



GNSS Interference

Signals from the Global Navigation Satellite System (GNSS) are one of the main inputs used for aircraft positioning or time reference for Communication, Navigation and Surveillance functions on-board most of the Airbus aircraft.

Operators report an increasing number of events related to the loss of GNSS signals due to Radio Frequency Interference (RFI) during operations in some areas of the world.

This article explains the causes of RFI, the effects on the aircraft systems and provides recommendations for flight and maintenance crews.

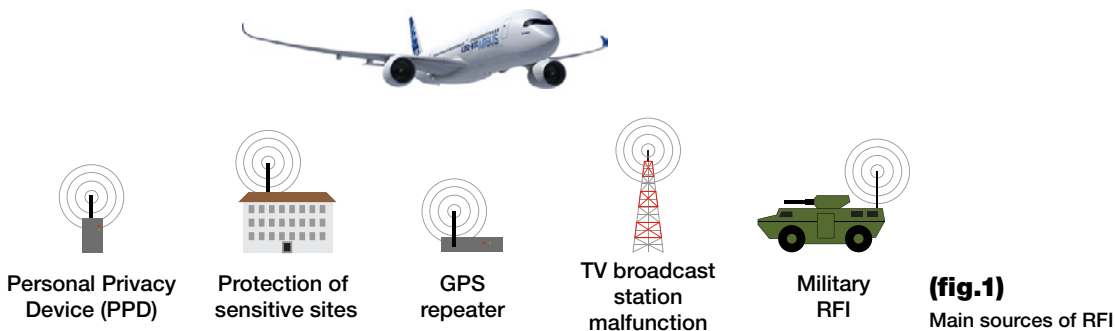
The Global Navigation Satellite System (GNSS) began in 1978 when the first satellite of the Global Positioning System (GPS) constellation was launched. The full operational capability of GPS was declared in 1995. In 2000 the full availability was granted to provide improved performance of the GPS position for civilians. The number of users and uses consequently increased, especially in civil aviation.

RADIO FREQUENCY INTERFERENCE (RFI)

A low power signal sent from space

The GPS signal is a low power signal. It is comparable to the power emitted by a 60W light-bulb located more than 20,000 km away from the surface of the earth. This means that the signal could easily be disturbed by any ground source located near an aircraft and emitting in the GPS L1 frequency band (1575.42 MHz $\pm$ 10 MHz), leading to the loss of GPS data **(fig.1)**.

Main known sources of RFI



Personal Privacy Devices (PPD)

Some of the reported disturbances were caused by portable Personal Privacy Devices that jam a GPS signal in the immediate area to avoid tracking. Operational disruptions at airports due to a loss of the GPS signal in the area around the airports have been caused when these devices were activated in the vicinity of an airport.

Protection of sensitive sites and VIPs

Certain sensitive sites may be protected using GNSS RFI for security reasons, such as correctional facilities or sites where dignitaries or political figures are living or visiting. Aircraft operating in the vicinity of these sites may be affected by interference with the GPS signal.

GPS repeater

GPS repeaters are used to make a GPS signal available inside a hangar during aircraft maintenance. GPS repeater signals have caused interference with actual GPS signal in some reported events, causing reception issues on aircraft located close to the hangar.

TV broadcast station malfunction

A TV broadcast station malfunction reportedly disturbed the GPS signal and affected aircraft operations.

Military GPS RFI in conflict zones

GPS RFI can also cause loss of the GPS signal in flight if too close to areas of military conflict. These areas are often known and NOTAMs inform flight crews that they may encounter interference close to these areas. It can be the case that military RFI activity is not known in advance or communicated leading to loss of GPS signal without prior notice. ■

GNSS spoofing

Some of the known RFI sources are reportedly capable of emitting signals that mimic GNSS signals.

Objectives for such spoofing include providing GNSS positioning service within hangar with repeaters, preventing GNSS receivers to compute position over prohibited area or triggering geo-fencing responses as part of anti-drone measures.

There are no reported events of GNSS spoofing leading to wrong aircraft position and timing on any Airbus aircraft to-date. However, Airbus constantly monitors the emerging threats and launched investigations to further evaluate GNSS spoofing threat and its possible consequences.

EFFECTS ON AIRCRAFT SYSTEMS AND ASSOCIATED COCKPIT EFFECTS

Impact on the aircraft position computation

GNSS RFI can cause the loss of GNSS position and timing. Even if GNSS plays a major role in the aircraft positioning system, Airbus aircraft are designed to be robust to GNSS signal loss. The use of other sources of data (IRS, VOR and DME) enables the aircraft systems to maintain a position computation capability. A loss of GNSS inputs does not lead to a map shift or to an erroneous position computation by the Flight Management Systems (FMS). In the case of a loss of GPS signal, the FMS switches from the mixed GPS/IRS position to an IRS-DME/DME position or IRS-VOR/DME or pure IRS in order of priority. Refer to the FCOM description of the FMS position computation for more detail.

“ Airbus aircraft are designed to be robust to GNSS signal loss ”

Potential loss of some navigation and surveillance functions as well as of certain operational capabilities

Certain navigation and surveillance functions or operational capabilities may be lost if there is a loss of the GPS signal **(fig.2)**. This is because the need for high accuracy and integrity of GPS position data is not met (e.g. for RNP AR, SLS, GLS, etc.) or when functions rely only on available GPS data for position or time reference. All, or some of the cockpit effects listed in **(fig.2)** may be triggered in an order that depends on the confirmation time of each system's monitoring function and how long the GPS signal is lost.

GPS signal loss and its associated effects were temporary in most of the reported events. The lost functions and capabilities were recovered immediately after aircraft moved out of range from the source of the radio-frequency interference.

(fig.2)

Potential effects of the loss of the GNSS signal on systems/functions with their associated cockpit effects

	Potential effect on systems/functions/operations	Main Cockpit effects					
		A300/A310	A220	A320	A330/A340	A380	A350
Navigation	Downgraded aircraft position computation	NAV GPS x FAULT	GNSS NOT AVAILABLE on EICAS	NAV GPS x FAULT GPS PRIMARY LOST on ND			NAV GNSS x FAULT NAV PRIMARY LOST on ND
	Impact on RNP operations (RNP4, RNP 2, RNP 1)	GPS PRIMARY LOST on ND and CDU	UNABLE RNP on EICAS				
	Loss of RNAV (GNSS) capability						
	Loss of RNP AR capability	N/A	APPROACH NOT AVAILABLE on EICAS	GPS PRIMARY LOST on ND		N/A	NAV RNP AR CAPABILITY DOWNGRADED NAV RNP AR CAPABILITY LOST
	Loss of the GLS function (No GLS approach)	N/A	N/A	NAV GLS x FAULT			
	Loss of the SLS function (No LPV approach)	N/A	LPV NOT AVAILABLE on EICAS	N/A	N/A	N/A	NAV SLS x FAULT
	Limited FLS function (only available for VOR or NDB approaches)	N/A	N/A	FLS LIMITED TO F-APP+RAW on ECAM STATUS F-APP+RAW on FMA			
	Loss of OANS/ANF function	N/A	SMS FAIL on EICAS	N/A	ARPT NAV POS LOST on ND		
Surveillance	Loss of the Predictive TAWS functions	TERR MODE "FAULT" light	TAWS MAP FAIL on EICAS	NAV GPWS TERR DET FAULT		SURV TERR SYS x FAULT	
	Loss of ADS-B out reporting	No alerting system	ADS-B OUT FAIL on EICAS	NAV ADS-B RPTG x FAULT		ADS-B POS RPTG LOST Memo	
	Loss of the ADS-B IN (ATSAW) function	N/A	N/A	NAV ADS-B TRAF FAULT or NAV ADS-B FAULT		N/A	SURV ADS-B TRAFFIC x FAULT
	Loss of ROW/ROPS	N/A	N/A	SURV ROW/ROP LOST			

“ It is not necessary to deselect GPS in the case of RFI as this would prevent the aircraft from recovering its full capabilities when the GPS signal is restored ”

OPERATIONAL CONSIDERATIONS

During Flight Preparation

Check RFI NOTAMs

Operators should consider the NOTAM related to known or expected areas with GNSS RFI when planning flights. If a NOTAM is applicable to the flight, then the availability of non GNSS-Based routes, procedures and approaches (such as ILS, VOR and DME) must be checked for the affected area.

During Flight

Application of ECAM/FCOM procedures

Flight crews must follow the associated ECAM or FCOM procedures if a loss of GNSS signal occurs during flight with a cockpit effect described in **(fig.2)**.

Recovery of the signal

Loss of GPS information is usually temporary and the normal navigation mode based on GPS data (“GPS PRIMARY” or “NAV PRIMARY”), as well as the communication and surveillance functions, are recovered as soon as the aircraft leaves the area affected by RFI. It is therefore not necessary to deselect GPS in the case of RFI as this would prevent the aircraft from recovering its full capabilities when the GPS signal is restored.

Zones with ADS-B OUT required

If the GNSS loss occurs in an area where ADS-B OUT is required per regulation, the flight crew should notify ATC of the loss of ADS-B OUT and report that this is due the loss of the GNSS signal.

After a flight with suspected loss of GNSS signals

Report to Maintenance

At the end of a flight where the effects of a loss of GNSS signal were experienced, the flight crew should report the event and cockpit effects to the Maintenance to investigate and confirm if the event was due to RFI or a result of a system or equipment malfunction.

Share information

Operators should report any identified suspected GNSS RFI events to regional (e.g. ANSPs) and international organizations, such as EUROCONTROL’s Voluntary ATM Incident Reporting (EVAIR). This will facilitate and accelerate GNSS RFI event confirmation or resolution, and enable the publication of a NOTAM to share information to all other operators flying near the affected area. ■



MAINTENANCE CONSIDERATIONS

At the end of a flight impacted by a transient loss of GNSS, a confirmation should be done to make sure that the effects encountered were due to RFI and not to a system or equipment malfunction.

Transient loss of GNSS in an area with known RFI

At the end of a flight affected by transient GNSS loss within an area with known RFI, Airbus recommends that maintenance personnel reset the system and test both Multi-Mode Receivers (MMR).

To ensure that there was no system failures, Airbus also recommends a system test of any equipment affected by a loss of GNSS signal based on the cockpit effects observed during the flight. Should any system test fail, maintenance personnel must perform troubleshooting in accordance with the associated Trouble-Shooting Manual (TSM) task.

Refer to the "GNSS loss and GNSS interference on Airbus aircraft" ISI article ref 34.36.00049 available on the Airbus World portal for more details and a list of the related AMM/MP tasks for system tests.

What if the interference is still present on ground?

If the GNSS is still impacted by RFI on ground, the aircraft should be moved out of the RFI area. A dispatch under MEL conditions should be considered if this is not possible to do so.

Transient loss of GNSS in areas not known for RFI

At the end of a flight affected with transient GNSS loss within an area without known RFI issues, Airbus recommends that maintenance personnel confirm the root cause of the GNSS loss by studying all potential sources: aircraft system failure, GNSS constellation anomaly, environment masking, multipath or space weather events such as ionospheric scintillation. When all these potential causes are eliminated, RFI can be suspected. In this case, aircraft data should be sent to Airbus for further investigation. A list of the information items to report is provided in the "GNSS loss and GNSS interference on Airbus aircraft" ISI article ref 34.36.00049, available on the Airbus World portal. ■

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The number of reported transient GNSS loss due to radio-frequency interference is increasing. The loss of GPS signal can cause a downgrade of the aircraft position computation capabilities. However, Airbus aircraft are designed to maintain position computation capability without a GPS signal by using IRS or ground NavAids data.

Certain navigation and surveillance functions may be lost temporarily. When radio-frequency interference is encountered during flight, the flight crew will be alerted to any loss of function or capability. The flight crew must then use the relevant ECAM/FCOM procedure associated to these cockpit effects.

In most reported cases of radio-frequency interference, there is a return to normal operations immediately after the aircraft has moved away from the affected area.

During flight preparation, precautions should be taken when flying to or above known area of RFI to avoid operational burdens.

When it is confirmed by the maintenance that RFI is suspected in an area not known to be impacted, the information should be shared with the aviation community.

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