SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division **Accident and Incident Investigations Division** Form Number: CA 12-57

LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

Reference Number	CA18/2/3/10301										
Classification	Accident		**Date**	4 May 2023			**Time**	2213Z			
Type of Operation	Remotely Piloted Aircraft System – Surveillance (Part 101)										
Location											
Place of Departure	Mondi Mill Bay, KwaZulu-Natal Province			Place of Intended Landing			Mondi Mill Bay, KwaZulu-Natal Province				
Place of Occurrence	Mondi Mill Bay, KwaZulu-Natal, approximately 100 metres from the launch station										
GPS Co-ordinates	Latitude	28° 46'05.21" S		Longitude	031° 59' 28.87" E		Elevation	93ft			
Aircraft Information											
Registration	ZT-XSD										
Make; Model; S/N	DJI; Mavic 2 Enterprise (Serial Number: Mav0073)										
Damage to Aircraft	Substantial			Total Aircraft Hours	150.34						
Pilot-in-command											
Licence Type	Remote Pilot Licence (RPL)			Gender	Male		Age	41			
Licence Valid	Yes	Total Hours		1284.45		Total Hours on Type		1284.45			
Total Hours 30 Days	32.8			Total Flying on Type Past 90 Days		57.36					
People Controlling	1	**Injuries**	0	**Fatalities**	0		**Other (on ground)**	0			

What Happened

On Thursday evening, 4 May 2023, a remotely piloted aircraft (RPA) DJI Mavic 2 Enterprise with registration ZT-XSD was launched for security surveillance from Mondi Mill, approximately 5 nautical miles (nm) north-west of Richards Bay Airport (FARB) in KwaZulu-Natal with the intention to return to the same take-off launch pad. The flight was conducted at night under beyond visual line of sight (BVLOS) rules and under the provisions of Part 101 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot reported that he conducted a pre-flight check with no anomalies noted. He then armed and launched the RPA for the mission with 99% battery power. Shortly after launch, he heard an unfamiliar noise coming from the RPA and, soon after, he saw it spiral down to the ground, approximately 100 metres (m) from the launch pad. The pilot recovered the RPA and found it substantially damaged. There were no injuries to persons reported as the result of the accident.

Figure 1: The RPA at the accident site. (Source: Google)

Post-accident investigation:

According to the operator's post-accident analysis, the RPA experienced an electronic speed control (ESC) unit malfunction which affected one of the motors, and caused it to spiral down before it impacted the ground.

C	00m 00s	0.0 ft	0 m	Tip	✓ Setting new Return-To-Home altitude to 120m (394 ft). ✓ Data Recorder File Index is 57. ✓ Setting new Maximum Flight Altitude to 250m (820 ft)
	00m 00s	0.0 ft	0 m		100% Battery
D	00m 00s	0.0 ft	0 m	Warning	Recalibrate the Vision System. Use DJI Assistant on Mac or PC. Calibrate Vision Sensors with DJI Assistant on PC or Mac for higher accuracy
E	00m 01s	0.0 ft	0 m	Mode	Mode changed to Assisted Takeoff
F	00m 11s	0.0 ft	0 m	Mode	Mode changed to P-GPS
G	00m 20s	108.6 ft	0 m	Mode	Mode changed to Waypoint
H	00m 22s	122.7 ft	0 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the left
I	00m 23s	103.0 ft	2 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the right
J	00m 23s	97.4 ft	2 m	Medium Risk	⚠ Detected side shock / possible collision, aircraft is rolling sharply to the left
K	00m 24s	90.2 ft	2 m	Low Risk	⚠ Not Enough Force/ESC Error
L	00m 25s	43.3 ft	3 m	Medium Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error
M	00m 25s	35.8 ft	4 m	High Risk	⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
N	00m 25s	35.8 ft	4 m	High Risk	⚠ Detected backward shock / possible collision, aircraft is pitching sharply backwards. ⚠ Not Enough Force/ESC Error. ⚠ Propeller Fell Off
O	00m 25s	30.8 ft	4 m	Low Risk	⚠ Not Enough Force/ESC Error
P	00m 25s	21.7 ft	5 m	Medium Risk	⚠ Detected forward shock / possible collision, aircraft is pitching sharply forward. ⚠ Not Enough Force/ESC Error
Q	00m 25s	19.0 ft	5 m	Low Risk	⚠ Not Enough Force/ESC Error

Figure 2: The flight log showing the ESC error.

The information below is an extract from the Mavic 2 Enterprise User's Manual

Remotely Piloted Aircraft

The DJI Mavic 2 Enterprise advanced drone is the latest commercial RPA with an advanced flight control system, featuring omnidirectional Vision System and Infrared Sensing System. It is constructed with a magnesium aluminium composite shell and carbon fibre arms that hold the motors and landing struts. During the flight, these arms are raised to allow unobstructed view from the camera that is suspended by the gimbal below the RPA. DJI technologies such as obstacle sensing, and the advance pilot assistance system help to capture complex shots effortlessly. Additional features like the built-in air sense makes the pilot aware of their surrounding airspace, and password protection helps maintain secure access to aircraft and protect data. The RPA features a fully stabilised 3-axis gimbal camera that shoots 4k video, 12-megapixel photos, supports 2x optical zoom, 24-48 mm lens and supports filters.

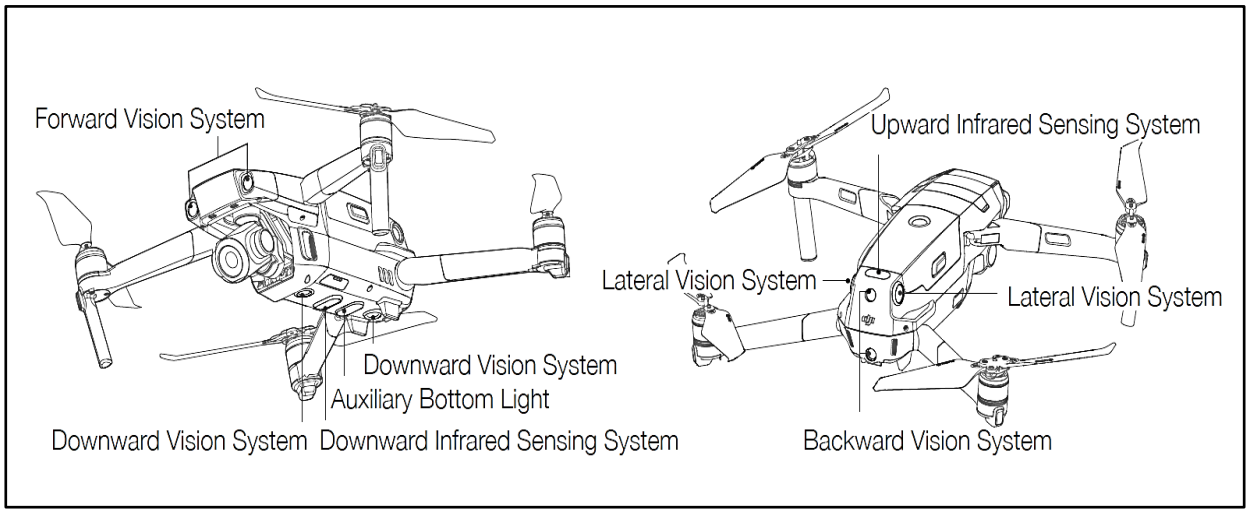

Diagram 1: An illustration of the DJI Mavic 2 Enterprise RPA schematic. (Source: DJI Mavic 2 User Manual)

The information below is an extract from: https://www.jouav.com/blog/electronic-speed-controller-esc.html

What is an Electronic Speed Controller (ESC) on RPA?

It is an electronic circuit that connect the motor, the battery, and the flight controller, whose primary purpose is to change the speed and direction of the RPA. Due to the difference technology, the flight controller of the RPA with brush and brushless motors cannot communicate directly with the motors. ESC helps them to establish a connection, thus allowing the RPA to control and regulate the speed of the motors in flight.

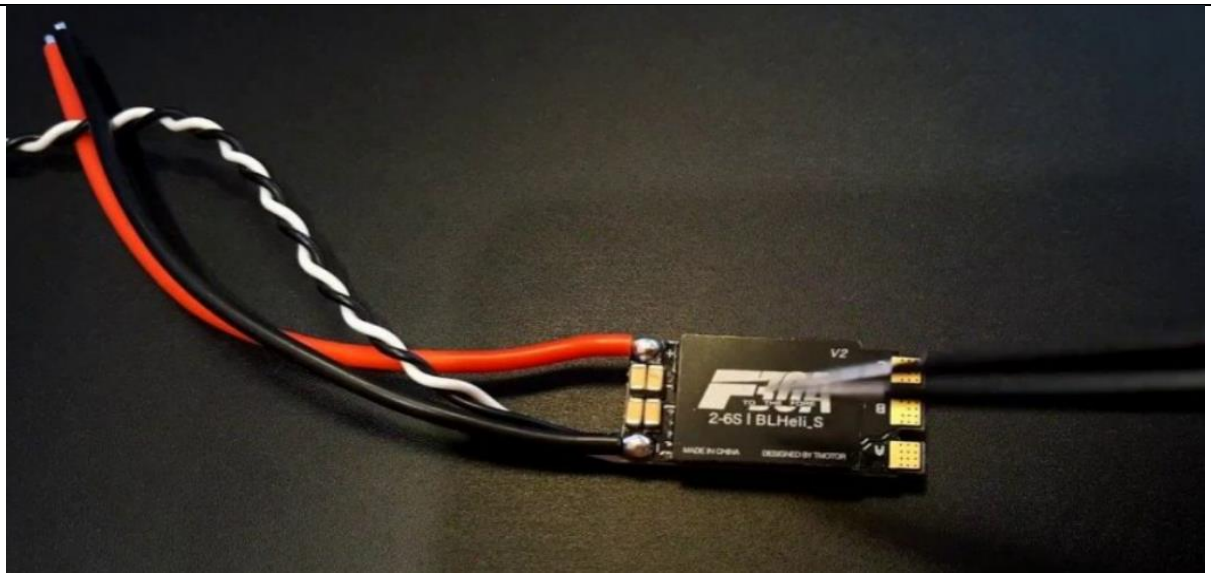

Figure 3: The electronic speed controller used on RPA.

How does an ESC work?

Whether brushed or brushless ESCs, they both work on basically the same principle. ESCs control the rotation of the motor by transmitting a timed electrical signal that is translated into a change in speed. First the pilot transmits a signal from a radio transmitter, which is received by a radio receiver fixed to the UAV, and then further sends that signal to the flight controller board, which generates an appropriate signal and forwards it to the BEC/ESC, which speeds up the motor depending on the strength of that signal.

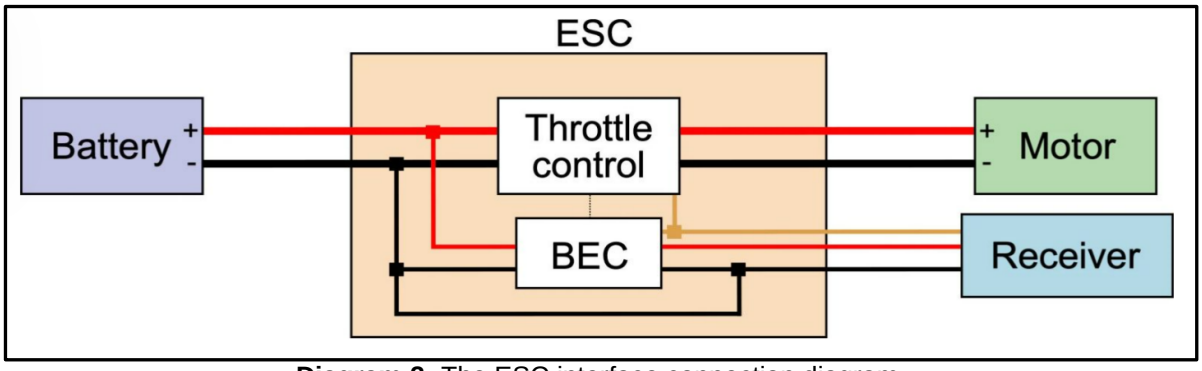

Diagram 2: The ESC interface connection diagram.

Findings

1. The pilot was issued a Remote Piloted Licence (RPL) by the Regulator (SACAA) on 10 February 2023 with an expiry date of 28 February 2025. The pilot had a Class 3 medical certificate that was issued on 7 November 2021 with an expiry date of 30 November 2026. The pilot had a multirotor visual line of site (VLOS) and beyond visual line of site (BVLOS) ratings. The pilot had a total of 1284.45 flying hours on the RPA type.

2. The RPA was initially issued a Remotely Piloted Aircraft System Letter of Approval (RLA) by the Regulator on 15 February 2022. The RLA was reissued on 6 March 2023 with an expiry

date of 14 February 2024. The last Mandatory Periodic Inspection (MPI) conducted on the RPA was carried out on 8 February 2023 at 586.35 hours. The RPA was issued a Certificate of Registration (C of R) by the Regulator on 15 November 2021.

3. The RPA maintenance was carried by a remote maintenance technician (RMT) with a RMT certificate that was issued by the Regulator on 27 July 2022 with an expiry date of 26 July 2024.

4. The operator had a valid operating certificate that was issued by the Regulator on 25 January 2023 with an expiry date of 31 January 2024. The operator's operating specification had the RPA type endorsed on it, issued on 25 January 2023 with an expiry date of 31 January 2024. The RPA is registered under Class 3A for BVLOS operations at a radius of 3.5 kilometres (km) and at a height restriction of 400ft above ground level (AGL).

5. The RPA's electronic speed control unit malfunctioned and affected one of the motors. This led to the RPA spiralling down at high speed and impacted the ground. The RPA sustained substantial damage.

Probable Cause(s)

The electronic speed control unit on the RPA malfunctioned during operation and affected the motor; this caused the RPA to spiral down and eventually crash on the ground. The cause of the ESC unit malfunction could not be determined.

Contributing Factor(s)

None.

Safety Action(s)

None.

Safety Message and/or Safety Recommendation/s

None.

About this Report

The decision to conduct a limited investigation is based on factors including whether the cause is known and the evidence supporting the cause is clear, the level of safety benefit likely to be obtained from an investigation and that will determine the scope of an investigation. For this occurrence, a limited investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this limited report. The report has been compiled using information supplied in the initial notification, as well as from follow-up desk top enquiries to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as possible safety action/s that the industry might want to consider in preventing a recurrence of a similar occurrence.

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose
In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011 and ICAO Annex 13, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and not to apportion blame or liability.
Disclaimer
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This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa