How the KIWI-OSD Start-Up Sequence works.

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Abstract:-
Over 2000 KIWI-OSDs were built and production ceased in 2008, so the youngest is getting on to be 10 years old. The non-volatile FLASH memory inside the Garmin GPS receiver retains the almanac that was downloaded from the GPS satellite constellation when it was last used. The almanac contains the GPS-time to UTC-time offset value. The longevity of the non-volatile memory is unknown, both in terms of capacity and functionality.

Perhaps a Garmin GPS Receiver had a well-functioning non-volatile FLASH memory when it was new, however now in 2017+ the capacity and functionality of the non-volatile FLASH memory may be reduced or it may have failed completely. If indeed this is the case, and the observer has become complacent, then bad timings will result.

This paper is to remind KIWI-OSD users, How the KIWI-OSD Start-Up Sequence works and How to Listen to what their KIWI-OSD is telling them. The receipt of either the “ERROR USE FIELD COUNT” or “PREVIOUS TIMES OK” messages, together with good historical usage notes gives the user the opportunity to assess the reliability of the Garmin’s so-called non-volatile memory so the user can adjust their start-up procedure accordingly, so the correct time is time-stamped – every time.

Introduction:-
BEFORE Power is applied KIWI-OSD knows nothing about time. The GPS receiver should retain some sort of almanac that gives the GPS-time to UTC-time correction offset. At this stage the state of the almanac is unknown.

The almanac can have three states:-
1) Default Almanac – the almanac that was installed in the device when it was manufactured.
2) Memory Almanac – the almanac retained in the device memory from the time it was last used.
3) Current Almanac – the almanac that has been downloaded from the satellite constellation this session.

Note1:– It takes up to 12 or 13 minutes of uninterrupted reception to download the Current Almanac.

Note2:– “This session” means - providing KIWI-OSD with continuous and uninterrupted supply of power. Removal of power means this session has been terminated, which means the Current Almanac has been terminated.

Note3:– KIWI-OSD needs a video stream to be input, to be stamped and the output fed to a monitor of some sort, so the user can see the OSD messages. The supply of a video-in stream probably has little effect on the operations of the GPS receiver, however applying a video stream after start-up can affect the readability of the OSD messages, requiring a Reset to correct the OSD. The extra resets may affect the interpretation of the OSD messages, therefore it is recommended that a video stream is maintained throughout the observation session.

KIWI-OSD Reset-Button Messages
When the reset button is pressed, KIWI-OSD will output either a:-
- “PREVIOUS TIMES OK” message, or an...
- “ERROR USE FIELD COUNT” message.

The vast majority of KIWI-OSDs have a Garmin 18 LVC GPS receiver – the GPS hockey puck. This device stores the almanac in so-called non-volatile memory.

- If the non-volatile FLASH memory is working well, it will retain the Memory Almanac for many months – possibly indefinitely, therefore you will almost always get a “PREVIOUS TIMES OK” messages, and it’s only after the insertion of a leap-second where you will receive an “ERROR USE FIELD COUNT” message.
- However some Garmins have a defective non-volatile FLASH memory, which may last; overnight, a day or two, or a week or two. If the Memory Almanac is lost it will revert to the Default Almanac, therefore you will receive an “ERROR USE FIELD COUNT” messages more frequently depending on the capacity of the device’s memory.
- The author’s KIWI-OSD P#0001 has a Deluo GPS receiver that has a volatile memory - it loses the Memory Almanac instantly on power-down. The author has reports of some Garmins behave in this manner as well, therefore users will receive an “ERROR USE FIELD COUNT” messages every time KIWI-OSD is started.
- Neither message is good or bad. Receipt of either is just telling the operator the state of the Current Almanac, compared to the Memory or Default Almanac that was used when KIWI-OSD started, this session.
- Receipt of either message will occur only when the reset button is pressed.
KIWI-OSD Start-Up sequence and interpretation of background activities.
KIWI-OSD will display a series of messages during the start-up sequence and after the reset button is pressed.

a) Power is applied and KIWI-OSD waits for a GPS-fix, displaying one or the other messages. Once a fix is achieved the GPS outputs two types of signals;
   1) A 1 pulse per second (1pps) signal that is accurately aligned to the atomic time second tick.
   2) A serial NMEA sentence that describes the time of the last 1pps as well as other data like geolocation information. The UTC is calculated based on the Memory or Default Almanac.

b) The observer knows the GPS fix has been obtained when KIWI-OSD lists the current latitude and longitude.

c) KIWI-OSD goes on to list other data like satellite count, HDOP and current altitude etc.

d) And the current UTC date.

e) KIWI-OSD then starts a 1 to 9 count. While it is displaying the counts it is performing integrity checks and adjustments. One of these adjustments is to sample the rate of the 1pps signal and to make a correction to the internal clock so it runs exactly true.

f) By now KIWI-OSD has completed it’s checks and adjustments. It takes a final look at the time in the NMEA sentences, and from now on, it ignores the NMEA sentences completely. It increments the time display solely based on the repetition of 1pps signals.

g) KIWI-OSD time stamps the first field(s).

Sometime during the next 12 minutes or so of uninterrupted running, the GPS receiver downloads the Current Almanac from the satellite constellation and will output NMEA sentences with the correct time. This may be the same as the Memory Almanac that it obtained when it was last used, but it will be different from the Default Almanac. However KIWI-OSD does not know this, because it is ignoring the NMEA sentences.

When the operator presses the reset button (and only then), KIWI-OSD takes a look at the most recent NMEA sentence to get UTC, calculated using the recently downloaded Current Almanac.

h) If the time in the NMEA sentence is different from the startup time + ‘x’ number of 1pps signals, then KIWI-OSD outputs an “ERROR USE FIELD COUNT” message.

i) If the time in the NMEA sentence is the same as the startup time + ‘x’ number of 1pps signals, then it outputs a “PREVIOUS TIMES OK” message.
Interpretation of KIWI-OSD Start-Up Messages
If you have received “ERROR USE FIELD COUNT “ message then you know that the Memory Almanac that was used at start-up was not the same as the Current Almanac. So long as both the power and the video stream are maintained you can press the reset button again to force a restart and you can be confident that the time display is correct.

If you received a “PREVIOUS TIMES OK” message then you are left guessing; was the time I allowed to download the fresh almanac enough? Was the 12 minutes uninterrupted – did it get ½ way through the download, only to have the GPS receiver loose signal and have to start over.

Remember KIWI-OSD doesn’t output the satellite count while it is time-stamping, so apart from the satellite count display during start-up, you can’t use the satellite count as a gauge to estimate the quality of GPS signal over a period of time. So all the user can do is to make sure the Garmin Puck is sited is a favourable location – raised off the ground and well clear of obstructions. If this is so then;

1) In all likelihood, after a 12 minute run, you get a “PREVIOUS TIMES OK” message, then the time display after restart will probably be OK.
2) It is only after receipt of either an “ERROR USE FIELD COUNT” or a “PREVIOUS TIMES OK” message can KIWI-OSD be considered to be in a fit-state to be used to time astronomical events.
3) It’s only the receipt of constant stream of “PREVIOUS TIMES OK” messages that will give confidence that KIWI-OSD display is correct.
4) After KIWI-OSD has been used to time an astronomical event, the receipt of a “PREVIOUS TIMES OK” message will guarantee the event timings are true.

Calibration of the Field Counter
In order to avoid the disaster of an unrecoverable event timings due to an unexpected “ERROR USE FIELD COUNT “ message after the observation, the only way you can indeed use the field counts to salvage your observation is if you;

a) are confident that KIWI-OSD is displaying the correct time as outlined in the “Interpretation of KIWI-OSD messages” section above, and
b) have taken the precaution to record the start-up sequence and, say 10 seconds of running. Doing will calibrate the field counter, so that field counting from calibration can be used to determine event times.

Recommendation
It is recommended that a note book be kept that simply lists the date and time KIWI-OSD was last used. Then a study of the reliability of the non-volatile memory in the Garmin GPS Receiver can be assessed, by careful examination of the Reset Messages. Only then can steps be taken to avoid erroneous time-stamps in future observations, and therefore build confidence in the KIWI-OSD time-stamps, so the old KIWI-OSD can remain a reliable device.

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Note:1 Unless the Kiwi/Garmin has not been used for a long time. With one example device that was unused for 7 years and upon application of power it displayed “RS232 OR 1PPS ABSENT” for the 12.5 minutes it took to download the Current Almanac.
Ref1:- Wiki https://en.wikipedia.org/wiki/Global_Positioning_System#Timekeeping
Ref2:- KIWI-OSD https://sites.google.com/site/kiwiosd/