3DFENSE

NavPack D04

Complete Navigation & Power Core for Professional VTOL UAV

3DFENSE · Preorder — Revision 1.06 · **Civilian version**



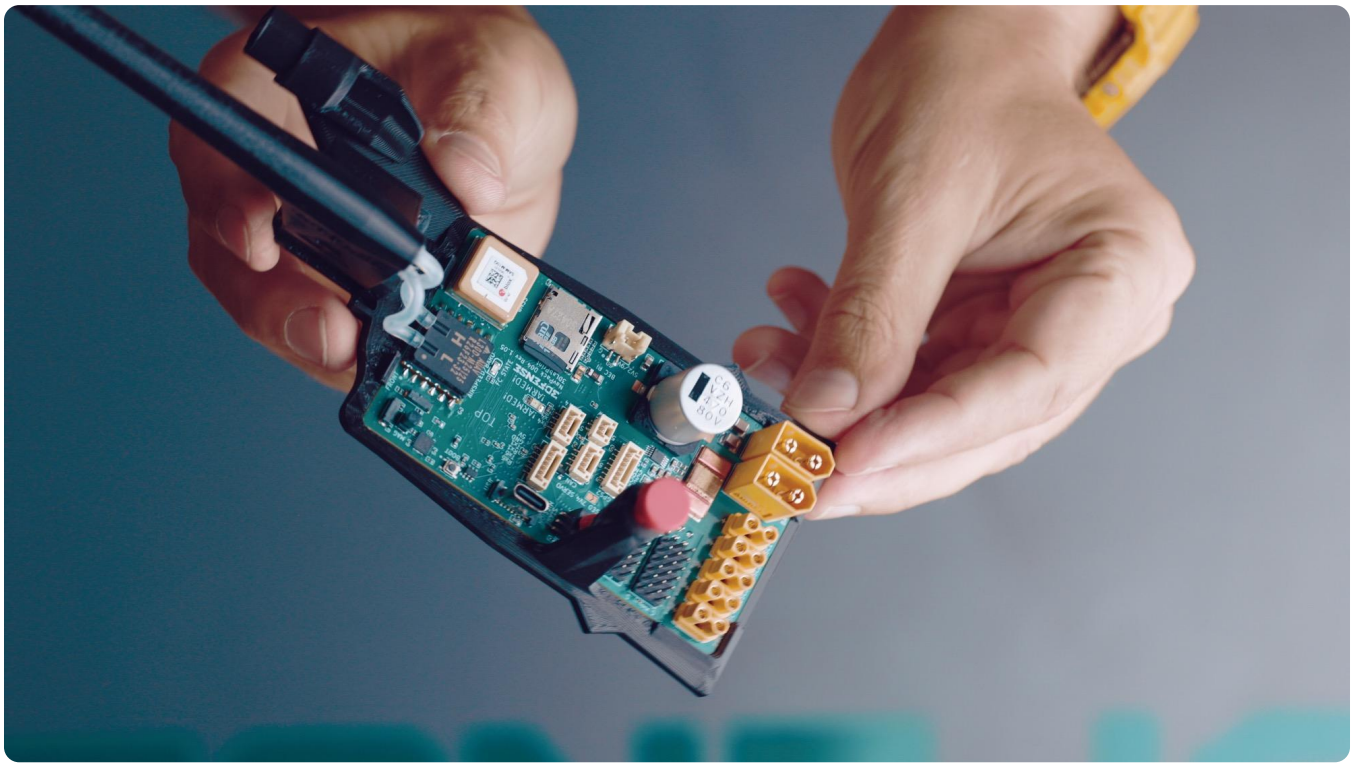
Overview

NavPack D04 is not just a flight controller. It is a **complete navigation pack** — autopilot, GNSS, professional magnetometer, digital pitot-static sensing and full power electronics on a single board. Instead of a box full of cables and five separate modules, you integrate one assembled, tested unit designed from the ground up for VTOL platforms with transition to fixed-wing flight.

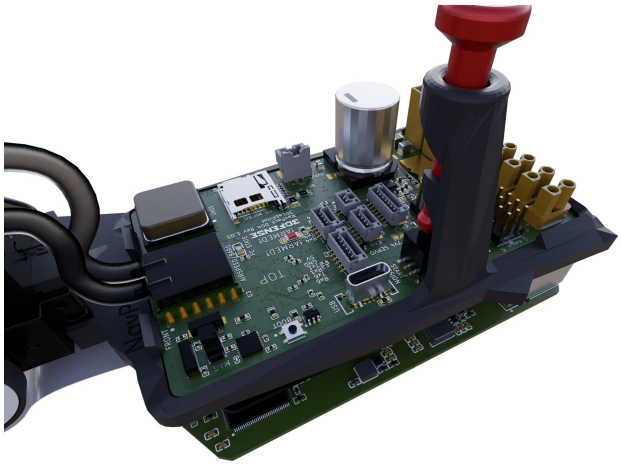
Getting everything onto one board is no small feat. It demanded **top-grade BEC regulators, rigorous placement and filtering of every power circuit, and carefully engineered shielding** of the sensitive sensors — without this approach, such a level of integration would simply not be possible.

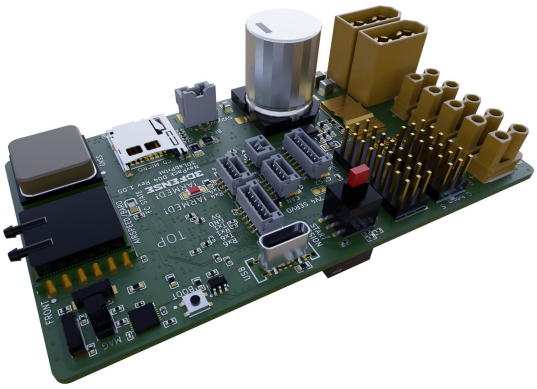
Thanks to these high-grade sensors and the careful tuning of the board, we are able to **navigate even in GNSS-jammed environments with a deviation of 2–5 %**.

Runs ArduPilot with a dedicated 3DFENSE hardware definition, including the unique **Autolaunch** feature — start the entire mission with a physical button on the airframe, no laptop, no RC transmitter.

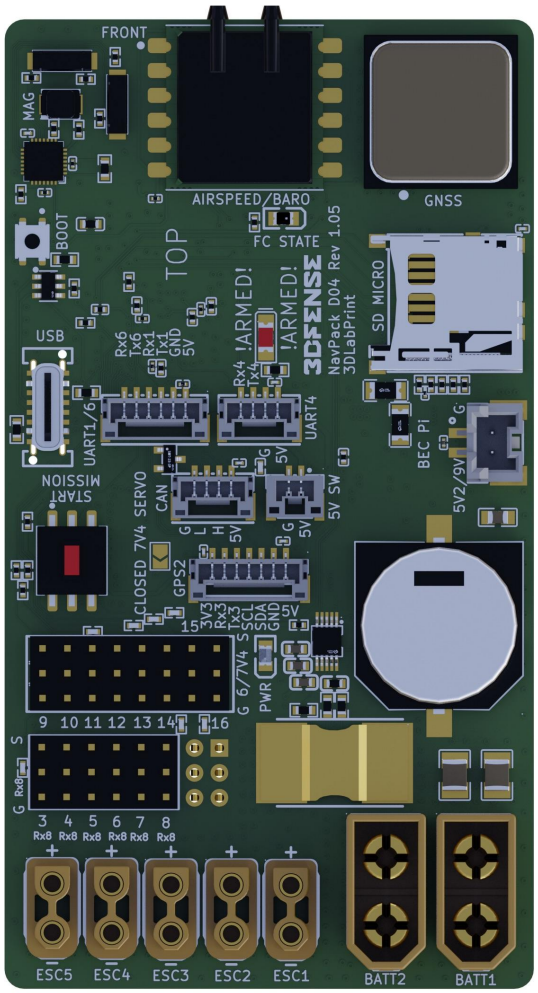


Assembled NavPack D04 — board, mount and pitot-static system

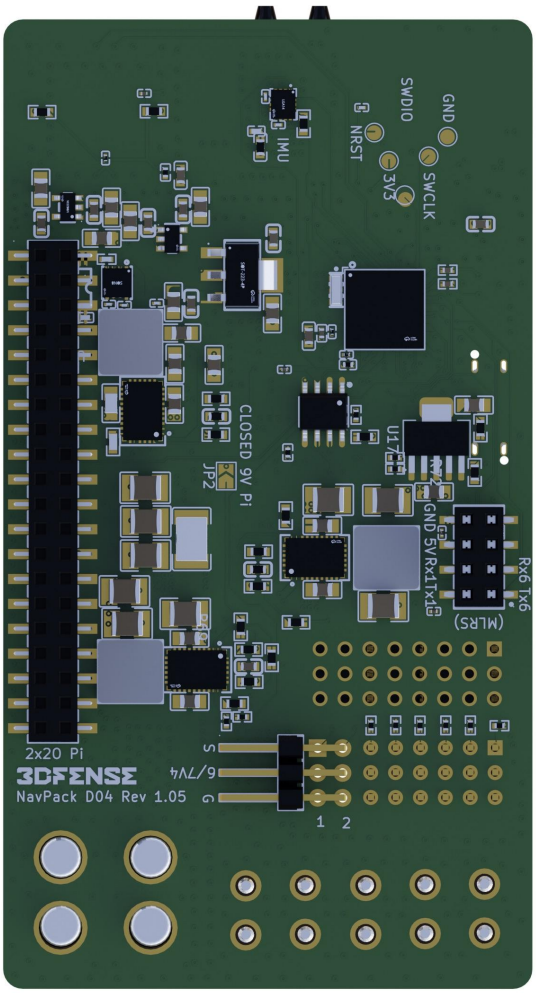




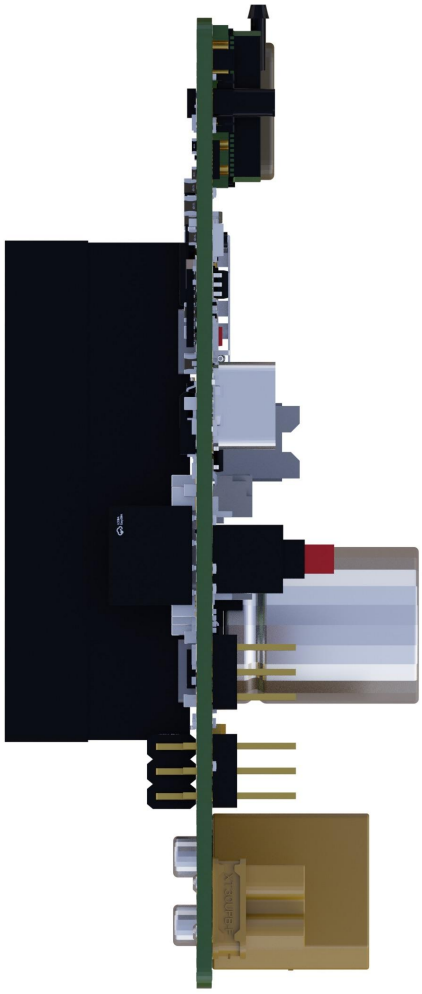
Board Views



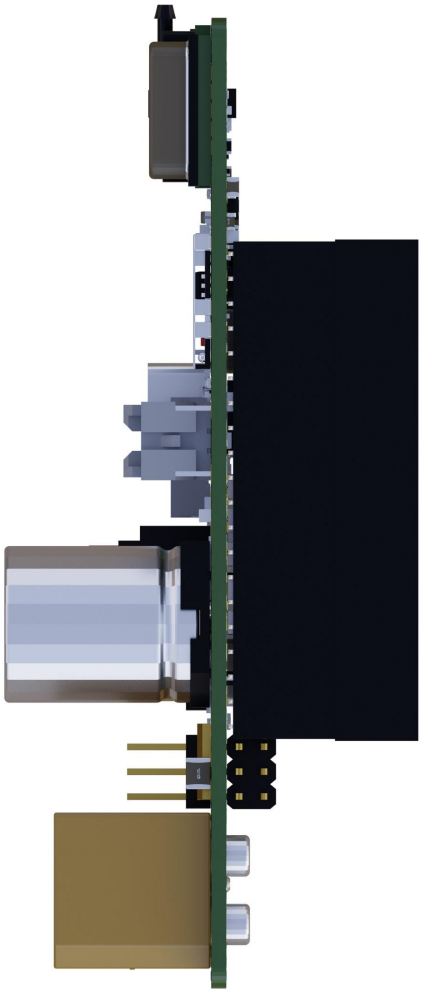
Top



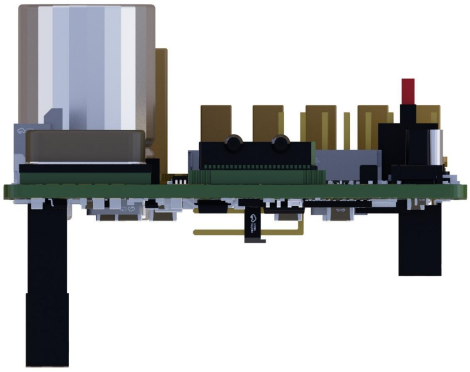
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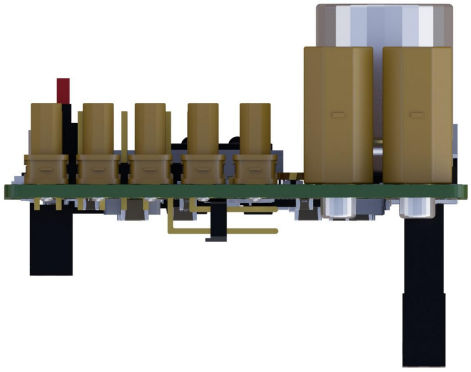
Left



Right



Front



Back

Core

Parameter	Value
MCU	STM32H743VIH6 — ARM Cortex-M7 @ 480 MHz, 2 MB flash, 1 MB RAM
Firmware	ArduPilot (ArduPlane / QuadPlane VTOL), custom 3DFENSE hwdef
Scripting	Lua enabled; Autolaunch mission-start script embedded in firmware (ROMFS — works without SD card)
Storage	microSD slot (SDMMC, 4-bit), logging + scripts + missions
Dimensions	99 × 54 mm
Weight	70 g
Debug	SWD service connector (JST 1.25 mm 6-pin), reset + DFU boot buttons on board

Sensors

Sensor	Part	Notes
IMU	TDK InvenSense ICM-42688-P	SPI, low-noise 6-axis, 2 kHz fast sampling
Compass	PNI RM3100	Full discrete coil set on board (SPI). Inductive magneto-inductive technology — no drift, far higher interference immunity than MEMS compasses
Barometer	Infineon DPS368	Dedicated high-precision barometer (±2 cm relative accuracy class), internal I2C sensor bus
Airspeed	Amphenol All Sensors AUAV-L30D-M25125	Digital differential ±30 inH_2O (airspeed 0–400 km/h) + absolute 250–1250 mbar as redundant static pressure source, I2C
GNSS	u-blox SAM-M10Q on board (GPS 1)	Second GNSS port for external unit (GPS 2) — dual-GPS redundancy
Power monitor	TI INA228	20-bit high-side voltage/current/energy monitoring, precise battery capacity telemetry

Power Architecture

Parameter	Value
Battery input	3S – 12S LiPo (XT60), filtered rail
Battery connectors	2× XT60 (input / pass-through)
ESC power outputs	5× XT30, fused/filtered VBAT rail
Power path current rating	100 A continuous / 180 A burst
Regulators	3× Analog Devices LT8645S synchronous buck (65 V technology, 8 A continuous / 10 A peak)
Rail 1 — FC	5 V system rail for autopilot, sensors and peripherals
Rail 2 — Companion	High-current rail for Raspberry Pi / AI companion computer, selectable **5.2 V (default) / 7 V** via solder jumper, **switchable by the autopilot** (software power control). In the 7 V setting it doubles as a power source for a **video transmitter or any HD air unit**
Rail 3 — Servo	Dedicated servo BEC rail, selectable **6.2 V (default) / 7.4 V** via solder jumper
Power multiplexing	TI TPS2113A automatic source switch — board runs from USB-C when battery is not connected
Aux switched output	5 V payload output (JST 1.25 mm 2-pin), switchable by the autopilot (GPIO-controlled), with status LED
Protection	resettable fuses, USB ESD protection (USBLC6), CAN bus TVS (PESD2CANFD)

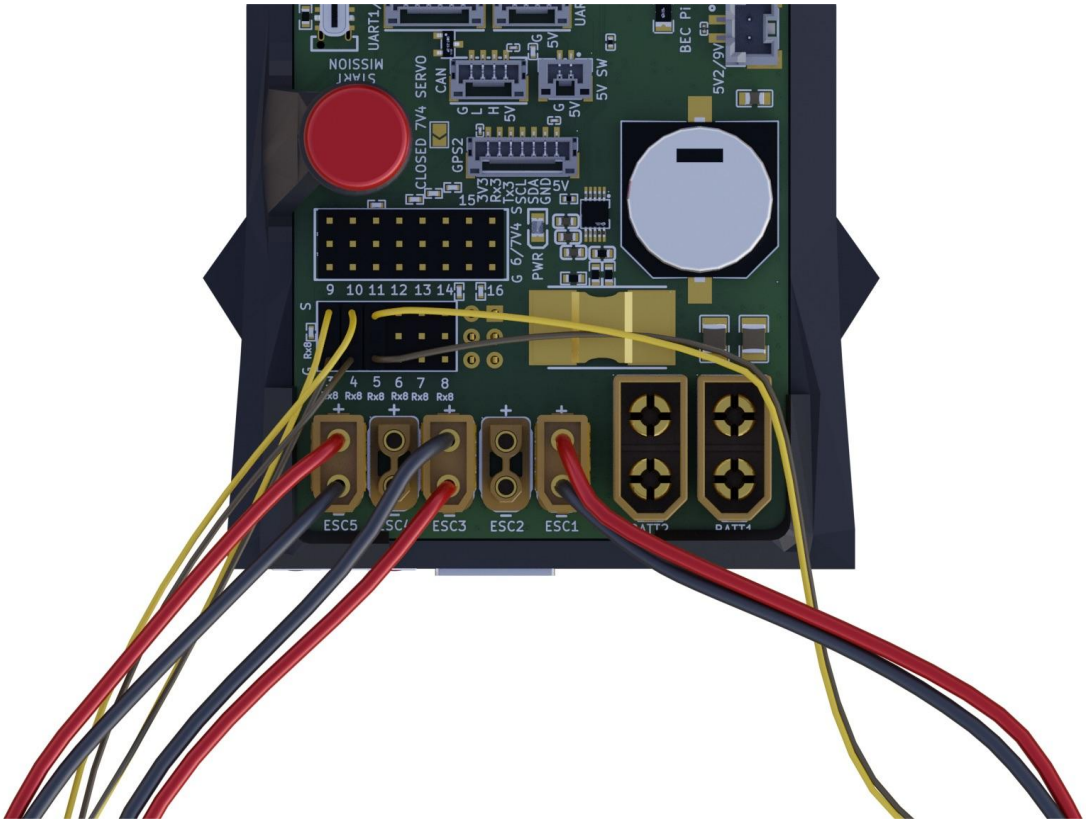
Actuator Outputs — 16 channels

Header	Channels	Rows	Notes
ESC header (2.54 mm, 3×6)	S3 – S8	signal / ESC telemetry / GND	Motor/ESC channels. Middle row = shared one-wire ESC telemetry line (UART8 RX) for extended telemetry (voltage, current, temperature…) beyond what BDShot provides
Servo header (2.54 mm, 3×8)	S9 – S16	signal / servo BEC / GND	Intended for servo operation, powered from dedicated servo BEC rail — up to **7.4 V** selectable
Aux servo header (2.54 mm, 2×3)	S1 – S2	signal / servo BEC / GND	On the **bottom side** of the board — neatly tucked away, ideal for camera / payload servos

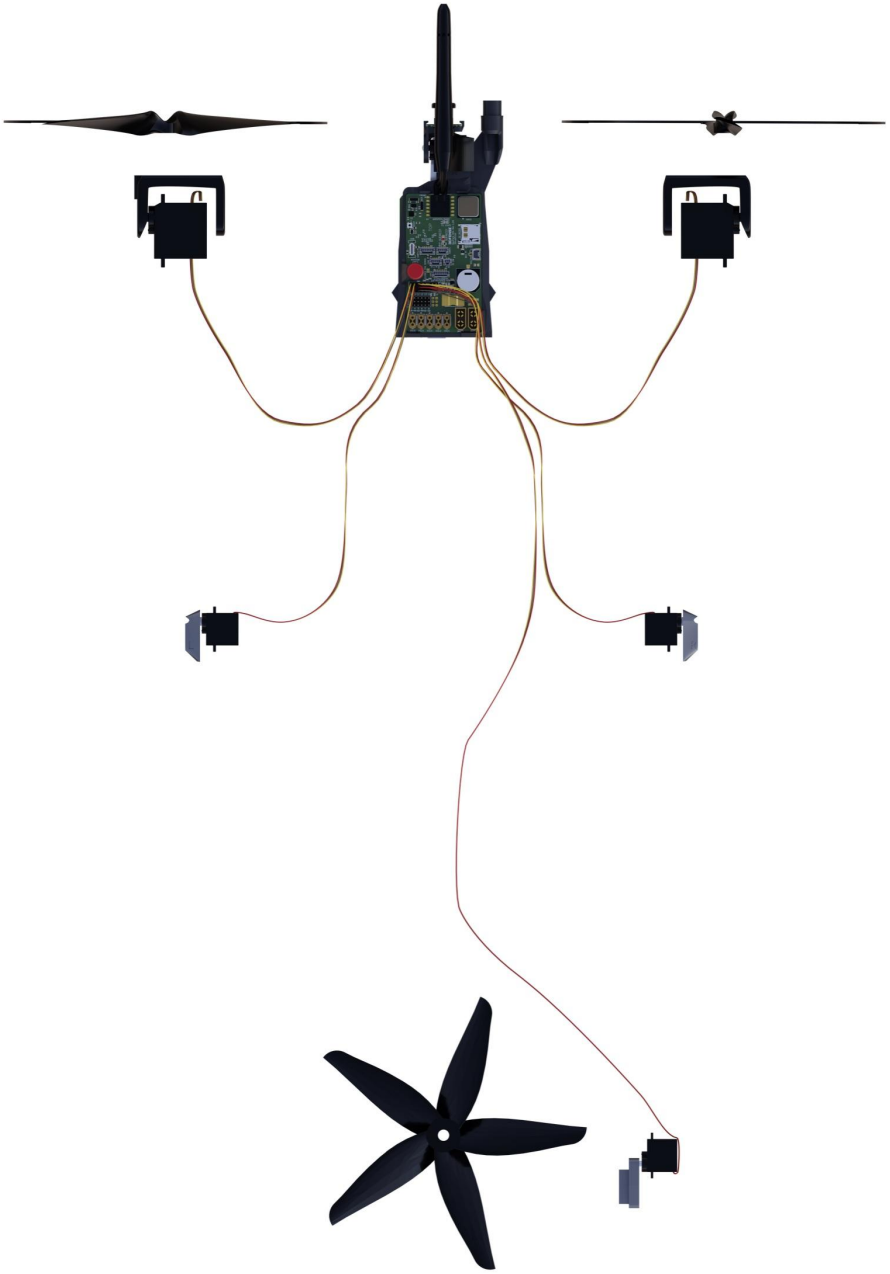
All 16 outputs support PWM; DShot on timer-backed groups. **Bidirectional DShot (BDShot) on the ESC outputs S3 – S8** — per-motor RPM telemetry without extra wiring (harmonic notch filtering, motor health monitoring).



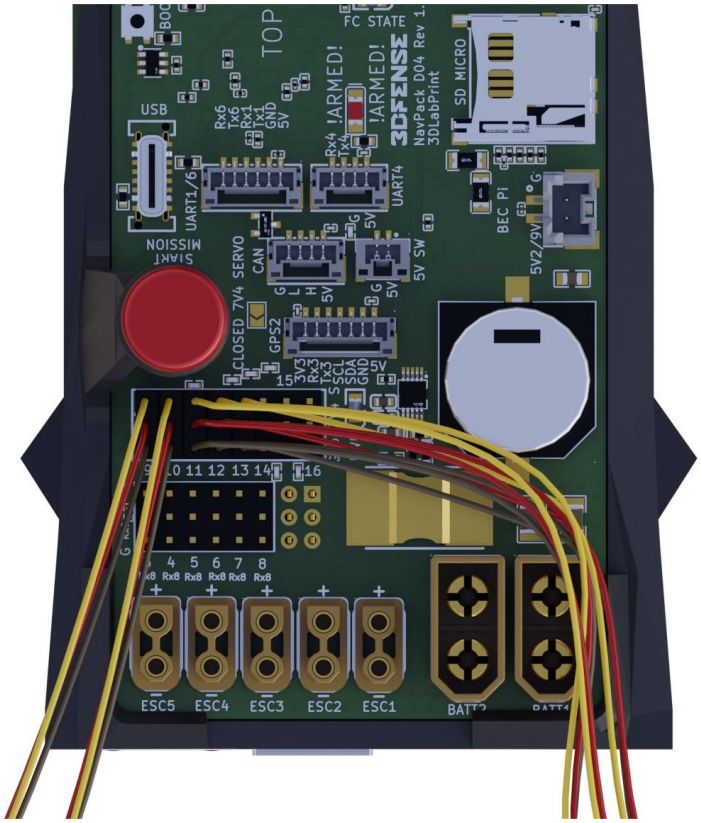
Example propulsion wiring — lift motors and cruise motor, ESCs powered directly from the XT30 outputs



Connector detail — ESC signal header, XT30 power outputs and battery XT60



Example servo wiring — wing, tail and tilt servos



Connector detail — servo header S9 – S16

Communication Interfaces

Interface	Connector	Signals
USB	USB-C 2.0, vertical	FW update, MAVLink, configuration
Telemetry + RC combo (mLRS)	JST 1.25 mm 6-pin	5 V, GND, UART1 TX/RX (MAVLink) + UART6 TX/RX (RC) — two UARTs on one connector, plugs an mLRS / ELRS combo module directly
GPS 2 + external I2C	JST 1.25 mm 7-pin	UART, I2C, 5 V, 3V3
CAN (DroneCAN ready)	JST 1.25 mm 4-pin	5 V, CAN_H, CAN_L, GND — standard DroneCAN pin order, ESD protected, on-board 120 Ω termination
General purpose UART	JST 1.25 mm 4-pin	UART + 5 V
ESC telemetry	on ESC header	dedicated UART RX
Companion (TELEM1)	on Pi header	UART to companion computer
SWD debug	JST 1.25 mm 6-pin	SWDIO, SWCLK, NRST, 3V3, GND

Total: 7 UART interfaces + USB + CAN + 2× I2C (internal sensor bus + external).

UART Map

UART	Function	Where
USART1	MAVLink telemetry	mLRS combo connector
USART2	GPS 1 (on-board SAM-M10Q)	internal
USART3	GPS 2 (external GNSS)	GPS 2 connector (JST 7-pin)
UART4	General purpose	UART4 connector (JST 4-pin)
USART6	RC input (CRSF / ELRS / SBUS)	mLRS combo connector
UART7	Companion computer (TELEM1)	Pi header pins 8 / 10
UART8	ESC telemetry (RX only)	ESC header, middle row

Compatible Radio Systems

The combo connector (RC + telemetry) is simply two standard UARTs with 5 V supply — NavPack is not locked to any single RC ecosystem. Verified / supported options:

System	RC (USART6)	Telemetry (USART1)	Notes
mLRS combo module	yes	full MAVLink	reference solution, single connector, no extra wiring
ExpressLRS 3.4+ (MAVLink mode)	yes	MAVLink over the same UART	one cable to USART6, USART1 stays free
ExpressLRS / TBS Crossfire (CRSF)	yes	CRSF telemetry	basic telemetry, no mission/parameter transfer
RFD900x / RFD868x (TXMOD)	SBUS	full MAVLink	maximum range
Dragonlink	SBUS	full MAVLink	
SBUS receivers (FrSky, Futaba…)	yes	—	RC only
HD systems (Herelink, SIYI MK15/HM30…)	SBUS	MAVLink	power the air unit from its own supply (7–12 V), not from the connector — e.g. the Companion BEC switched to 7 V

All UARTs are 3.3 V logic; protocols are selected purely in ArduPilot parameters (`SERIAL_PROTOCOL`) — no hardware changes required.

Companion Computer Interface (Raspberry Pi)

40-pin header with **Raspberry Pi GPIO-compatible pinout** — the Pi (or Pi-compatible AI module) mounts directly, no cables:

Pi header pin	Function
2, 4	**Power to the Pi** from dedicated high-current buck rail (5.2 V default, 7 V via solder jumper) — switchable by the autopilot (the FC can power-cycle the companion in flight or keep it off until needed)
8 (GPIO14 / TXD)	→ FC TELEM1 RX (UART7)
10 (GPIO15 / RXD)	← FC TELEM1 TX (UART7)
6, 9, 14, 20, 25, 30, 34, 39	GND (full RPi ground pattern)

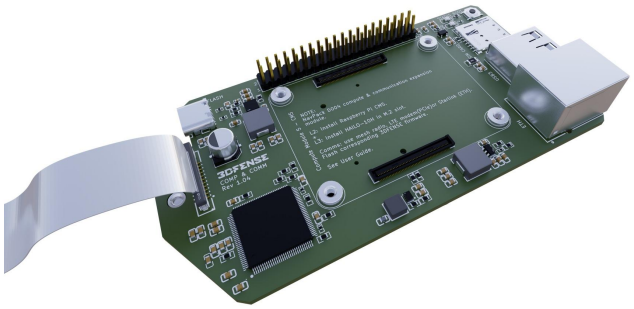
Additional JST-PA 2-pin connector on the same switched companion rail for external accessories (fan, LED, USB hub power).

Part of a Larger Ecosystem

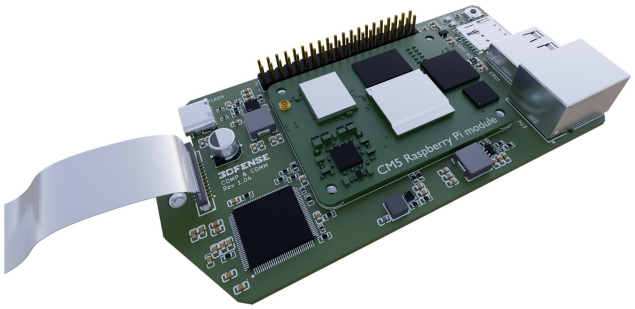
NavPack is not a standalone product — it is the core of the **3DFENSE ecosystem**. Together with the **CM5 Extension Module** (Raspberry Pi Compute Module 5 carrier) it grows into a complete airborne compute and communication stack:

- **Complete datalink** — LTE, mesh radio and **Starlink** connectivity for true beyond-visual-line-of-sight operations
- **On-board AI** — optional **Hailo-10H** accelerator for real-time computer vision and edge inference
- **One integration path** — the CM5 module mounts directly on the NavPack companion header; power, telemetry and control are already routed

This opens the door well beyond hobby use — **professional deployments, research & development, and education** on a single, coherent hardware platform.



CM5 Extension Module — compute & communication carrier
(40-pin header, Ethernet, USB 3, SIM, microSD)



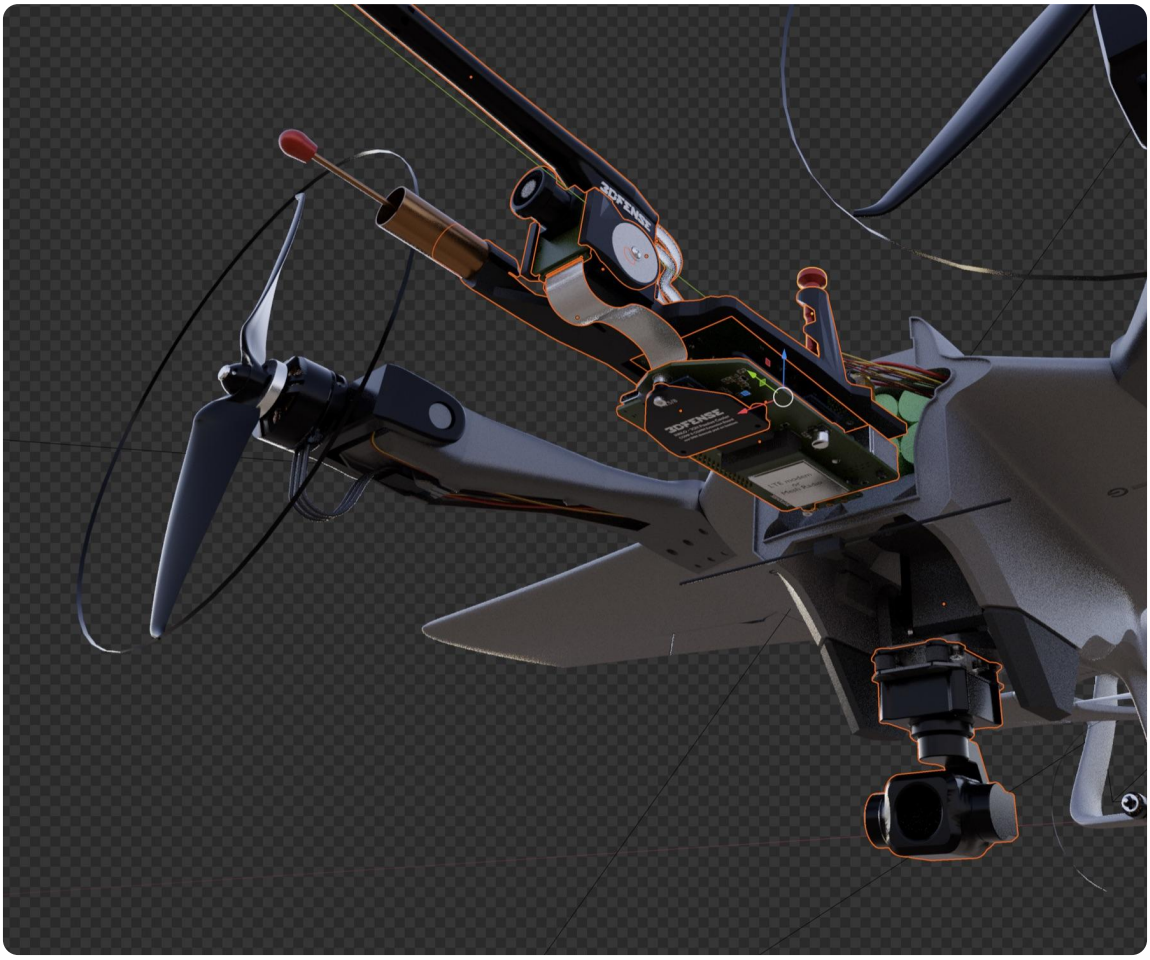
Raspberry Pi Compute Module 5 mounted on the carrier



Optional Hailo-10H AI accelerator (M.2) and LTE modem / mesh radio (mPCIe)



Fully assembled stack with passive cooler and RadioLink module (mLRS / ELRS / SBUS / CRSF)



The whole stack in its element — NavPack + CM5 module on the slide-out avionics tray of the D-22 Twin Iron, gimbal camera below (design view)

Mission Start — Autolaunch

- **START button** on board (external button input supported) wired to a dedicated MCU GPIO
- Multi-stage press sequence (triple confirmation with timing windows) makes accidental activation practically impossible
- Automatic checks: flight mode, mission with VTOL takeoff, AHRS/pre-arm status
- 5-second countdown with audio indication, then automatic arm & mission start
- Implemented as a Lua script embedded in the firmware image — no SD card required, survives any reflash of parameters

Indication & Controls

- Status LED (autopilot-driven) + power LEDs
- 3 buttons: START (Autolaunch), RESET, BOOT (DFU firmware recovery)

Specifications at a Glance

MCU	STM32H743VIH6 — ARM Cortex-M7 @ 480 MHz, 2 MB flash, 1 MB RAM
Firmware	ArduPilot, custom 3DFENSE hwdef (Autolaunch Lua in ROMFS)
IMU	ICM-42688-P (SPI, 2 kHz)
Barometer	Infineon DPS368 (internal I2C)
Compass	PNI RM3100 (SPI), discrete coil set on board
Airspeed	AUAV-L30D-M25125 digital, ±30 inH_2O + absolute static channel (I2C)
GNSS	u-blox SAM-M10Q on board + port for external second GNSS
Power monitor	TI INA228, 20-bit (voltage / current / energy)
Blackbox	microSD slot (SDMMC, 4-bit)
UARTs	7× (USART1, 2, 3, UART4, USART6, UART7, UART8)
I2C	2× — internal sensor bus + external
CAN	1× — DroneCAN ready, ESD protected, on-board 120 Ω termination
PWM outputs	16× — PWM / DShot, **BDShot on S3 – S8**
Relay outputs	2× autopilot-switched power rails — **companion BEC enable** (Pi power-cycle) + **5 V payload output**
RC input	CRSF / ELRS / SBUS on USART6 (mLRS combo connector)
USB	USB-C 2.0, vertical
Buttons	START (Autolaunch), RESET, BOOT (DFU)
Battery input	3S – 12S LiPo, 2× XT60, 100 A continuous / 180 A burst
ESC power outputs	5× XT30, fused/filtered VBAT
BEC — FC	5 V (LT8645S, 8 A continuous / 10 A peak)
BEC — Companion	5.2 V / 7 V via jumper (LT8645S, 8 A continuous / 10 A peak), relay-switched; at 7 V usable for VTX / HD air unit
BEC — Servo	6.2 V / 7.4 V via jumper (LT8645S, 8 A continuous / 10 A peak)
Aux output	5 V payload (JST 1.25 mm 2-pin), relay-switched, status LED
Dimensions	99 × 54 mm
Weight	70 g

ArduPilot Mapping

Firmware target family: **3DFENSE04_H743** (Rev 1.06 boards ship with the **3DFENSE04_H743-Rev106** target; aircraft-specific builds add a suffix, e.g. **-D20** for the D-20 Personal Eagle). Everything below ships pre-configured — listed here so you never have to guess.

Serial ports

ArduPilot	MCU port	Where on board	Default use
SERIAL0	USB (OTG1)	USB-C	MAVLink2, firmware update
SERIAL1	UART7	Raspberry Pi header	Companion / TELEM1 (MAVLink2)
SERIAL2	USART1	mLRS combo connector	Telemetry / TELEM2 (MAVLink2)
SERIAL3	USART2	internal	GPS 1 — on-board SAM-M10Q
SERIAL4	USART3	GPS 2 connector	GPS 2 — external GNSS
SERIAL5	UART8	ESC header, middle row	ESC telemetry (RX only)
SERIAL6	UART4	GP UART connector	free — user peripheral
SERIAL7	USART6	mLRS combo connector	RC input (CRSF / ELRS)
SERIAL8	USB (OTG2)	USB-C (composite)	SLCAN / secondary MAVLink

Sensors & buses

Peripheral	Bus	Notes
IMU ICM-42688-P	SPI	2 kHz
Compass RM3100	SPI	`ROTATION_NONE` — orientation handled in hwdef
Barometer DPS368	I2C internal (bus 0)	
Airspeed AUAV-L30D	I2C internal (bus 0), addr 0x26	`ARSPD_TYPE` = 19 (AUAV), `ARSPD_BUS` = 0 — pre-set
Battery monitor INA228	I2C internal (bus 0), addr 0x40	`BATT_MONITOR` = 21 — pre-set
External I2C	I2C bus 1	GPS2 + external I2C connector

GPIO functions

Function	GPIO pin	Usage
Companion BEC switch	81 (PINIO1)	`RELAY1_PIN` = 81 → power-cycle the Pi rail from the autopilot
Payload 5 V switch	82 (PINIO2)	`RELAY2_PIN` = 82 → switch the aux 5 V payload output
START button	80	`BTN_PIN1` = 80 — Autolaunch trigger (pre-set)
Status LEDs	90 (blue), 91 (green)	autopilot driven

Timer groups

All outputs in one group must use the same protocol and frequency (PWM / OneShot / DShot).

Group	Timer	Outputs	Board header	Capability
1	TIM8	S1 – S2	Aux servo (bottom)	PWM
2	TIM5	S3 – S6	ESC	PWM / DShot / **BDShot**
3	TIM4	S7 – S10	ESC (S7 – S8) + Servo (S9 – S10)	PWM / DShot / **BDShot**
4	TIM15	S11 – S12	Servo	PWM
5	TIM1	S13 – S16	Servo	PWM
—	TIM2	buzzer	on board	alarm

BDShot (RPM telemetry) covers the entire ESC header S3 – S8; groups 2 and 3 have dedicated DMA for bidirectional operation.

Factory Testing & Quality Control

Every single unit goes through the same outgoing test procedure before it ships — no sampling, 100 % of production:

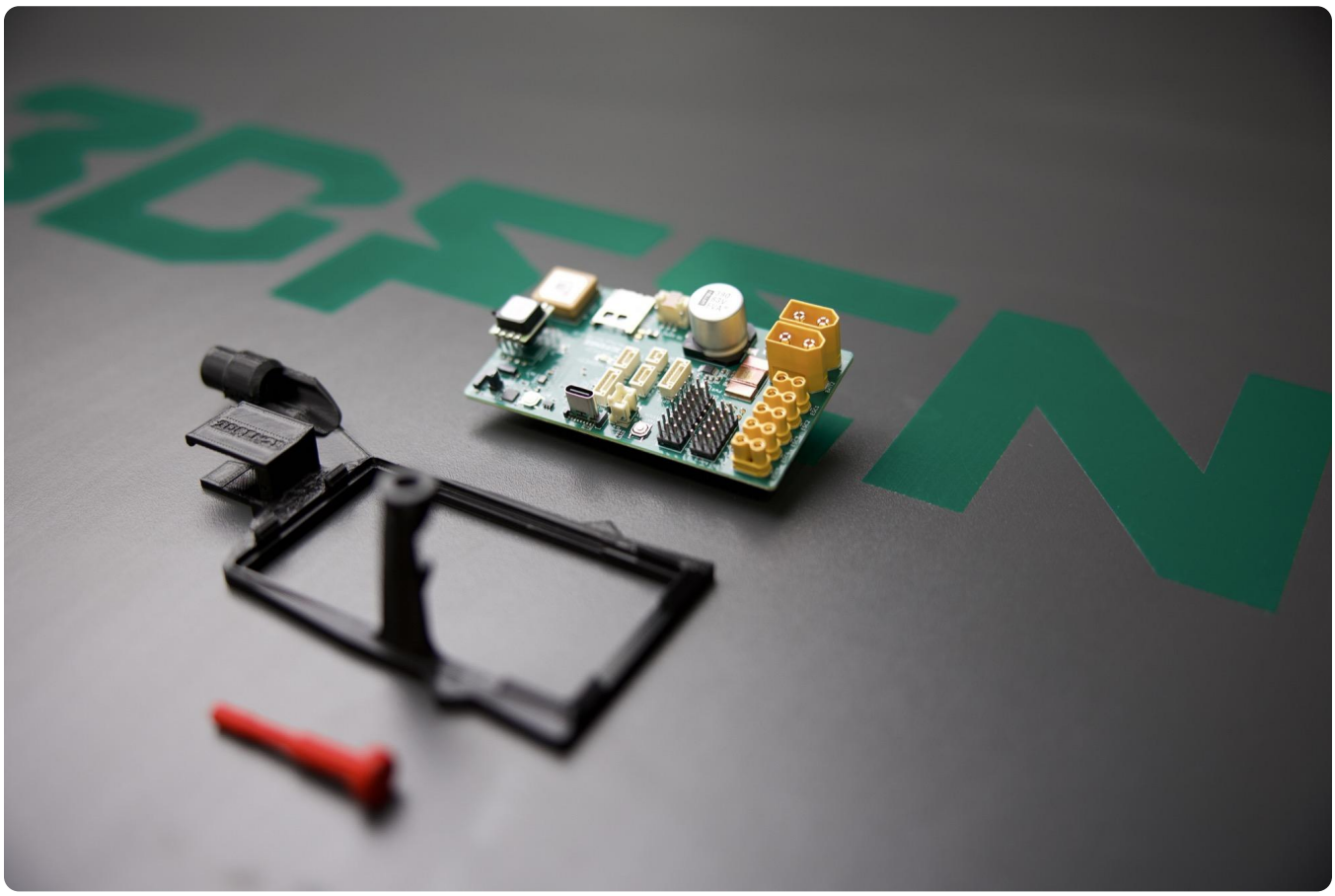
1. **Full-image DFU flash** — bootloader, firmware and complete base configuration are written in one verified 2 MB image, so every unit leaves the line in a bit-exact, known-good state
2. **Firmware verification over MAVLink** — build hash and full parameter set are read back and checked against the golden reference
3. **Barometric cross-check** — the DPS368 barometer is validated against the AUAV absolute static channel; the two independent pressure sources must agree within < 1 hPa
4. **Magnetometer validation** — the RM3100 is checked against the live geomagnetic field, including field-magnitude plausibility (not just "the sensor responds")
5. **Airspeed test** — zero-flow noise check plus a dynamic pressure response test on the pitot port
6. **Traceability** — the unique MCU UID of each unit is recorded in its individual test protocol

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What's in the Box (preorder)

- NavPack D04 — assembled board, individually tested (see Factory Testing & Quality Control)
- Pre-installed ArduPilot 3DFENSE firmware incl. Autolaunch — **build of your choice** (aircraft-specific or universal, selected at purchase), calibrated sensors, test protocol
- 20 cm silicone tube for the airspeed sensor
- STL/3MF files for 3D printing (plus ready-made G-code for Prusa MK4S) — pitot-static system, NavPack mount and Autolaunch button
  - **Pitot-static system:** non-foaming TPU, harder grades preferred — factory-tested with **Shore 55D**
  - **NavPack mount:** PETG (recommended) or PLA / PolyAir
  - **Autolaunch button:** PLA

No cables or connectors included — none are needed.



NavPack D04 with the 3D-printed pitot-static system and mount

Ready to Fly

This is the **civilian version of the NavPack**. At purchase you simply pick the firmware it ships with:

- **Aircraft-specific build** — fully configured for one of our airframes: parameters, mixes, transition logic and Autolaunch pre-set. We are starting with the **D-20C Personal Eagle II** VTOL, with more airframes in the pipeline.

- **Standard / universal build** — a clean ArduPilot 3DFENSE build ready for configuring your own airframe.

Firmware Images & Self-Flashing

Boards ordered with a firmware build ship **flashed, tested and ready** — nothing to install. All builds will also be **available as free downloads**, so you can buy a **clean NavPack** and flash it yourself — or switch airframes and update whenever you like:

- Aircraft-specific builds are distributed as **complete 2 MB flash images** — bootloader, firmware and the full airframe parameter set in a single file (e.g. `3DFENSE04_H743-Rev106-D20C` for the D-20C Personal Eagle II). This is the exact same gold-image process used on our production line: one flash, and the board is in a known-good, ready-to-configure state.
- Flashing is done over **USB-C in DFU mode** — hold the BOOT button while connecting (factory-blank boards enter DFU automatically). Use **STM32CubeProgrammer** (free official GUI, Windows / macOS / Linux) or **dfu-util** (command line); a step-by-step flashing guide is included with every image.
- Image downloads: **3dlabprint.com** → **My Account** → **Downloads** — the golden image and the User Guide (flashing + 3D-printed parts) are included with every NavPack D04 purchase

No ground-station software is required for flashing itself — Mission Planner / QGroundControl come into play afterwards, for calibration and your own configuration.



D-20C Personal Eagle II — backpack-portable VTOL (first supported airframe)



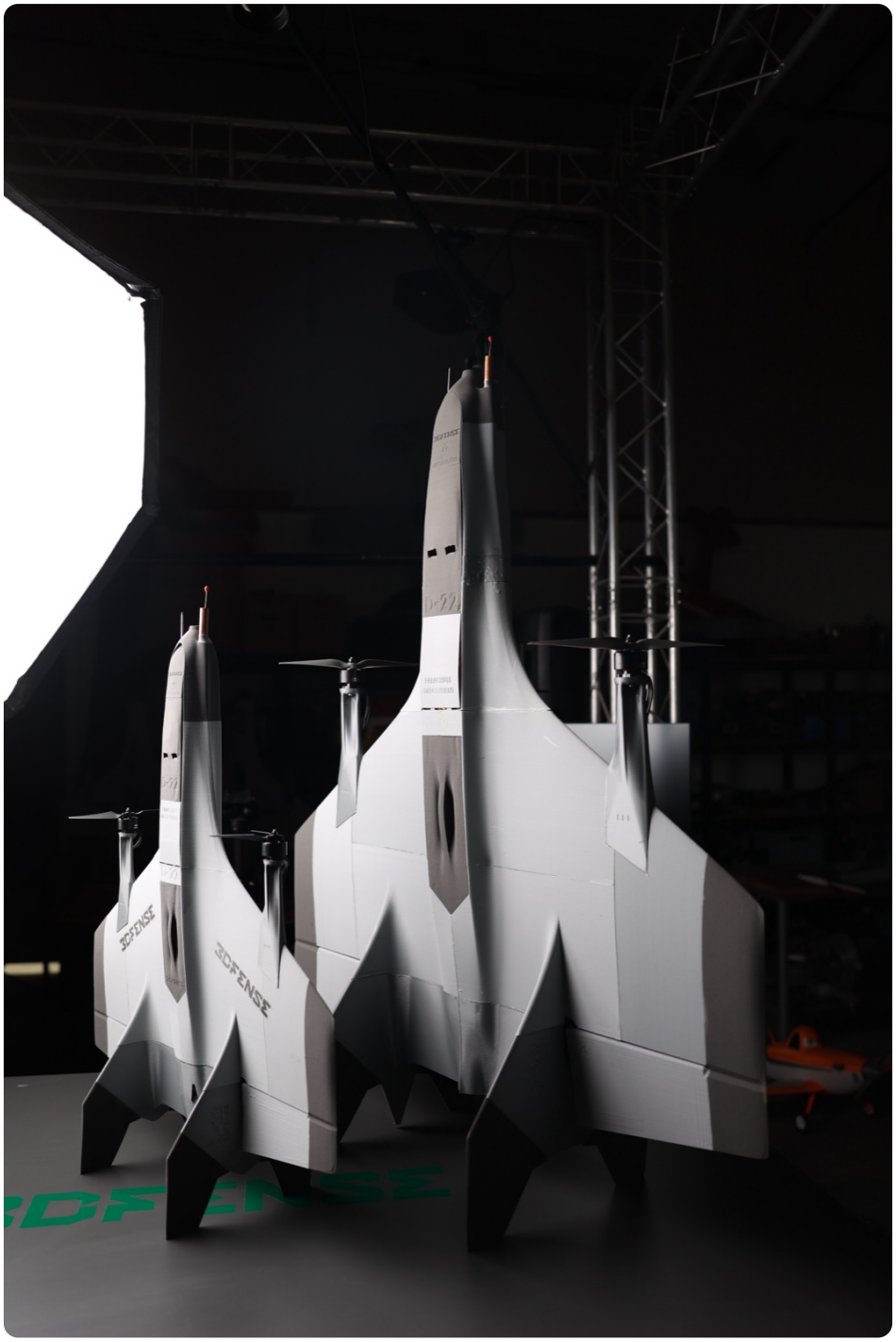
D-22 Twin Iron



D-24



D-18 Iron



3DFENSE airframes in the hangar

Every supported airframe comes with a **detailed step-by-step application guide** for its NavPack installation. Setting up a flight controller for a VTOL has **never been easier** — a genuine game changer for UAV production.

With an aircraft-specific build, **just plug in motors and servos** according to the supplied wiring diagram — no soldering, no wiring, no tears. Before the first flight you only need to:

1. Set up your RC receiver
2. Trim the servos
3. Set motor rotation direction (or servo direction if using different servo types)

And yet the NavPack still leaves plenty of room to grow — second GNSS, DroneCAN devices, external I2C sensors, general-purpose UART and a companion computer. Simple to start, no ceiling.

And of course — you can use the NavPack in **any other VTOL, classic fixed-wing airplane, and experimentally in multicopters**. It is a full ArduPilot autopilot; configuring it for your own airframe is entirely in your hands.

Pricing, lead time and warranty terms will be specified in the preorder form.

3DFENSE — Navigation. Power. Launch. One board.