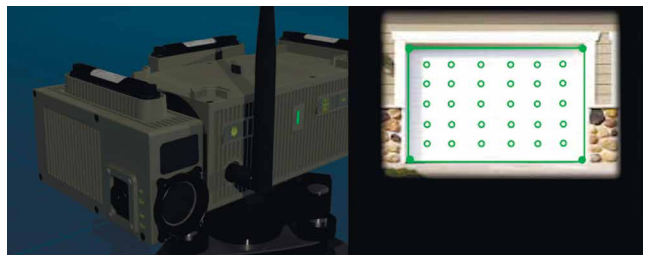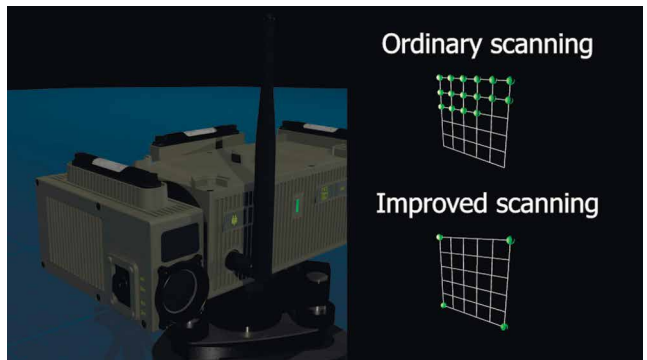# Introducing
J-Mate

Smart laser scanner

J-Mate is also a camera-aided, smart laser scanner. The camera identifies redundant points that do not need to be scanned, but instead can be copied or interpolated from other readings without loss of information. That is, if the camera identifies a completely uniform flat area, it only scans the four corners of that area and interpolates in between. This feature can increase the effective speed of the scanner to much higher than its native 10-points-per-second speed.

The scanning feature can also be used to find items like wires and poles and "closest-in-view" items and shoot them automatically.

We have a "**Total GNSS**" with a "**Robotic Total Station**" and a "**Smart Laser Scanner**". We call it our **"Total Solution"** and it can be operated by one person to perform jobs.

Ordinary scanning

Improved scanning

And all components fit in this small carrying case.

This is **J-Mate**

J-Mate features a **camera** that can also find targets automatically, and a **laser module** for accurate distance measurements. It scans and examines the area around the intended target to ensure reliable identification. Two **precision encoders** measure vertical and horizontal angles to the target. Three **precision vials** allow a visual check on levelness of the instrument.

Take control with J-Mate + TRIUMPH-LS

Similar to using conventional total stations, to use the J-Mate you need first to establish its accurate position and calibrate its vertical and horizontal encoders. Then proceed to shoot the unknown points. This is similar to using any total station, but we have improved and automated the process.
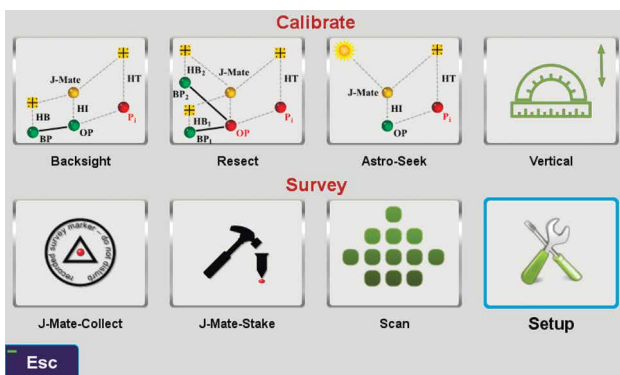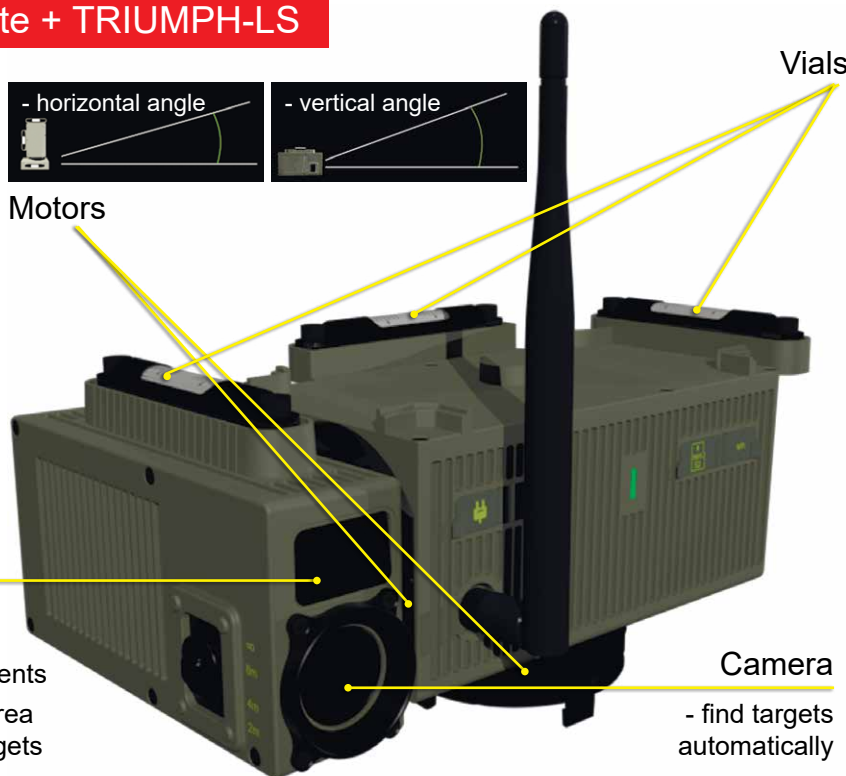
Vials

- horizontal angle
- vertical angle

Motors

Laser

- scanning
- distance measurements
- examine area around targets

Camera

- find targets automatically

Calibrate

Backsight   Resect   Astro-Seek   Vertical

Survey

J-Mate-Collect   J-Mate-Stake   Scan   Setup

Esc

With J-Mate you can establish your occupied position via three different ways: 1) Backsight; 2) Resection; or 3) our new Astro-Seek (more of that later).

When you click the Setup icon of the J-Mate screen you get access to parameters that tunes J-Mate to your desire.

After the J-Mate is calibrated, you can proceed with your work as normal via the Collect or Stake icon.

LIVE video at **www.javad.com**

These are ways that we defend against jammers and spoofers and inform users of details.

J-Shield Filter
and Near Band Interference

J-Shield is a robust filter in our antennas that blocks out-of-band interference. In particular signals that are near the GNSS bands like the LightSquared signals. The graph on the right shows the protection characteristics of our J-Shield filters. It has a sharp 10dB/KHz skirt which provides up to 100 dB of protection. It makes the precious near band spectrums available for other usages and protects GNSS bands now and in the future.
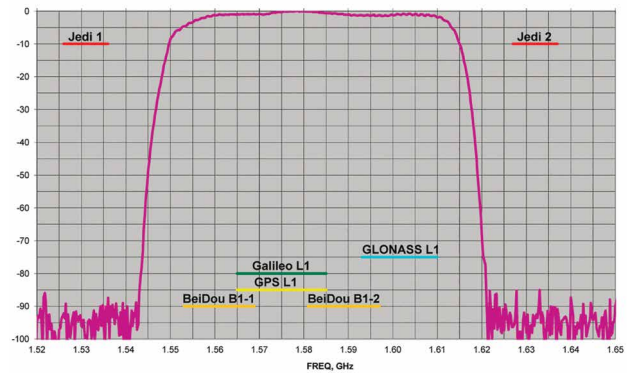
FIR (Digital Filter)
and In-Band Interference

Our In-Band protection digital filter protects against in-band interference like harmonics of TV and radio stations when you get close to them, or against illegitimate in-band transmissions. Our in-band interference protection is based on the 16 adaptive 80th-order filters. AJM-filters can be combined in pairs for complex signal processing. This filter can simultaneously suppress several interference signals.
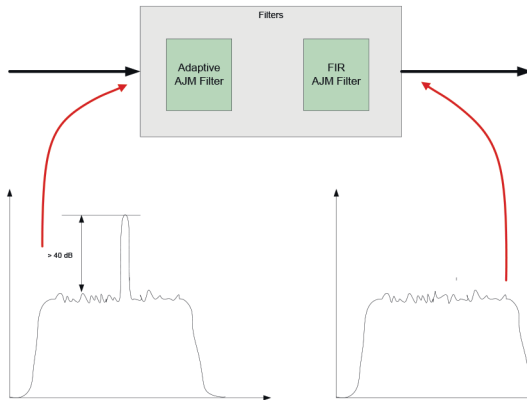
The 16 FIR AJM-filters can be combined in any number in chain. Each filter is a 255 order FIR-filter. It can be used to suppress the stationary interference signal in programmable (in compare with adaptive AJM-filter) area or for spectrum shaping. To have more suppressing areas or more aggressive suppressing one can combine FIR_AJM serial.

In-Band noise
Measurement

This figure-of-merit number shows the level of interference as percentage of noise above the normal condition. The first row of the first screenshot shows the condition in a clean environment. 8 GPS satellites were visible (according to the almanac). 8 C/A, 6 P1, 6 P2, 6 L2c and 2 L5 GPS signals were tracked. The noise level is 2% on C/A and L5, and 0% on P1,P2,and L2C. The screenshot below that, shows 290% noise in GPS C/A and %121 on Galileo E1. Only one of 8 GPS C/A code and none of 5 Galileo E1 signals were tracked. ▶

This typical screenshot shows details of each signal. In the last column (T) indicates the signal was tracked by the main channels, (Q) by the Fast Acquisition Channels and (U) signal was used in position calculations. The SN color coded column shows the signal-to-noise ratio of tracked signals. Blue is perfect, green is 3 dB down, and red is 6 or more dB down. Percentage numbers show the percentage of interference above the normal level. We explain other columns later. ▶

No jammer can escape our figure-of-merit test.

Filters: Adaptive AJM Filter — FIR AJM Filter

> 40 dB

First data grid (clean environment):

	CA	P1	P2	2C	L5	1C
GPS 8	2% — 8 0	0% — 6 0	0% — 6 0	0% — 6 0	2% — 2 0	- — - -
	C1	P1	P2	C2	L3	
GLONASS 9	0% — 9 0	0% — 9 0	0% — 7 0	0% — 8 0	0% — 0 0	N/A
	E1	E5	5B	E6	5A	
Galileo 3	0% — 3 0	- — - -	23% — 3 0	- — - -	2% — 3 0	N/A
	11	12	B2	B3	5A	1C
BeiDou 7	0% — 7 0	0% — 3 0	0% — 7 0	- — - -	1% — 3 0	0% — 3 0
	CA	SF	LX	2C	L5	1C
QZSS 1	- — - -	- — - -	- — - -	0% — 1 0	2% — 1 0	- — - -

Esc | Number formats | tracked | spoofed | View

Second data grid:

	CA	P1	P2	2C	L5	1C
GPS 8	290% — 1 0	0% — 0 0	0% — 0 0	0% — 5 0	2% — 2 0	-
	C1	P1	P2	C2	L3	
GLONASS 9	0% — 9 0	0% — 7 0	0% — 5 0	0% — 8 0	0% — 0 0	N/A
	E1	E5	5B	E6	5A	
Galileo 5	121% — 0 0	- — - -	22% — 5 0	- — - -	2% — 5 0	N/A
	11	12	B2	B3	5A	1C
BeiDou 7	0% — 5 0	60% — 0 0	0% — 7 0	- — - -	2% — 2 0	72% — 0 0
IRNSS 3	N/A	N/A	N/A	N/A	L5 0% — 3 0	N/A
	CA	SF	LX	2C	L5	1C
QZSS 1	-	-	-	-	1% — 1 0	-

Esc | Number formats | tracked | spoofed | View

Detailed signal table:

SAT	EL	SIG	SS	MIN	C1	SS	MAX	C1	NV	SN	Spec	noise	stat
GPS8	52	C/A	--	5.1	--	--	3.3	--	45	--	16.4	136%	
GPS22	13	C/A	--	--	--	--	--	--	4	--	16.4	136%	
GPS13	28	C/A	--	5.5	--	--	6.2	--	4	--	16.4	136%	
GPS32	49	C/A	--	18.0	--	--	4.1	--	42	44	16.4	136%	T
GPS28	16	C/A	--	5.1	--	--	4.0	--	4	41	16.4	136%	T
GPS27	35	C/A	--	--	--	--	--	--	45	--	16.4	136%	
GPS24	16	C/A	--	6.0	--	--	4.2	--	42	46	16.4	136%	T
GPS18	45	C/A	--	17.7	--	--	4.1	--	4	46	16.4	136%	T
GPS14	28	C/A	--	5.0	--	--	3.7	--	4	39	16.4	136%	T
GPS11	33	C/A	--	8.3	--	--	3.7	--	4	41	16.4	136%	T
GPS10	61	C/A	--	30.0	--	--	3.8	--	42	48	16.4	136%	T
GPS1	21	C/A	--	6.2	--	--	3.6	--	42	40	16.4	136%	T
GPS20	20	C/A	--	8.4	--	--	3.7	--	4	40	16.4	136%	T
GPS24	16	L2c	16.5	5.0	86	2.5	3.5	0	0	47	8.1	0%	QT
GPS32	49	L2c	21.9	12.5	174	2.9	3.5	0	0	49	8.1	0%	QT
GPS27	35	L2c	--	--	--	--	--	--	42	31	8.1	0%	TU
GPS10	61	L2c	13.8	12.5	174	2.5	3.5	0	0	47	8.1	0%	QT
GPS8	52	L2c	--	5.0	--	--	3.3	--	45	--	8.1	0%	

Esc | Last Reset: 25m15s 2+0+0+0+0=2 | 1 | 2 | dPos: No Ref. | Age: <1s | Reset

Spectrum Shape

We have a very powerful spectrum analyzer within our GNSS TRIUMPH chip. Each spectrum shows the power and the shape of the interfering signals and jammers. This is more powerful and more efficient than having a $30,000 commercial spectrum analyzer to evaluate the environment. The screenshot on the right shows the shape of the GPS L1 band spectrum when the band is not jammed. The GPS C/A code peak at the 2-MHz center of the L1 band is visible. ▶

The height of the spectrum is 11.2 dB.

This is an example of GPS L1 spectrum with a commercial $30,000 spectrum analyzer. ▶

Our integrated spectrum analyzer has the advantage that it monitors the spectrum inside the chip where it matters. It has effective bandwidth of 1 KHz.

Our embedded spectrum analyzer also has the advantage that it can be programmed to automatically record the spectrum (and other information) periodically or according to the set conditions, and monitor the environment continuously.

This is the spectrum example of a GPS L1 band when it is jammed. There is a huge peak in the center where the C/A code is. The number on the bottom left is the height of the peak. ▶

The height of the spectrum is 21.1 dB, which compared to the calm 11.2 dB, indicates about 10dB of jammer.

Although we label the bands as three GPS and 3 GLONASS bands, but they represent all bands of all GNSS signals, because bands are shared by all GNSS signals.
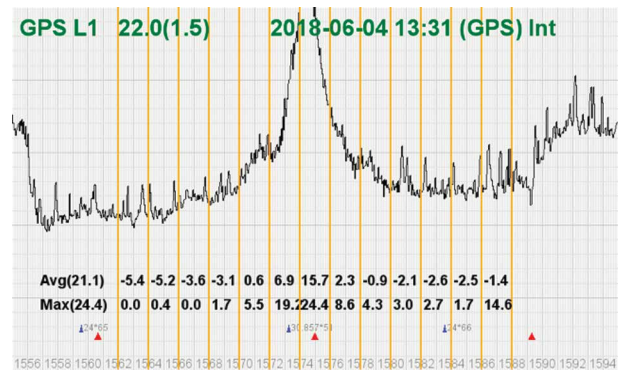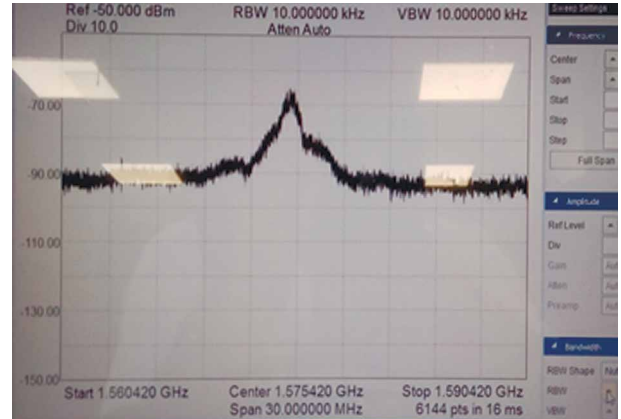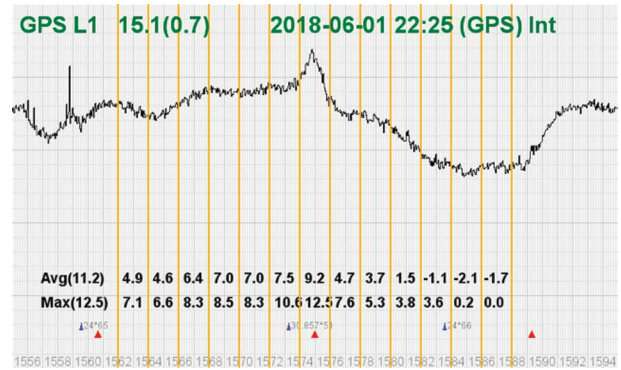
AGC
Automatic Gain Control

In addition to the spectrum, we also keep record of Automatic Gain Control which is another indicator of external signals. ▶

The AGC monitors the environment and adjusts the gain to keep the voltage at a certain level. The change in AGC is an indicator of interference existence.

The narrow orange line in the middle of the band in this screenshot shows a quiet AGC.

AGC in this screenshot shows there are activities in this band which our AGC was able to defend against it. ▶

We believe it could be harmonics of GSM cellular phone near our site.

Our AGC mitigates the effect of such interference completely.
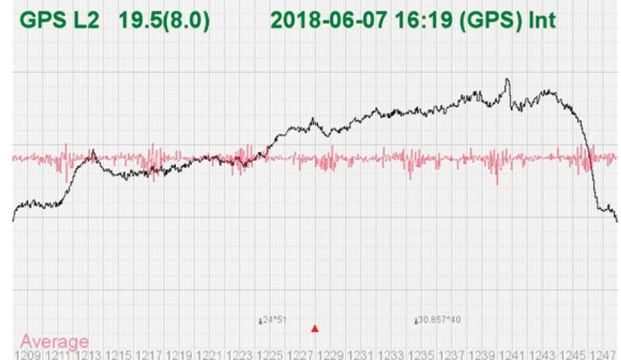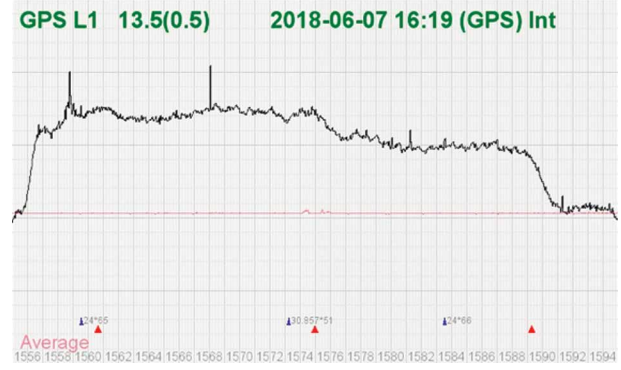
Spoofers & 2 Peaks

Spoofers are quite different from jammers. They don't disturb the environment and the spectrum shape. They broadcast a GNSS-like signal to fool the GNSS receivers to calculate wrong positions.

In the top screenshot 10 GPS satellites were visible (according to the Almanac). 6 of the 9 GPS satellites that we tracked were spoofed, as indicated by the red number, while the noise level was 0% in the GPS C/A band.

In the second screenshot, 5 of the 6 GPS C/A signals were spoofed while the noise in the band was only 2%.

We detect spoofers by digital signal processing. With 864 channels and about 130,000 Quick Acquisition Channels 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 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 spoofer signals. Figure on the right is an example of two peaks. We isolate and ignore the wrong peak.

The screenshot on the right shows details of each signal. The first six lines in this screenshot show the spoofed signals that we detected as soon as they appeared (numbers "1" in those line). The two section columns represents the characteristics of each peak. Second SS column show if the second peak is a consistent signal.

While six satellites were spoofed, there was no indication on the noise level (0%) and no indication on the spectrum shape and level as shown on the screenshot on the right below the chart.
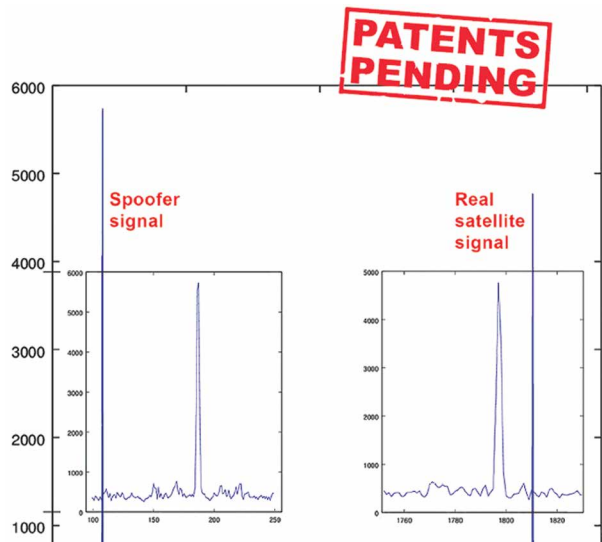
If the spoofer strategy is to cover the real satellite signal and then put the fake signal on top of it to produce only one peak, we notice that by more that 200% of noise level that it has to introduce.

We reject infected signals and then among all the available GPS, GLONASS, Galileo, BeiDou, IRNSS and QZSS multiple signals we use the healthy ones.
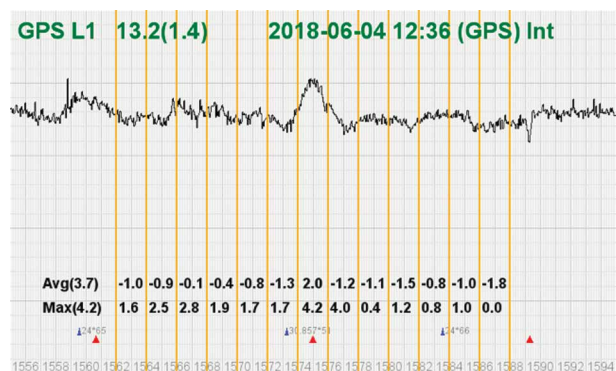
Usually there are over 100 signals available at any given time, and we need only four good signals to compute position. In rare cases that all signals are affected, we inform the user and guide them to use compass and altimeter to get out of the Jammed area.

There is absolutely no way that we can be spoofed without our knowledge. We will immediately recognize and take corrective action.

Jamming and Spoofing protection option is available in all of our products and OEM Boards.

SAT	EL	SIG	SS MIN	C1	SS MAX	C1	NV	SN	Spec	noise	stat
GPS3	44	C/A	36.5 31.3	83	24.2 24.2	1	42	53	11.0	0%	QTS
GPS6	38	C/A	23.4 23.4	83	22.3 22.3	1	42	49	11.0	0%	QTS
GPS9	54	C/A	24.4 5.3	83	23.1 23.1	1	42	46	11.0	0%	QTS
GPS16	23	C/A	23.4 8.0	83	7.9 7.9	1	4	41	11.0	0%	QTS
GPS22	21	C/A	23.4 7.2	83	9.6 9.6	1	4	43	11.0	0%	QTS
GPS23	85	C/A	33.9 33.9	83	23.8 23.8	1	4	51	11.0	0%	QTS
GPS26	29	C/A	22.0 13.1	83	2.2 3.2	0	0	48	11.0	0%	QTU
GPS31	11	C/A	16.9 5.6	11	2.2 3.2	0	0	48	11.0	0%	QTU
GPS7	13	C/A	-- --	--	-- --	--	4	--	11.0	0%	
GPS2	19	C/A	20.6 5.7	83	4.0 4.0	0	0	37	11.0	0%	QTU
GPS3	44	L2c	32.9 13.9	82	2.9 3.3	0	0	51	9.1	0%	QT
GPS7	12	L2c	-- --	--	-- --	--	4	--	9.1	0%	
GPS31	11	L2c	-- 5.1	--	-- 3.1	--	0	38	9.1	0%	T
GPS26	29	L2c	10.4 8.2	82	2.7 3.2	0	0	45	9.1	0%	QT
GPS9	54	L2c	14.3 5.0	35	3.0 3.3	0	0	46	9.1	0%	QT
GPS6	38	L2c	26.6 17.6	82	3.5 3.5	0	0	50	9.1	0%	QT
GPS3	44	L5	22.8 11.9	82	2.5 3.4	0	0	54	3.3	4%	QT
GPS6	38	L5	51.0 22.7	82	2.8 3.3	0	0	57	3.3	4%	QT

Esc | Last Reset: 12m34s 3+0+0+0+0=3 | [1] [2] | dPos: No Ref. | Age: <1s | Reset

GPS L1 13.2(1.4)   2018-06-04 12:36 (GPS) Int

Avg(3.7) -1.0 -0.9 -0.1 -0.4 -0.8 -1.3 2.0 -1.2 -1.1 -1.5 -0.8 -1.0 -1.8
Max(4.2) 1.6 2.5 2.8 1.9 1.7 1.7 4.2 4.0 0.4 1.2 0.8 1.0 0.0

And Examples of when the world is peaceful.

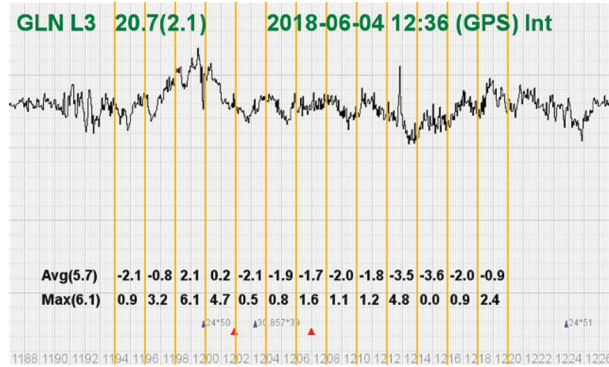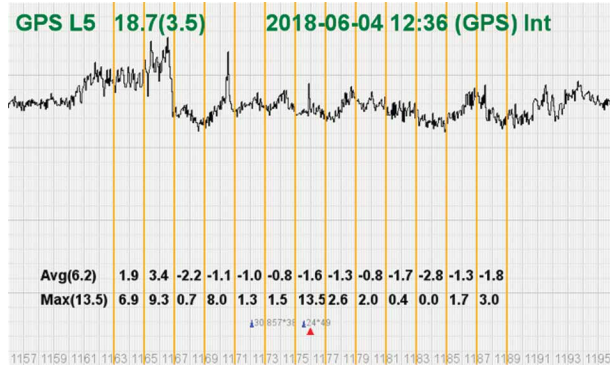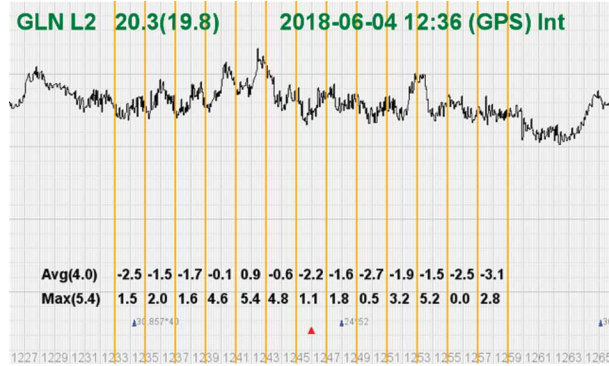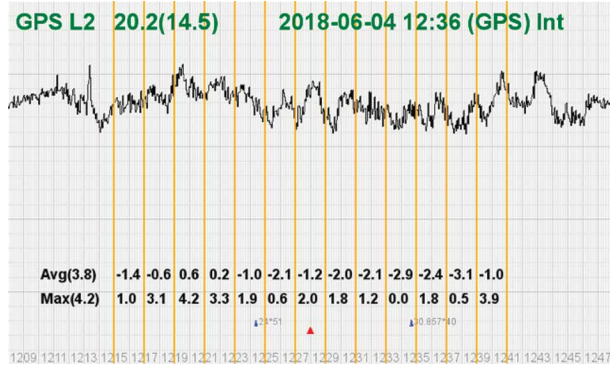Jamming and Spoofing protection option is available in all of our products and OEM Boards.

All screenshots are from our TRIUMPH-LS Receiver.

GPS 8	CA 2%	8 0	P1 0%	6 0	P2 0%	6 0	2C 0%	6 0	L5 2%	2 0	1C --- ---
GLONASS 9	C1 0%	9 0	P1 0%	9 0	P2 0%	7 0	C2 0%	8 0	L3 0%	0 0	N/A
Galileo 3	E1 0%	3 0	E5 -	--- ---	5B 23%	3 0	E6 -	--- ---	5A 2%	3 0	N/A
BeiDou 7	11 0%	7 0	12 0%	3 0	B2 0%	7 0	B3 -	--- ---	5A 1%	3 0	1C 0% 3 0

QZSS 1	CA -	--- ---	SF -	--- ---	LX -	--- ---	2C 0%	1 0	L5 2%	1 0	1C --- ---

Esc ⚙ Number formats [tracked] [spoofed] View⁺

GPS L1 13.2(1.4)   2018-06-04 12:36 (GPS) Int

Avg(3.7)	-1.0	-0.9	-0.1	-0.4	-0.8	-1.3	2.0	-1.2	-1.1	-1.5	-0.8	-1.0	-1.8
Max(4.2)	1.6	2.5	2.8	1.9	1.7	1.7	4.2	4.0	0.4	1.2	0.8	1.0	0.0

1556 1558 1560 1562 1564 1566 1568 1570 1572 1574 1576 1578 1580 1582 1584 1586 1588 1590 1592 1594

GLN L1 13.5(0.9)   2018-06-04 12:36 (GPS) Int

Avg(2.3)	-1.1	0.2	0.1	0.3	-0.3	-0.2	0.1	-0.1	-1.7	-1.9	-2.0	-1.8	-1.4
Max(7.0)	1.5	1.8	7.0	6.0	1.6	2.2	1.8	1.8	0.5	0.0	0.1	0.2	0.5

1583 1585 1587 1589 1591 1593 1595 1597 1599 1601 1603 1605 1607 1609 1611 1613 1615 1617 1619 1621

GPS L2 20.2(14.5)   2018-06-04 12:36 (GPS) Int

Avg(3.8)	-1.4	-0.6	0.6	0.2	-1.0	-2.1	-1.2	-2.0	-2.1	-2.9	-2.4	-3.1	-1.0
Max(4.2)	1.0	3.1	4.2	3.3	1.9	0.6	2.0	1.8	1.2	0.0	1.8	0.5	3.9

1209 1211 1213 1215 1217 1219 1221 1223 1225 1227 1229 1231 1233 1235 1237 1239 1241 1243 1245 1247

GLN L2 20.3(19.8)   2018-06-04 12:36 (GPS) Int

Avg(4.0)	-2.5	-1.5	-1.7	-0.1	0.9	-0.6	-2.2	-1.6	-2.7	-1.9	-1.5	-2.5	-3.1
Max(5.4)	1.5	2.0	1.6	4.6	5.4	4.8	1.1	1.8	0.5	3.2	5.2	0.0	2.8

1227 1229 1231 1233 1235 1237 1239 1241 1243 1245 1247 1249 1251 1253 1255 1257 1259 1261 1263 1265

GPS L5 18.7(3.5)   2018-06-04 12:36 (GPS) Int

Avg(6.2)	1.9	3.4	-2.2	-1.1	-1.0	-0.8	-1.6	-1.3	-0.8	-1.7	-2.8	-1.3	-1.8
Max(13.5)	6.9	9.3	0.7	8.0	1.3	1.5	13.5	2.6	2.0	0.4	0.0	1.7	3.0

1157 1159 1161 1163 1165 1167 1169 1171 1173 1175 1177 1179 1181 1183 1185 1187 1189 1191 1193 1195

GLN L3 20.7(2.1)   2018-06-04 12:36 (GPS) Int

Avg(5.7)	-2.1	-0.8	2.1	0.2	-2.1	-1.9	-1.7	-2.0	-1.8	-3.5	-3.6	-2.0	-0.9
Max(6.1)	0.9	3.2	6.1	4.7	0.5	0.8	1.6	1.1	1.2	4.8	0.0	0.9	2.4

1188 1190 1192 1194 1196 1198 1200 1202 1204 1206 1208 1210 1212 1214 1216 1218 1220 1222 1224 1226

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.

	GPS	GLN	GAL	BDU	ALL
MaxNum	11	6	3	6	26
MinNum	2	1	1	1	5
Max-Min	9	5	2	5	21
MinNumDeg	187	185	187	185	187
MaxSNR	521	293	153	282	1249
MinSNR	55	25	31	21	132
Max-Min SNR	466	268	122	261	1117
MinSNRDeg	192	248	187	250	187

Start

Azimuth: **283°**
Compass value

Approximate direction of spoofer

Esc [GPS] [GLN] [Galileo] [BeiDou] [**All**]
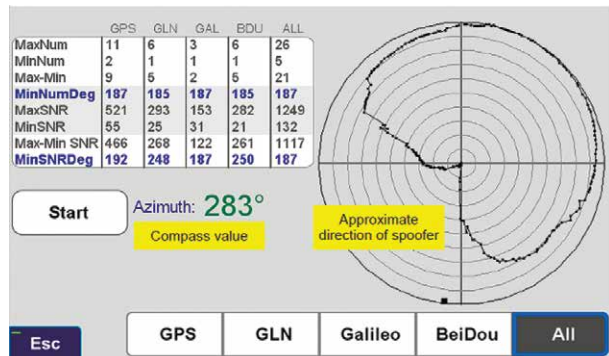
Backsight icon

If GNSS signals are available at the job site, click the J-Mate Backsight icon.
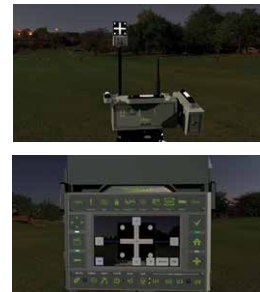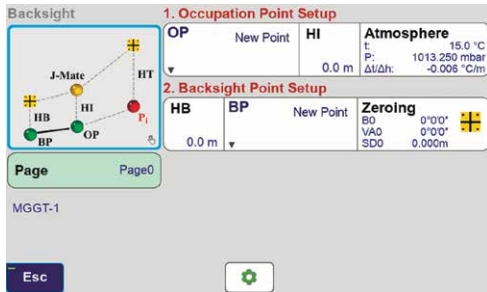
This screen appears which guides you to determine the accurate positions of the Occupation Point and the Backsight Point, to establish an azimuth and calibrate the J-Mate angular encoders.
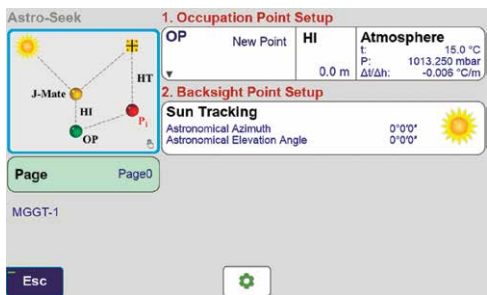
Resect icon

If GNSS signals are not available at the Occupation Point, click the "J-Mate-Resect" icon
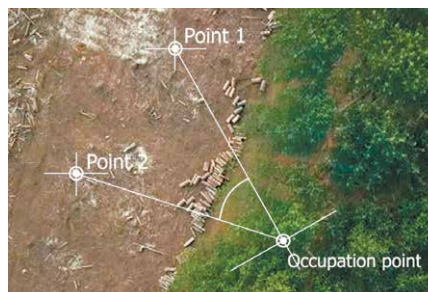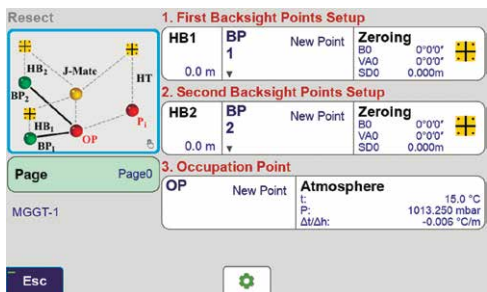
Shoot two or more known points to establish an accurate position and calibrate the encoders. Then continue to shoot the unknown points.

Astro-Seek icon
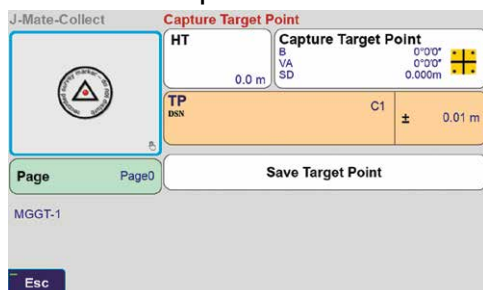
And now our new feature!

We have added a new innovative feature to the J-Mate that it can automatically calibrate itself via its automatic Sun or other astronomical objects-Seeking feature.

J-Mate-Collect

After calibration is performed, click the J-Mate-Collect icon to shoot the unknown points.

J-Mate-Stake

Click the J-Mate-Stake icon to use for stakeout.

The functions and features of the J-Mate stakeout are very similar to our conventional GNSS stakeout: RTK solutions guide you to the stake points. But with the J-Mate the camera follows the "+" sign that you carry and then the encoders and laser measurements (shown on screenshots) provide guidance to the stakeout features. This is similar to Visual Stakeout and other useful and innovative features of our TRIUMPH-LS GNSS RTK stakeout.

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Linux Operating System

Now Available for the TRIUMPH-LS

Javad GNSS has enhanced and improved the capabilities and performance of the TRIUMPH-LS by creating a customized Linux operating system to replace the existing Windows CE operating system of the TRIUMPH-LS. Some of the noticeable benefits of this Linux Yocto Project operating system include:

- **Decreased startup and boot time**
- **Improved stability and general performance**
- **Improved WiFi, Bluetooth and cellular modem connectivity**
- **Improved database speed**
- **SSH connections for advanced remote support**
- **Improved camera performance**

Like always, this software update and all software and firmware updates are free to all owners of a TRIUMPH-LS and can easily be installed. The installation process of software and firmware updates only requires an internet connection to the receiver. More information can be found about this and other exciting topics on the Javad GNSS Support Forum at **http://support.javad.com**.