

# Effects on GNSS receivers, due to Ham radio interference on Galileo signals

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The studies regarding the protection of the primary radionavigation-satellite service (space-to-Earth) by the secondary amateur and amateur-satellite services in the frequency band 1 240-1 300 MHz are looking at the frequencies used by Galileo. Protection curves used in the documents are determined to research the possibility of interference of ham radio signals on the Galileo signals.

Galileo signals are used for calculating navigation position in a GNSS receiver. Modern GNSS receivers use all available signals, not only from Galileo but also from the other GPS and Glonass standards. There are only very few Galileo only receivers, and for as far as I know most or even all consumer GNSS receivers are using all available signals from GPS and Glonass and Galileo simultaneously.

The few Galileo only receivers are probably not consumer receivers and mostly used only for measurement purposes of the Galileo signals, for instance at a satellite monitoring station.

Looking at the website of Galileo: <https://www.gsc-europa.eu/support-to-developers/galileo-compatible-devices> it becomes clear that Galileo will only be successful if the available GNSS receivers will have Galileo-enabled receivers, chipsets and modules – many of which are already available on the market. This means that the available GNSS receivers are using GPS, GLONASS and now also extra the signals from Galileo.

What does this mean in using a GNSS receiver also using the Galileo signals and what will be the effect on possible interference from Ham radio signals on this GNSS receiver overall performance.

A modern GNSS receiver will use all available signals for calculating the actual position of the receiver. It will use GPS, GLONASS and Galileo signals available when the chipset is able to receive the Galileo signals. Most new GNSS receivers will be able to use all available signals.

If there is a harmful interference from a Ham radio signal on the Galileo frequencies, will not cause the GNSS receiver to stop operating. It still will be able to receive the GPS and GLONASS signals available and it still will be able to calculate the correct position of the receiver necessary for the navigation purposes.

The discussions related to the interference of Ham radio signals to Galileo only are related to the Galileo signals, the protection curves used are showing levels of interference causing loss of receiving the Galileo signals. **The protection curves do not tell anything what will happen to the GNSS receiver navigating capability which still is able to receive the signals from GPS and GLONASS.**

In other words, if the Galileo signals are severely jammed, it will have little or no effect on the navigation task of the GNSS receiver.

As experiment I have tried to interfere on my home GNSS receiver in the KIWI SDR which also is Galileo enabled.

By putting a strong signal within the frequency band of the Galileo signals I am able to interfere with the reception of these signals but the GNSS navigation function still continues due to the fact that the GPS and GLONASS signals are free of the frequency interference.

The protection curves used in the documents to prove that Ham radio signals can cause jamming of the Galileo signals, are not telling anything about the function of the GNSS receiver being able to also use the other GPS and GLONASS signals.

At this moment, as far as I know, there are no consumer GNSS receivers on the market using only Galileo signals for navigation. All modern consumer receivers are as much as possible able to work with all available systems. Interference on only Galileo signals will not destroy the usage of the receivers navigation task. Most end users will never even notice if Galileo signals are interfered by Ham radio signals.

Harmful interference on a Galileo signal probably will lead to non reception of the Galileo signals which will only influence the receivers navigation performance very little. Depending on satellite constellation of the remaining GPS and Glonass signals there is a extremely small chance of losing position. Also the risk of decreased navigation accuracy is relative small. In my opinion it will be hard to notice effects on Galileo interference on the navigation performance on a consumer GNSS receiver.

Looking from a GNSS users perspective there is only a very small chance that the receiver will stop navigating during a period when the Galileo signals encounter strong Ham radio interference well within the level of the defined protection levels.

Conclusion:

- Harmful interference on Galileo only GNSS receivers might occur by Ham radio signals stronger than defined in the protection criteria.
- Modern consumer GNSS receivers are GPS, Glonass and Galileo enabled reception simultaneously and any harmful interference on Galileo signals from Ham radio transmissions will not lead to failing the navigation task of the receiver. Most consumers will not even notice any degradation on the navigation performance.
- Experiments with a GNSS multi band receiver able of receiving GPS, Glonass and Galileo show that extreme strong interference on Galileo signals does not cause the navigation task of the receiver to crash or stop. Signals from GPS and Glonass are reliable enough to keep the navigation task working as before
- Only by looking at the receiver interface showing the actual received satellites might show to a consumer some loss of Galileo reception during a period of harmful interference by Ham radio station.
- In practical situations and related to Ham radio activity and the used protection criteria for Galileo signals it is already obvious that harmful interference of Ham radio signals will be a very small risk of losing Galileo signals.
- The consumer GNSS receivers will normally continue working to calculate navigation position and consumers will not notice that Galileo signals are influenced by Ham radio interference.
- Hence it is obvious that demanding strong regulations against Ham radio operators or removing these out of the Galileo band will not lead to better consumer GNSS receiver performance.
- As at this moment most GNSS receivers are using automatic multi band receiving the protection parameters in GNSS multi band reception should be based on protection against overall receiver performance and not only on Galileo signal protection. Any harmful interference from Ham radio signals to Galileo will result only in very, difficult noticeable degraded navigation performance.
- It is not realistic to demand Ham radio to stop operating in the Galileo bands as long as any Galileo interference does not lead to harmful degraded performance of consumer GNSS receivers.