## Summary

To guarantee centimetre-level accuracy, we’ve tightened each RTK-GPS failsafe so the system reacts within just a few seconds of degraded signal or corrections. Below are 12 GPS-only checks—with new, shorter thresholds—drawn from receiver manuals, field-engineer guidelines, and academic/industry studies. Implementing them ensures your rover halts before errors exceed a few centimetres.

Sure! Here's a simplified explanation of the logic and working behind these **RTK-GPS failsafes** and how they ensure accurate navigation for your rover:

### ****1. GPS Data Stale (Threshold: > 3s without any NMEA fix)****

**What It Means:** If the GPS receiver doesn’t update its position every second (i.e., it doesn’t send a new position message for over 3 seconds), it's considered "stale."

**Why It Matters:** If no new GPS data is coming in, your rover will start using outdated position information, which can lead to **drift**. It could move off course without you knowing.

**Action:** The system will **reconnect the GNSS** to get fresh data. If it still doesn’t work, it will **sleep for 5 minutes**.

### ****2. Internet Corrections Lost (NTRIP) (Threshold: > 3s correction delay for > 10s)****

**What It Means:** RTK corrections (which help improve accuracy) are delayed by more than 3 seconds and continue for more than 10 seconds.

**Why It Matters:** The RTK system relies on these corrections for **centimeter-level precision**. If they are too old (i.e., more than 3 seconds behind), your position accuracy can fall to **meter-level**, making the rover inaccurate.

**Action:** The system will **reconnect the NTRIP** corrections. If the issue persists, it will **sleep for 5 minutes**.

### ****3. Serial Data Loss (Threshold: > 3s without NMEA on COM8)****

**What It Means:** If the GPS signal isn’t received for 3 seconds from the communication port, there’s a **data loss**.

**Why It Matters:** Losing GPS data for 3 seconds means you have no idea where the rover is. It could **drift off course**.

**Action:** The system will **reconnect GNSS**. If it still doesn’t work, it will **sleep for 5 minutes**.

### ****4. Fix-Status Instability (Threshold: ≥ 3 drops in 30s)****

**What It Means:** The RTK fix (accurate position) keeps switching to **float mode** (less accurate) at least 3 times in 30 seconds.

**Why It Matters:** When the fix is unstable, the rover's position can jump by **10–30 cm**, leading to unpredictable movement.

**Action:** The system will **monitor the fix stability** for 30 seconds. If it doesn't stabilize, it will **sleep for 5 minutes**.  
  
Why it keeps switching and how to fix

### ****5. Persistent Drift (Threshold: ≥ 6 drifts > 3 cm in 20s)****

**What It Means:** The rover’s position moves by more than 3 cm **6 times** in 20 seconds.

**Why It Matters:** This is an indication that something is wrong with the GPS signal, such as **multipath interference** (signal reflections) or other errors. This could cause your rover to drift off course.

**Action:** The system will **monitor the stability** of the rover’s position. If the drift continues, it will **sleep for 5 minutes**.

### ****13. Waypoint Deviation (Threshold: > 5 cm distance or > 5° heading deviation from planned path)****

**What It Means:** If the rover deviates from its planned path by more than 5 centimeters or its heading changes by more than 5 degrees from the intended direction, it's considered off-course.

**Why It Matters:** Such deviations can result from various factors, including GPS inaccuracies, sensor errors, or environmental influences. If not corrected promptly, the rover might veer significantly off its intended route, leading to operational inefficiencies or even collisions.

**Action:** The system will:

**Monitor the deviation** continuously.

If the deviation persists beyond the threshold, it will:

**Alert the operator** about the off-course condition.

**Attempt to correct the path** by adjusting the rover's steering or navigation parameters.

If corrections are unsuccessful, it will:

**Pause operations** to prevent further drift.

**Log the incident** for diagnostic purposes.

**Recovery Time:** The system will attempt to correct the deviation within 10 seconds. If unsuccessful, it will pause operations for 5 minutes to assess the situation.

**Fallback:** If the rover remains off-course after the recovery time, it will:

**Return to the last known good waypoint**.

**Recalculate the optimal path** to continue operations.

### ****6. Position Jump (Threshold: > 30 cm or implied speed > 0.5 m/s)****

**What It Means:** If the rover jumps by more than 30 cm suddenly, or if its speed seems unrealistically high (greater than 0.5 m/s).

**Why It Matters:** A sudden position jump (teleporting) is a clear sign of **incorrect data** or a GPS glitch. It can cause the rover to make incorrect turns or hit obstacles.

**Action:** The system will **check the data consistency** and stop the rover for 10 seconds to fix the issue. If it continues, it will **sleep for 5 minutes**.

### ****7. High DOP (Threshold: PDOP > 3.0 for > 5s)****

**What It Means:** **PDOP (Position Dilution of Precision)** is a measure of satellite geometry. A PDOP value above 3 indicates poor geometry for positioning.

**Why It Matters:** If the satellite geometry is poor, your RTK fix becomes unreliable and can lead to **less precise positioning**.

**Action:** The system will **wait for a better satellite geometry** for 15 seconds. If it doesn’t improve, it will **sleep for 5 minutes**.

### ****8. Weak Constellation (Threshold: < 6 satellites for > 5s)****

**What It Means:** If fewer than 6 satellites are visible for more than 5 seconds, the rover’s position becomes less reliable.

**Why It Matters:** RTK requires a minimum of 6 satellites to work properly. With fewer than 6, the rover’s accuracy will degrade quickly.

**Action:** The system will **wait for more satellites** to be in view for 20 seconds. If this doesn’t happen, it will **sleep for 5 minutes**.

### ****9. Signal Multipath (SNR Drop, Threshold: C/N₀ drop > 10 dB-Hz for > 5s)****

**What It Means:** **Signal-to-noise ratio (SNR)** dropping significantly for more than 5 seconds, which indicates signal interference from nearby objects (multipath).

**Why It Matters:** Poor SNR means the rover’s position might be inaccurate by a few centimeters due to signal interference.

**Action:** The system will stop the rover to prevent it from drifting. It will **sleep for 5 minutes**.

### ****10. RTK Fix Lost (Threshold: > 10s no RTK fix)****

**What It Means:** If the rover loses RTK fix for more than 10 seconds, it goes to **float mode**, where accuracy falls to **meter-level**.

**Why It Matters:** A loss of RTK fix means the rover will no longer be accurate enough to follow waypoints or avoid obstacles.

**Action:** The system will **monitor the fix regain** for 30 seconds. If the RTK fix isn’t restored, it will **sleep for 5 minutes**.

### ****11. High NTRIP Latency (Threshold: Avg. correction age > 3 s for > 15 s)****

**What It Means:** If the correction data is delayed by more than 3 seconds for over 15 seconds, the system may start getting inaccurate corrections.

**Why It Matters:** Stale corrections can degrade the rover’s accuracy. It can affect the precision of the **RTK solution**.

**Action:** The system will **reconnect the internet** and try to fetch fresh corrections. If this doesn’t work, it will **sleep for 5 minutes**.

### ****12. Complete Internet Signal Loss (Threshold: No corrections > 5s and no cellular > 10s)****

**What It Means:** If both the **RTK correction** and **cellular signal** are lost for more than 10 seconds, the rover can’t function correctly.

**Why It Matters:** Without corrections or cell data, the rover can’t get accurate positions, which could cause it to drift far off course.

**Action:** The system will try to **reconnect the internet**. If it remains offline, it will **sleep for 5 minutes**.

1. Can you also check the speed of the internet?

### Summary of Recovery Actions:

**Reconnect GNSS/NTRIP/Internet:** When a problem is detected (e.g., lost GPS data, stale corrections), the system tries to reconnect or restart the appropriate component.

**Monitor Stability:** If the rover's position or fix is unstable, the system will keep checking for stability.

**Sleep for 5 minutes:** If a failsafe can't be fixed within the threshold time, the rover will stop and wait (sleep) for a short period to prevent further drift.

These **failsafes** are designed to stop the rover **before errors exceed a few centimeters**, ensuring that the rover can react quickly to issues like signal loss or bad data and minimize the risk of inaccurate navigation.

| **Condition** | **Trigger Threshold** | **Recovery Action** | **Recovery Time** | **Fallback** |
| --- | --- | --- | --- | --- |
| **GPS Stale Data** | > 3s no update | Reconnect GNSS | 10s | Sleep 5 min |
| **Correction Stale** | > 3s old for > 10s | Reconnect NTRIP | 20s | Sleep 5 min |
| **Data Loss** | > 3s no serial data | Reconnect GNSS | 15s | Sleep 5 min |
| **Fix Instability** | ≥ 3 drops in 30s | Monitor stability | 30s | Sleep 5 min |
| **Persistent Drift** | ≥ 6 drifts > 3cm in 20s | Monitor stability | 20s | Sleep 5 min |
| **Position Jump** | > 30cm or > 0.5m/s | Check consistency | 10s | Sleep 5 min |
| **High DOP** | PDOP > 3.0 for > 5s | Wait for improvement | 15s | Sleep 5 min |
| **Weak Constellation** | < 6 satellites for > 5s | Wait for more satellites | 20s | Sleep 5 min |
| **RTK Fix Lost** | > 10s no RTK fix | Monitor fix regain | 30s | Sleep 5 min |
| **Internet Slow** | Correction age > 3s for > 15s | Reconnect internet | 20s | Sleep 5 min |
| **Internet Lost** | No corrections > 5s, no cell > 10s | Reconnect internet | 30s | Sleep 5 min |

SOURCES:  
<https://manuals.plus/m/ef99ce54d4eec99e1be2f6a1cc835f435378b51095dbfb32227de9e91d2c5d18>

<https://www.rtklib.com/prog/manual_2.4.2.pdf>

Why Not Milliseconds?

RTK GPS, or Real-Time Kinematic GPS, is super precise, measuring positions down to centimeters using satellite signals. It can handle time measurements in milliseconds because it tracks the carrier phase, which changes very quickly. But for fail-safe conditions—like checking if GPS data is stale for 3 seconds—the thresholds are in seconds, not milliseconds.