

Integrating a GPS Receiver with Digiquartz Intelligent Transmitters



Paroscientific, Inc.
4500 148th Ave. N.E.
Redmond, WA 98052, USA
Tel: (425) 883-8700 Fax: (425) 867-5407
www.paroscientific.com
support@paroscientific.com

“The standard by which other standards are measured”

Integrating a GPS Receiver with Digiquartz Intelligent Transmitters

Overview

Starting with firmware versions R5.20 and Q1.00, Digiquartz Intelligent Transmitters equipped with a PPS input can interface with compatible GPS receivers. GPS integration enables the following features:

- Measurements synchronized with GPS time
- Absolute time-stamping of measurement data
- Precisely synchronized measurements between multiple Digiquartz Intelligent Transmitters
- Internal real-time clock synchronized with GPS time

This Application Note is a supplement to the Intelligent Instruments manual, document number 8819-001.

Compatible GPS Receiver

The following Garmin GPS receiver has been qualified for use with Digiquartz Intelligent Transmitters:

- Garmin GPS 19x HVS

Interfacing a GPS receiver to a Digiquartz Intelligent Transmitter

1. Connect GPS to the Digiquartz Intelligent Transmitter

Refer to Figure 1 to connect the GPS receiver to the Digiquartz Intelligent Transmitter. Ensure that the included Rate Select Cable is installed per Figure 1.

2. Set up the Digiquartz Intelligent Transmitter to enable the GPS interface

Issue the command `*0100EW*0100GE=1` to enable the GPS interface.

3. Set the Digiquartz Intelligent Transmitter GPS port baud rate to 4,800 baud.

Issue the command `*9900BR2=4800`.

4. Configure the GPS receiver for use with a Digiquartz Intelligent Transmitter.

Issue the command `*0100EW*0100GI=1`. The unit should respond with `>OK: GPS ready for operation, cycle power`. Cycle power to establish communications between the GPS receiver and the Digiquartz Intelligent Transmitter. If an error message is received, please refer to the GPS troubleshooting section on page 6.

NOTE: If the Digiquartz Intelligent Transmitter firmware has been updated from Q1.00 or Q1.01 to Q1.02 or later, re-issue the `*0100EW*0100GI=1` command. This will ensure the GPS receiver is optimally configured to produce reliable time data.

5. Enable Timestamps

If timestamps are desired, issue the command `*0100EW*0100TS=1`. Refer to the Absolute Timestamps section on page 3 for timestamp details and format options.

6. Test the Digiquartz Intelligent Transmitter to verify successful interface with the GPS receiver

Issue the command `*0100GP` to get the status of the GPS interface. The unit should respond with `>1: GPS is functioning properly`. If you receive any other response, please refer to the GPS troubleshooting section on page 6.

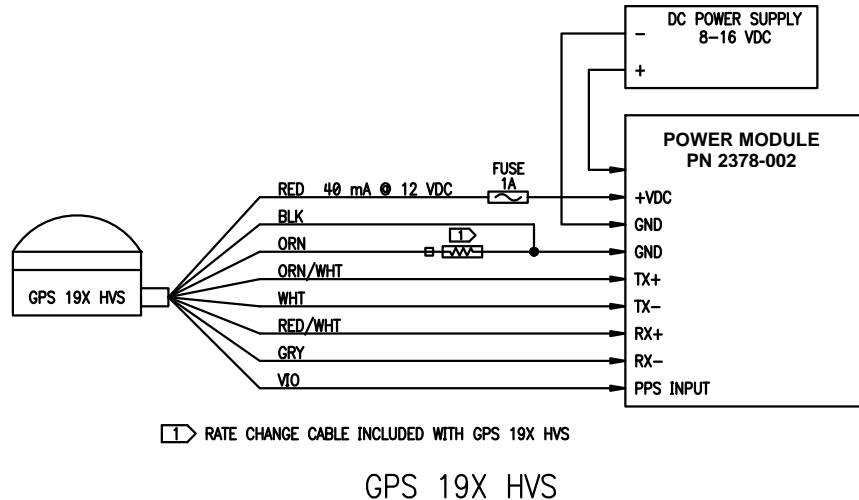


Figure 1. Garmin GPS 19x HVS wiring diagram

Garmin GPS19x HVS Rate Select Cable

The function of the GPS 19x Rate Select Cable is to set the GPS default baud rate to 4800 and serial data rate to 1Hz. Install the Rate Select Cable per Figure 1.

Firmware Update

If the Digiquartz Intelligent Transmitter firmware has been updated from Q1.00 or Q1.01 to Q1.02 or later, re-issue the *0100EW*0100GI=1 command to re-initialize the GPS receiver. This will ensure the GPS receiver is optimally configured to produce reliable time data.

Behavior when GPS data and PPS are interrupted

If the GPS serial data or the PPS signal is interrupted, the GPS status indicator becomes the character “V”, and the unit will continue to trigger measurements and generate time stamps based on the internal real-time clock. When GPS serial data and PPS signal are restored, the GPS status indicator becomes the character “A”, the unit immediately synchronizes with any resulting GPS timing change, and measurements will continue uninterrupted.

Behavior when GPS position lock is interrupted

If the GPS loses position lock due to acquisition of insufficient satellites, the GPS status indicator becomes the character “V”, and the unit will continue to trigger measurements and generate time stamps based on GPS time and PPS. When the GPS regains position lock, the GPS status indicator becomes the character “A”, the unit immediately synchronizes with any resulting GPS timing change, and measurements will continue uninterrupted.

Absolute Timestamps

When enabled, absolute timestamps add date, time, and GPS status to measurement command responses.

Timestamp Example

The following is an example of a P3 command response with absolute time stamps enabled:

```
*0001A,11/25/13 11:33:58.174 PM,14.67276
```

*0001 is the standard address header.

The “A” character is the GPS/PPS status. An “A” character indicates the GPS is functioning properly and is position locked. A “V” character indicates the GPS is either not functioning properly or is not position locked; please refer to the GPS troubleshooting section on page 6.

11/25/13 11:33:58.174 PM – Timestamp data in the format:
MM/DD/YY HH:MM:SS.mmm, where mmm is fractional seconds in milliseconds.

The example shows the default timestamp format. Several options are available to alter the timestamp format; please refer to the Timestamp Options section for details.

Note that commas separate the GPS status, timestamp, and measurement data.

Configuring a Digiquartz Intelligent Transmitter for Absolute Timestamps

1. Enable Absolute Timestamp

Issue the command `*0100EW*0100TS=1` to enable timestamps. When the GPS interface is enabled (`GE=1`), absolute timestamps are selected as opposed to relative timestamps.

2. Test the Timestamp

Any measurement command can be used to test the timestamp. For example, `*0100P3` should produce a single timestamped pressure measurement response. If no absolute timestamp is produced, ensure that `TS=1` (timestamp enabled) and `GE=1` (GPS interface enabled) and try again.

Timestamp Options

Timestamp Format

The TJ parameter selects from six available timestamp formats. Set TJ to the value associated with the desired timestamp format. Example: To select the standard format with millisecond resolution, issue the command `*0100EW*0100TJ=0`.

- 0 Standard format, millisecond resolution.
Format: MM/DD/YY HH:MM:SS.sss
- 1 Standard format, microsecond resolution.
Format: MM/DD/YY HH:MM:SS.ssssss
- 2 GSE format, millisecond resolution.
Format: YYYY/MM/DD HH:MM:SS.sss
- 3 GSE format, microsecond resolution.
Format: YYYY/MM/DD HH:MM:SS.ssssss
- 4 NTP format, hexadecimal, microsecond resolution. Seconds from 1/1/1970
Format: AAAAAAAAA.aaaaaaa, where AAAAAAAAA=seconds, aaaaaaaa=fractional seconds
- 5 NTP format, hexadecimal, 232ps ($1/2^{32}$ second) resolution. Seconds from 1/1/1900
Format: AAAAAAAAA.aaaaaaa, where AAAAAAAAA=seconds, aaaaaaaa=fractional seconds

Time Zone Offset

Timestamps default to UTC time. The TF parameter enables you to offset UTC time to match your time zone. TF can be set within a range of -12 to 14. Example command: To set the UTC offset to -8 hours, set TF to -8 with the command `*0100EW*0100TF=-8`.

Note: TF has no effect on GSE and NTP format timestamps.

Time Stamp Position

The TP command positions the timestamp either before or after the measurement data. Set TP to the value associated with the desired position. Example command: `*0100EW*0100TP=0`

- 0 Timestamp positioned before data.
Example: `*0001A,11/26/13 09:26:21.005 AM,14.63821`
- 1 Timestamp positioned after data.
Example: `*000114.63821,A, 11/26/13 09:26:21.005 AM`

Time Format

The GT command selects 12 hour or 24 hour time format. Set GT to the value associated with the desired format.

Example command: *0100EW*0100GT=0

- 0 12-hour time format.
Example: *0001A,11/26/13 01:33:57.201 PM,14.63887
- 1 24-hour time format.
Example: *0001A,11/26/13 13:33:57.201,14. 63887

Date Format

The GD command selects MM/DD/YY or DD/MM/YY date format. Set GD to the value associated with the desired format. Example command: *0100EW*0100GD=0

- 0 MM/DD/YY date format.
Example: *0001A,11/26/13 13:33:57.201,14. 63887
- 1 DD/MM/YY date format.
Example: *0001A,26/11/13 13:33:57.201,14. 63887

Current Date and Time

The GR command sets and reports the current date and time. Date and time are reported according to the current date and time format settings. When setting date and time, the values must be entered according to the current date and time format settings.

Example commands:

To report current date and time, issue the command *0100GR.

To set date and time, issue the command *0100EW*0100GR=01/25/13 11:45:53 PM, substituting current date and time. This example assumes MM/DD/YY and 12-hour date and time formats

Note: When connected to a GPS receiver, the internal real-time clock is synchronized with GPS date and time. It is only necessary to set the date and time when not using a GPS receiver. The real-time clock must be set each time the unit is powered on.

Starting a Measurement Sequence with Timestamps Enabled

When a measurement command is issued, measurements commence at the next PPS pulse, and the first response packet will have a timestamp one sampling interval later. Example: If a measurement command is issued at 09:59:59.500AM and TH=40, the first measurement will be time-stamped 10:00:00.025AM

Synchronous Measurements

When a Digiquartz Intelligent Transmitter is integrated with a GPS receiver, continuous measurement commands (P4, E4, etc.) produce measurements synchronized with GPS time, enabling precise measurement synchronization between multiple Digiquartz Intelligent Transmitters.

For most applications, the most effective synchronization occurs when all Digiquartz Intelligent Transmitters are set up identically. The following operating parameters should be identical for all Digiquartz Intelligent Transmitters used in synchronous measurement applications:

Serial Port Baud Rate

Set all units to the same baud rate (BR command). Refer to the Intelligent Instruments manual for BR command details.

Data Rate

Setting the data rate with the TH command provides precise data intervals and consistent data rates. Refer to the Intelligent Instruments manual for TH command details. Setting the data rate with the PI and TI commands is not recommended in synchronous applications.

Measurement Mode

Set all units to Standard Resolution or Nano Resolution mode (XM command). If using Nano Resolution, set all units to the same corner frequency (IA command). Refer to the Intelligent Instruments manual for details.

Measurement Type

Continuous measurement commands (P4, E4, etc.) used in conjunction with the TH command will produce measurements at consistent intervals and with identical timestamps. Refer to the Intelligent Instruments manual for measurement command details.

Time stamp parameters

Set up all units to the same time stamp format. Refer to page 4.

PPS Only

The GPS interface also enables the Digiquartz Intelligent Transmitter to be synchronized to systems that provide a pulse per second (PPS) signal.

Compatibility

If the 2378-002 Power Module is being used, please refer to the 2378-002 Power Module SCD for PPS signal requirements.

If the 2378-002 Power Module is not being used, please refer to the Digiquartz Intelligent Transmitter SCD for PPS signal requirements.

Setting up for PPS only operation

1. Connect PPS signal to the Digiquartz Intelligent Transmitter

If using the Power Module P/N 2378-002:

Connect the PPS signal from the signal source to the Power Module PPS terminal, and connect the ground from the PPS signal source to a Power Module ground terminal.

If not using the Power Module P/N 2378-002:

Connect the PPS signal from the signal source to the Digiquartz Intelligent Transmitter pin 11, and connect the ground from the PPS signal source to Digiquartz Intelligent Transmitter pin 5.

2. Configure the Digiquartz Intelligent Transmitter for PPS only

Issue the command `*0100EW*0100GE=2` to enable the PPS interface

3. Test the PPS interface

Issue the command `*0100GP`. The unit should respond with `>9:PPS signal detected`. If any other response is received, refer to the troubleshooting section on page 6.

A few points to keep in mind in PPS-only applications:

Date and time information used to create timestamps is provided by the Digiquartz Intelligent Transmitter's real-time clock. The real-time clock is volatile and must be set whenever to unit is powered up.

The GPS status is provided in PPS only mode when timestamps are enabled. A "P" character indicates the PPS signal is detected and measurements are being synchronized to the PPS signal. A "V" character indicates a problem with the PPS signal. Check that the signal is present on the PPS input and the signal conforms to the required criteria.

Troubleshooting

The GP command reports the status of the GPS/PPS. Whenever a problem is encountered with the GPS/PPS interface, issue the command `*0100GP` to help diagnose and correct the problem.

The GP command produces the following responses. Take the corrective action recommended for the response received and issue the GP command again to see if the problem has been resolved.

GPS Mode Status Messages (GE=1)

>0: GPS Functions are disabled

Corrective action: Enable GPS functions by issuing the command *0100EW*0100GE=1 for GPS or *0100EW*0100GE=2 for PPS only.

>1: GPS is functioning properly

No corrective action needed.

>2: PPS signal not detected yet

GPS serial data is being received, but PPS signal has not yet been detected. Corrective action: Allow time for the GPS receiver to achieve position lock and produce a PPS signal. Ensure that the GPS receiver has been configured to work with the Digiquartz Intelligent Transmitter by issuing the command *0100EW*0100GI=1. Check wiring to ensure the PPS signal is properly wired to the Digiquartz Intelligent Transmitter.

>3: Lost GPS serial communications

GPS serial data is no longer being received but the PPS signal is still being received. Corrective action: Ensure the GPS serial port is still at the correct baud rate, typically 4800 baud. Ensure that GPS serial wiring is correct.

>4: Lost PPS and GPS serial communications

GPS serial data and PPS are no longer being received. Corrective action: Verify that GPS is still being powered properly and GPS wiring is correct.

>5: Acquiring more GPS satellites

Corrective action: Wait for GPS to acquire sufficient satellites for position lock. The GPS status indicator will change from V to A when sufficient satellites have been acquired. If this status never clears, ensure that GPS is in an appropriately unobstructed location.

>6: GPS port baud rate greater than 38400

Corrective action: Do not attempt to set the baud rate of the com port used for GPS communications to greater than 38,400 baud. It is almost never necessary to use anything other than the default baud rate of 4,800 baud.

>7: GPS serial communications not received

Corrective action: Check GPS power, GPS port baud rate, and GPS wiring.

>8: PPS signal not detected

GPS serial data being received with position lock achieved, but no PPS signal detected. Corrective action: Ensure that the GPS receiver has been configured to work with the Digiquartz Intelligent Transmitter by issuing the command *0100EW*0100GI=1. Check that PPS signal is wired correctly.

PPS Mode Status Messages (GE=2)

>9: PPS signal detected

Unit configured for PPS only and PPS signal is detected. No corrective action needed.

>10: PPS signal not detected

Unit configured for PPS only and PPS signal is not detected. Corrective action: Ensure that the GPS receiver has been configured to work with the Digiquartz Intelligent Transmitter by issuing the command *0100EW*0100GI=1. Check PPS signal source and wiring.