

Aircrew Operator's and Maintenance Manual: DJI Phantom 2

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|--|----|
| 1. Introduction..... | 8 |
| 1.1 Phantom 2 Performance Specifications..... | 8 |
| 2. Operation Checklists..... | 9 |
| 2.1 DJI Phantom 2 Pre-Mission Checklist..... | 9 |
| 2.2 Preflight Checklist..... | 9 |
| 2.3 Power-Up Checklist..... | 10 |
| 2.4 Takeoff and Hover..... | 10 |
| 2.5 Landing and Shut Down..... | 10 |
| 2.6 Post Flight..... | 10 |
| 2.7 DJI Phantom 2 Common LED Codes..... | 11 |
| 3. Lost Link Procedures..... | 12 |
| 3.1 DJI Lost Link Protocol..... | 12 |
| 3.2 Home Point Establishment..... | 12 |
| 3.3 Fly-Away..... | 12 |
| 3.4 Recovery..... | 12 |
| 3.5 Imminent Crash..... | 12 |
| 4. Maintenance..... | 13 |
| 4.1 Introduction..... | 13 |
| 4.2 Inspection and Maintenance Procedures..... | 13 |
| 4.3 DJI setup utilities..... | 14 |

1. Introduction

The **DJI Phantom 2** 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 by the University of Nevada AirCTEMPs instrument center. This document is intended for AirCTEMPs aircrew familiar with the operations and maintenance of the DJI Phantom 2. The following DJI documents provide supplemental and more detailed information: PHANTOM 2 User Manual, PHANTOM Quick Start Manual, PHANTOM Flying Flowchart, and Ground Station Wireless Data-Link User Manual. New AirCTEMPs aircrew are encouraged to familiarize themselves with the above DJI documents before operation or maintenance, and during training.

1.1 Phantom 2 Performance Specifications

Aircraft

| | |
|----------------------------|-----------------------------------|
| Weight (including battery) | 1000g |
| Maximum takeoff weight | 1300g |
| Operating temperature | -10°C to 50°C |
| Max yaw (angular velocity) | 200°/s |
| Max tilt Angle | 35° |
| Max ascent | 6m/s |
| Max descent | 2m/s |
| Max flight speed | 15m/s (not recommended) |
| Max flight altitude | 6000m |
| Max flight altitude A.G.L. | 122m (FAA regulations, Geofenced) |
| Flight time | 20m (approximate) |

Radio Control

| | |
|----------------------|--------|
| Frequency | 2.4GHz |
| Control signal range | 1000m |
| Receiver sensitivity | -97dBm |

Drone Smart Battery

| | |
|--------|-----------------|
| Type | Lithium Polymer |
| Weight | ~350g |
| mAh | 5200 |
| Vdc | 11.1 (3 cell) |

Controller Battery

| | |
|------|-----------------|
| Type | lithium Polymer |
| mAh | 2000 |
| Vdc | 3.7V |

2. Operation Checklists

2.1 DJI Phantom 2 Pre-Mission Checklist

- ___ Flight Log, Registration, Manual, Check lists
- ___ Firmware up to date, log book check
- ___ Airframe no cracks or separation
- ___ Motors free and no roughness
- ___ Motor Airframe and Accessory screws tight
- ___ Propellers and spares in good condition
- ___ Gimbal guards in place
- ___ Batteries half charge for transport, or full charge if mission imminent
- ___ Craft and control battery charger
- ___ Control switches, sticks, functioning
- ___ Camera SD card(s) cleared
- ___ Volt meter and battery connector

2.2 Preflight Checklist

Registration, Manual, Log, Com Radios (if applicable)

Craft

| | |
|-----------------------|----------------------------|
| Airframe and hardware | Check |
| Propellers | No nicks, cracks |
| Motors | Free |
| Flight battery | 4 Lights, Voltage recorded |
| Flight battery | Install |
| Camera system | Check |
| Camera SD Card | Installed |

Control

| | |
|----------|-----------------|
| Battery | 3-4 lights |
| Sticks | Full and smooth |
| Switches | GPS and Course |
| Antenna | 45 degrees |

2.3 Power-Up Checklist

| | |
|----------------|---------------------------|
| Observer Check | Radio and Visual Check |
| Control | On |
| Flight battery | On |
| Compass | Calibrate if new location |
| Home point | Establish |
| Camera | Started |
| Take off Area | Clear for 5m |
| Flight Timer | Set at take off |

2.4 Takeoff and Hover

| | |
|---------------------------|--------------------|
| Controls | All axis check |
| FPV | Check if installed |
| OSD | Check if installed |
| Telemetry Data Collection | Check |

2.5 Landing and Shut Down

| | |
|----------------|-----------------------------|
| Landing area | Clear for 5m |
| Motors | Stopped |
| Camera | Stopped or Off |
| Flight Time | Recorded |
| Flight Battery | Power Off, Voltage recorded |

2.6 Post Flight

| | |
|-----------------------|-----------------------------|
| Flight Battery | Off |
| Control | Off |
| Motors | Check and remove propellers |
| Airframe and Hardware | Check |
| Camera SD card | Removed and mission labeled |

2.7 DJI Phantom 2 Common LED Codes

Normal

 Red, Green and Yellow flashing sequentially and rising tone beep Start up and self-test

GPS and Control Mode

 GPS Mode
 ATTI Mode

GPS Status Control mode followed by GPS status

 GPS Mode, >6 Satellites
 GPS Mode, 6 Satellites
 GPS Mode, 5 Satellites
 GPS Mode, <5 Satellites

Home Point

 Rapid green series Home Point Acquired.

Compass Calibration: Toggle control from GPS to ATTI 6-12 times until constant yellow LED

 Constant Yellow Begin horizontal compass calibration
 Constant Green Begin vertical compass calibration
 Flashing Green Compass calibration successful
 Flashing Red Compass calibration error
 Alternate long red and yellow Compass error too great
 Rapid Flashing Yellow Lost radio link or Return to home
 Rapid Flashing Red Low battery warning

For other error codes refer to Phantom 2 Quick Start Guide

3. Lost Link Procedures

3.1 DJI Lost Link Protocol

DJI lost link protocol (failsafe) is initiated if control signal is interrupted or lost for a period of greater than 3 seconds. This will initiate either a land immediately or a return to home position which is set in the craft autopilot controller using the Phantom 2 Assistant Software. If signal is lost the craft will hover in place after 3 seconds the failsafe will initiate and the craft will land immediately or climb to 20 meters above the home point altitude and fly directly to the home point at this altitude and initiate an auto land. The default for AirCTEMPs Phantom 2 is return to home. If terrain between the takeoff (home) point and the flight course exceeds 20 meters the failsafe should be changed using the Phantom 2 Assistant Software to land immediately. The DJI flight controller does not provide a means of programming a remote lost link landing point.

3.2 Home Point Establishment

The PIC shall access the flight course to determine if terrain or obstacles are within the course area exceed 20 meters above the launch point. If there are any terrain or obstacles greater than 15 meters the failsafe mode should be changed to “land Immediately” using the Phantom 2 Assistant Software. If the flight course is clear of obstacles the PIC shall establish home point at the takeoff location. The DJI flight controller does not provide a means of programming a remote lost link landing point.

3.3 Fly-Away

The DJI 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 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.

3.4 Recovery

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

3.5 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 DJI Phantom 2 is powered by electric motors and lithium polymer batteries, and the manufacture DJI does not have a specified TBO or specified periodic maintenance, UNR 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 20 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.

4.2 Inspection and Maintenance Procedures

UNR AirCTEMPs Phantom 2 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 gimbal locks. 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 separation. 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.

_____ **Batteries**

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

_____ **Tablet**

Check tablet for current flight app. version.

_____ **Accessories**

Check flight, controller and tablet 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.

4.3 DJI setup utilities

DJI provides two PC based utilities for setup and updating firmware of the Phantom 2 and controller.

Phantom 2 Assistant Software is used for setup and updating the DJI NAZA auto pilot system.

Phantom RC Assistant Software is used for setup and updating the control system.

DJI WIN Driver Installer may be required for the PC to recognize the Phantom 2 and the controller.