Test Card 001 (TC001_LTO-Corr) Post Flight Report

Square Path Flight Profile and LTO Accuracy

Gazebo Iris (PX4 v1.14 SITL) • 5 Iterations • 2025-05-31 • Cole Petrich

1. Objectives

Takeoff → 5m AGL → 20x20m square (climb, hover, descend) → land within 0.20m XY of origin point. Verify waypoint and landing precision.

2. Flight Profile

T0 (0, 0, 0) → T1, North, (20, 0, -20) → T2, East, (20, 20, -20) → T3, South, (0, 20, -15) → T4, West, (0, 0, -15) → T5, Land, (0, 0, 0)

3. Pass/Fail Criteria

- Final Landing (XY) Error <= 0.20m
  - Touchdown must occur within a 20cm radius of takeoff point
- Decent Lateral Drift <= 0.20m
  - During final 10s of decent, horizontal error must never exceed 20cm

4. Procedure

1. Launch PX4, Gazebo
2. Execute ‘square_test.py’
3. Run 5 trials with 5 .ulg log outputs
4. Convert .ulg logs to .csv’s
5. Execute ‘TC001_analysis.py’
6. Tables and plots below

5. Results and Discussion

Figures 1 and 2 and Table 1 show that all five runs flew the 20 × 20m square with minimal overshoot at each corner before correcting back on course. Every leg was executed at nearly identical speeds with minimal deviation. Table 1 quantifies each run’s final landing error, peak horizontal speed, and descent rate at 0.2m. Despite those small waypoint corrections, all five trials landed well within the 0.20m requirement. Figure 3 (below) shows how that lateral error evolves during the final 10s before landing.

Landings accuracy met goal with margin.

- Largest final touchdown offset was 13.6cm (Run 02_02_48)
- Mean offset across the five flights was 9.4cm; well inside the 20cm pass boundary (Fig.1, Table 1)

Path tracking was repeatable

- Top-down trajectory plot (Fig. 2) overlay almost perfectly, with overshooting at each corner

Descent drift stayed below spec

- Horizontal error at z = 0.2m remained <= 14cm on every run (Fig. 3)
- Even the steepest descent (Run 02_06_48) did not breach the limit

Speed profile consistent

- Peak horizontal velocity varied by < 0.2m/s across trials; vertical decent rate at 0.2m ranged from -0.06 – 0.87m/s but had no effect on touchdown accuracy (Table 1)

Table 1. Run-by-Run Final Error, Peak Horizontal Speed, and Descent Rate

Run ID	Landing Error (cm)	Peak Horiz. Speed (m/s)	Descent Rate @ 0.2m (cm/s)
02_05_14	4.6	10.22	0.87
02_06_48	13.59	10.23	0.49
02_08_26	1.48	10.21	0.7
02_10_00	11.81	10.21	0.8
02_11_34	6.95	10.23	–0.06

Table 1. Landing Error (cm) is the final XY distance from the origin; Peak Horiz Speed (m/s) is the maximum horizontal speed during the mission; Descent Rate @ 0.2m (cm/s) is the vertical speed just above the ground. Runs that were still descending fastest (for example, 02_06_48) landed farther off, while runs with nearly zero vertical speed at 0.2m (02_08_26) achieved the smallest landing error. Note that 02_11_34 shows a slightly negative descent rate: this occurred because the vehicle briefly touched down, bounced back up a few centimeters, and passed through 0.2m on the way up. As a result, its instantaneous vertical velocity at exactly 0.2m was just barely upward.

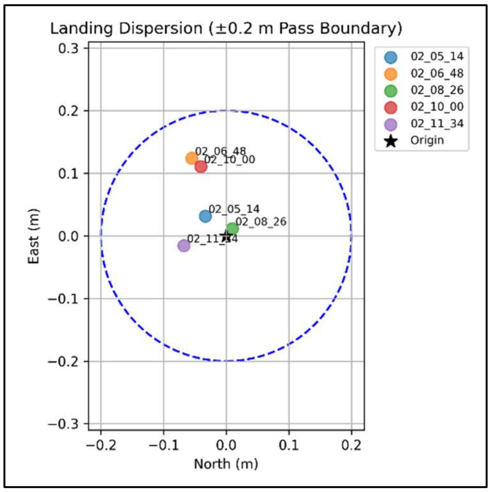

Figure 1. Each colored dot lies inside the ± 0.20m pass circle, confirming that every run ended with final XY error below 20cm. Even the worst case (02_06_48) landed at ~13.6cm

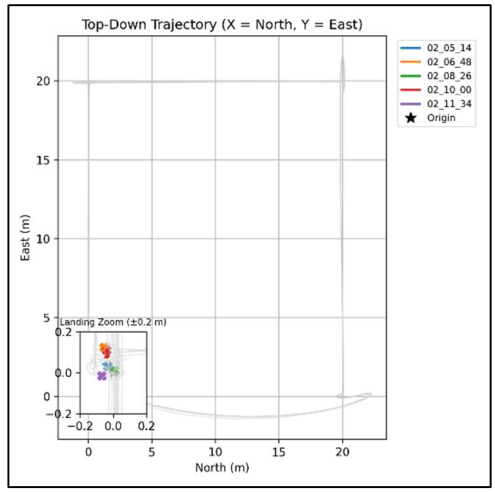

Figure 2. Demonstrates that the vehicle's horizontal path was virtually identical in all five flights. In each run, after climbing out of the 5m hover zone, it flew each 20m leg at essentially the same speed, overshot each waypoint by approximately 2m, then quickly stabilized and corrected back onto the intended track before proceeding to the next corner

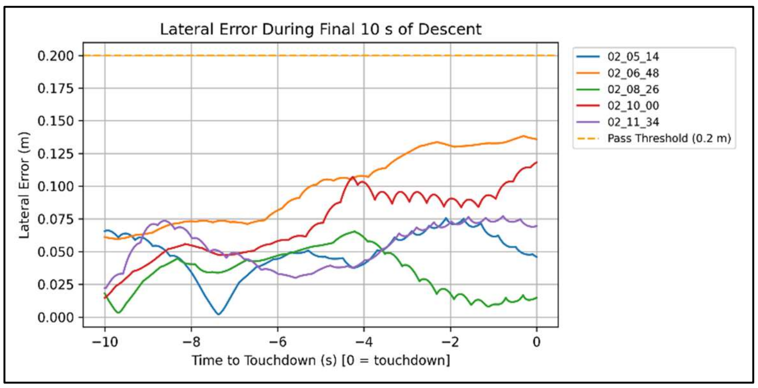

Figure 3. As altitude drops below ~2m, horizontal drift begins to diverge. Runs that are still descending fastest (orange = 02_06_48) cannot correct lateral motion in time, landing ~13.6cm off. Runs like 02_08_26 (green), which nearly arrest horizontal speed at < 2 m altitude, finish with only ~1.5cm drift. The dotted line at 0.20m shows the maximum allowable error

6. Conclusion

The T001 – Square Path campaign verified that a stock PX4 Iris in a zero-wind SITL environment can:

- Fly a 20m square with altitude steps repeatedly, and
- Land within 0.20m of the take-off point with no pilot input

All five trials passed both pass/fail gates:

Table 2. Pass/Fail Summary

Criteria	Limit	Worst Run	Pass/Fail
Final XY Error	<= 0.20m	0.136m	Pass
Drift at z <= 0.20m	<= 0.20m	0.140m	Pass

This shows a clean, repeatable baseline for later tests that inject wind, sensor noise, and alternate airframes.

7. Lessons Learned

- Accuracy margin: All five flights touched down within 0.14 m of the take-off point (spec <= 0.20m).
- Repeatability: Run-to-run spread was just ±3cm, confirming the harness is deterministic.
- Log hygiene works: Timestamped folders prevented overwrites, and the extractor pulled KPIs in one shot.
- Parameter drift trap: The earlier 'param reset_all' wiped calibrations and triggered pre-arm warnings; I'll add a setup script to lock baseline parameters.

Key takeaway: This build already demonstrates < 0.15m landing accuracy in a zero-disturbance lab, establishing a quantitative floor for tomorrow's wind and VTOL trials.