J-Shield

You can either hope that interferences will never happen; or get a GNSS receiver that has protection against interferences.

You can either hope that special interest groups, and Coalitions, who cannot build a good filter, will always be successful in lobbying to offer mediocre technology, keep the precious bands near GNSS wasted and prevent systems like LightSquared authorization, or get a GNSS receiver that has protection against such systems while offering better performance too.

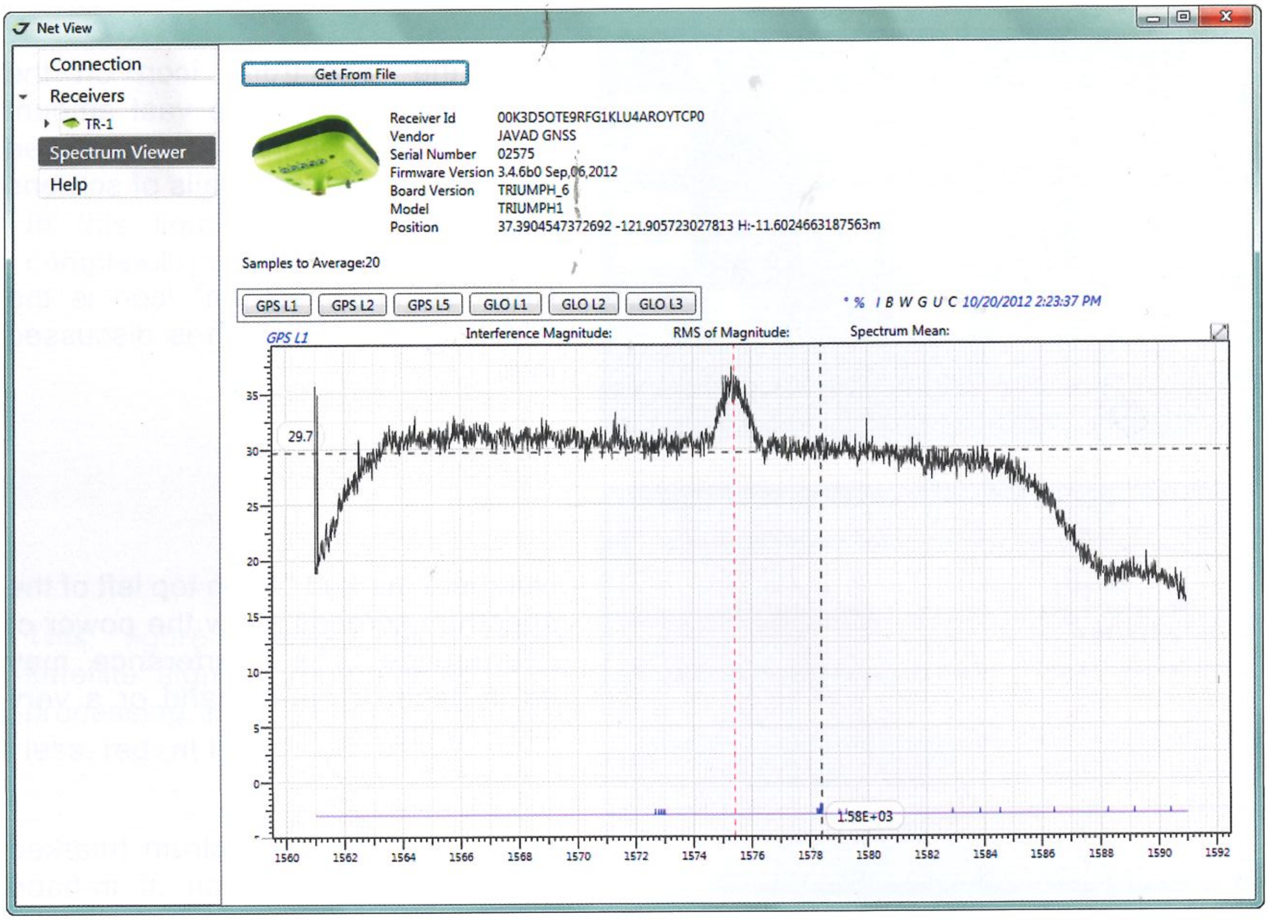
The United States of America is currently ranked 16th on broadband wireless connectivity. We are proud that our technology not only protects and improves the performance of the GNSS system, but also helps to support proper usage of the precious bands to improve broadband wireless communication and reduce user costs to 1/3 of what is today.

You can either trap yourself by owning defective GNSS receivers which forces you to support coalitions preventing progress of wireless broadband in the United States, or you can own a GNSS receiver that performs better, has protection against such interferences and frees you from such political games.

Our team has been bringing you the latest GNSS technology for the past 30 years. We were working on defending against in-band and out-of-band interferences ten years before the LightSquared issue surfaced.

You can either listen to some folks who do not have sufficient knowledge about GNSS technology, but give advice and testimony to Congress, or analyze the technical details that we present in the next few pages which are backed by our GNSS receivers in mass production today.

NetView Monitors Interferences



- Ability to get interference spectrum from any of our receivers
- Display interference characteristics by AGC vairations
- Supported bands: GPS L1/L2/L5 GLONASS L1/L2/L3 *
- Store to file / Plot from file

SNR	Nsat	Nsat aver	Sat %	Timei	Nslip	Nslip aver	Slip / hour
50	5	4.54	53.78	3581	0	0.00	0.00
45	1	1.84	19.59	3213	0	0.00	0.00
40	2	1.88	20.28	3267	0	0.00	0.00
35	1	1.12	5.72	1547	1	NA	NA
30	0	1.00	0.48	146	15	NA	NA
25	0	1.00	0.12	37	26	NA	NA
20	0	1.00	0.02	6	6	NA	NA
0	0	0.00	0.00	0	0	NA	NA

Real time cycle slip detection is a powerful tool to see the effect of interferences.

* - depends on enabled options SPECTRUM, SCIENTIFIC, GALILEO

Several ways to report interferences

GNSS receivers in reference stations should have Interference monitoring and reporting features.

Via Wi-Fi to Victor-VS

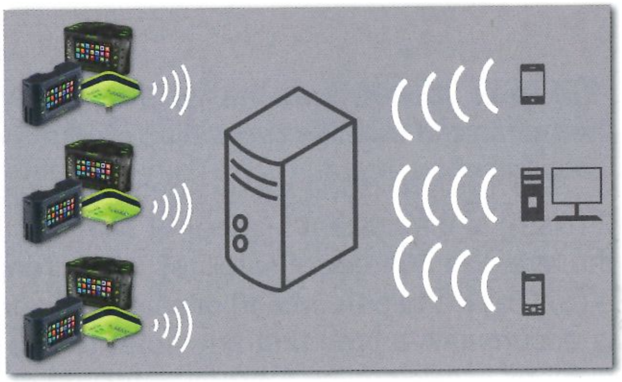
Victor-VS can connect to TRIUMPH-1 or TRIUMPH-VS anywhere in the world and get direct report about interferences.

Via Wi-Fi to NetView

NetView, running on any PC, can connect to TRIUMPH-1 or TRIUMPH-VS anywhere in the world and get direct report about interferences.

Via Wi-Fi to NetHub

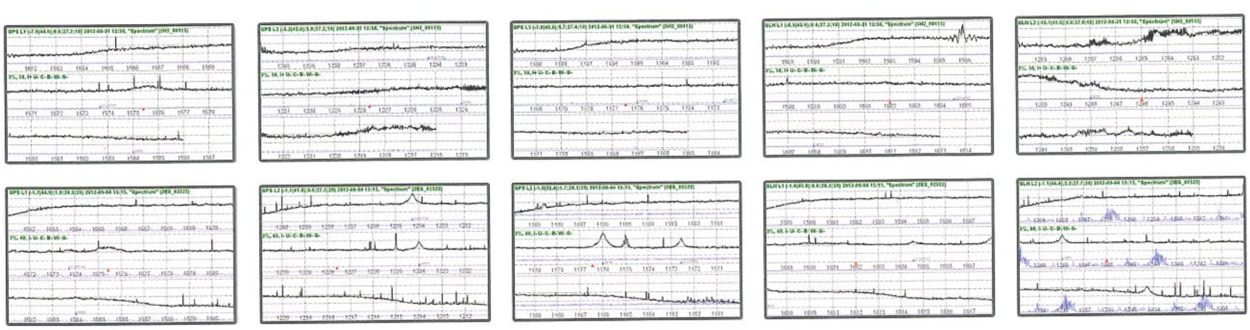
NetHub, running on any PC, can connect to several TRIUMPH-1's or TRIUMPH-VS's anywhere in the world and get direct report about interferences.



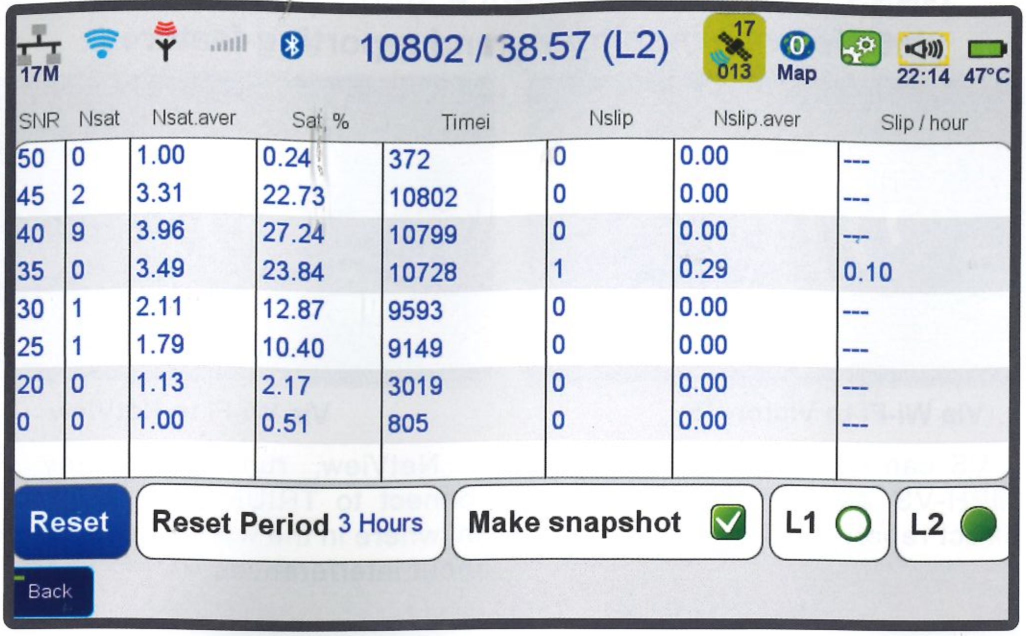
Via Wi-Fi to FTP or E-mail

TRIUMPH-VS and Victor-VS can send interference reports to FTP sites and authorized persons can view them via browsers (computers, iPhones, etc). It can also e-mail reports to intended people.

Monitor interference in any area before performing task; like pilots check the weather before take off.



... Monitoring the "Heartbeat"



SNR	Nsat	Nsat.aver	Sat, %	Timei	Nslip	Nslip.aver	Slip / hour
50	0	1.00	0.24	372	0	0.00	---
45	2	3.31	22.73	10802	0	0.00	---
40	9	3.96	27.24	10799	0	0.00	---
35	0	3.49	23.84	10728	1	0.29	0.10
30	1	2.11	12.87	9593	0	0.00	---
25	1	1.79	10.40	9149	0	0.00	---
20	0	1.13	2.17	3019	0	0.00	---
0	0	1.00	0.51	805	0	0.00	---

Figure above shows the cycle slip screen which is updated every second and records the number of satellite cycle slips grouped according to their signal strengths.

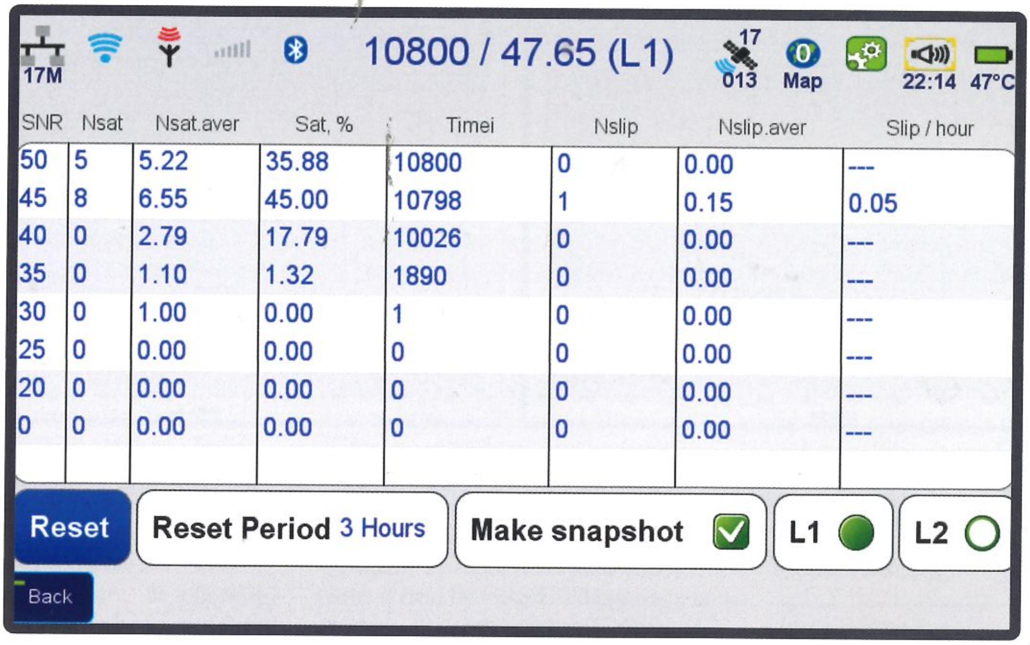
Col 1 (SNR) is the signal strength of satellites grouped from 0 to above 50 dB/Hz. Col 2 (Nsat) is the current number of satellites with strength in each bin. Col 3 (Nsat aver) is the average number of satellites with strength in each bin since test started or reset. Col 4 (Sat %) is the percentage of satellite signals in each bin during test period. Col 5 (Timei) is accumulative time that any satellite has strength in that bin. Col 6 (Nslip) is the total number of cycle slips form all satellites during the test period. Col 7 (Nslip aver) is the average number of cycle slips per satellites during the test prior. Col 8 (Slip/hour) is the average number of cycle slip per satellite per hour during the test period (N/A is shown during the first 30 minutes).The number on the top left (10800) is the elapsed time since test started. The number on the top next to it (47.65) is the average of all satellite signal strengths during the test period. Reset button restarts the test; Reset Period selection option restarts test automatically after this elapsed test time; and Make snapshot checkbox records this screen after each test period (if checked). L1 and L2 buttons select screens for L1 and L2 signals.

Figure on the right side shows similar items for the L2 band. Note that the average signal strength of the L2 band is about 9 dB less than the L1 band (47.65 - 38.57). This is because the GPS L2 signals are encrypted.

With comprehensive test features that we have embedded in our receivers users can monitor the environment and gain detailed information about possible interferences and their spectral characteristic. They can also look at the heartbeat of a receiver by looking at the cycle slip screen.

All such tests are being performed in the background without any interruption to the normal operation of the receiver in performing survey and RTK tasks.

Real-Time Cycle Slip Detection...



SNR	Nsat	Nsat.aver	Sat, %	Timei	Nslip	Nslip.aver	Slip / hour
50	5	5.22	35.88	10800	0	0.00	---
45	8	6.55	45.00	10798	1	0.15	0.05
40	0	2.79	17.79	10026	0	0.00	---
35	0	1.10	1.32	1890	0	0.00	---
30	0	1.00	0.00	1	0	0.00	---
25	0	0.00	0.00	0	0	0.00	---
20	0	0.00	0.00	0	0	0.00	---
0	0	0.00	0.00	0	0	0.00	---

Tracking and measuring carrier phases of satellites are the foundation for all GNSS precision applications. This is why high precision GNSS receivers are much more complicated and more expensive than low precision receivers which only measure code phases. Any internal deficiency in design and/or manufacturing of high precision GNSS receivers; or the effect of any external phenomena (like interference and multipath) can cause carrier phase tracking to jump from one cycle of carrier to another. This is called carrier "Cycle Slip". You may call it missing a "heartbeat".

Unlike "loss of lock" which is obvious to detect, carrier cycle slips may have no apparent effect on satellite signal tracking and producing navigation solutions. They can be discovered and repaired in post processing software or in RTK engines after enough data is processed. Erroneous results in high precision solutions (post processed or RTK) are the result of undetected cycle slips.

If the ultimate objective of any high precision receiver is to track carrier phases of satellites correctly, it is highly desirable that any test that is intended to monitor the effect of interferences of other signals on GNSS, should also focus on monitoring and quantifying cycle slips. It is much like monitoring the "heartbeat" of a GNSS receiver in real-time.

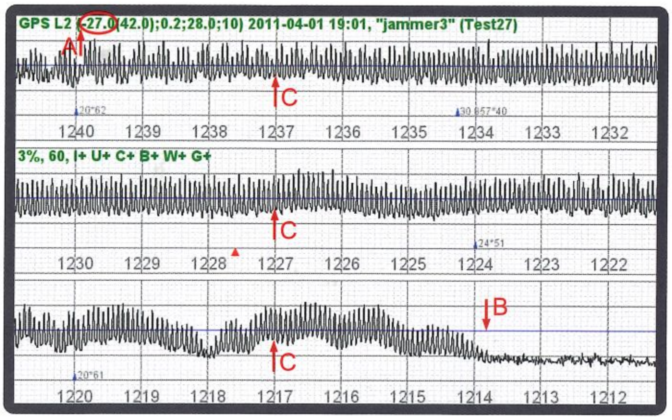
We are proud to announce that we have been able to provide this feature in our GNSS receivers and monitor cycle slips in real-time as the ultimate way to determine the quality of a GNSS receiver and the effect of interferences.

Part of our confidence in the excellent performance of our J-Shield filters is based on monitoring the heart beat and observing that J-Shield does not cause even one cycle slip after 24 hours of tracking. Not even missing one "heartbeat" in 24 hours!

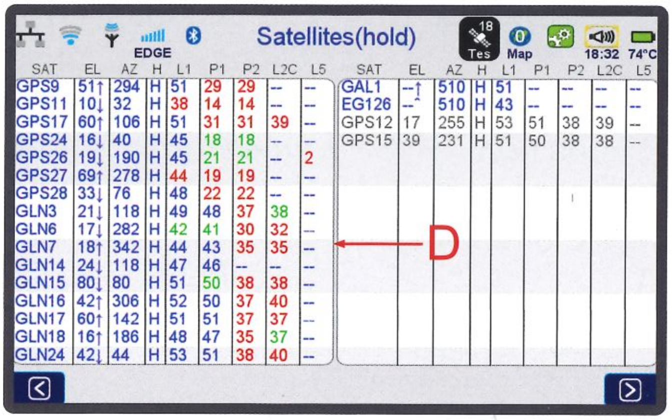
An interesting feature of our innovation is that it is available in our GNSS receivers and users by a simple click can access screens and features that we are going to explain next.

... Monitoring/quantifying Interferences

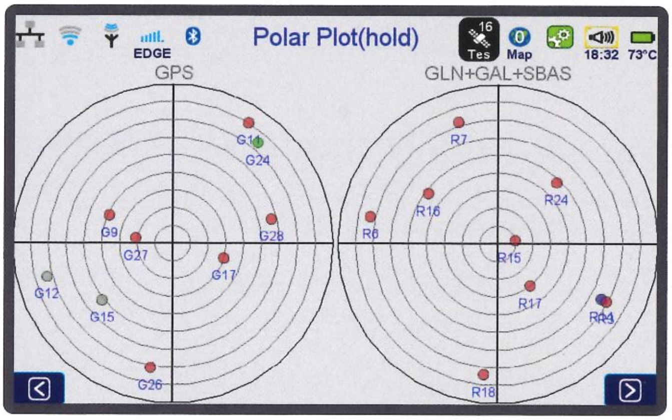
In this figure the band has been completely jammed by a $400 jammer.



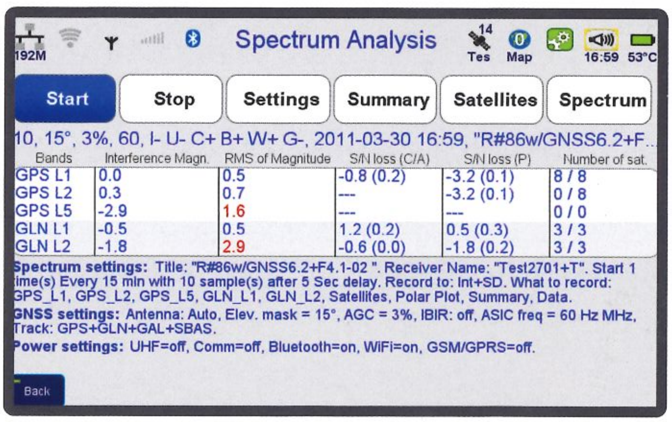
This figure shows color coded satellite signal strength after signal processing. Blue: Perfect, green: 3dB less, red: at least 6 dB less.



This figure shows the same color coded information in polar coordinates of satellites. This helps to verify if satellites have been blocked by obstruction(s).



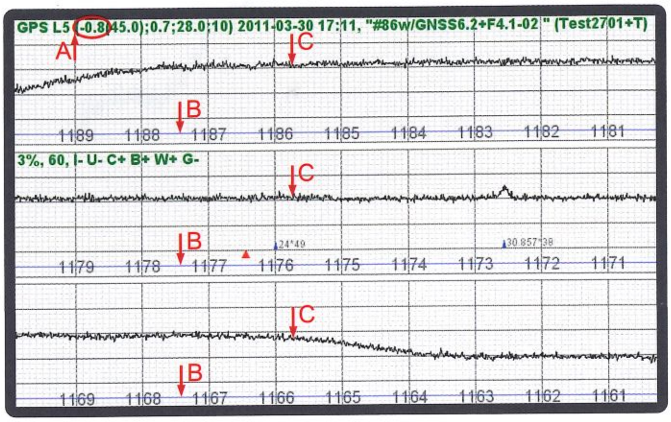
This figure shows the summary of the spectrum analysis before and after the signal processing. See details in a 22-minute video at www.javad.com in “video lesson” section.



Interference Analyzer ...

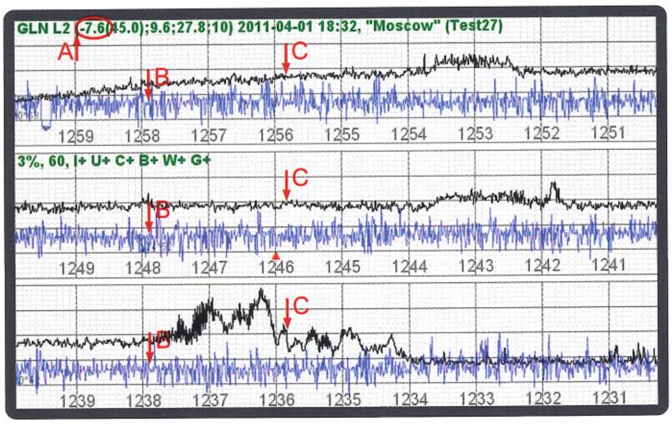
Click the "Spectrum" icon on the Home page to see the vast amount of information on interferences. See www.javad.com for details of screens which follows.

Next to the "Spectrum" icon is the "Cycle Slip" icon which is discussed later.

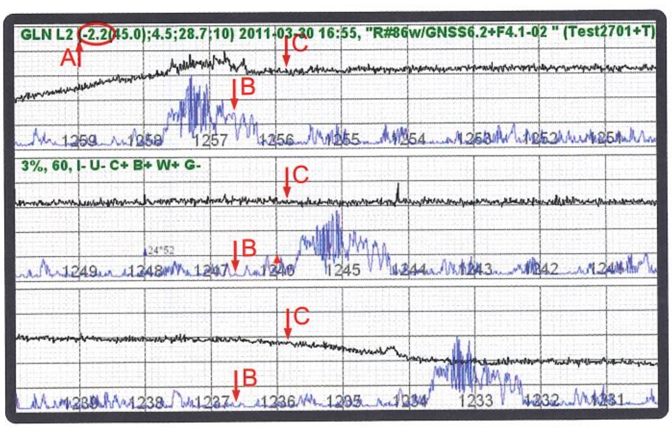


Numbers marked "A" on top left of the spectrum screens show the power of interference. The interference may be in-band or out-of band or a very wide "white noise".

The shape of the spectrum (marked "C") shows the location of in-band interference.



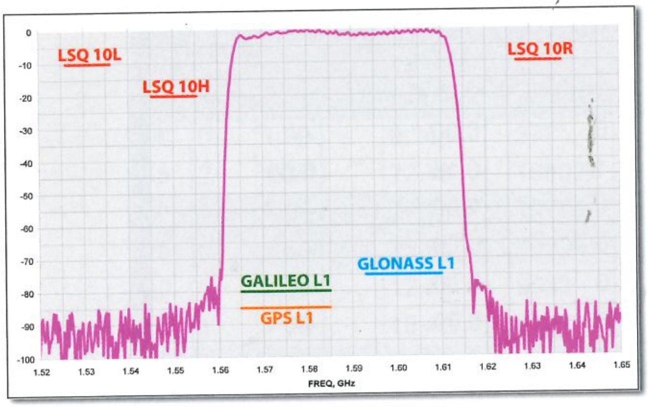
We have assigned 60 of our 216 GNSS channels to monitor the 6 GNSS bands and report interferences in four different ways. You can check interferences in your environment before starting your job to ensure your environment is clean.

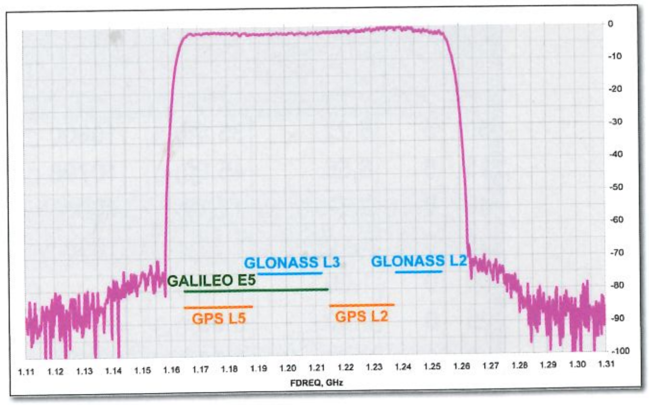


The blue line (marked "B") is the control voltage and fluctuations there shows the presence of unwanted signals with some visual quantification.

First screen shows no interference and the two figures below it show some interference as shown by A, B and C designations.

J-Shield For All GNSS Bands





A good GNSS receiver should bring in ALL of wideband GNSS signals and reject all other unwanted signals. We announced the existence of this technology months ago for the L1 band. Now we have improved this filter and added similar protection for all other GNSS bands.

The figure left above shows the frequency response of our filter for L1. As shown in this figure, it allows complete, undisturbed L1 signals in and defends against any other signals outside this band. In particular it defends against LightSquared signals of 10L, 10H, and 10R (Handsets). The filter drops down quickly, at the rate of 12 dB/MHz outside the GNSS band.

The figure right above shows the frequency response of our filter for other GNSS bands. Although there are no requests for other systems near these GNSS bands yet, our filters have protection if this happens in future.

Interference is not limited to wideband wireless systems. Harmonics of other transmitters can occur anywhere and we see it as an essential requirement to protect all GNSS bands in our receivers against all interferences as much as possible. Our technology allows us to do a better job today.

Our effort in protecting the GNSS bands did not end with designing appropriate filters. We needed to a) prove that these filters work, b) prove that these filters not only do not degrade the performance of GNSS receivers but improve performance, c) devise features that any person can use to test our receivers, and d) devise features where users can readily see the effect of interferences that may fall within the GNSS bands in some areas or see the effect of intentional jammers that are marketed these days with prices as low as $400.

Without proper equipment and knowledge any technical issue can turn political and lobbyists, politicians, bloggers and editors will take over and stars of generals and titles of people will eclipse the scientific facts.

To study the effect of interferences in some official tests, they had to use very expensive equipment in highly sophisticated laboratories, employ experts, and then wait for several weeks to get the test results. These results were not conclusive and therefore were open to interpretation.

It is our claim that these new innovative test features that we have embedded in our GNSS receivers a) are much more comprehensive than those done in laboratories with a roomful of equipment, b) can be used by any novice user in the field, and c) provide instantaneous results.