

Aircrew Operator's and Maintenance Manual: Turbo Ace MATRIX

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1. Introduction

The **Turbo Ace MATRIX** is a commercial hobby type UAS commonly used for photography and recreational use, and provides a stable platform for aerial photography. This document describes operating and maintenance procedures developed with the help of the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the Turbo Ace MATRIX. The following Turbo Ace documents provide supplemental and more detailed information: Turbo Ace MATRIX User’s Manual and the NAZA-M LITE GPS User’s Manual.

1.1 Turbo Ace MATRIX Performance Specifications

Aircraft

Weight (excluding battery)	2180g
Max Payload	1500g (battery weight dependent)
Optimal Payload	1130g
Max yaw (angular velocity)	200°/s
Max tilt Angle	45°
Max ascent	6m/s
Max descent	6m/s
Max flight speed	27m/s
Max flight altitude A.G.L.	122m (FAA regulation, Geofenced)
Flight time	(assuming 22000mAh) 40 mins max

Radio Control

Frequency	2.4GHz
Operating Temperature	-10.0°C – 50.0°C
Working Voltage Range	7.2V – 22.2V

Drone LiPo Battery

Type	Lithium Polymer
Weight	~2500g
mAh	22000
Vdc	14.8 (6 cell)

2. Operation Checklists

2.1 Turbo Ace MATRIX Pre-Mission Checklist

- ___ Flight Log, Registration, Manual, Check lists, Com Radios
- ___ Firmware up to date, log book check
- ___ Airframe: no cracks or separations
- ___ Folding arms in good condition
- ___ Motors free and no roughness; only slight detent
- ___ Motor Airframe and Accessory screws tight
- ___ Battery Velcro support straps in good condition
- ___ Propellers, spares in good condition, tightened
- ___ Gimbal guards in place (when applicable)
- ___ Batteries half charge for transport, or full charge if mission imminent
- ___ Battery chargers (LiPo battery, controller battery, laptop battery)
- ___ Control switches, sticks
- ___ Primary and backup laptop check and map(s) Pre-fetched
- ___ Primary and spare USB cables
- ___ SD card(s) cleared
- ___ Firmware up to date
- ___ Transmitter Calibrated

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios

Craft

Airframe and Hardware	Check
Gimbal	Locks removed and gimbal free (if necessary)
Propellers	No nicks, cracks Propellers on correct motors (cw and ccw)
Battery	Strapped and secured
Center of Gravity	Check. If off, re-adjust battery
Gyro	Calibrated
Motors	Free, slight detent
Camera SD Card	Installed

Controls

Sticks	Full and smooth
Controller Display	Check
Laptop	Attached, screen clean
Antenna	45 degrees

2.3 Power-Up Checklist

Control	On
Laptop	On
Connection Established	Check
GPS lock	Check. Wait 2-3 minutes after power up
Data Channel	Check
Compass	Calibrate if in new location
Home Point	Establish
Take off Area	Clear for 10m

2.4 Takeoff and Hover

Taking off Home Point	Check (auto created by Mission Planner)
GPS fix	>6 satellites?
Controls	All axis check
Video Link	Check (if applicable)
Telemetry Data Collection	Check
Camera Gimbal	Check
Camera	Start

2.5 Landing and Shut Down

Camera	Stop
Landing Area	Clear for 10m
Motors	Stopped
Battery and Flight Time	Recorded
Flight Battery	Power Off

2.6 Post Flight

Flight Battery	Off (too hot?)
Control	Off, throttle down
Motors	Check and remove propellers
Gimbal	Install locks, remove camera
Airframe and Hardware	Check
Camera SD card	Removed and mission labeled.

3. Lost Link Procedures

3.1 MATRIX Lost Link Protocol

Turbo Matrix signal loss protocol, or fail-safe protocol, is initiated if control signal is interrupted or lost. This will initiate a return to home function. If signal is lost, the failsafe will initiate.

3.2 Controller Signal Loss

An automatic failsafe procedure is programmed into the MATRIX, so that in the event of controller signal loss, the “Return Home” feature is automatically enabled. See DJI Naza User’s Manual for steps on how to configure this feature.

3.3 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area. If there are any terrain or obstacles, PIC must be aware that the return to home, though automatically established at startup if using Mission Planner software, function will not automatically avoid these features. The Turbo Ace flight controller does not provide a means of programming a remote lost link landing point.

3.4 Fly-Away

The Turbo Ace flight controller failsafe mode is to land immediately or return to home. Because of this fly-away is unlikely to occur providing that proper start up procedures are followed and the craft is not launched before GPS satellite acquisition has occurred and home point has been established.

In the event of a suspected fly-away the craft should be monitored, after above-mentioned attempts to correct the errant flight have been attempted, and if it appears the craft is not responding to controls, or does not appear to be following fail safe mode of land immediately or return. ATC shall be notified of the last position and altitude and heading of the craft, and of the approximate flight time remaining.

3.5 Recovery

All reasonable efforts shall be made by the flight crew to recover lost aircraft, with crew safety a priority.

3.6 Imminent Crash

If all attempt to regain control fail and a crash is Imminent. PIC is to first: attempt to, if at all possible, steer the UAS away from bystanders and other field workers. Second: audibly communicate to any nearby workers or bystanders of the imminent crash, forcing all nearby personnel and bystanders to keep their eyes on the UAS if possible.

4. Maintenance

4.1 Introduction

Because the Turbo Ace MATRIX is powered by electric motors and lithium polymer batteries, and the manufacture Turbo Ace does not have a specified TBO or specified periodic maintenance, AirCTEMPs conducts physical inspection of craft pre- and post-flight and post-mission for any mechanical defects or indication of wear or aging of the airframe and components. Since flights are of a duration of approximately 25-30 minutes, because of battery capacity, problems with propulsion motors such as indications of bearing wear should be evident on inspection and initial power up. Also because of the short duration of flight, motors have a low likelihood to fail catastrophically during flight. Because this is a multi-rotor VTOL craft and does not have control surfaces, there are no moving parts or actuators other than the flight motors that require inspection or for wear or function. The lithium polymer battery life expectancy is dependent on charge and discharge rates and storage practices, and have an unpredictable life expectancy. To predict battery replacement interval, the voltage of each battery shall be recorded in a battery log along with the flight time and the percent battery remaining as indicated on the laptop display.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs MATRIX is to be inspected by the PIC pre- and post-flight and pre- and post-mission by the AirCTEMPs Technician.

Pre- and Post-mission Inspection

_____ Static Start Up

Remove propellers or secure aircraft landing gear to test bench. Start aircraft and ensure indicator lights and annunciators are functioning. Arm motors and listen for uniform idle operation.

_____ Control

Test control sticks for correct motor response. Test function of controller switches and sticks.

_____ Firmware

Check last firmware update in log book and confirm firmware is current version. Update as needed.

_____ Airframe

Ensure airframe has no cracks or separations. Replace airframe shell or other components if cracks are detected. Shell separation may be due to miss-alignment and may snap into place with slight pressure. Confirm that shell separation is not due to missing or loose screws or hardware, and replace any damaged components.

_____ **Motors**

Motors free and no roughness. Inspect motors visually for any debris between rotor and stator. Place propeller on motor and spin with finger to confirm motors turn freely with slight detent due to motor magnets. Any grinding, ticking or squeaking sound may indicate debris in the motor or worn bearing. Clean or replace motor as necessary.

_____ **Propellers**

Inspect primary propellers and spares for cracks chips or nicks. Replace cracked or chipped propellers. Small nicks may be sanded or burnished, however it is advisable to replace rotors with even slight defects.

_____ **Gimbal**

Inspect gimbal for free movement and put guards in place. Remove GoPro for storage and transportation (post mission).

_____ **Batteries**

Confirm batteries are at half charge for long term storage or full charge if mission is imminent.

Check batteries for bloating. This is an indication of a failing LiPo battery. If battery shell is bloated, replace as soon as possible and do not continue use.

_____ **Laptop**

Check laptop for current Mission Planner/software updates. Ensure it is current.

_____ **Accessories**

Check flight, controller and laptop battery chargers cables and connectors.

_____ **Test Flight**

Schedule test flight if control systems, propulsion motors or airframe components have been replaced, or if firmware has been upgraded.