

# VOTER-GPS

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# 1 VOTER-GPS

**Legacy Version** - This page is about a legacy version of AllStarLink. See <sup>1</sup>

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<sup>1</sup> <https://allstarlink.github.io/voter/index>



## 2 Introduction

This page will outline the requirements and troubleshooting for using a GPS with the RTCM/VOTER.



## 3 GPS

The RTCM/VOTER will work with most GPS available. It requires either NMEA or Trimble TSIP binary data. It only receives data **from** the GPS (GPS TX), it does not send anything **to** the GPS.

**If you are planning on doing voting and/or simulcast, your GPS also needs to have a "Pulse-per-second" (PPS) output.**

The RTCM/VOTER firmware is specifically written to talk to Trimble Thunderbolt receivers using Trimble's TSIP binary data interface, however, other Trimble's GPS receivers that talk TSIP are generally compatible. There are some specific *hacks* that have now been added to the firmware to work with the Thunderbolt to overcome *week number rollover* issues.

### 3.1 NMEA Sentences

If you are using an NMEA GPS (as opposed to a Trimble using the TSIP binary interface), the RTCM/VOTER is looking for the following NMEA sentences:

```
$GPGGA  
$GPGSV  
$GPRMC
```

It wants \$GPGSV to see the number of satellites in view is >0 (determines whether we are getting any GPS data).

It uses \$GPRMC to get the timestamp.

It uses \$GPGGA to determine whether we have a valid GPS fix, and get the latitude/longitude/altitude.

## 3.2 Trimble TSIP Packets

The VOTER/RTCM when in TSIP mode (Trimble), assumes it is a Trimble Thunderbolt and is looking for two packets:

0x8F-AB - Primary Timing Packet  
0x8F-AC - Supplemental Timing Packet

Grab a copy of the Thunderbolt User Guide<sup>1</sup>.

Pages 78-83 are the important ones.

Packet 0x8F-AB is what grabs the timing information, and packet 0x8F-AC is what is used for everything else (including debug).

---

1 <https://wiki.allstarlink.org/wiki/File:Thunderbolt-2012-02.pdf>

## 4 RTCM GPS Connections

There are some quirks specific to the RTCM that are not well documented.

The GPS connections for the RTCM are on the DB15 connector. Note that the labels for GTX and GRX are misleading. GTX is the data **FROM** the GPS **TO** the RTCM (GPS TX/RTCM RX). GRX is data from the RTCM to the GPS, but that is currently not used, so it does not need to be connected.

PPS is obvious, that is your PPS signal from your GPS.

Also note, inside the RTCM, there are jumpers to set for TTL or RS-232 data, depending on the type of GPS you are connecting. Set them accordingly. The RS-232 setting loops the data through a MAX3232 converter on the board.

You will still need to set the data and PPS polarity, and baud rate in the configuration menus to get everything to work.



## 5 GPS Lock

The GPS LED will go solid regardless of the connection LED. That **has** to happen or it won't connect to the Asterisk server.

It is not unusual for it to take up to 20 mins to get a GPS lock LED (ie. using a Trimble Thunderbolt) after any reboot. It is highly dependent on how long your GPS takes to lock up, whether it has a current almanac, etc.



# 6 GPS Issues

## 6.1 GPS Desense

If you are having odd loss of lock issues (or can't get/maintain lock), consider you may have interference to your GPS antenna from strong RF nearby. A note from Jesse Lloyd:

I also had crazy problems with poor signal on my GPS when I set it up sitting in a window, and once installed at site I had the GPS antenna maybe 6 ft from the VHF antenna, and after some troubleshooting found it was getting swamped with RF and loosing lock.

I found the debug setting of 32 useful in the RTCM, you can see a hex output of the GPS status.

If you are in a known high-RF environment (lots of co-located transmitters, broadcast, etc.), you will probably be disappointed if you try using a cheap patch antenna. You will need to get a decent active antenna that also has a built-in bandpass filter for the L1 frequency. Most commercial (surplus or otherwise) antennas fit this category.

## 6.2 Trimble Thunderbolt

You may find your Trimble Thunderbolt is showing the incorrect date at the moment. It could be showing the year as 1997. This is due to the date in the Thunderbolt being reported incorrectly.

**This can cause some of your voting receivers to not connect, if they are used with other GPS in your system.** If you have **ALL** Thunderbolts, or **NO** Thunderbolts, you are probably fine. If you have **ALL** Thunderbolts, the date/time is probably wrong, but they will ALL be wrong, so they will connect.

GPS Time is a continuous counting time scale beginning at the January 5, 1980 to January 6, 1980 midnight. It is split into two parts: a time of week measured in seconds from midnight Sat/Sun, and a week number. The time of week is transmitted in an unambiguous manner by the satellites, but only the bottom 10 bits of the week number are transmitted. This means that a receiver will see a week number count that goes up steadily until it reaches 1023 after which it will “roll over” back to zero, before steadily going up again. Such a week rollover will occur approx. every 20 years. A GPS week rollover occurred in 1999 and another one happened in 2019.

The Thunderbolt manual states:

The ThunderBolt adjusts for this week rollover by adding 1024 to any week number reported by GPS which is less than week number 936 which began on December 14, 1997. With this technique, the ThunderBolt will provide an accurate translation of GPS week number and TOW to time and date until July 30, 2017.

As such, the Trimble Thunderbolt has a firmware issue with the GPS Week rollover that manifested itself on July 30, 2017, causing the date to become incorrect. The Thunderbolt thinks the week changed from 935 to 936 (actual week  $1959-1024=935$ ), so it stopped adding 1024 to the week.

We have added a brute-force fix starting in RTCM/VOTER firmware  $\geq 1.51$ . This fix adds 619315200 seconds (1024 weeks) to the time reported by the GPS. It fixes the Thunderbolts, we have not done extensive testing to see how it affects other TSIP receivers.

That was fine until the week in the Thunderbolt hit the next rollover... when it rolled back to week 0, so additional checks were added, and now we have to add 2048 weeks (since the current GPS week is  $>2048$ ). Hopefully, by the time November 21, 2038 rolls around, all the Thunderbolts will have had their OCXO's drift to far to correct, and will be turned in to pop cans.

## 6.3 Garmin

### 6.3.1 Garmin 18x LVC Wiring Issues

If you have issues with your GPS 18x LVC not talking to the RTCM/VOTER, it may not be hooked up to the RTCM correctly.

The Garmin pin labeling is backwards to what you may think. See below. You probably need to swap pins 6 and 14.

RTCM		GPS 18x LVC
6 GRX	<-- Rx Data	6 Green
7 GPPS	<-- Pulse Output 1	Yellow
8 GND	Ground	3 Black
8 GND	Ground	5 Black
13 +5V	-->Vin	2 Red
14 GTX	--> TX Data	4 White

Log into the RTCM and do 98 and you should see something like this:

```
Current Time: Sun Apr 20, 2014 04:37:02.820
Last Rx Pkt System time: 04/20/2014 03:55:35.580, diff: 2487260 msec
Last Rx Pkt Timestamp time: 04/20/2014 03:55:32.064, diff: 3515 msec
Last Rx Pkt index: 160, inbounds: 1
```

### 6.3.2 Garmin and the RTCM

Beware when buying newer Garmin GPS's to use with the Micro-Node RTCM.

The RTCM expects a 5V PPS signal.

Newer Garmin's (GPS 18X, 18X LVC, etc.) MAY NOT output 5V, and can cause issues. **Check the Garmin datasheet.**

The VOTER is designed to accept both 3.3V or 5V signals, and *should* work fine.

### 6.3.3 Garmin Speed Issues

Some of the Garmin GPS's come with 4800 baud set as default. If you are getting a "Warning: GPS Data time period elapsed" error on your RTCM, change both the GPS and RTCM to use 9600 baud.

To do this, interface the GPS to a DB9 connector as per page 8 of the manual<sup>1</sup> (remembering to ONLY use 5V as the power source \*facepalm\*).

Once done, download, extract and open SNSRXCFG\_330.exe<sup>2</sup> and run.

1. Select your GPS (in most cases GPS 18x PC/LVC). Press F10 to switch to NMEA mode (Config > Switch to NMEA Mode)
2. Select Config > Setup and choose the COM port your GPS is connected too. Leave baud rate as auto for now, OK.
3. Select Comm > Connect to connect to the GPS.
4. Go to Config > Get Configuration from GPS to download it's current configuration
5. Click File > Save to save the current configuration
6. In Config > Sensor Configuration change the Baud Rate to 9600. You can also check to make sure 1PPS is enabled here too. Click OK.
7. Hitting F7 when in the main window of the software also brings up the GPS sentences to output if that is of interest.
8. File > Save to a different file than step 5.
9. Press F9 or Config > Send Configuration to GPS. This will then send all the changes you made to the GPS unit (including baud rate so a reconnect may be needed)

## 6.4 uBlox GPS

You can use uBlox GPS modules with the VOTER/RTCM. The ones readily available usually have a 5 pin header on them (5V, GND, TXD, RXD, PPS), as well as an integrated patch antenna, and a SMA connector for an external antenna.

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1 [http://wiki.allstarlink.org/w/images/4/41/GPS\\_18x\\_Tech\\_Specs.pdf](http://wiki.allstarlink.org/w/images/4/41/GPS_18x_Tech_Specs.pdf)

2 [http://www8.garmin.com/support/download\\_details.jsp?id=4053](http://www8.garmin.com/support/download_details.jsp?id=4053)

As noted above, beware of desense. You may have variable success using a mag-mount patch antenna. You may want to use a commercial-grade GPS external antenna to benefit from better filtering of the GPS signal.

Data is TTL, so make sure to set the jumpers inside the RTCM for TTL data. Baud rate is 9600 by default, and uses NMEA. Set those accordingly in the configuration menu.

The RTCM and VOTER require different settings for data and PPS polarity. The VOTER wants **inverted** for both, and the RTCM wants **non-inverted** for both.

Make sure to save (99) and reboot (r) your VOTER/RTCM after making changes for them to be effective.



# 7 GPS Debug

To turn on GPS Debugging, set the Debug Option Level in the RTCM/VOTER to 32.

See [Debug levels](#)<sup>1</sup> for more information on how this works.

## 7.1 Trimble Debug Status Decoding

The VOTER/RTCM when in TSIP mode (Trimble), assumes it is a Trimble Thunderbolt and is looking for two packets:

0x8F-AB - Primary Timing Packet  
0x8F-AC - Supplemental Timing Packet

Grab a copy of the [Thunderbolt User Guide](#)<sup>2</sup>.

Pages 78-83 are the important ones.

Packet 0x8F-AB is what grabs the timing information, and packet 0x8F-AC is what is used for everything else (including debug). Not all bytes are used by all TSIP devices.

Presently, the debug strings that the VOTER/RTCM reports are:

```
printf("GPS-DEBUG: gps_epoch_time: %ld, ctime: %s, gps_week:
%d\n",gps_time,ctime((time_t *)&gps_time),gpsweek);
```

---

1 [https://wiki.allstarlink.org/wiki/VOTER-Hardware#Debug\\_Options](https://wiki.allstarlink.org/wiki/VOTER-Hardware#Debug_Options)  
2 <https://wiki.allstarlink.org/wiki/File:Thunderbolt-2012-02.pdf>

```
printf("GPS-DEBUG: TSIP: ok %d, 2,3,9 - 14: %02x %02x %02x %02x %02x %02x %02x\n",
      happy, gps_buf[2], gps
      _buf[3], gps_buf[9], gps_buf[10], gps_buf[11], gps_buf[12], gps_buf[13], gps_buf[14]);
```

In real life, this is output like:

Example Unhappy Message:

```
GPS-DEBUG: gps_epoch_time: 1643742941, ctime: Tue Feb 1 19:15:41 2022
, gps_week: 2195
GPS-DEBUG: TSIP: ok 0, 2,3,9 - 14: 07 00 00 00 00 08 08 00
```

The *gps\_epoch\_time* is GPS time, in seconds since epoch, plus any corrections added (GPS Time Offset, "Fix 1 Second Off" debug code). It *should* be corrected for any leap seconds (it should be UTC time).

The *ctime* is conversion of *gps\_epoch\_time* into *calendar time*. It is the human-readable conversion of the *gps\_epoch\_time*.

The flag after *TSIP: ok* is the **happy** GPS flag. The GPS is flagged as **NOT HAPPY** in TSIP mode if **ANY** of the following are TRUE:

- If GPS Decoding Status (Byte 12) is anything other than "Doing Fixes".
- If Disciplining Activity is not Phase Locking or Recovery Mode.
- Any Critical Alarms.
- Any Minor Alarms.

The other 5 bytes are GPS buffer bytes 2, 3, and 9-14 (in hex). That translates to 0x8F-AC message bytes 1, 2, and 8-13.

Inspecting the rest of the debug string to look at the 0x8F-AC bytes:

```
Msg: 07 00 00 00 00 08 08 00
Byte: 1 2 8 9 10 11 12 13
```

Byte 1 - Receiver Mode  
 0 Automatic (2D/3D)  
 1 Single Satellite (Time)  
 3 Horizontal (2D)  
 4 Full Position (3D)  
 5 DGPR Reference  
 6 Clock Hold (2D)  
 7 Overdetermined Clock

Byte 2 - Disciplining Mode  
 0 Normal (Locked to GPS)  
 1 Power Up  
 2 Auto Holdover  
 3 Manual Holdover  
 4 Recovery  
 5 Not Used  
 6 Disciplining Disabled

Byte 8/9 - Critical Alarms (MSB/LSB) Bit Masked  
 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Bit 4 = DAC at Rail

Therefore, bytes 8/9 will either be 00 00 (all good) or 00 10 (DAC at Rail).

Byte 10/11 - Minor Alarms (MSB/LSB) Bit Masked  
 0 0 0 0 0 0 0 0 0 0 0 0 0 0  
 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0

Bit 0 = DAC Near Rail  
 Bit 1 = Antenna Open  
 Bit 2 = Antenna Shorted  
 Bit 3 = Not Tracking Satellites  
 Bit 4 = Not Disciplining Oscillator  
 Bit 5 = Survey In-progress  
 Bit 6 = No Stored Position  
 Bit 7 = Leap Second Pending  
 Bit 8 = In Test Mode  
 Bit 9 = Position is Questionable  
 Bit 10 = Not Used  
 Bit 11 = Almanac Not Available  
 Bit 12 = PPS Not Generated  
 Bit 13-15 = Not Defined

Therefore, 00 08 would be Bit 3 set, which would be Not Tracking Satellites.

Byte 12 - GPS Decoding Status (result is in hex)

0x00 Doing Fixes  
0x01 Don't Have GPS Time  
0x03 PDOP is Too High  
0x08 No Usable Sats  
0x09 Only 1 Usable Sat  
0x0A Only 2 Usable Sats  
0x0B Only 3 Usable Sats  
0x0C The Chosen Sat is Unusable  
0x10 TRAIM Rejected the Fix

To get "happy", we need 00. Anything else will cause loss of GPS lock. So, a 08 would be No Usable Sats.

Byte 13 - Disciplining Activity (result is in decimal)

0 Phase Locking  
1 Oscillator Warm-up  
2 Frequency Locking  
3 Placing PPS  
4 Initializing Loop Filter  
5 Compensating OCXO (Holdover)  
6 Inactive  
7 Not Used  
8 Recovery Mode  
9 Calibration/Control Voltage

Former versions of firmware reported less information:

```
printf("GPS-DEBUG: TSIP: ok %d, 9 - 14: %02x %02x %02x %02x %02x %02x\n",  
happy, gps_buf[9], gps_buf[10], gps_buf[11], gps_buf[12], gps_buf[13], gps_buf[14]);
```

Those reported 0x8F-AC bytes 8-13. See above for a breakdown.

Sample messages:

```
GPS-DEBUG: TSIP: ok 1, 9 - 14: 00 00 00 00 00 00 - everything is good in the  
'hood, Doing Fixes, Phase Locking  
  
GPS-DEBUG: TSIP: ok 0, 9 - 14: 00 00 00 18 08 06 - not happy, Not Tracking  
Satellites, Not Disciplining Oscillator (0x18 --> 0b000000011000), No Usable  
Sats, Inactive  
  
GPS-DEBUG: TSIP: ok 0, 9 - 14: 00 00 00 08 08 05 - not happy, Not Tracking
```

Satellites, No Useable Sats, Compensating OXCO (holdover)

GPS-DEBUG: TSIP: ok 0, 9 - 14: 00 00 00 00 00 05 - not happy, Compensating OXCO  
(holdover)

GPS-DEBUG: TSIP: ok 1, 9 - 14: 00 00 00 00 00 08 - happy, Recovery Mode

GPS-DEBUG: TSIP: ok 0, 9 - 14: 00 00 00 00 00 04 - not happy, Initializing Loop  
Filter



## 8 Related Pages

Documentation on the VOTER/RTCM is extensive, and as such, has been split across multiple pages. They are usually linked, where appropriate, throughout the content. However, here are all the related pages that are available:

- [Main VOTER Page](#)<sup>1</sup>
- [Original VOTER Hardware Documentation](#)<sup>2</sup>
- [RTCM Hardware Documentation](#)<sup>3</sup>
- [Menu Structure and Definitions](#)<sup>4</sup>
- [Firmware Upgrading](#)<sup>5</sup>
- [Audio Interfacing and Configuration](#)<sup>6</sup>
- [voter.conf Documentation](#)<sup>7</sup>
- [chan/voter and Asterisk Console Documentation](#)<sup>8</sup>
- [Simulcasting Configuration](#)<sup>9</sup>
- [Buffer Tuning](#)<sup>10</sup>
- [Interfacing to the Motorola Quantar](#)<sup>11</sup>

### 8.1 Contributors

- [VE7FET](#)<sup>12</sup>
- This page was last edited on 5 June 2025, at 00:16.

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1 <https://wiki.allstarlink.org/wiki/VOTER>  
2 <https://wiki.allstarlink.org/wiki/VOTER-Hardware>  
3 [https://wiki.allstarlink.org/wiki/RTCM\\_Client](https://wiki.allstarlink.org/wiki/RTCM_Client)  
4 <https://wiki.allstarlink.org/wiki/VOTER-Menus>  
5 [https://wiki.allstarlink.org/wiki/RTCM\\_Firmware\\_upgrading](https://wiki.allstarlink.org/wiki/RTCM_Firmware_upgrading)  
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11 [https://wiki.allstarlink.org/wiki/Quantar\\_RTCM](https://wiki.allstarlink.org/wiki/Quantar_RTCM)  
12 <https://wiki.allstarlink.org/index.php?title=User:VE7FET&action=edit&redlink=1>



# 9 Contributors

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1 Chapter 10 on page 33





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