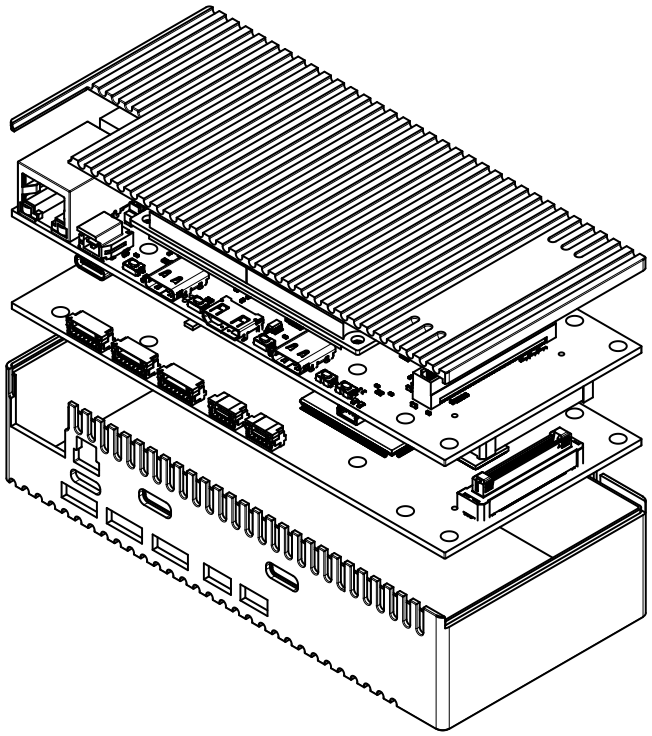
ES01-01 Datasheet

January 2024

- Carrier board revision: **1.1.6**
- Flight controller (FC) board revision: **0.4.1**



Aleph is a flight computer that combines a Nvidia Jetson Orin NX and an STM32H747IIT6. It is designed as an open development platform that allows users to run Elodin's Roci flight software, Betaflight, PX4, or something homegrown.

Contents

1. Overview 2
1.1. Hardware 2
2. Carrier Board 2
2.1. Connectivity 2
3. Flight Controller Board 3
3.1. Power Supply 3
3.2. STM32H7 Microcontroller 3
3.3. Sensors 3
3.4. Connectivity 4
3.5. RP2040 Microcontroller 5
3.6. LEDs 5

Overview

Hardware

Aleph features two boards connected via a Samtech ERF5-040 board to board connector. The “carrier board” – the upper level board – connects to the Orin NX module. The “flight controller board” features the STM32H747, and a full suite of sensors.

Carrier Board

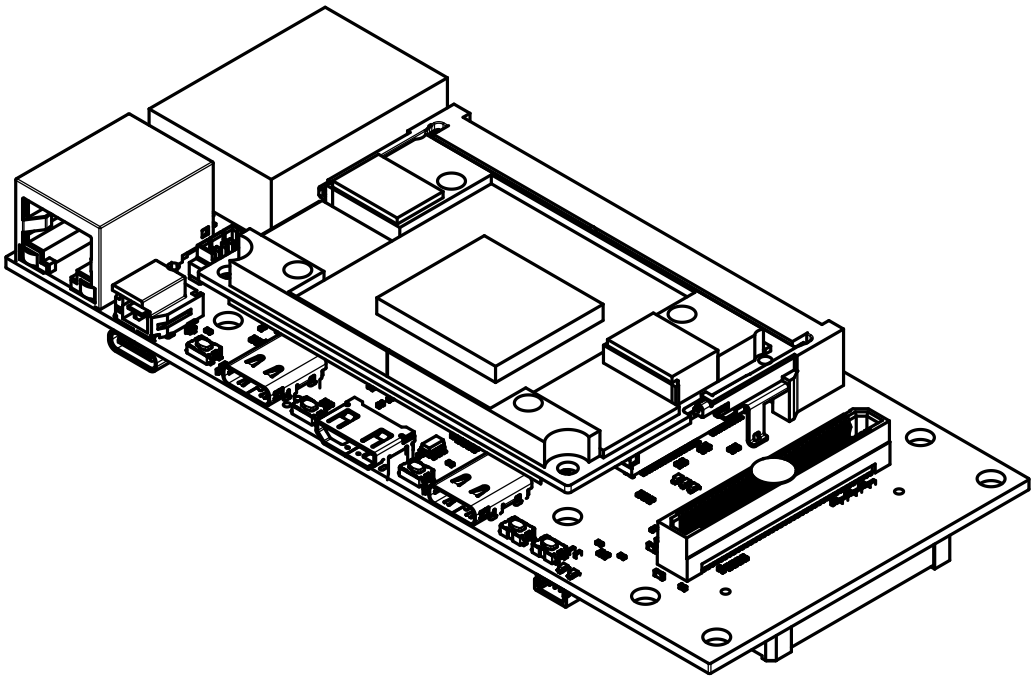


Figure 1: Carrier board

Connectivity

- M.2 M Key - PCIe x4
- M.2 E Key - PCIe x1, USB FS (12 Mbit/s), I2C, UART
- USB-C Serial Debug Port with PD
- USB-C SS+ (10 Gbit/s) with USB PD and DP
- USB-C SS+ (10 Gbit/s)
- RJ45 GigE
- MIPI CSI-2 Interface
- Samtech ERF5-040 B2B connector
  - PCIe x2
  - USB FS (12 Mbit/s)
  - 1x I2C
  - 1x SPI
  - CAN
  - UART

Flight Controller Board

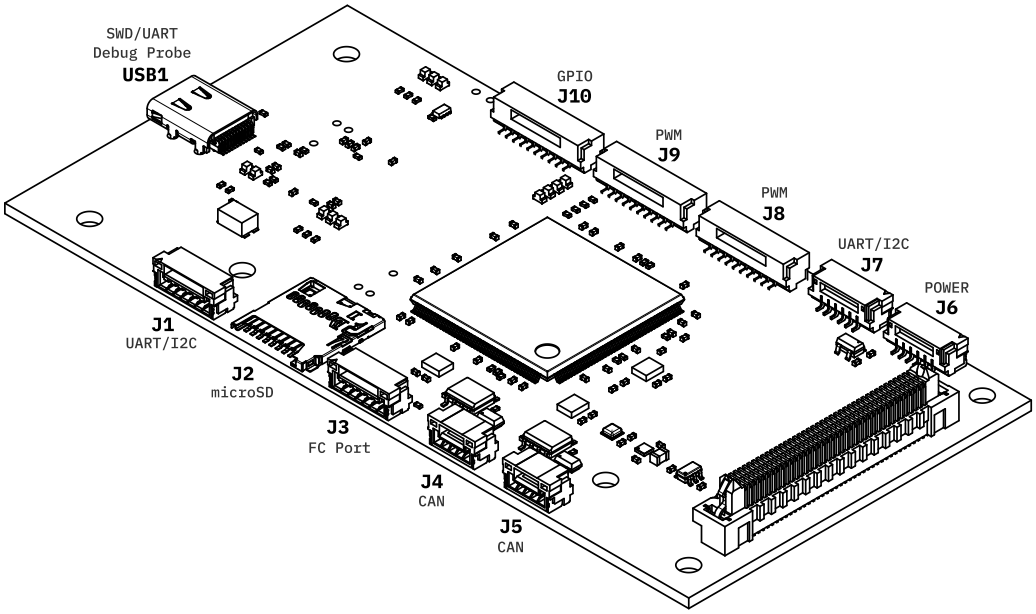


Figure 2: Flight controller board

Power Supply

The flight controller board requires 10W+ of regulated 5V DC power. There are 3 options for supplying power to the flight controller board:

1. B2B connector (carrier board will supply necessary power by default).
2. **USB1** VBUS (USB-PD is not required).
3. **J6** DC power connector.

NOTE: Even though the board requires a 5V supply, it operates on 3.3V VDDIO (I/O voltage).

STM32H7 Microcontroller

The primary MCU on the flight controller board is an STM32H747IIT6:

- 32-bit dual-core processor
  - ARM Cortex-M7 @ 480MHz
  - ARM Cortex-M4 @ 240MHz
- 2MB flash memory
- 1MB RAM
- Datasheet: DS12930
- Reference manual: RM0399

Sensors

- 3x BMI270 IMUs (I2C1, I2C2, SPI1)
  - Datasheet: BST-BMI270-DS000
- BMM350 Magnetometer (I2C1)
  - Datasheet: BST-BMM350-DS001
- BMP581 Barometer (I2C1)
  - Datasheet: BST-BMP581-DS004

Internal bus pin mapping:

- I2C1: SCL (PB6), SDA (PB7)
- I2C2: SCL (PF1), SDA (PF0)
- SPI1: SCK (PG11), MOSI (PD7), MISO (PG9), CS (PG10)

Connectivity

For all of the JST-GH connectors on the flight controller board, the left-most circuit is considered pin 1 and is typically +5V output (except for the power connector). The right-most circuit is always ground.

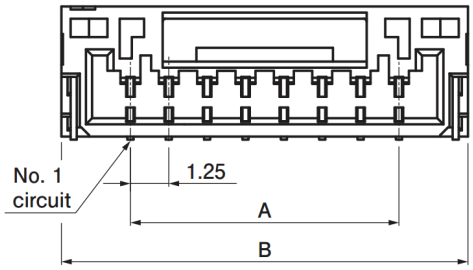


Figure 3: JST-GH header side view

J1: UART3/I2C4 6-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2,3: UART3 TX (PD8), RX (PD9)
  - 4,5: I2C4 SCL (PF14), SDA (PF15)
  - 6: GND

J2: SDMMC1 microSD
- STM32 pin mapping
  - DAT0-3 (PC8-11)
  - CLK (PC12)
  - CMD (PD2)

J3: UART4 FC Port 6-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2,3: SBUS IN (PB8), OUT (PB9)
  - 4: SMART (PG14, 10kOhm pullup)
  - 5: FPORT (PB4, 10kOhm pullup)
  - 6: GND

J4: FDCAN1 4-pin JST-GH
- STM32 pin mapping
  - TX (PD1)
  - RX (PD0)
- Connector pinout
  - 1: 5V out
  - 2,3: CAN-H, CAN-L
  - 4: GND

J5: FDCAN2 4-pin JST-GH
- STM32 pin mapping
  - TX (PB13)
  - RX (PB12)
- Connector pinout
  - 1: 5V out
  - 2,3: CAN-H, CAN-L
  - 4: GND

J6: **Power In** 6-pin JST-GH
- 5V, 10W+ regulated input
- Connector pinout
  - 1,2: 5V in
  - 3,4: ADC1 IN2 (PF11), IN6 (PF12)
  - 5,6: GND

J7: UART2/I2C4 6-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2,3: UART2 TX (PD5), RX (PD6)
  - 4,5: I2C4 SCL (PF14), SDA (PF15)
  - 6: GND

J8: PWM TIM2/TIM1 10-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2-5: TIM2 CH1-4 (PA5, PA1, PA2, PA3)
  - 6-9: TIM1 CH1-4 (PE9, PE11, PE13, PE14)
  - 10: GND

J9: PWM TIM3/TIM4 10-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2-5: TIM3 CH1-4 (PA6, PA7, PB0, PB1)
  - 6-9: TIM4 CH1-4 (PD12, PD13, PD14, PD15)
  - 10: GND

J10: GPIO 10-pin JST-GH
- Connector pinout
  - 1: 5V out
  - 2-3: PC4-5
  - 4-9: PG2-7
  - 10: GND

RP2040 Microcontroller

The flight controller board also has an RP2040 MCU:
- 32-bit dual-core ARM Cortex-M0+ @ 133MHz processor
- 264KB on-chip SRAM
- 16MB external QSPI NOR flash (W25Q128JVSIQ)
- USB FS (12 Mbit/s)
- Datasheet: RP2040 Datasheet

The RP2040 is connected to the STM32H747's SWD and UART1 pins:
- **SWD**: STM32 PA13, PA14 <-> RP2040 GPIO11, GPIO12
- **UART1**: STM32 PA9, PA10 <-> RP2040 GPIO4, GPIO5

It's also connected to the **USB1** USB-C connector on the FC board.

This allows the RP2040 to serve several useful functions on the FC board. When flashed with debugprobe firmware, it can serve as a CMSIS-DAP probe and USB-to-UART bridge. This provides a convenient way to flash new firmware onto the STM32 over USB using standard tools such as OpenOCD or probe-rs. Since the RP2040 can monitor the STM32's UART1 and pull its nRST low, it can also function as a watchdog.

NOTE: the RP2040 is pre-flashed with debugprobe firmware.

LEDs

There are 4 LEDs connected to the following pins on the STM32H747:
- "SA0" (STM32 amber LED 0) -> PB14
- "SB0" (STM32 blue LED 0) -> PB15
- "SG0" (STM32 green LED 0) -> PD10
- "SR0" (STM32 blue LED 0) -> PD11

There are 5 LEDs connected to the following pins on the RP2040:
- "RA0" (RP2040 amber LED 0) -> GPIO0
- "RA1" (RP2040 amber LED 1) -> GPIO1
- "RA2" (RP2040 amber LED 2) -> GPIO2
- "RG0" (RP2040 green LED 0) -> GPIO24
- "RG1" (RP2040 green LED 1) -> GPIO25