SOMAT XR

# EGPS-200

## Precision GPS Module

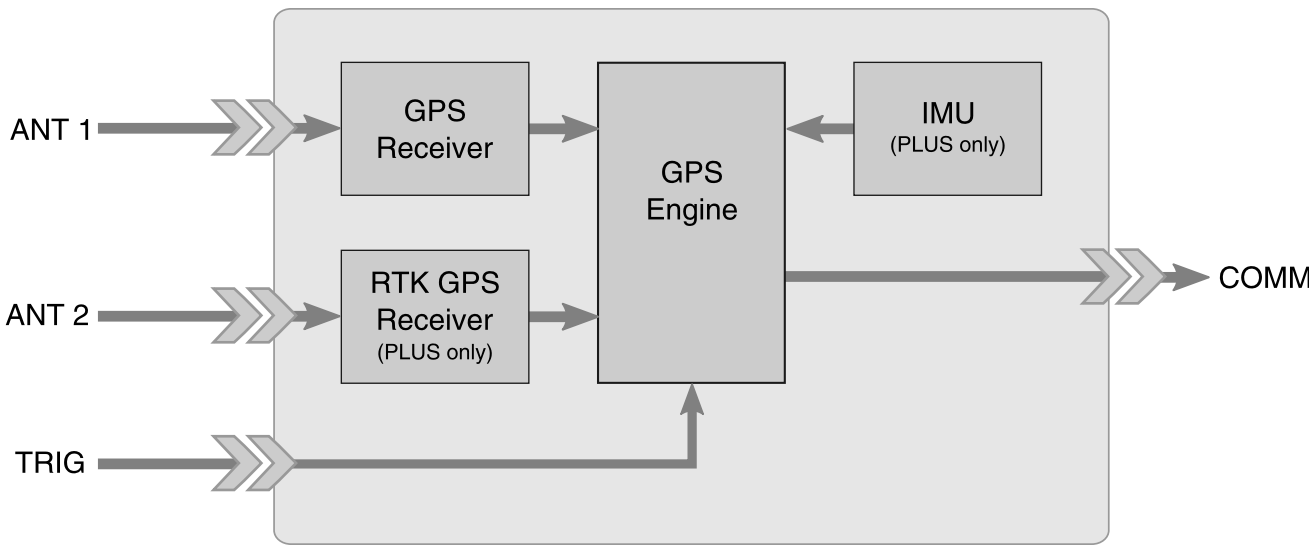
1-EGPS-200-P-2 shown

### Special Features

- **High-accuracy speed output with update rate of 200Hz**
- **22 base measurement channels**
- **PLUS package with RTK and IMU options provides additional channels and accuracy**
- **Rugged environmental protection to IP67 standard**
- **Integrated trigger input to synchronize measurements with external events**

Data sheet

### Block diagram




**NOTE**
A double-arrowhead symbol in the diagram represents male and female connectors only, not power polarity or input/output direction.

## Detailed Description

The Precision GPS Receiver (EGPS-200) is designed for non-contact speed measurements in professional vehicle testing applications such as braking, acceleration and general vehicle dynamics. This module combines data from GPS and inertial sensors to provide a robust 200Hz update rate for maximum reliability and accuracy, even in areas with short interruptions in GPS reception. The EGPS-200 combines GPS and accelerometer data, so it outperforms devices dependent on GPS or survey grade receivers that emphasize absolute position, rather than speed.

EGPS-200 Base and PLUS packages are available. Both modules provide 22 possible channels including speed, absolute position, three-axis instantaneous acceleration, number of satellites and date and time information. Both modules have an input trigger channel through the TRIG input connector, for synchronizing data values with external events such as brake pedal depression or passing a marker point.

The PLUS package provides all the channels of the base model plus IMU (inertial measurement unit) and RTK (real time kinematic) measurements. The IMU option improves acceleration accuracy and completes the six degrees of freedom measurements by adding axis rotation (roll, pitch and yaw). The RTK option uses readings from two GPS antennas to output high-accuracy yaw, pitch and slip angle measurements. The PLUS module directly measures the yaw and pitch at any time, while slip angle calculations are made only when a vehicle is in motion.

The modules are engineered to operate from -20 to +65 °C. They are sealed for an IP67 protection class rating. Each module has four mounting holes for secure attachment to a test object.

The EGPS-200 modules are supported by the eDAQ ECOM layer (with ECO-1666 applied for compatibility with the EGPS-200), the eDAQlite ELCOM layer, the CX23-R, the eDAQXR CPU and the eDAQXR-lite CPU. The GPS connector on these devices powers the EPGS-200 module with 12 Vdc, at about 2.4 W. On boot up of the CX23-R, eDAQXR or eDAQXR-lite, GPS power output is always set to 5 Vdc. With the power option set to 5 Vdc, the modules operate in a minimal mode that is sufficient to send a message to the processor, allowing the processor to identify the module. When the processor receives this message, it switches to the 12 Vdc power mode.

## Ordering options, accessories and cables (Order Separately)

| Order No. | Description |
|---|---|
| 1-EGPS-200-B-2 | Precision GPS receiver, Includes (1) Trigger Cable (1-SAC-GPSTRIG-2) and (1) GPS Antenna (1-EGPS-200-ANT-2) To connect to an eDAQ or eDAQlite COM layer, or an eDAQXR or eDAQXR-lite CPU, please also order an SAC-EXT-MF cable. To connect to the SomatXR CX23-R please also order a KAB2102 cable. |
| 1-EGPS-200-P-2 | Precision GPS receiver PLUS Package - IMU and RTK Measurements, Includes (1) Trigger Cable (1-SAC-GPSTRIG-2), (2) GPS Antennas (1-EGPS-200-ANT-2) and (1) Dual Antenna Template (1-EGPS-200-TEM-2). To connect to an eDAQ or eDAQlite COM layer, or an eDAQXR or eDAQXR-lite CPU, please also order an SAC-EXT-MF cable. To connect to the SomatXR CX23-R please also order a KAB2102 cable. |
| 1-EGPS-200-ANT-2 | EGPS-200 GPS Antenna |
| 1-EGPS-200-TEM-2 | EGPS-200 Dual Antenna Template - RTK, Required for EGPS-200 PLUS Package |
| 1-SAC-GPSTRIG-2 | EGPS-200 Trigger Cable, TNC Male to Pigtail - 2 Meters Length |
| 1-SAC-EXT-MF-0.4-2 | Extension Cable - Male/Female Connectors - 0.4 Meters Length |
| 1-SAC-EXT-MF-2-2 | Extension Cable - Male/Female Connectors - 2 Meters Length |
| 1-SAC-EXT-MF-5-2 | Extension Cable - Male/Female Connectors - 5 Meters Length |
| 1-SAC-EXT-MF-10-2 | Extension Cable - Male/Female Connectors - 10 Meters Length |
| 1-SAC-EXT-MF-15-2 | Extension Cable - Male/Female Connectors - 15 Meters Length |

1-EGPS-200-P-2 (ANT1, ANT2) shown

1-EGPS-200-B-2 (ANT1) shown

Common Trigger connector and TNC connector

## Specifications

| Parameter | Unit | Value |
|---|---|---|
| Dimensions (including connector), width x length x height | mm | 135 x 215 x 40 |
| Weight | kg [lb] | 1.4 [3.0] |
| Operating temperature range | °C [°F] | -20 ... +65 [-4 ... +149] |
| Storage temperature range | °C [°F] | -20 ... +65 [-4 ... +149] |
| Input power | W [V] | 2.4 [12] |
| Combined speed | - | - |
| accuracy [1)] | km/h | ±0.05 |
| update rate | Hz | 200 |
| maximum | m/s | 514 |
| minimum | km/h | 0.01 |
| resolution | km/h | 0.01 |
| Absolute position | - | - |
| accuracy (95% CEP) [1) 2)] | m | ±3 |
| altitude accuracy | m | ±6 |
| update rate | Hz | 20 |
| resolution | ° | $1 \times 10^{-7}$ |
| Heading | - | - |
| accuracy (at 10 m/s) | ° | 0.05 |
| resolution | ° | $1 \times 10^{-5}$ |
| Acceleration | - | - |
| accuracy | % of full scale | 0.5 |
| update rate | Hz | 200 |
| maximum (Base, 1-EGPS-200-B-2) | *g* | ±2 |
| maximum (Plus, 1-EGPS-200-P-2) | *g* | ±6 |
| resolution | *g* | 0.01 |

[1)] GPS velocity can be calculated far more accurately than GPS position data, since it is calculated using advanced techniques such as measuring changes in carrier frequency cycles from the satellites used to carry the raw GPS data. It is impossible to quote absolute positional accuracies of GPS systems simply because accuracy depends on time of day, satellite coverage, weather, antenna mounting, tree and building coverage, etc. The specifications provided represent typical real-world performance.

[2)]95% CEP (circle of error probable) indicates that 95% of position readings will fall within a circle of the stated diameter.

## Standards

| Category | Standard | Description |
|---|---|---|
| Environmental | IP67 | Dust tight, immersion up to 1 m |
| Radiated emissions and susceptibility | EN 61326-1:2006 | |

## Base channels

| Channel | Units | Range | Description | Update Rate |
|---|---|---|---|---|
| trigger | - | 0 or 1 | Current state of the trigger input (via TRIG connector). | 200Hz |
| latitude | ° | -90 ... +90 | Standard earth latitude position measurement. | 20Hz |
| longitude | ° | -180 ... +180 | Standard earth longitude position measurement. | 20Hz |
| altitude | m | -10000 ... +10000 | Standard altitude measurement, per WGS 84 ellipsoid (mean sea level). | 20Hz |
| speed_3d | km/h | 0 ... 1852 | Combined speed generated using raw speed and accelerometer channels. | 200Hz |
| speed_raw2d | km/h | 0 ... 1852 | 2-D raw speed channel for testing on flat ground. | 20Hz |
| speed_raw3d | km/h | 0 ... 1852 | 3-D raw speed channel for testing over elevation changes. | 20Hz |
| heading | ° | 0 ... 360 | Heading reference. | 20Hz |
| gradient | ° | -90 ... +90 | Angle of orientation with respect to the horizontal reference plane. | 20Hz |
| accel_x | *g* | -6 ... +6 | Instantaneous acceleration measurement for the x component. | 200Hz |
| accel_y | *g* | -6 ... +6 | Instantaneous acceleration measurement for the y component. | 200Hz |
| accel_z | *g* | -6 ... +6 | Instantaneous acceleration measurement for the z component. | 200Hz |
| year | - | 1998 ... 2038 | Current year. | automatic |
| month | - | 1 ... 12 | Current calendar month. | automatic |
| day | - | 1 ... 31 | Current day of the month. | automatic |
| hour | - | 0 ... 23 | Current hour of the day. | automatic |
| minute | - | 0 ... 59 | Current minute. | automatic |
| second | - | 0 ... 60[3)] | Current second. | automatic |
| nsec | - | 0 ... 1 x $10^9$ | Current nanosecond. | selectable |
| nsat | - | 0 ... 255 | Current total number of satellites in view. | 20Hz |
| fix_quality | - | 0, 1, 20 or 30 | Quality of the GPS fix and speed channels data. | 20Hz |
| - | - | - | 0: Inadequate for GPS location, inadequate for speed | - |
| - | - | - | 1: Adequate for nominal GPS location, inadequate for speed | - |
| - | - | - | 20: Adequate for GPS location, adequate (but not optimal) for speed | - |
| - | - | - | 30: Optimal for GPS location, optimal for speed | - |
| faa_mode | - | A (65) or N (78) | Quality of the GPS fix. | 20Hz |
| - | - | - | A: Inadequate for determination of nominal GPS location fixes | - |
| - | - | - | N: Not adequate for determination of GPS location fixes | - |

[3)] A second value of 60 indicates the occurrence of a leap second.

## IMU Specifications (PLUS only, 1-EGPS-200-P-2)

| Parameter | Units | Value |
|---|---|---|
| Gyroscope sensitivity (per axis) | - | - |
| typical initial sensitivity (dynamic range = ±300 °/s, 25 °C) | °/s/LSB | 0.07326 |
| minimum initial sensitivity (dynamic range = ±300 °/s, 25 °C) | °/s/LSB | 0.0725 |
| maximum initial sensitivity (dynamic range = ±300 °/s, 25 °C) | °/s/LSB | 0.0740 |
| typical initial sensitivity (dynamic range = ±150 °/s, 25 °C) | °/s/LSB | 0.03663 |
| typical initial sensitivity (dynamic range = ±75 °/s, 25 °C) | °/s/LSB | 0.01832 |
| temperature coefficient | ppm/°C | 40 |
| axis nonorthogonality (difference from 90° ideal, 25 °C) | ° | ±0.05 |
| axis misalignment (relative to base plate and guide pins, 25 °C) | ° | ±0.5 |
| nonlinearity (best fit straight line) | % of full scale | 0.1 |
| Gyroscope bias | - | - |
| in run bias stability (1 standard deviation, 25 °C) | °/s | 0.015 |
| angular random walk (25 °C) | °/√h | 4.2 |
| temperature coefficient | °/s/°C | 0.01 |
| linear acceleration effect (any axis, 1 standard deviation) | °/s/*g* | 0.05 |
| Gyroscope noise performance (25 °C) | - | - |
| output noise (±300 °/s range, 2-tap filter setting) | °/s rms | 0.60 |
| output noise (±150 °/s range, 8-tap filter setting) | °/s rms | 0.35 |
| output noise (±75 °/s range, 32-tap filter setting) | °/s rms | 0.17 |
| rate noise density (f=25 Hz, ±300 °/s, no filtering) | °/s/√Hz rms | 0.05 |
| Gyroscope frequency response | - | - |
| 3 dB bandwidth | Hz | 350 |
| sensor resonant frequency | kHz | 14 |
| Accelerometer sensitivity | - | - |
| typical dynamic range | *g* | ±10 |
| minimum dynamic range | *g* | ±8 |
| typical initial sensitivity (25 °C) | m*g* /LSB | 2.522 |
| minimum initial sensitivity (25 °C) | m*g* /LSB | 2.471 |
| maximum initial sensitivity (25 °C) | m*g* /LSB | 2.572 |
| temperature coefficient | ppm/°C | 40 |
| axis nonorthogonality (difference from 90° ideal, 25 °C) | ° | ±0.25 |
| axis misalignment (relative to base plate and guide pins, 25 °C) | ° | ±0.5 |
| nonlinearity (best fit straight line) | % of full scale | ±0.2 |
| Accelerometer bias | - | - |
| in run bias stability (1 standard deviation, 25 °C) | m*g* | 0.7 |
| velocity random walk (25 °C) | m/s/√h | 2.0 |
| temperature coefficient | m*g* /°C | 0.5 |
| Accelerometer noise performance (25 °C, no filtering) | - | - |
| output noise | m*g* rms | 35 |
| noise density | m*g* /√Hz rms | 1.85 |
| Accelerometer frequency response | - | - |
| 3 dB bandwidth | Hz | 350 |
| sensor resonant frequency | kHz | 10 |

## PLUS Package Channels

The following channels are only available with the PLUS package (1-EGPS-200-P-2). In addition, the base three-axis acceleration channels accel_x, accel_y and accel_z are derived from the higher accuracy IMU measurements.

| Channel | Description | Units | Update Rate |
|---|---|---|---|
| yaw_rate | Angular velocity about the yaw axis. | °/s | 200Hz |
| pitch_rate | Angular velocity about the pitch axis. | °/s | 200Hz |
| roll_rate | Angular velocity about the roll axis. | °/s | 200Hz |
| rtk_yaw | Angular position about the yaw axis.[4)] | ° | 20Hz |
| rtk_pitch | Angular position about the pitch axis. | ° | 20Hz |
| rtk_baseline | Distance between RTK antennas (should be near 800 mm). | mm | 20Hz |
| rtk_accuracy | Expected accuracy of rtk_yaw and rtk_pitch channel data. | mm | 20Hz |

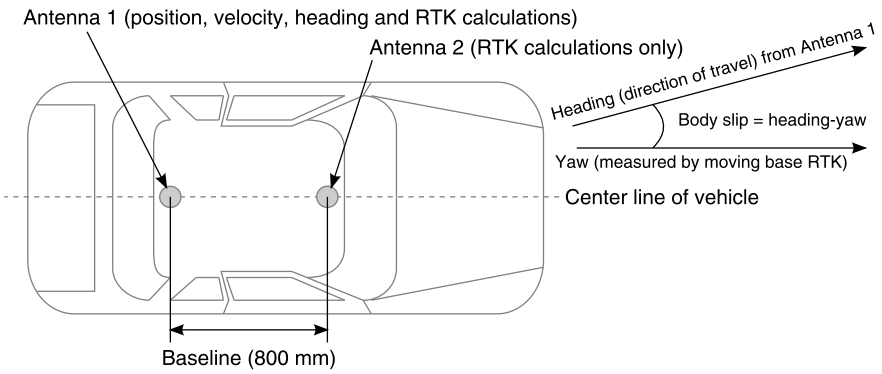
[4)] Slip angle can be calculated as heading minus yaw angle.

## Antennae and unit installation

To obtain maximum EGPS-200 data accuracy and integrity, it is essential that the GPS antennae and the EGPS-200 unit be properly mounted in the test vehicle. The EGPS-200 units require a 3.3V active antenna which must be mounted in a position giving a good view of the sky. The antennae (1-EGPS-200-ANT-2) supplied with the EGPS-200 unit are adequate for most EGPS-200 testing applications. However, for the most demanding applications, the user may want to consider procuring the highest quality antennae available. These are typically larger in size (and typically quite expensive).

**EGPS-200 (1-EGPS-200-B-2) Base unit:** The single antenna lead is connected to the ANT connector. Mounting the antenna on the top of the vehicle is recommended. The user should be careful not to crush the antenna lead – for example when a vehicle window or door is closed.

**EGPS-200 (1-EGPS-200-P-2) Plus unit:** Following is a diagram that illustrates the recommended antennae mounting on a test vehicle.

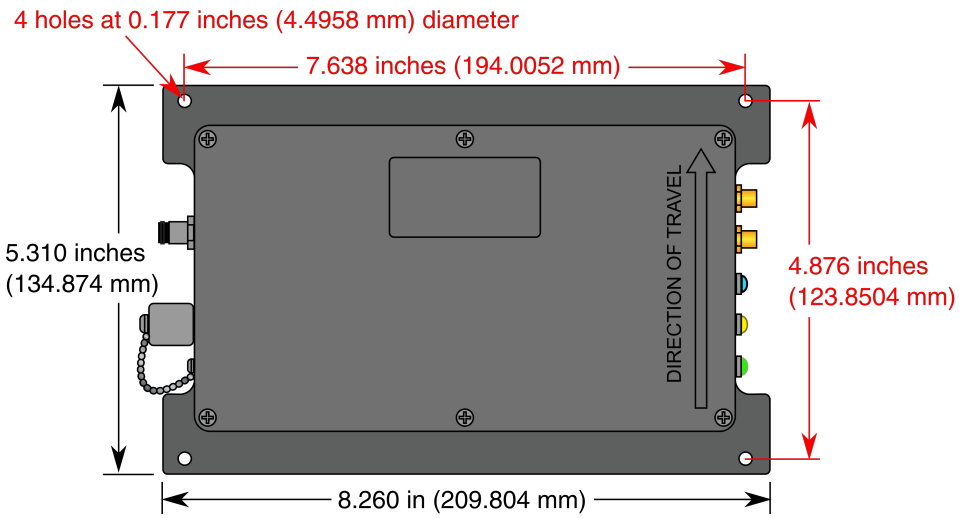



1. It is strongly recommended that the two antennas be mounted on the roof of the vehicle. The (primary GPS measurements) antenna that is connected to ANT1 must be to the rear of the (RTK measurements) antenna that is connected to ANT2.
2. The distance between the two antennae should be as close as possible to the RTK baseline distance of 800 millimeter. The magnetic mounting dual antenna template (1-EGPS-200-TEM-2) is provided to facilitate this. Small deviations on the order of a few millimeters can be tolerated with fairly insignificant loss of accuracy for the RTK channels.

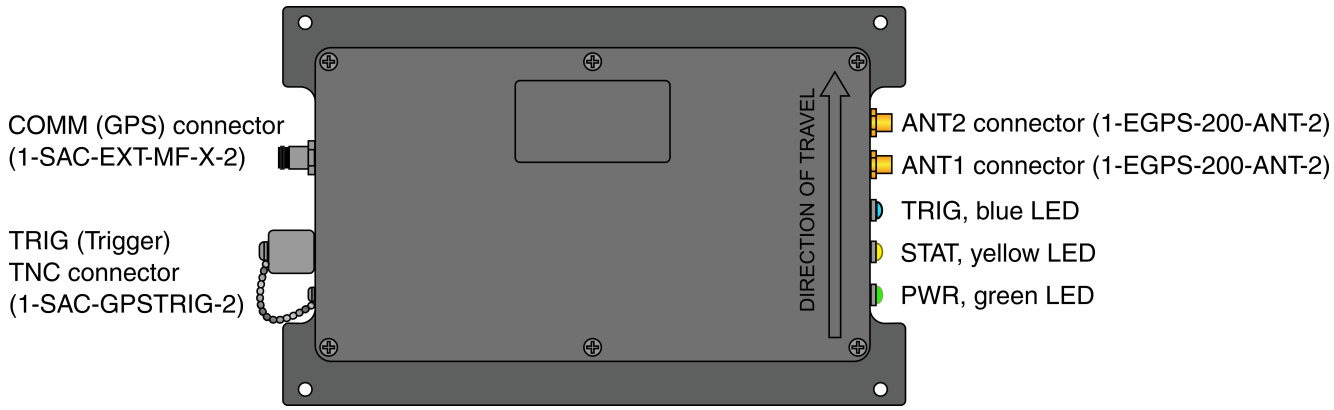
3. The antennae should be mounted parallel to the direction of travel center line. This will minimize the difference between the heading channel data and the rtk_yaw channel data when there is no vehicle slip.
4. The antennae should be mounted so that both are the same distance above the ground. This will minimize the difference between the gradient channel data and the rtk_pitch channel data when there is no vehicle squat (dive).
5. Both antennas should be mounted directly to the metal roof of the vehicle. The metal under the antenna acts as a “ground plane” for the antenna. This is important for optimal satellite signal acquisition. Do not use adhesive tapes or any other material to hold the antennae in place - some adhesive tapes completely block acquisition of the GPS signals.
6. To avoid any possible damage to the car paintwork, clean the metal to remove any dirt or grime before mounting the antenna. This also reduces the possibility that the antenna will move when the vehicle experiences high acceleration rates or encounters strong wind gusts.
7. The antennas should be mounted so the antenna cables point in the same direction – for example, mount the antennae such that both cables exit towards the rear of the test vehicle.
8. Both antennas must be of the same make and model. This is critical for acquiring accurate differential GPS data for the RTK channels.

Requirements and recommendations for mounting EGPS-200 units are as follows:

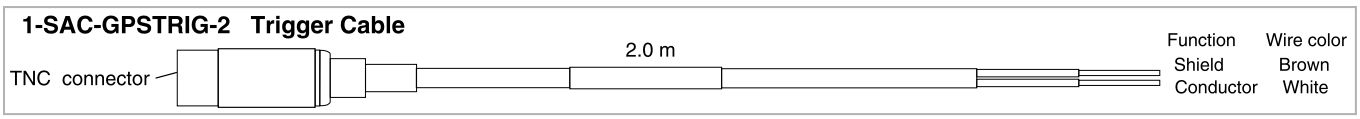
1. Due to the relatively small size of the EGPS-200 unit, mounting it in the test vehicle at the optimal orientation can be somewhat challenging. However, for acquisition of the combined speed, acceleration and gyroscope channels (1-EGPS-200-P-2 only), it is important to make a concerted effort to mount the unit per the following recommendations.
    a. The unit should be mounted such that the “direction of travel” arrow on the EGPS-200 lid is parallel to the direction of travel center line, and points to the forward direction.
    b. The unit should be mounted such that the XY plane of the unit is parallel to the ground plane. One way to check this is to verify that the X and Y axis accelerometers are centered at zero g’s when the vehicle is parked on flat ground.
    c. Ideally, the unit should be mounted such that it sees the same IMU accelerations and angular displacements as the (typically roof mounted) antennae. While this may not be feasible in all situations, it is critical that the unit be rigidly secured to the vehicle chassis to minimize the differences between what the GPS antennae sense and what the IMU senses.
    d. Before using the EGPS-200 for formal test data acquisition, the user is strongly advised to perform some check out tests to verify proper antennae and EGPS-200 unit installation.




Common mounting diagram (Top view of 1-EGPS-200-P-2 shown)




Cable connection and status LEDs diagram (Top view of 1-EGPS-200-P-2 shown)




## EGPS-200 Status LEDs

| LED | Description |
|---|---|
| PWR (green) shows power and PPS lock status | |
| Off | Unit is not powered. |
| On | Turns on immediately after 12 volt power is applied to the unit, which is typically several seconds after the connected CPU is powered up. |
| 1Hz | PPS lock is attained. |
| STAT (yellow) shows GPS signal status | |
| Off | Unit is not powered. |
| 1Hz | Unit has acquired enough satellites to get a GPS position fix (i.e., after the fix_quality channel is 1 or higher). |
| On | For the EGPS-200 Plus (1-EGPS-200-P-2) only, RTK lock is attained. |
| TRIG (blue) shows input from the TRIG connector | |
| Off | No connection to the trigger input connector, so trigger channel is pulled high (internally). |
| On | Connection to trigger input connector and the trigger channel input is pulled down to logic 0, when the two wires of the trigger cable pigtail (1-SAC-GPSTRIG-2) are connected to each other. |

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