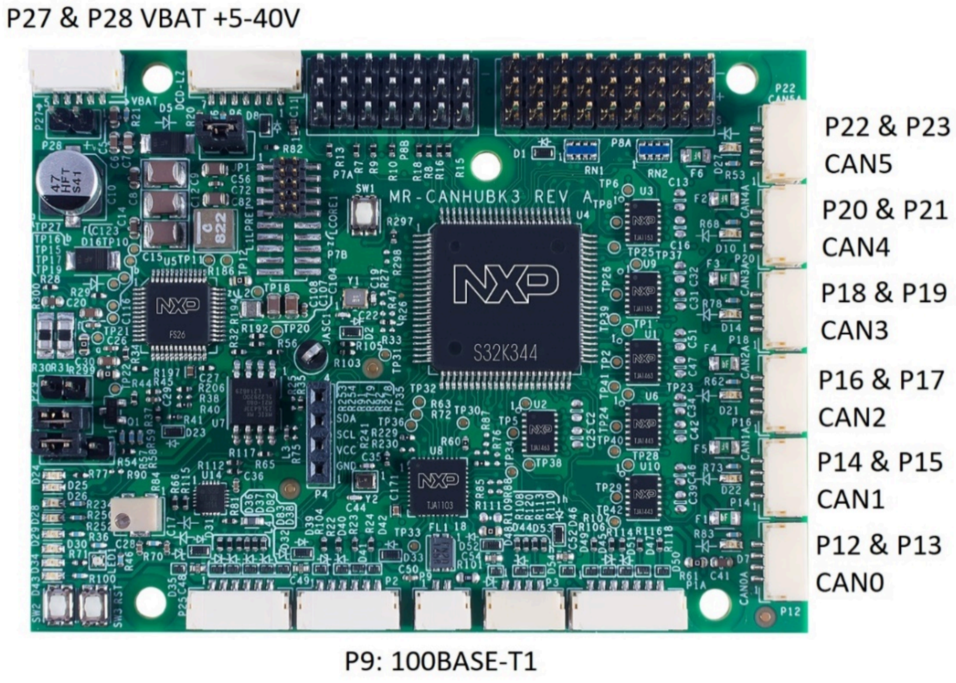

Figure 5. Connectors used in CAN over Ethernet demo

3.2 Power input connectors

P27: Power is normally applied at the 5-pin JST-GH connector P27

Table 2. P27 Power input connector

Pin #	Signal	Specification
1	Power+	+5 to +40 V
2	Power+	+5 to +40 V
3	NC	NC
4	Power (GND)	0 V
5	Power (GND)	0 V

P28: Alternatively, power may be supplied at the two-pin header P28 located directly below P27

Table 3. P28 Alt Power input connector

Pin #	Signal	Specification
1	Power+	+5 to +40 V
2	Power- (GND)	0 V (GND)

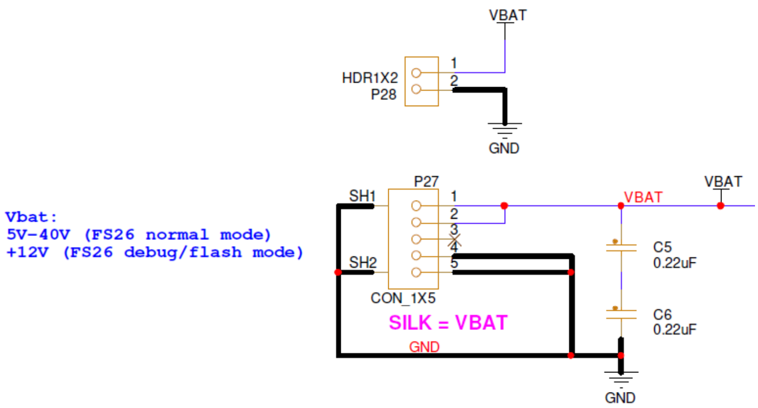

Figure 6. Power input connectors P27, P28 schematic

3.3 CAN connectors

There are six independent CAN FD capable CAN buses each with two connectors.

The dual connectors are only for convenience in forming a bus and or plugging in a can termination board.

Table 4. CAN interface chip assignment

BUS name	CAN PHY	Type
CAN0, CAN1	TJA1443	CAN FD
CAN2, CAN3	TJA1463	CAN SIC (Signal Improvement)
CAN4, CAN5	TJA1153	CAN FD/SCT (Secure CAN transceiver)

Connectors P12 through P23 are the CAN connectors. For each "CANx" bus connector the pinout is as follows (where x = BUS number 0 to 5):

Table 5. CAN connectors pinout

Pin #	Signal	Specification
1	5V4	5.4 V *output*
2	CANx_H	5.0 V
3	CANx_L	5.0 V
4	GND	0 V

Pin 1 of each CAN connector is available to supply 5 V to externally connected CAN devices. This optionally is used to supply limited power to a CAN peripheral. A blocking diode prevents powering the CANHUBK344 from the CAN BUS.

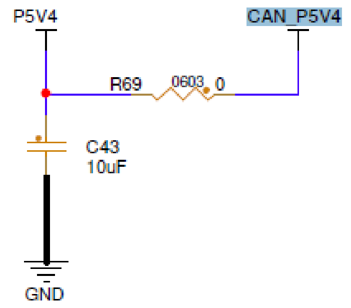

Figure 7. CAN_P5V4 power output R69 disconnect

3.3.1 Termination

A CAN bus usually requires 60-Ohm termination at both ends of a CAN bus. This may be accomplished using one of the included CAN-TERM boards. Each CAN bus connects to TWO identical connectors labeled A and B. This is to allow for daisy chain wiring and multiple drops along a CAN bus. The MR-CANHUB344 must be the end of the CAN bus and require termination. Then termination is provided by plugging in a termination board or populating (soldering) the normally unpopulated termination resistors directly on the board.

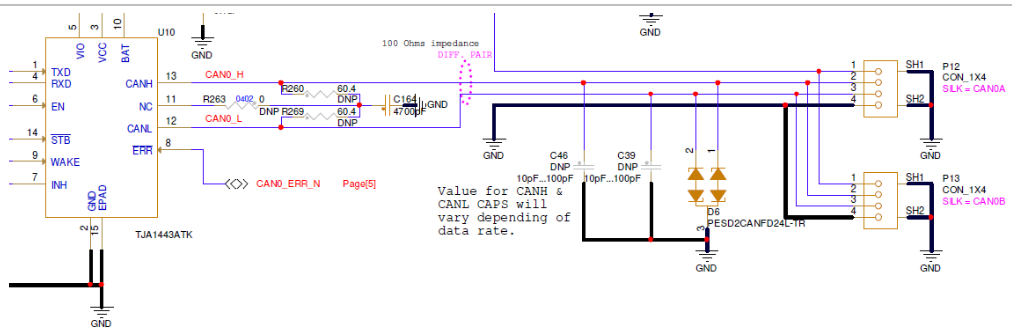

Figure 8. CAN bus representative schematic

3.3.2 CAN SIC termination

Note: *The CAN **SIC** PHYs are able to operate with stub connections and potentially a single or central termination. The signal integrity should be validated against your specific system configuration.*

3.4 P9 - 100Base-T1 Ethernet connector

P9 is a two-pin JST-GH connector provides the 100Base-T1 "two wire" Ethernet connection. The connection can plug directly into a MR-T1ETH8 network switch or other mobile robotics boards such as NavQPlus or FMURT6. You may create a simple adapter cable to adapt to other systems (such as automotive devices) which have 100Base-T1 Ethernet.

Automotive 100Base-T1 Ethernet uses two wires to provide full duplex 100 Mbit/s Ethernet signaling without the need for large or heavy magnetics like 100Base-TX Ethernet. The signals are capacitively coupled and there is a simple filter network before external signals reach the PHY.

The yellow LED (D88) on the backside of the PCB indicates the link status. Flashing indicates that there is a link.

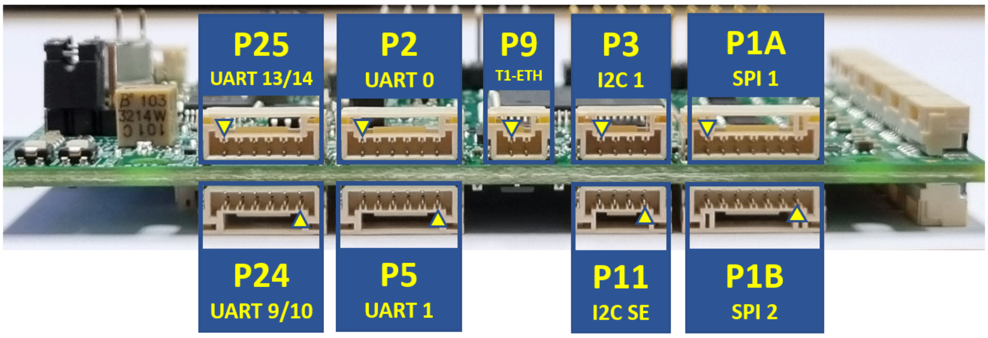

Figure 9. Bottom Edge connectors

Table 6. P9 100Base-T1 "two wire" connector

Pin #	Signal	Specification
1	T1-P(N)	Polarity is automatically negotiated
2	T1-N(P)	Polarity is automatically negotiated

3.5 UARTS

3.5.1 P2 - UART0, P5 - UART1

These two S32K3 LPUARTs follow the DroneCode 6 pin UART standard. Pin 1 supplies limited 5 V power to an external device such as a GPS module or sensor.

Table 7. P2 UART 0 and P5 UART 1 pinout

Pin #	Signal	Specification
1	5 V	(Optional) Limited 5 V output
2	TX	3V3
3	RX	3V3
4	CTS	3V3
5	RTS	3V3
6	GND	0 V (GND)

3.5.2 P24 - UART9/10, P25 - UART 13/14

Connectors P24 and P25 are also 6-pin JST-GH. However, they are not fully compliant with the DroneCode standard since pins 4 and 5 are repurposed to be a second UART channel instead of the handshaking lines RTS/CTS. The pinouts are shown below.

Table 8. P24 UART9/10 pinout

Pin #	Signal	Specification
1	5 V	(Optional) Limited 5 V Output
2	TX (UART9)	3V3
3	RX (UART9)	3V3
4	TX (UART10)	3V3
5	RX (UART10)	3V3
6	GND	0 V (GND)

Table 9. P25 UART13/14 pinout

Pin #	Signal	Specification
1	5 V	(Optional) Limited 5 V Output
2	TX (UART13)	3V3
3	RX (UART13)	3V3
4	TX (UART14)	3V3
5	RX (UART14)	3V3
6	GND	0 V (GND)

3.6 I2C interfaces

3.6.1 P3 - I2C1

I^2C1 interface connects to the outside via a 4-pin JST-GH and internally to the SE050 Secure Element. There is also a second I^2C bus described in the next chapter that comes from the SE050 itself. **Power output supply on I^2C connectors:** The I^2C1 and I^2CSE interfaces include zero-Ohm resistor jumpers, which can be used to select 5 V (default) or 3V3 output on pin one. The PWR output is intended for limited current supply and the overall power supply draw for external peripherals must be considered.

Table 10. I2C1 pinout

Pin	Signal	Specification
1	PWR	5 V output default (3V3 optional)
2	SCL	3V3
3	SDA	3V3
4	GND	0 V (GND)

3.6.2 P11 - I^2CSE

P11 is a I^2C bus, which is from the SE050 Secure Element device. It can be used for special applications such as encrypted sensor data. Refer to the SE050 data sheet for detailed information on how this may be used.

Table 11. I^2CSE (Secure Element)

Pin	Signal	Specification
1	PWR	5 V output (optional)
2	SCL	3V3
3	SDA	3V3
4	GND	0 V (GND)

3.6.3 P4 - I2C0 OLED interface

This connector is for attaching the included I^2C-connected 0.91 OLED display. These OLED displays use an SSD1306 type controller and information about their use is commonly available from online sources. The pinout does not follow a standard, but most of them use the pinout chosen here. Double check the pinout and orientation that you must replace or use an alternative similar display.

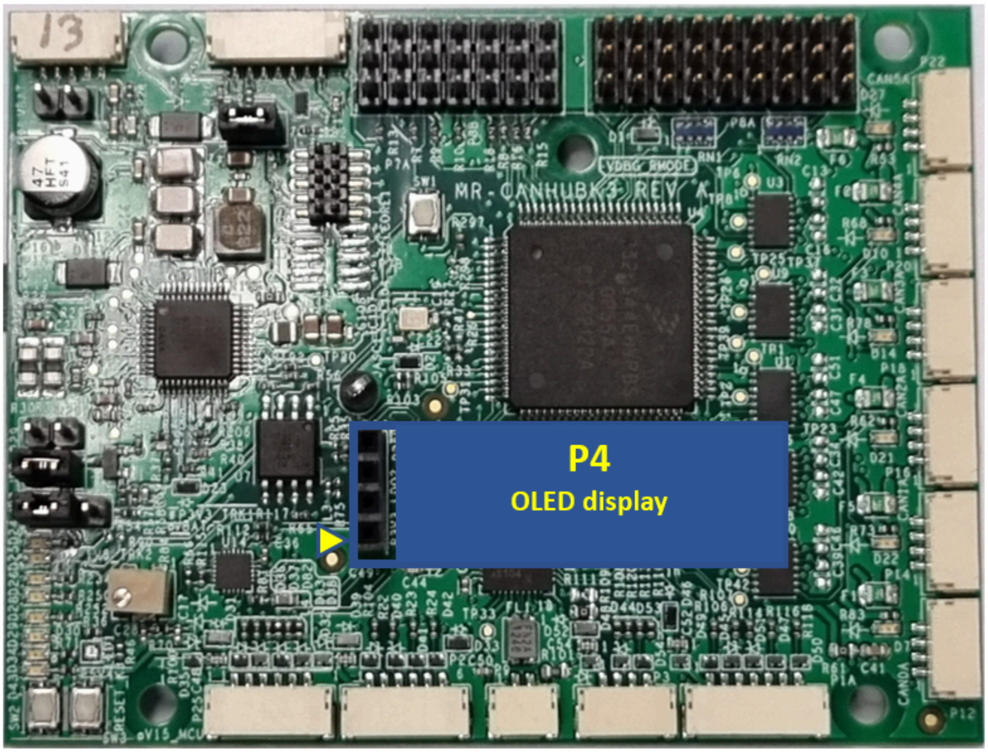

Figure 10. P4 I2C OLED and display placement

Table 12. I^2C0 OLED display pinout

Pin #	Signal	Specification
1	GND	0 V (GND)
2	VCC	5 V default (3V3 optional using R25)
3	I^2C0 SCL	3V3 (w/4K pullup on signal line)

Table 12. I^{2}C0 OLED display pinout...*continued*

Pin #	Signal	Specification
4	I^{2}C0 SCK	3V3 (w/4K pullup on signal line)

3.7 SPI interfaces

3.7.1 P1A - SPI1, P1B - SPI2

Two independent SPI interfaces are available and follow the DroneCode connector standard for a SPI port. Two independent chips are available on each connector using a JST-GH 7-pin connector.

Table 13. SPI interface(s) pinout

Pin #	Signal	Specification
1	PWR	5 V
2	LPSPIx_SCK	3V3
3	LPSPIx_MISO	3V3
4	LPSPIx_MOSI	3V3
5	LPSPIx_CS0	3V3
6	LPSPIx_CS1	3V3
7	GND	0 V

3.8 P26 - Pixhawk V6X IMU

This is a custom connector for attaching an Inertial Measurement Unit (IMU) board from a Pixhawk V6X FMU module. It is included in the design for testing purposes only. This IMU board is not readily available from NXP. The Pixhawk design is open source and may be obtained from Linux Foundation Dronecode.org. It may also be possible to buy this module directly from the manufacturer - ***Holybro***. For more general investigation of IMUs the NXP Mobile robotics team may have adapter boards (or designs to share) that plug on top of the MR-CANHUBK344 and provide typical IMU components and connector interfaces such as RTK GPS connectors like those needed for a full FMU/VMU (Flight/Vehicle Management Unit).

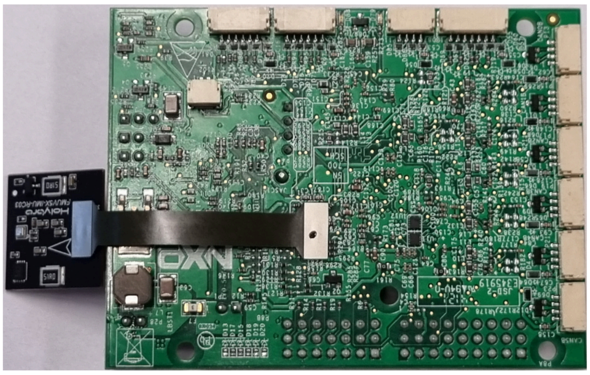

Figure 11. Connection of Holybro IMU module

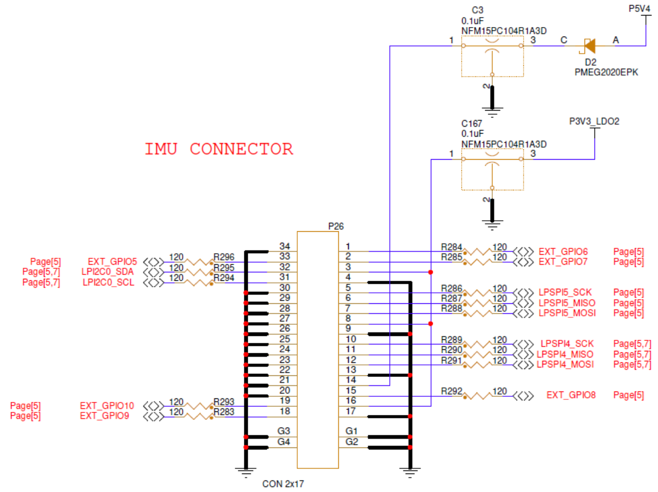

Figure 12. IMU pinout and power

3.9 Programming connectors

Two programming connectors are provided. The traditional ARM 10-Pin JTAG/SWD and a “DCD-LZ” Drone code Debug connector. The 10-Pin JTAG/SWD may be removed and replaced with a larger connector giving full access to the TRACE debug pins.

3.9.1 P6 - DCD-LZ

This is a JST-GH connector from DroneCode Standard, which combines the SWD and Console UART into a single connector. The *-LZ* version of the spec also adds an RST pin.

3.9.2 P26 - ARM 10-Pin JTAG/SWD

This is a 10 pin 0.50” space JTAG with the standard pinout used by standard Arm® debuggers.

Ensure pin 1 on the PCB silkscreen is aligned with pin 1 on the debugger.

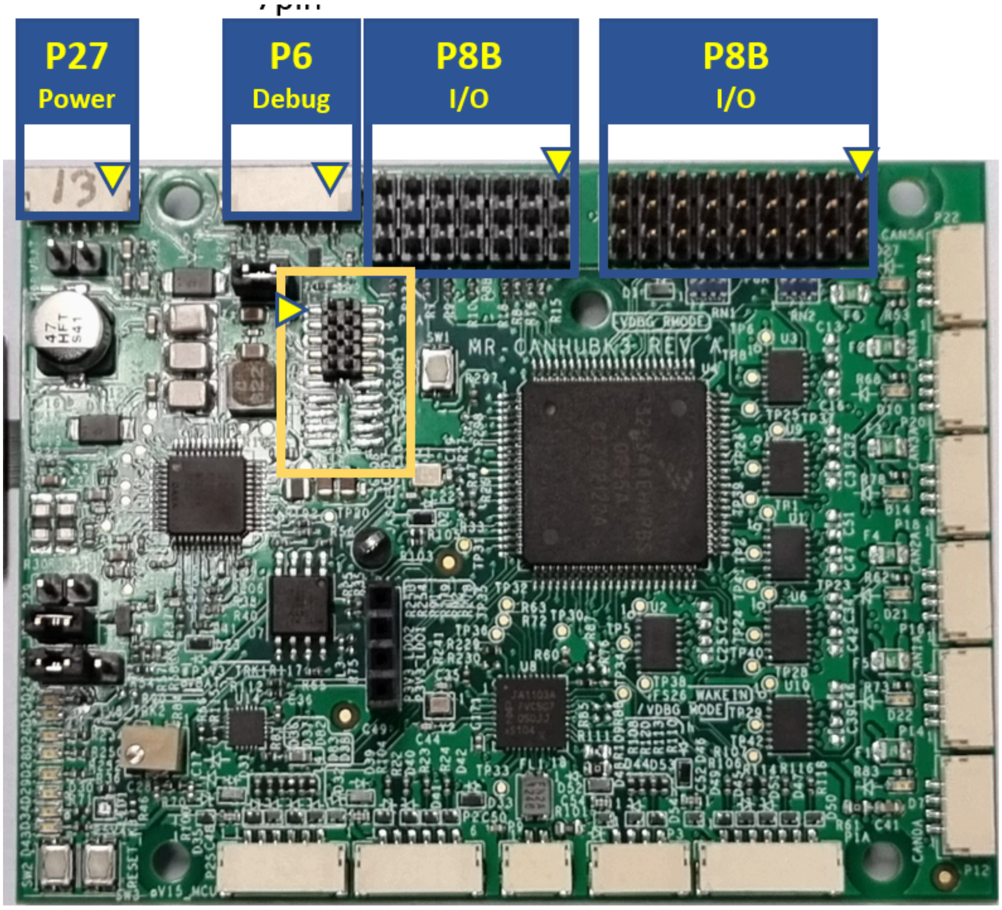

Figure 13. JTAG header, P6"DCD-LZ" w/ SWD+Console

3.10 SW1 and SW2 user buttons

Two user programmable buttons are available for use.

These buttons are configured as pull-downs and are active high when pressed. The buttons are filtered with a pi filter to minimize transient effects.

There are multiple options for which pin functions are mapped and are assigned to PTx/GPIO. Note that SW2 does allow mapping to WKPU37 (wake-up) signal on the MCU and SW1 allows mapping to CMP0 (comparator) signal on the MCU. These pin mux settings could be configured for interesting software use cases.

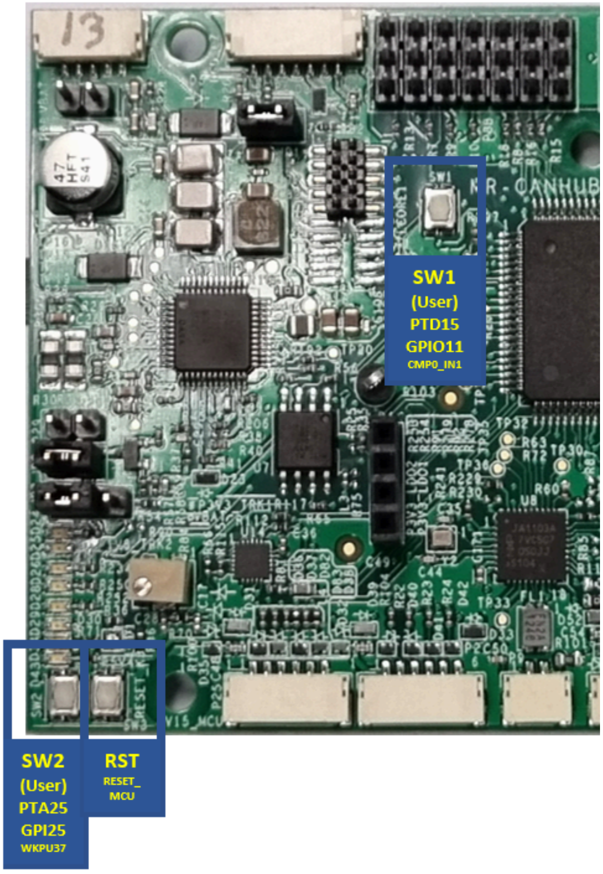

Figure 14. SW1 and SW2 user buttons

3.11 P10 - NFC antenna

This two-pin connector is suitable for an ISO-14443 NFC antenna system. One is provided in your kit from AMOTECH.

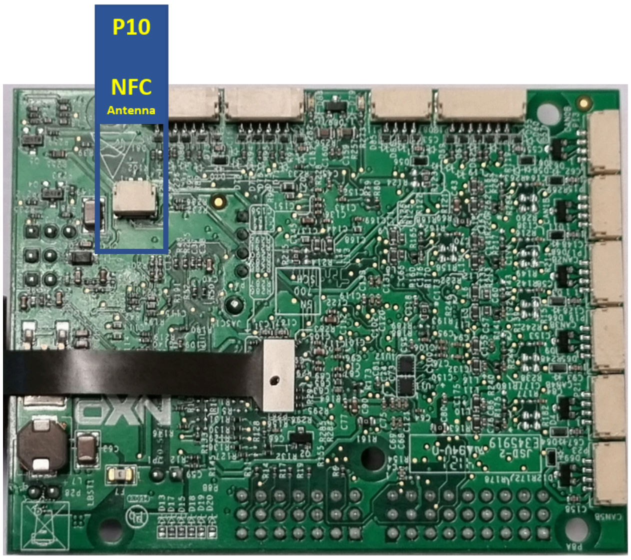

Figure 15. P10 NFC antenna connector

3.12 PWM and GPIO headers P8A P8B

These 0.100” pin headers are available for experimentation with PWM signals and other GPIO.

3.12.1 RC-PWM

RC-PWM refers to radio control hobby style PWM signals. These are pulses between 1000 msec and 2000 msec. The PWM channels that drive these pins are capable of faster and high-resolution timing and could be configured to drive a BLDC motor Gate driver directly.

3.12.2 P8A, P8B connectors

P8A has intentionally been ***physically*** configured with the center pin as a common BEC power rail and the left pin as GND to allow RC hobby style RC servos or ESCs to plug in directly. Often one of the RC devices, such as an ESC, can actually supply 5 V BEC power to the other servos. An actual separate RC BEC may also be plugged in to provide independent power to the RC devices. See the schematics for further details. There are no actual constraints on the PWM signal timings from the MCU.

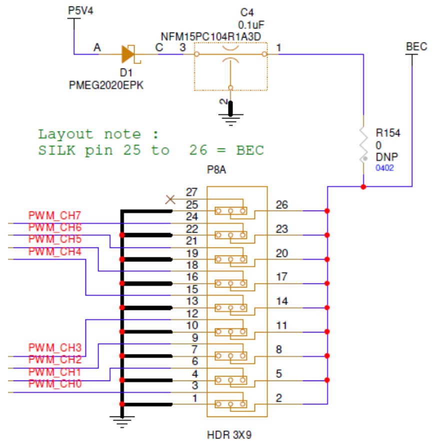

Figure 16. P8A pin header PWM (RC-PWM)

P8B includes access to the SPI4 interface, ADC channels, and eight GPIOs. Reminder that these pins also have alternative pin map assignments available. The ADC channels may be considered for use in motor control applications.

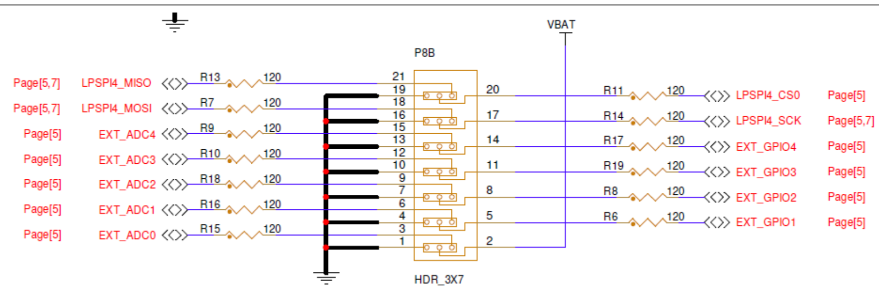

Figure 17. P8B pin header w/ SPI4, ADC, and GPIO

3.13 R84 - Analog potentiometer

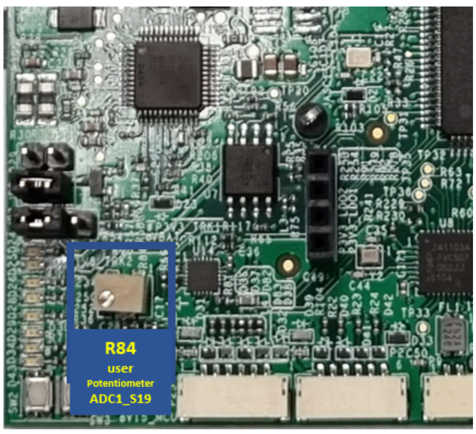

Figure 18. R84 - Analog potentiometer

R84 is a 10K potentiometer between 3V3 and GND, and connects to the net named ADC_POT0. This net then connects to pin 11 – PTE13/ADC1_S19. The potentiometer was included for board test validation and can be repurposed for any user intent.

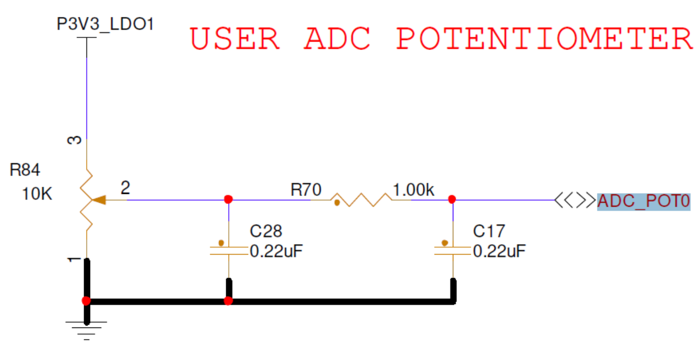

Figure 19. User potentiometer schematic

4 Board status LEDs

The MR-CANHUBK344 has various LEDs to indicate status as shown in Figure 6. Under normal circumstances, the state of the LEDs must be indicated as in the table below.

Table 14. Onboard LEDs description

Dxx	LED name	Normal state	Description
D24	RESET_K3	Off	Indicates if the S32K344 is in reset
D25	P1V8_TRK2	On	Indicates FS26 SBC 1V8_TRK2 status
D26	P3V3_TRK1	On	Indicates FS26 SBC 3V3_TRK1 status
D28	P3V3_LDO2	On	Indicates FS26 SBC 3V3_LDO2 status
D29	P3V3_LDO1	On	Indicates FS26 SBC 3V3_LDO1 status
D30	VBATP_SW	On	Indicates VBAT status
D34	V15_MCU	On	Indicates FS26 SBC V15 status
D43	P5V4	On	Indicates FS26 SBC P5V4 status
LED1	RGB Status led	Green	Controlled by the software. Green indicates normal operation. Blue indicates initialization. Red indicates that an error has occurred.

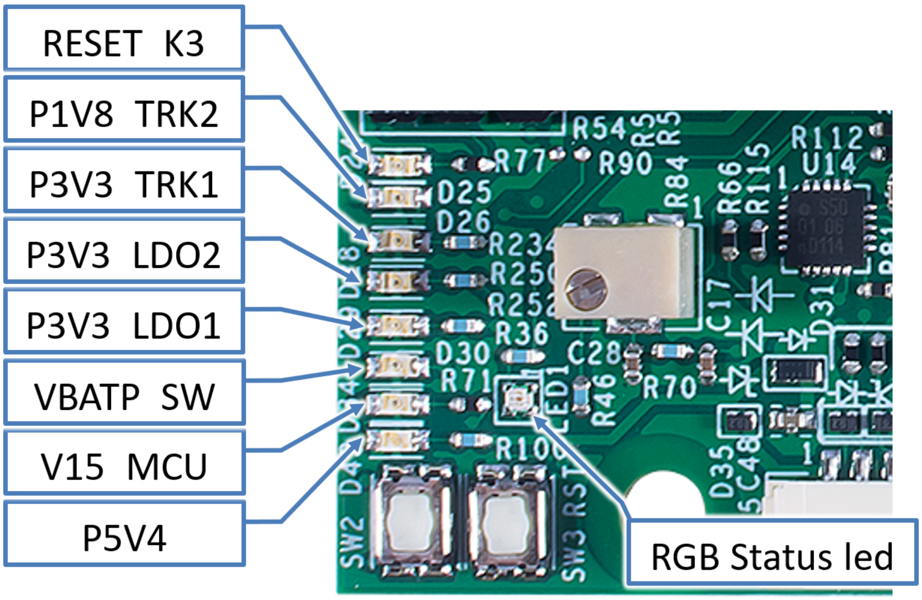

Figure 20. MR-CANHUBK344 Status LEDs

5 Revision history

Table 15. Revision history

Document ID	Release date	Description
UG10154 v.1.0	01 April 2025	Initial release

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