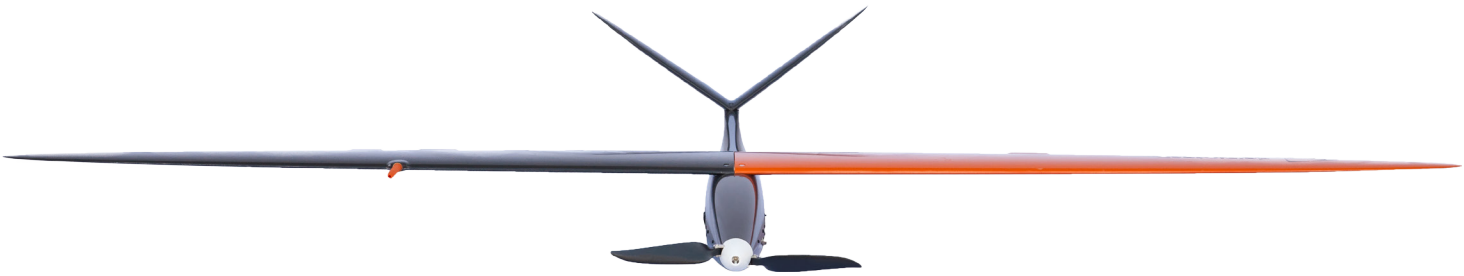
delair-tech
AIRBORNE SENSORING



Technical details about DT18 for Civil Aviation Administrations

Content

Telecoms

Frequencies/bands (OFCOM regulated), transmission power, range and the requirements for base-stations.

3 radio links

- C2 :
  - ◊ Usage : Command and control
  - ◊ 869 MHz (25 kHz wide), up to 500 mW EIRP (UAV)
  - ◊ 902-928 MHz (400 kHz wide)
  - ◊ Range : up to 20 km with MAMA Bear GCS and 6.5 km with Baby Bear GCS
- C2-Datalink:
  - ◊ Usage : C2 + datalink (real time video of photo transmission)
  - ◊ 2400-2483 MHz, up to 630 mW EIRP (UAV).
  - ◊ Range : up to 20 km with MAMA Bear GCS
- Safety link :
  - ◊ Usage : Short distance, C2
  - ◊ 2400-2483, up to 100mW EIRP (UAV)
  - ◊ Range : up to 1km

Compliance with ARCEP & ETSI EN 300 220-1 and FCC (part 15) requirements is reached by setting appropriate modem transmit powers based on UAV usage (location).

System redundancies

4 failures levels defined in the autopilot gathering :

- 20 individual component failure cases
- A number of combined failures

- Level 1 : mission continues with specific actions taken
- Level 2 : return home (loss of communication for instance)
- Level 3 : spiral descent to current position
- Level 4 : V-tail disconnection for instant descent to the ground*

Failsafe measures

In case of critical failure (loss of battery or autopilot) : V-tail disconnection
Nota: in case of fail-safe activation (and fall of the drone), the shock energy is limited to 69 Joules.

Glide-clear distance

Lift to drag ratio : 17

See and avoid technology

Front Video link available to the pilot (with Mama Bear station)

Safety by design

Safety analysis has been carried out and all critical functions are gathered on the same (autopilot) computer board, fully designed by DLT (hardware and software). No operating system on this board. A second on-board computer is in charge of all other non-critical functions.

Flying weight, materials, construction

- Flying weight : 2 kg
- Material: fiber glass.
- Construction: entirely manufactured within DLT premises and controlled via a strict quality process.

Operational characteristics

- Flight speed : 17 m/s airspeed
- Launch : hand or catapult
- Recovery area :
  - ◊ flat preferably +/-5° inclination
  - ◊ 100m after threshold
  - ◊ No obstacle above 15m between the threshold and 100m before the threshold
- Light rain, light snow resistant

Optimum operational height above ground

130 m

Return to home system? How operated and when instigated?

See level 2 alarms:

- Completely automatic (for instance low battery, loss of communication, failure of initial sensors, etc.)
- Home return strategy configurable before the mission (following waypoints, direct route)

Loss link behaviour?

Home return

Dynamic battery management with power level warnings?

Yes.

- Voltage/amps indicators available in real time
- Battery percentage left available in real time
- Reference battery discharge curve displayed along with the ongoing battery discharge curve

Average flight endurance?

- 2h max
- Avg : 90 min (depending on flight conditions: weather, altitude, etc.)

MTBF

Delair-Tech was granted in September 2012 the first Beyond Line of Sight certificate by the French Civil Aviation Authority (DGAC) for the DT18 system. Since then, the DT18 system has flown in numerous places and situations all around the world. In total, 60000km of distance have been flown.

Thanks to this great amount of data, Delair-Tech estimates in the following table the reliability of the DT18 system. Failure probability P is estimated as

$P = 1 - e^{-\lambda t}$ so $P \sim \lambda t$ if $\lambda t < 0.1$

where $1/\lambda$ is the MTTF (Mean Time to Failure), and P the probability for the system to encounter a failure after being used for a period of time t. The following estimates only consider only hardware failures.

Sub-System	Estimated MTTF (hours)	Consequences
Servomotor	100 000	Emergency landing or crash
Engine	10 000	Emergency landing or crash
Controller	1 000	Emergency landing or crash
Autopilot	100 000	Emergency landing or crash
On-board Computer	10 000	End of mission, back to landing area and normal landing
Modem Command&Control	100 000	End of mission, back to landing area and normal landing
Modem Datalink	10 000	Nothing
GPS continuity (if GPS was acquired, probability to lose it)	100 000	Emergency landing
Pitot Tube	100 000	Emergency landing
Battery	1 000	End of mission, Emergency landing
GCS	10 000	End of mission, back to landing area and normal landing

Critical software (all located on the Autopilot component) is entirely developed by Delair-Tech and has been thoroughly developed, tested and validated according to software quality guidelines during 4 years. The whole code is about 25 000 lines.

FMECA (Failure Modes, Effects, and Criticality Analysis) and FTA (Fault Tree Analysis) have been performed on the whole system, and Alarm Levels have been defined. The probability for each alarm to occur during one flight has been evaluated :

- Level1 (Nothing special) : 5.10-3
- Level 2 (End of mission, back to landing area and normal landing) : 2.10-3 Failure per Hour (F/H)
- Level 3 (Emergency landing) : 10-3 F/H
- Level 4 (Crash) : 3.10-5 F/H

Finally, the flights are realized in so-called “Park Zones”, which are user-defined geographic areas outside of which the plane is not allowed to go. It is considered a Major Risk if the plane actually goes out of such an area (and eventually crashes). Therefore, specific mechanisms have been implemented in the system to avoid such a situation, so that the probability for such a risk is evaluated as 5.10-9 F/H.

Since the first flight of DT18, among all Delair-Tech customers or Delair-Tech operations, not one single injury or material casualty has been observed.

What is the expected life of components used in the DT-18?

MTBM (Mean Time between Maintenance) = 100 flights

What Single Points of Failure (SPOF) have been identified for the DT-18 and GCS ?

There is no component redundancy on board the UAV.

However as per previous explanations on the redundancy strategy: several levels of failures are defined triggering different recovery procedures of the UAV. This process guarantees a high level of safety and is approved by the French DGAC.

How is the shock energy on impact limited to 69 Joules? From what height is this calculated?

150 m. Fall speed is limited to 8 m/s with V-tail disconnection

Can the V-Tail be detached on pilot command?

Yes

What batteries are used? What is their capacity? How many are required for flight?

Single lithium polymer battery used, 8900 mAh

Does the DT-18 connect to other GNSS network than GPS?

Yes, Glonass/Galileo is available. Furthermore, with there is a capability to connect to a local DGPS or GNSS corrections network through our 3G modem onboard.

Does the DT-18 have a RTK option ?

Yes. There is an option with a dual band (L1/L2) receiver which allows to get down to 2cm precision. Furthermore, it includes a high precision IMU with down to 0.025° accuracy.

Does the DT-18 support Differential GPS connections via RTCM.3?

RTCM2.3 is supported

Do the propellers fold or disconnect in the event of an impact, collision or crash?

Propellers fold

Is there any encryption of the C2 link? How is the C2 link secured?

Yes, AES128 and AES256

Have you identified any Known Failure Modes for the DT-18?

Yes, based on these modes are defined alarm levels and recovering strategies

What are the transportation requirements for the DT-18? What sort of case or box does it have?

No specific requirements. DT18 can be transported in thick cardboard box, a rugged case that can fit 2 UAVs or a light backpack that can also fit 2 UAVs. Furthermore the battery of the DT18 is IATA certified for aerial transportation.

What systems within the DT-18 have in built redundancies?

See SPOF answer.

What is the operating temperature range of the DT-18?

DT18 can be used at a maximal temperature range of: -25° to +50°C

What is the maximum height that the DT-18 can operate?

3000 m AMSL (above mean sea level)

What materials, other than fiberglass, are used in the construction of the DT-18?

Carbon fiber

What on-board telemetry systems are there? Attitude indicator, airspeed indicator etc.?

The list is very long but it includes attitude, air speed, ground speed, altitude, position, battery level, telecom status…

What technical specification of computer is required for the Mama-Bear GCS?

Minimum specifications:

- Screen resolution: WXGA (1366 x 768)
- Screen characteristics: Matte / Anti-reflective
- Processor: Intel Core i5 or greater
- RAM: 4 GB
- HDD: 500 GB
- OS: Windows 7 / 8 / 8.1
- RJ45 Port (Ethernet)
- SD Card Slot
- 2 x USB ports