SPOOFER BUSTERS

Spoofers are not only of the Black Sea type, as reported in the press, kids are going that direction too. It is time to take spoofers seriously.

Spoofers are completely different from jammers that block GNSS signals. Spoofers create GNSS-like signals that fool receivers to provide false location solutions.

PATENTS PENDING

We combat spoofers in two ways:

1. Detect and alarm that spoofer exist.
   We ignore the spoofer and use valid satellite signals.
2. Help find the direction that spoofed signals are coming from.

Spoofer detection is available in all of our OEM boards.

See details inside

“Why Javad?
Because it works where nothing else will and it has abilities and features that nothing else does.”

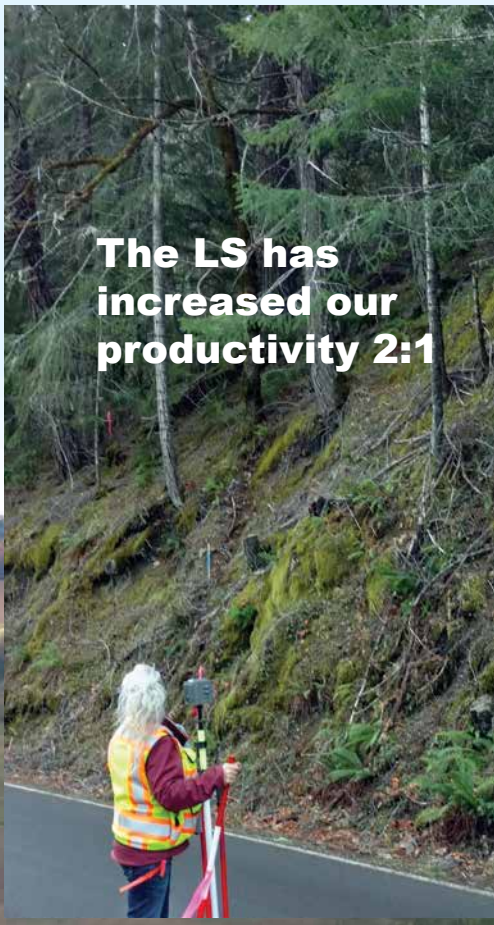
“Truly amazing with a 4” grape vine directly overhead and the tree cover.”

“I got some ridiculous ‘fixes’ today in some horrible situations. Reset receiver, moved around, etc. Tried to get a bad fix but had a hard time doing it.”

“This thing is bad ass!”

“I had 100% confidence this RTK was good. As soon as I stored the shot I inversed to my design point at that location and got 0.06’. No second PPK necessary! Then for the cherry on top, I processed the PPK at the office at it was 0.05’ from the RTK I stored. Just an amazing Surveying machine!”

“Thank you for the most awesome set of equipment I have had the pleasure of running in my 41 years of surveying. I am having the most fun I have ever had!”



The LS has increased our productivity 2:1

FL

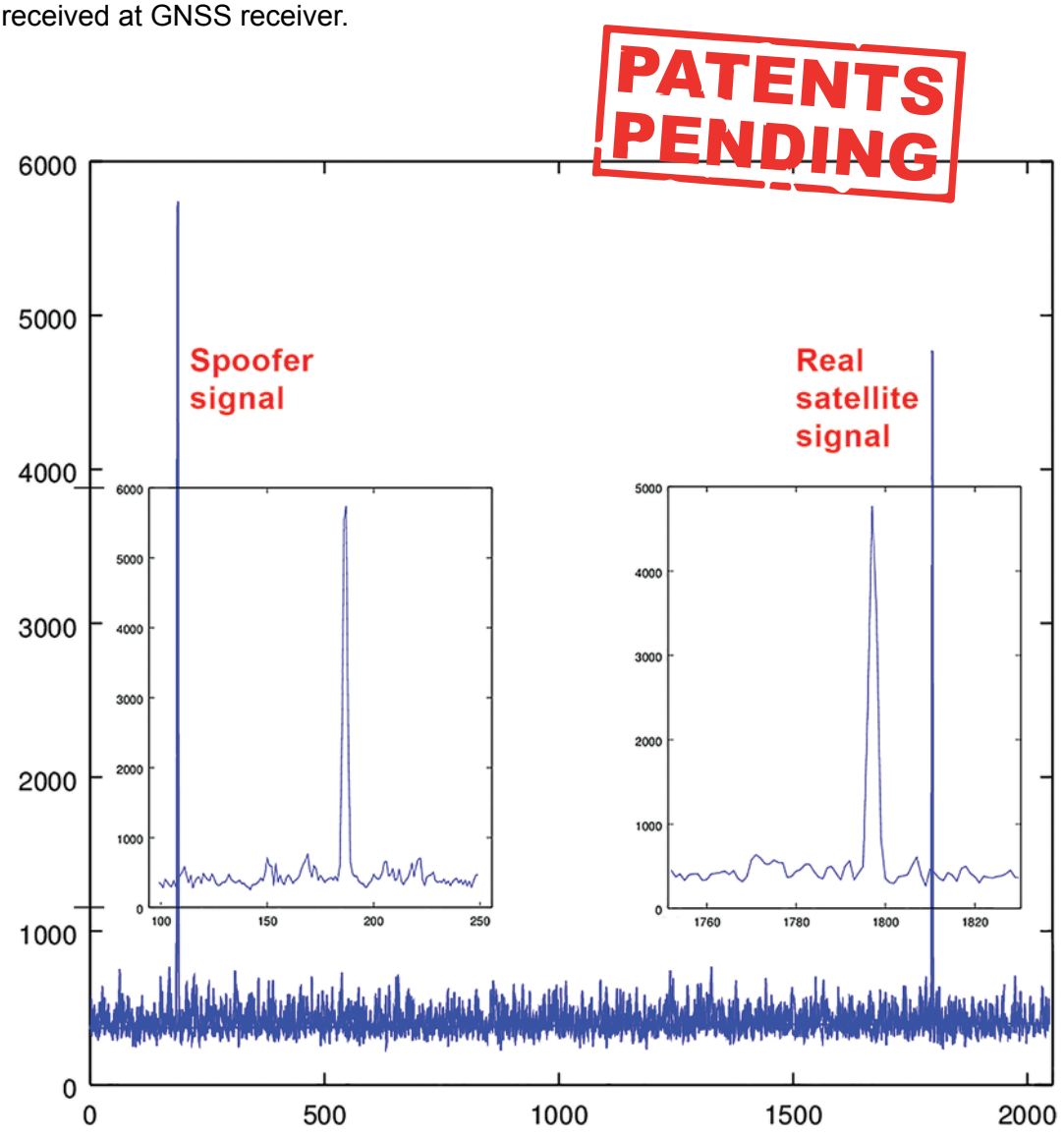
Spoofer Detection

With 864 channels and about 130,000 quick acquisition correlators in our TRIUMPH chip, we have resources to assign more than one channel to each satellite to find ALL signals that are transmitted with that GNSS satellite PRN code.

If we detect more than one reasonable and consistent correlation peak for any PRN code, we know that we are being spoofed and can identify the spoofed signals.

When we detect that spoofing is in effect, we use the position solution provided by all other clean signals (L1, L2, L5, etc... GPS, GLONASS, Galileo, Beidou, etc...) to identify the spoofer signal and use the real satellite measurement. If all GNSS signals are spoofed or jammed, then we alarm you to ignore GNSS and use other sensors in your integrated system.

Figure below shows an example of a spoofer signal and a real satellite signal received at GNSS receiver.



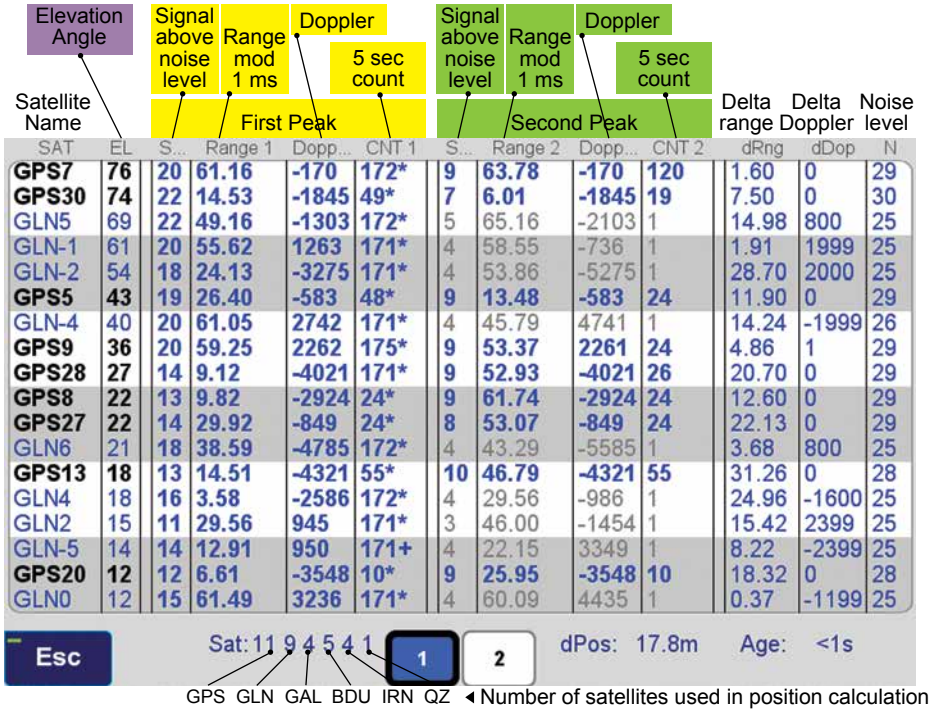
Satellite and Spoofer Peaks

The screenshots below are from a real spoofer in a large city. The bold numbers are for the detected peaks. The gray numbers represent highest noise, not a consistent peak. "*" symbol next to the CNT numbers indicate that signal is used in position calculation. Each CNT count represent about 5 seconds of continuous peak tracking.

SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS5	33	**16**	**61.14**	**1382**	**184***	4	25.95	181	1	29.32	1201	29
GPS7	51	**21**	**14.39**	**1146**	**184***	4	18.21	-453	1	2.80	1599	29
GPS8	30	**18**	**65.10**	**-918**	**184***	4	4.26	-1318	1	3.68	400	29
GPS9	12	**14**	**40.46**	**2966**	**184***	4	2.08	3765	1	26.13	-799	29
GPS13	40	**16**	**46.92**	**-3525**	**184***	4	8.21	-4325	1	25.80	800	29
GPS15	12	**14**	**12.46**	**-4336**	**30***	5	33.00	-1536	1	19.52	-2800	28
GPS20	24	**12**	**13.19**	**-1707**	**107***	4	29.32	-3307	1	15.11	1600	29
GPS27	16	**11**	**10.26**	**1264**	**184***	4	43.55	63	1	31.22	1201	29
GPS28	53	**19**	**9.41**	**-2724**	**184***	4	7.93	-4724	1	0.46	2000	29
GPS30	81	**22**	**13.79**	**-332**	**184***	5	34.16	1266	1	19.35	-1598	28
GLN-4	54	**20**	**62.08**	**1498**	**1158***	5	21.72	2697	1	24.16	-1199	25
GLN5	46	**20**	**18.04**	**-2897**	**524***	4	26.26	-3697	1	7.20	800	25
GLN0	37	**18**	**30.37**	**2355**	**1469***	4	38.37	1554	1	6.98	801	25
GLN-1	82	**18**	**34.92**	**-776**	**189***	4	12.54	-1576	1	21.35	800	25
GLN-2	26	**12**	**30.96**	**-4358**	**229***	4	11.80	-3158	1	18.13	-1200	25
GLN2	21	**10**	**59.73**	**288**	**551***	4	47.55	1087	1	11.16	-799	25
GLN4	22	**15**	**30.59**	**-3361**	**208***	4	11.74	-5361	1	17.83	2000	25
GLN-5	21	**14**	**20.17**	**276**	**187+**	3	25.45	2275	1	4.26	-1999	25

Esc Sat: 10 7 6 4 4 0 dPos: 19.0m Age: <1s

No spoofer. Only one reasonable peak for each satellite.



SAT	EL	S...	Range 1	Dopp...	CNT 1	S...	Range 2	Dopp...	CNT 2	dRng	dDop	N
GPS7	**76**	**20**	**61.16**	**-170**	**172***	**9**	**63.78**	**-170**	**120**	1.60	0	29
GPS30	**74**	**22**	**14.53**	**-1845**	**49***	**7**	**6.01**	**-1845**	**19**	7.50	0	30
GLN5	69	**22**	**49.16**	**-1303**	**172***	5	65.16	-2103	1	14.98	800	25
GLN-1	61	**20**	**55.62**	**1263**	**171***	4	58.55	-736	1	1.91	1999	25
GLN-2	54	**18**	**24.13**	**-3275**	**171***	4	53.86	-5275	1	28.70	2000	25
GPS5	**43**	**19**	**26.40**	**-583**	**48***	**9**	**13.48**	**-583**	**24**	11.90	0	29
GLN-4	40	**20**	**61.05**	**2742**	**171***	4	45.79	4741	1	14.24	-1999	26
GPS9	**36**	**20**	**59.25**	**2262**	**175***	**9**	**53.37**	**2261**	**24**	4.86	1	29
GPS28	**27**	**14**	**9.12**	**-4021**	**171***	**9**	**52.93**	**-4021**	**26**	20.70	0	29
GPS8	**22**	**13**	**9.82**	**-2924**	**24***	**9**	**61.74**	**-2924**	**24**	12.60	0	29
GPS27	**22**	**14**	**29.92**	**-849**	**24***	**8**	**53.07**	**-849**	**24**	22.13	0	29
GLN6	21	**18**	**38.59**	**-4785**	**172***	4	43.29	-5585	1	3.68	800	25
GPS13	**18**	**13**	**14.51**	**-4321**	**55***	**10**	**46.79**	**-4321**	**55**	31.26	0	28
GLN4	18	**16**	**3.58**	**-2586**	**172***	4	29.56	-986	1	24.96	-1600	25
GLN2	15	**11**	**29.56**	**945**	**171***	3	46.00	-1454	1	15.42	2399	25
GLN-5	14	**14**	**12.91**	**950**	**171+**	4	22.15	3349	1	8.22	-2399	25
GPS20	**12**	**12**	**6.61**	**-3548**	**10***	**9**	**25.95**	**-3548**	**10**	18.32	0	28
GLN0	12	**15**	**61.49**	**3236**	**171***	4	60.09	4435	1	0.37	-1199	25

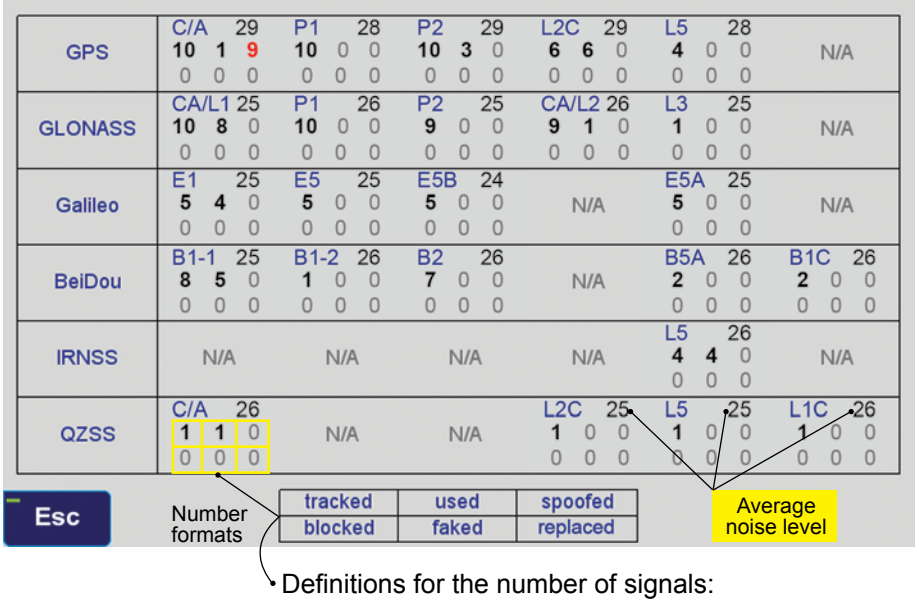
Esc Sat: 11 9 4 5 4 1 1 2 dPos: 17.8m Age: <1s

GPS GLN GAL BDU IRN QZ ◂ Number of satellites used in position calculation

In the above screenshot all GPS satellites have two peaks and all are spoofed. We were able to distinguish the spoofer signal and use the real satellite signals in correct position calculation as indicated by the "*" next to the CNT numbers.

GNSS Overall View

The screenshot below shows the status of all GNSS signals.
The format and the signal definitions are explained below.



GPS L2C: L+M
GLN L3: I+Q
GAL E1: B+C
GAL E5: alboc
GAL E5B: I+Q
GAL E5A: I+Q
BeiDou B2: B5B
QZSS L2C: L+M
QZSS L1C: I+Q

Definitions for the number of signals:

Tracked: Tracked by the tracking channels and has one valid peak only.

Used: Used in position calculation.

Spoofed: Has two peaks. Good peak is isolated, if existed.

Blocked: Blocked by buildings or by jamming. If jammed, shows higher noise level.

Faked: Satellite should not be visible, or such PRN does not exist.

Replaced: Real signal is jammed and a spoofed signal put on top of it. Because of jammer, it shows higher noise level.

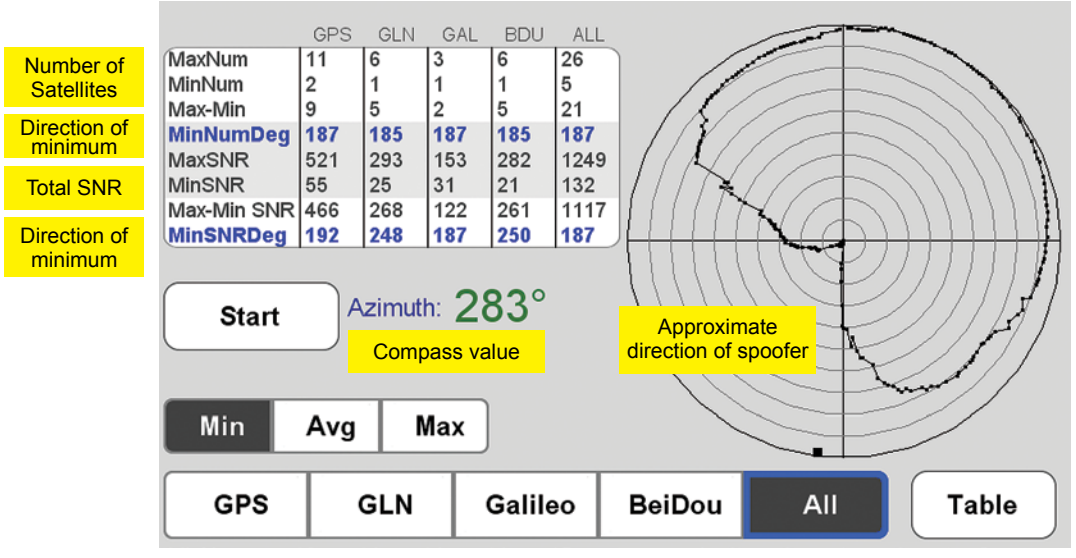
Spoofer detection available in all of our OEM boards too.

See details in GPS World expert opinions section “What is the biggest challenge facing designers of multi-constellation GNSS receivers today?” with Javad Ashjaee and at www.javad.com

Spoofer Orientation

When you detect that spoofers exist, you can also try to find the direction that the spoofing signals are coming from. For this, hold your receiver antenna (e.g. TRIUMPH-LS) horizontally and rotate it slowly (one rotation about 30 seconds) as shown in the picture and find the direction that the satellite energies become minimum. This is the orientation that the spoofer is behind the null point of the antenna reception pattern.

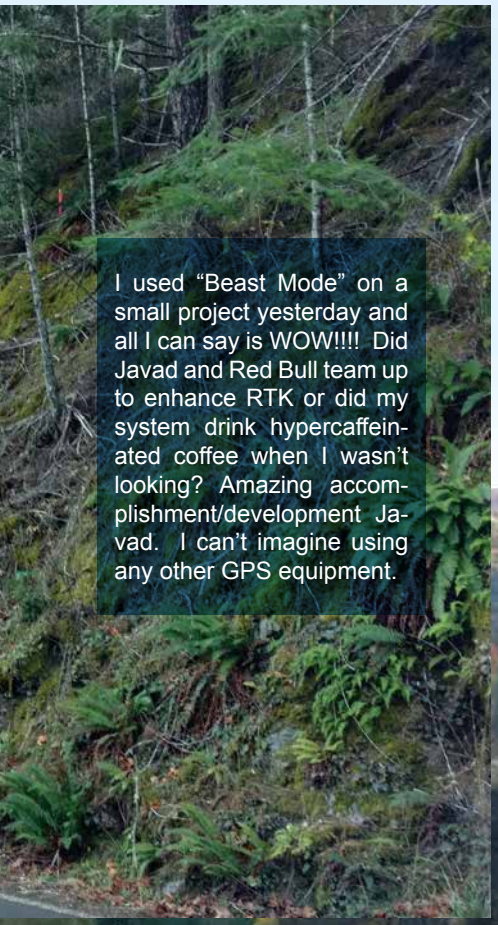
After one or more full rotations observe the resulting graph that shows approximate orientation of the spoofer as shown in figure below.



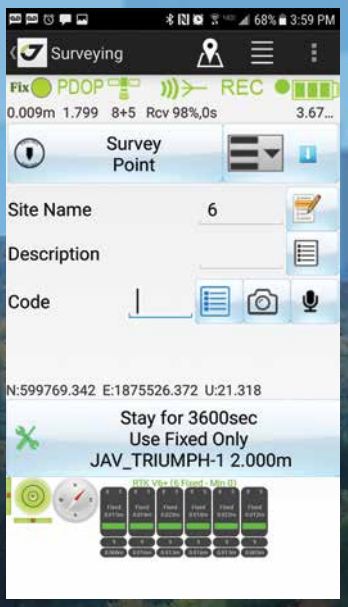
This screenshot is from the experiment within an anechoic chamber. That is why the picture is clean and smooth.

www.javad.com

Javad Mobile Tools (J-Mobile)



I used “Beast Mode” on a small project yesterday and all I can say is WOW!!!! Did Javad and Red Bull team up to enhance RTK or did my system drink hypercaffeinated coffee when I wasn’t looking? Amazing accomplishment/development Javad. I can’t imagine using any other GPS equipment.



Javad Mobile Tools (J-Mobile) is an RTK & static control software app which allows you to connect JAVAD GNSS receivers to Android™ or iPhone/iPad devices. J-Mobile includes a full set of RTK and static survey routines including, data collection (RTK and static), RTK stakeout, CoGo, localization and more.

“I surveyed 20 acres today and never used the total station.”

“Since I got the Javad system, I go places NEVER BEFORE possible, and WITH confidence, because, the quality checks are there.”

“The only bitching now is for the crew that has to take out the Hyper V.”

“Using licensed professionals for development has been a brilliant idea. Tip of the hat to the programmers and designers that put the original box together it appears to me that they knew where they were going with this years ago.”

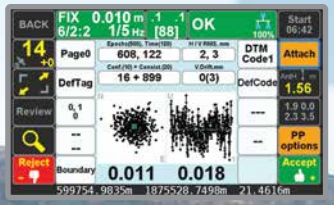
JAVAD

“More than just a ding, an RMS and here’s your answer, trust us. Complete Data Analysis for every shot.”

J-Field Software Features

864 Channels
RTK 6 Pack
BEAST MODE RTK

Only from JAVAD GNSS



Verification & Validation Automatic

Only from JAVAD GNSS

Customer favorite feature #1

Hybrid RTK Another check on the work PPK Solution

Only from JAVAD GNSS

Customer favorite feature #2

RTK Rovers - On a Budget

TRIUMPH-2 Complete RTK Network Rover

$5,680 with Budget Smartphone & JMT

$8,255 with Rugged Victor-LS & J-Field

TRIUMPH-2 Complete RTK UHF Rover

$6,930 with Budget Smartphone & JMT

$8,265 with Rugged Victor-LS & J-Field