

SRO-100 Status 5 Alarm Application Note**APPENDIX I****Acronyms & Definitions:**

hw:	Hardware
sw:	Software
Unit:	SRO
Tracking:	Unit locked to a reference such as GPS or Maser in Track or Sync mode
Status=5:	Alarm status with a value of "5" generated by the unit
PPSREF:	Reference signal generated by a Stratum 1 source such as GPS, Cesium, or Maser
TRAIM	Time Receiver Autonomous Integrity Monitoring

1) Status=5 Alarm Issue

Product application: SRO
Product issue: If you encounter an issue with the Status=5 alarm from a unit, please read this document carefully for specific explanations.

2) Status=5 Alarm Description

A) At the beginning of a Tracking, Status=5 can be generated by the unit if the frequency stability of the PPSREF is lower than $1e-10$.
B) After a successful Tracking with Status=2 or Status=3, the change to Status=5 is possible because of the following condition: The unit is in Holdover mode, for although the PPSREF is present, it is out of the tracking window defined with a threshold of $\pm 2 \mu s$ by factory default.

3) How to Read the Status Value?

There are 2 possibilities as follows:

- A) With the command **ST** (once)
Using Hyperterminal: Type **ST**
Using iSyncMgr.exe application: Timing+Tracking/ST
- B) With the command **BT5** (every second)
Using Hyperterminal: Type **BT5**. To stop it: **BT0**
Using iSyncMgr.exe application: Timing+Tracking/BTx/5: General Status

4) Status=5 When the SRO is Used as A Frequency Reference in Laboratory

In such condition, Status=5 can be generated based on the following conditions:

- A) At the beginning of a reference tracking when the stability of PPSREF is lower than $1e-10$.
Solution: choose a better PPSREF source such as a Maser, GPS, or another Rb clock.
- B) When the user is switching between different PPSREF sources. Example: If a user has 2 PPSREF sources: a local Maser and a GPS receiver. First the user performs a successful Tracking of the unit from a Maser with Status=2. After a while, the user replaces the Maser PPSREF with a GPS PPSREF. Status=5 appears immediately from the unit and stays "5" until changed. This is because the SRO is still waiting for the first PPSREF type it was tracking from (i.e. the Maser). If the user reverts to Maser PPSREF, the Status value will return to "2")

Solution: the user should respect the following sequences:

- Plug in PPSREF, source 1
- Initiate a Tracking. By hw: ground pin 15. By sw: TR1
- If the tracking is good, Status=2
- Stop the Tracking. By hw: unground pin 15. By sw: TR0

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- Unplug PPSREF, source 1
- Plug in PPSREF, source 2
- Initiate the Tracking. By hw: ground pin 15. By sw: TR1
- If the Tracking is good, Status=2

NOTE: If a user doesn't want to use the TR1 / TR0 / TR1 commands, he/she can enable the Restart Tracking mode instead

5) Enabling the Restart Tracking Mode

Using Hyperterminal:

- Type **MCL06**. Answer (=>): => 00 or else
- Set bit 2 => 04
- Type **MCS0604**

Using iSyncMgr.exe:

- Timing+Tracking / MCsxx / 04 in position 06
- Store this page

Now this mode is stored in the permanent, non volatile, EEPROM memory. At this point, there is no need to type TR1 / TR0 / TR1 each time the PPSREF is changed. To take into account the new PPSREF, the SRO needs about 5 minutes or more than a normal Tracking setup. So be patient after each PPSREF change.

WARNING: Allowing the Restart Tracking mode may lead to faulty behaviors in case the SRO is disciplined by a GPS receiver. That's why this mode is not set by factory default. To cancel it:

Using Hyperterminal:

- Type **MCL06** Answer (=>): => 04 or else
- Clear bit 2 => 00
- Type **MCS0600**

Using iSyncMgr.exe:

- Timing+Tracking / MCsxx / 00 in position 06
- Store this page

6) Understanding GPS Receiver Behaviors

To understand why the SRO doesn't restart the tracking by itself, the user should first grasp some of the key characteristics of a GPS receiver as follows:

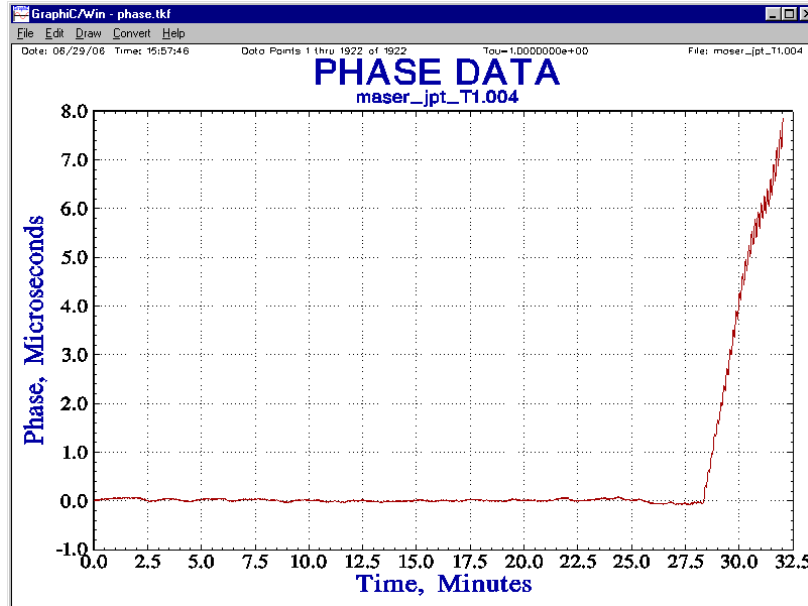
A) Typically, a GPS receiver outputs its PPSREF (i.e. 1 PPS), regardless of the conditions or quality of the PPSREF. Even with no satellites in view or a disconnected antenna, the PPSREF is outputted from a GPS receiver if it is not specifically configured. This PPSREF is driven by the internal crystal oscillator of the GPS receiver, with stability in the 1E-6 range or less.

B) The internal crystal oscillator of a GPS receiver is not designed for long term stability.

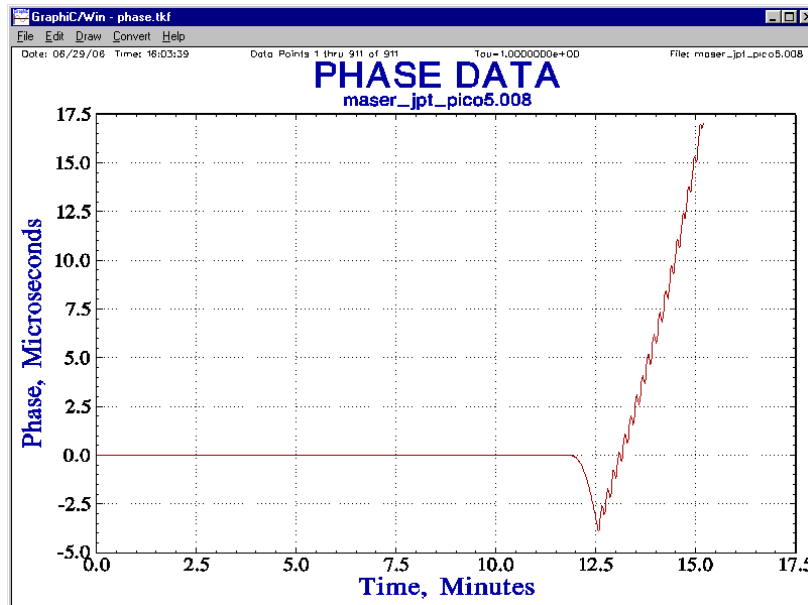
C) Typically, the firmware of a GPS receiver doesn't have a holdover mode, in which the last qualified frequency value is saved in memory before the satellites are out of sight. Instead, the internal crystal oscillator typically drifts exponentially. Below are some GPS behavioral graphs, illustrating a condition where a user disconnects the cable of the GPS antenna.

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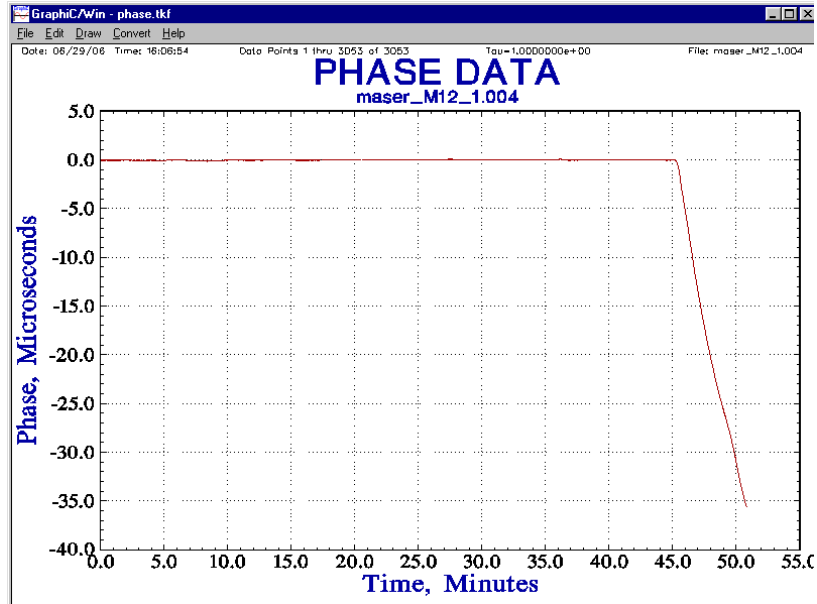
The Navman Jupiter-T GPS is not configured. It is possible to configure the GPS to disable its PPSREF output in case of violation of the integrity of the GPS signal thru the TRAIM function. On the date of publication of this document, Navman has discontinued the production of the Jupiter-T GPS model.



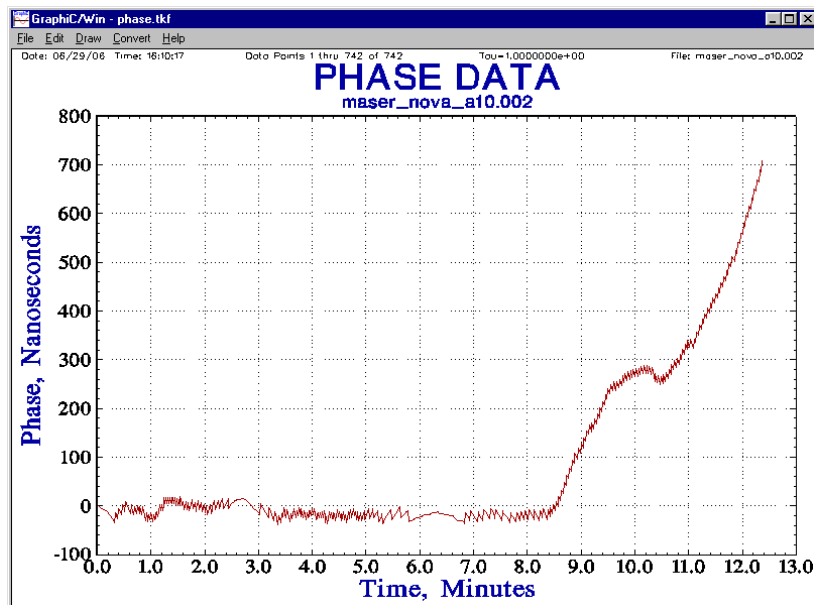
The Navman Jupiter Pico-T GPS is not configured. It is possible to configure the GPS to disable its PPSREF output in case of violation of the integrity of the GPS signal thru the TRAIM function. On the date of publication of this document, Navman offers this GPS model.

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The Motorola M12+ GPS is not configured. Unfortunately, the TRAIM function embedded into the GPS is not able to disable the PPSREF output. Thus, this GPS model should only be integrated in a system solution with a complete sw control. On the date of publication of this document, Motorola has discontinued the production of the M12+ GPS model. However, Synergy announced to fully support and continue the production and marketing of this product.



Novatel SuperStar II GPS is configured for timing, but doesn't disable the PPSREF output in case of TRAIM (signal integrity) violation. The SRO is able to configure this GPS model for TRAIM and position hold performance during power on. Unfortunately, a complete dialogue is often needed to/from the GPS. That's why the simple configuration

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commands sent out automatically by the SRO during power on are often not taken into account. Thanks to its superior performance in holdover mode, this GPS is able to drive the SRO in a complete out-of-frequency situation. However, this GPS model should only be integrated in a system solution with a complete sw control. On the date of publication of this document, Novatel offers this GPS model.

7) SRO Behavior After Disconnecting the GPS antenna

These are the events happening upon disconnecting the antenna from the GPS receiver:

- It will try to track the PPSREF from the low-end, free-running oscillator inside the GPS receiver.
- Once the tracking window exceeds the SRO's threshold window of $\pm 2 \mu\text{s}$, it will go in holdover mode (i.e., free running, for the GPS reference is not good).

This is the condition if the Restart Tracking function is enabled (bit 2 of parameter 06 set):

- Since the PPSREF is identified, a new Tracking will be initiated.
- The new Tracking may be successful for a short amount of time until the tracking window exceeds again the SRO's threshold window of $\pm 2 \mu\text{s}$
- The above Tracking behavior goes on and on until the antenna of the GPS receiver is reconnected.

Note: In this case, the SRO will not go in holdover mode during the disconnection of the GPS antenna cable, but it will feature an erratic frequency behavior. This is unacceptable in telecom applications; thus not allowing the Restart Tracking mode avoids the issue.

8) Side Effects for Enabling the Restart Tracking Mode

A) GPS and SRO system at power on:

- The SRO is in Tracking mode setup because the pin 15 is permanently grounded or the command BT2 was sent once
- The SRO goes in Rubidium locked mode before the GPS receiver finds its satellites. At this point, the SRO is ready to initiate a Tracking. Since the GPS PPSREF is present, the SRO initiates its tracking on a bad PPSREF. The term "bad" means that the SRO is locked to the internal free-running oscillator of the GPS.
- After some time, the GPS finds its satellites and a good PPSREF is available. The term "good" means that the PPSREF is based on a qualified stratum 1 GPS signal. If this good PPSREF is up to 0.5 second ahead or behind from the bad PPSREF, the SRO goes in holdover mode with the unchanging Status=5 value.

B) GPS and SRO system running for a long time. The SRO is in Status=2 or Status=3. Suddenly the GPS cable is disconnected for many days.

- For many minutes, the SRO will follow the PPSREF from the internal free-running oscillator of the GPS. Once the tracking threshold window is reached, the SRO goes in holdover mode with Status=5.
- After many days, the theoretical time interval between the SRO PPSOUT and the good GPS PPSREF will be larger than the tracking threshold window.
- Once the good PPSREF of the GPS is back, the SRO will not be able to track this good PPSREF because it is outside of its tracking threshold window. Thus the SRO will stay in Status=5, unless changed.

9) Avoiding the Status=5 Without the Restart Tracking Mode

First of all, it is the user's responsibility to guarantee the integrity of the PPSREF feeding the SRO:

- Use a GPS receiver with TRAIM (Time Receiver Autonomous Integrity Monitoring) and position hold capabilities.
- The SRO is able to send configuration commands to some qualified GPS receivers. Choose GPS vendors that support TRAIM and position hold features.

If for economical or any other reason the integrity of the PPSREF cannot be guaranteed, the user should design a logic to check the SRO Status value by sw or hw (pin 5) and stop / start the tracking mode in case of Status=5.

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10) Temex Time Guidelines in Case of Status=5

These are our recommended guidelines:

- Any SRO leaving the factory is thoroughly tested in tracking mode. In fact, our SRO stock is based on powered on units, which are aging over time. A PPSREF from a master Maser reference is used and fed to each SRO, while testing and qualifying the parameters of the SRO. This means the user receives a SRO that was in tracking mode for many months.
- It is the user's responsibility to feed the SRO with a good or qualified GPS PPSREF for tracking purpose. A GPS receiver can have unexpected behavior and must be tested in depth before integration in a GPS/SRO system.
- The user should pay special attention to side effects. For instance, it is essential to test the GPS behavior in a system in case of no GPS antenna, GPS cable issue, and/or low satellites in view. If a PPSREF is outputted from a GPS which has a disconnect antenna, it will be difficult to expect a "safe/reliable" behavior of the GPS/SRO system.
- GPS receivers with a simple disabling feature of the PPSREF in case of low satellites in view are not reliable enough. It is strongly recommended to use GPS receivers with a real TRAIM (Time Receiver Autonomous Integrity Monitoring) capability.
- By factory default, the SRO is not able to restart tracking its PPSREF in Status=5. This is the only way Temex Time can guarantee some tracking integrity in case of uncertain quality of PPSREF fed to the SRO. Thus the Restart Tracking mode on the SRO must be restarted in case of Status=5.
- The user should include in his/her system design a specific logic ensuring the Restart Tracking mode capability. It can be a simple button on a front panel. The on/off control of the Restart Tracking is also possible remotely by sw. In such case, the sw control should assume this function.

11) Fast Q&A Support

If you have any questions about this AppNote, please feel free to contact us at fastsupport@temex.com.