IVS Memorandum 2014-001v01

29 April 2014

"IVS Recommended Maser Timing Practices"

Roberto Ambrosini, Tom Clark, Brian Corey, Ed Himwich

IVS Recommended Maser Timing Practices

Roberto Ambrosini, Tom Clark, Brian Corey, and Ed Himwich, 2014/04/29

We recommend the following practices for management of the 1 PPS derived from the Maser and used as the station 1 PPS. Its synchronization with UTC as derived from the GPS 1 PPS offers a common timing reference for all VLBI stations worldwide. In this memo, we refer to the difference in the epochs of the Maser and GPS 1 PPS signals, as measured by a counter, as the Maser/GPS offset, regardless of which signal is later.

Because it is evident that crossing zero time for the Maser/GPS offset should be carefully avoided (the counter would read the complement of one second of the desired delay, arithmetic processing of data by the counter not being recommended), we recommend keeping the offset at a small but significant distance from zero and its drift rate positive.

We also recommend keeping the time and frequency retuning of the Maser at a minimum, typically no more than once in a year.

This procedure offers: less work at the station, better modelling of the long term drift of the Maser, and a better chance to identify jumps in the offset.

Here follow some practical recommendations for the Maser/GPS offset:

(1) Either the Maser 1 PPS or the GPS 1 PPS can occur first.
(2) The offset should be significantly, at least a few microseconds, different from zero.
(3) The offset should not be too large, a useful upper limit might be on the order of 100 microseconds.
(4) The offset should be growing slowly, typically less than 0.1 microseconds/day.
(5) The offset should not be adjusted unnecessarily, no more often than once per year if possible.
(6) Items (2)–(5) are only recommendations and may not be feasible in some situations and do not need to replace existing successful practice at any station. However to the extent it is reasonable, stations should align themselves with these practices.

Recommendation (1) is a recognition that different stations have different preferences for which 1 PPS occurs first: Maser or GPS.

Recommendations (2)–(4) are intended to minimize both the need to re-tune the Maser and the chances of the offset going through zero.

Recommendation (5) is intended to make it easier to relate the offset data from one experiment to another.

For completeness, the following *requirements* (as opposed to recommendations) are listed for the FS log recorded offset between GPS and formatter 1PPS signals, the "GPS/FM offset". These requirements are necessary to allow correct interpretation of the offset data

downstream. Please note that these requirements deal with the GPS/FM offset, which is related to, but different from Maser/GPS offset discussed above. In addition to the GPS/FM offset, stations can, and are encouraged to, record (appropriately labelled) additional available clock offset data, including the Maser/GPS offset, in their FS logs or separately.

The requirements for the GPS/FM offset recorded in the FS logs are [note the continuing numbering scheme, that is, starting this list at (7), to avoid confusion]:

(7) The offset is positive and small, i.e. close to (but not too close to) zero and NOT close to one second. If the recommendations (2)–(4) for the Maser/GPS offset above are used for that offset, they are likely to also be true for the GPS/FM offset as well. In any event, the GPS/FM offset should not cross zero in normal usage.

(8) The offset is recorded with either of two possible commands depending on how the counter is connected. The connections should be chosen to agree with (7) and:
   (A) If the counter is started by the GPS 1 PPS, use the "gps-fmout" command. This should be the case if the formatter output 1 PPS (typically determined by the Maser) is late.
   (B) If the counter is started by the fmout 1 PPS, use the "fmout-gps" command. This should be the case if the GPS 1 PPS is late.

   It will be necessary to change which command is used if which signal is late changes. This should not be needed if recommendations (2)–(4) for the Maser/GPS offset are followed.

(9) The offset counter does not use arithmetical processing. It just reports the "raw" difference in time between the start and stop signal. So for example, the small positive offset in (7) is not achieved by subtracting the raw difference from 1 second.

(10) The offset counter does not use averaging. This allows immediate detection of jumps. Averaging can be applied in post processing of the data.

(11) The offset must be measured at least once per scan in MIDOB. Additional measurements are acceptable as well.