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Connected Aircraft • Connected Automobile • Connected Home • Connected Building Connected Plant • Connected Supply Chain • Connected Worker



THE POWER OF CONNECTED

GPS Jamming and Spoofing

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GPS Jamming

- GPS Jamming occurs when an RF signal drowns out the transmission from the GPS satellites.
- Symptoms of GPS Jamming on Avionics
 - Loss of GPS Navigation mode
 - GPS Receiver loses satellite signal, so ACQUISITON mode is likely.
 - Any system using direct GPS will drop back to a degraded state
 - Synthetic Vision drops to 'Blue over Brown'.
 - ADS-B fails

- GPS x FAIL messages are annunciated

- System EPU increases. If it exceeds current RNP, the necessary alerts are posted.
- FMS Navigation Mode reverts to next best sensor based on EPU
 - (for IRS-equipped aircraft, HYBRID or IRS is next best, until the assumed drift is equal to radios).

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GPS Jamming Cannot Cause Misleading Guidance

GPS Spoofing

- GPS Spoofing occurs when the genuine RF signals from GPS satellites are replaced with counterfeit ones.
- 2 Types of Spoofing (there are more):
- Asynchronous/Non-coherent Spoofing
 - Similar to Jamming in that the spoofer uses a GNSS Signal imitator to overpower Genuine GPS signals, but introduces counterfeit ones
 - Transmits different position/time.
 - Jump in coordinates and/or time are indications of this type of attack
- Synchronous/Coherent Spoofing
 - Spoofer generates signal identical to the real one in time, Coordinates Doppler and range relative to the aircraft.
 - GPS Receiver switches to spoofed signal.
 - Spoofer can then smoothly move position and other parameters.
 - Very complex execution and difficult to detect.

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GPS Spoofing -Common Symptoms (Asynchronous)

- GPS Navigation mode
 - GPS Receiver switches to spoofed GPS signal.
 - GPS remains in "NAVIGATION" or "DIFFERENTIAL" mode.
 - GPS Clock and position jumps
 - GPS Position Frozen or moving very slowly
- FMS-related symptoms
 - CHECK GPS POSITION messages are annunciated (followed by others)
 - FMS-GPS MISCOMPARE
 - Map Position shifts
 - Degrade Light
 - System EPU increases. If it exceeds current RNP, the necessary alerts are posted.
 - Aircraft turns unexpectedly
 - Impact to PNR/ETE/ETP, ETA/Fuel predictions
 - If on LPV approach, FMS would follow deviations based on spoofed GPS

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Multiple Indications Likely



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GPS Spoofing and FMS Navigation/Guidance



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GPS Spoofing and FMS Navigation/Guidance



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GPS Spoofing -Common Symptoms (Asynchronous)

- Synthetic Vision
 - Blue/Brown reversion
- Ground Proximity
 - Pull Up/Terrain warnings
 - Red/Yellow Terrain Flashing
- Datalink
 - Log times incorrect
 - Messages time out/aborted
- ADS-B
 - Reports of ADS-B Failures

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Multiple Indications Likely

GPS Spoofing Detection





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Look for Position Differences



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Look for Erroneous Altitude/Speed/Range Information

GPS Spoofing Detection

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GPS Spoofing Detection



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FMS Commands Turn

GPS Spoofing and IRS

Non-Hybrid IRS:

- Non-hybrid IRS provides pure independent inertial position
- IRS position is initialized at aircraft power-up.
 - <u>Pure</u> IRS position is independently computed and naturally drifts during the flight.
 - Position output is based on IRS internal sensors with an ADC altitude correction. There is no dependency on any other position sensor after alignment.
 - GPS Spoofing has no impact on pure IRS position.

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GPS Spoofing has no Impact on Pure IRS Position

GPS Spoofing and IRS

• Hybrid IRS:

- Hybrid IRS is a single unit that provides both separate pure IRS and GPS-augmented IRS positions.
- Systems using Hybrid IRSs always consider the input as 2 separate position sensors. The FMS user interfaces vary as to how the separate positions are displayed.
- Pure IRS position is initialized at aircraft power-up and is the same as described in the previous slide.
- GPS-augmented IRS position is Initialized at aircraft power-up
 - Internal sensor data and GPS pseudo-range is combined for better position accuracy including when GPS is unavailable
- Some Hybrid IRSs have GPS Position Step Protection:
 - When the GPS signal is spoofed, a position step is detected and the GPS signal is removed from the Hybrid IRS position that is sent to the FMS.
 - GPS is excluded for a short duration of time (specific time varies depending on distance to spoofed position).
 - FMS continues to use the Hybrid IRS position and annunciates HYBRID as the Navigation Mode.

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• At some point, the Hybrid IRS will begin to use the Spoofed GPS signal. Honeywell Confidential © 2023 by Honeywell International Inc. All rights reserved.

GPS Spoofing has no Impact on Pure IRS Position

GPS Spoofing and Navigation Radios

Navigation Radios:

- Navigation Radios are not affected by GPS spoofing.
- FMS Autotuning is based on FMS position.
 - A navaid candidate list of the nearest navaids is used to chose the best combination for VORDME and DMEDME navigation.
 - If the FMS position is incorrect, the navaid candidate list is also not accurate, and the FMS may not be able to tune the selected VOR or DME stations.

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GPS Spoofing Does Not Impact Nav Radios

GPS Spoof Mitigation/Recovery

- Removing Hybrid IRS and GPS sensors from the FMS position solution forces FMS to use Radios and Pure IRS.
 - FMS Nav radio auto tuning may be delayed until FMS position is updated to a known good position.
 - If Hybrid IRS and GPS positions are removed after spoofing has occurred, the FMS position will eventually drift back to Pure IRS position, but the return will be slow.
 - Reasonable EPU is restored when a Navigation Radio position is obtained.
- Removing position sensors from FMS use does not affect products outside of FMS that use GPS directly.
- The GPS status page can be monitored to determine if the spoofing event is over.
 - Clock time is correct
 - GPS position moves and matches closely with the Pure IRS position
 - GPS distance from FMS position is reasonable.

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Radios and IRS can be used for Navigation

GPS Jam/Spoof Guidance

- Honeywell has published SIL D202311004193 in our Tech Pubs and Pilot Gateway websites to describe general system behavior in these areas.
- Refer to your Aircraft OEM and/or Company information for operational guidance prior to departure.
- Follow that guidance for mitigating Jamming and Spoofing events and for recovery procedures.

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Refer to Aircraft OEM for Operational Guidance



Thank You!



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