

Setup and Operation of Local and Remote PhaseID System Base Stations

Introduction

The Origo PhaseID System identifies phase attributes in a power distribution system by using a GPS timing signal to simultaneously measure voltage phase at a base location and at a field location. By comparing the unknown phase at the field location to the known phase at the base location, the unknown field phase attribute can be determined.

This white paper explains how to setup and operate both local and remote base stations. A local base station is one located within the utility's area of operation. A remote base station is one located outside the utility's area of operation.

This paper assumes the base station is already installed and the user is familiar with how to operate the base station software.

Local Base Station Phase Attribute Setup

Step-by-step instructions for setting up and using the base station can be found in the installation and operating manuals that come with the base station. The original version base station software uses a manual method for setting up the base station phase attribute. The new base server software version (that support the PhaseID Datalogger field probes) uses an auto configuration method. However, both software versions are based on the same basic principal as described in this section.

The base station software Phase Attribute table under the Setup "System" tab is based on the phase diagram in Figure 1. This diagram illustrates the relative phase offsets of all 12 possible secondary phase attributes. Leading phase is in the counterclockwise direction. Lagging phase is in the clockwise direction.

To setup the original version, the field probe obtains a primary phase measurement on tagging reference phase A at a substation. The base station software is initially set to phase A and Secondary connection so that all 12 phase attributes will be indicated. If the field measurement indicates phase A, then the base station 120V wall outlet is also phase A.

However, if the field measurement indicates phase AB, then the substation is leading the wall outlet by 30 degrees so the base station phase attribute must be changed to 30 lagging so the base station will correctly

Origo PhaseID System
Base Station
"ABC" Phase Attributes

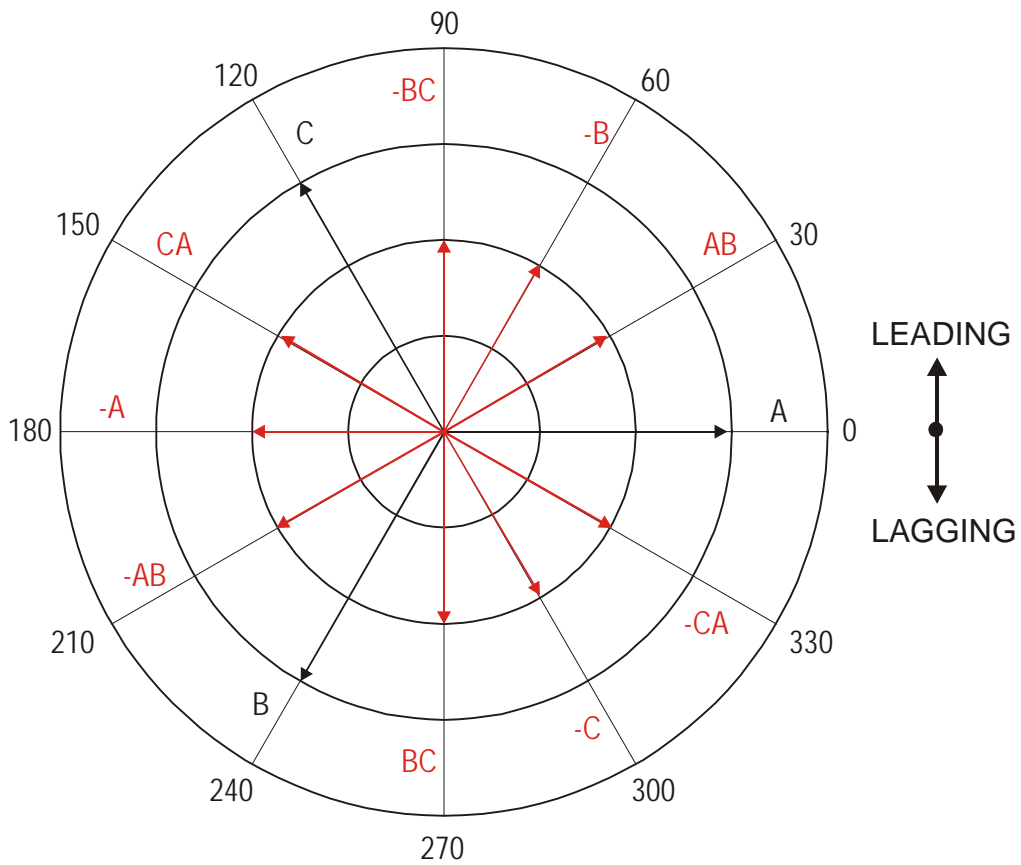


FIGURE 1

indicate the substation as phase A. The phase diagram indicates that 30 degrees lagging is phase attribute – CA. Thus, the original version software "Help" screen table (reproduced below) indicates to set the base station to phase attribute –CA if attribute AB as obtained from the substation measurement.

<u>Attribute obtained</u>	<u>Set base to</u>
A	A
AB	-CA
-B	-C
-BC	BC
C	B
CA	-AB
-A	-A
-AB	CA
B	C
BC	-BC
-C	-B
-CA	AB

Likewise, if the substation attribute –B was obtained, then the base station attribute must be set 60 degrees lagging which is attribute –C. The rest of the table is obtained following this same procedure.

The PhaseError1 reported indicates that the differential phase measurement between the field probe and base station is not an exact multiple of 30 degrees. If a PhaseError1 of 5 degrees is reported, it means that the field probe measurement leads the indicated attribute by 5 degrees. To correct this static offset, simply set the Primary Offset and the Secondary Offset to 5 degrees in the software setup screen. Fine adjust all the offsets over time as described in the base station installation and instruction manuals.

The new base server software eliminates the “Help” screen table. Instead, an “Auto Config” button is provided on the Setup “System” tab. Simply click on this button and select the phase attribute for the tagging reference phase measurement sequence entered. The software will automatically determine the base station phase attribute and offset of the wall socket required to correctly display the substation measurement tagging reference phase on the main screen.

Remote Base Station Phase Attribute Setup for Permanent Users

If you don't have access to a local base station, but instead use a remote station as your default or permanent base station, then the setup procedure is essentially the same as for a local base station. The only difference is that you must obtain your field probe measurement data prior to downloading the base station data. Remote base station data is uploaded every 10 minutes so field probe data must be gathered up to 10 minutes prior to downloading the remote base station file.

Obtain at least two substation field probe measurements for redundancy. Also obtain a few other other Primary, Secondary, and Capacitive measurements at other locations in which the phase attributes are known. These additional measurements can be used to test the PhaseID System installation and setup.

After the remote base station file is downloaded, setup the base station in the same way as described in the last section for the local base station.

Remote Base Station Phase Attribute Setup for Intermittent Users

This section describes a remote base station setup for the situation where you normally use a local base station, or you are a permanent user of a different remote base station. If the data from your local or permanent base station is not recorded or lost, it can be replaced using the data from a remote base station.

A map of remote base stations, and the procedure for downloading the data, is available under Downloads at www.origocorp.com. Place the remote base station file in a new directory and create a new configuration file so you don't have to change the file pointer and offsets back to their original values next time you use your normal base station. For example, call it Phoenix_remote.pid if the data was from the remote Phoenix, AZ base station.

To determine the phase attribute and offset for a remote base station, you must have a field probe measurement from one or more locations in which you know the phase attribute. The more recent these measurement

have been taken the better. Typically, these locations will be ones you had obtained and identified during the last few days using your local or permanent remote base station.

To setup the new remote station, you would first retrieve the remote base station data file for the day in which you obtained field probe measurements at phase identified locations. These field measurements would be used to determine the remote base station phase attribute and offsets for that day. These same attribute and offsets would then be used for the remote base station on the day of the lost data file.

The phase attribute could be setup using the same procedure as explained in the last two sections if a known phase A measurement is available (any known phase measurement for the base server software version). The following procedure allows the remote base station to also be setup using measurements from any phase identified location for the original base station software version. Here is how it works.

Suppose you had a field probe Secondary measurement available from a location in which you knew the phase attribute was $-CA$ in an "ABC" phase sequence system. Using the same base station attribute and offsets as your normal base station, determine the phase attribute of this location using the new remote base station data file. Suppose it indicated the phase attribute was B with a PhaseError1 of 8 degrees.

Referring to the phase diagram in Figure 2, the remote base station indicates the field attribute is leading B by 8 degrees thus placing it at 248 degrees on the chart. However, the location was previously identified to be at phase $-CA$ or 330 degrees. This indicates that the remote base station lags the true phase by 82 degrees ($330 - 248$). A lagging differential phase of 82 degrees means that -82 degrees must be added to the existing base station offsets. Therefore, add -82 to the Primary offset, the Secondary offset, and the Capacitive offset. Now, the remote base station will indicate the field attribute to be $-CA$ as was previously identified.

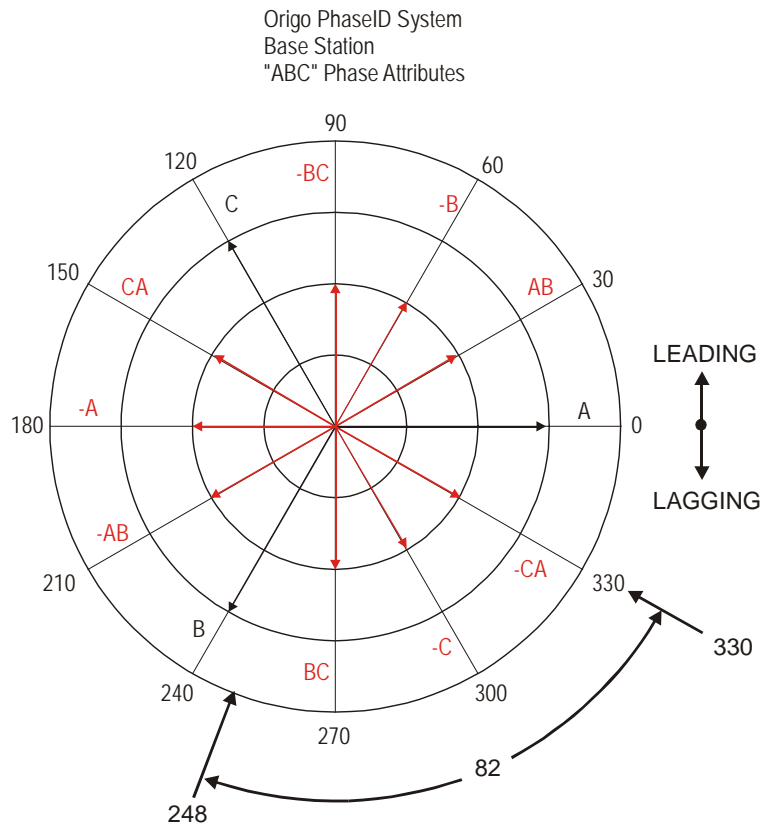
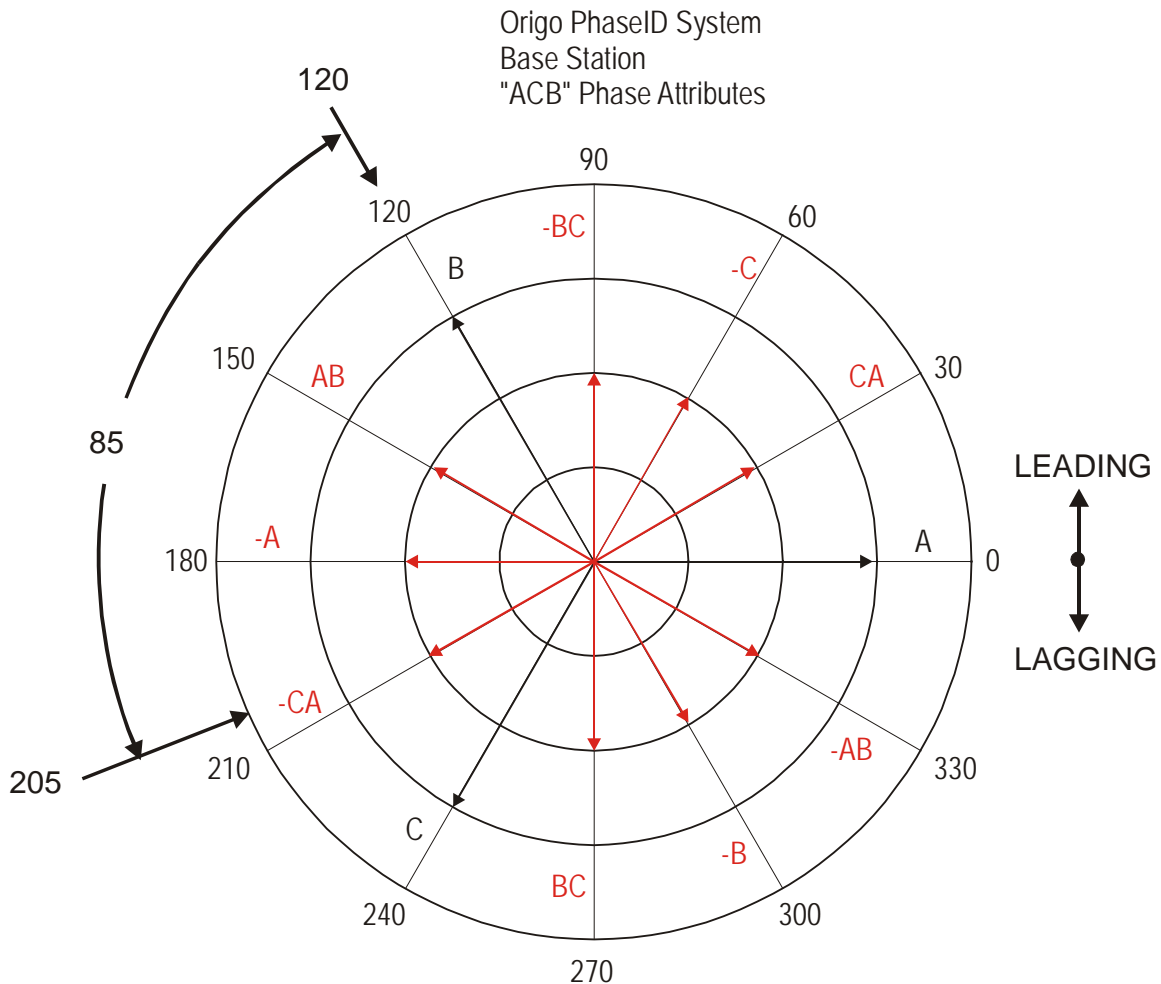


FIGURE 2

This technique can also be used for Primary and Capacitive measurements. Suppose a phase B field probe location measurement indicated phase C with a PhaseError1 of -35 degrees in an "ACB" phase sequence system. Referring to the phase diagram in Figure 3, the remote base station indicates the field attribute is lagging C by 35 degrees thus placing it at 205 degrees on the chart. However, the location was previously identified to be at phase B or 120 degrees. This indicates that the remote base station leads the true phase by 85 degrees (205 - 120). A leading differential phase of 85 degrees means that 85 degrees must be added to the existing base station offsets. Therefore, add 85 degrees to all the offsets.

With this procedure in mind, along with the discussion of remote base station static phase offsets in the next section, it would be a good practice to always obtain one or more field probe measurements at a previously identified location every GPS day in which field probe measurements are collected. Doing so will always ensure that recent measurement data is available for removing remote base station static phase offsets if the normal base station data is unavailable.



Remote Base Station Static Phase Offset

Within each national grid, phases from every location are correlated. However, a static phase shift exists between any two locations and the value of this phase shift changes over time. For locations close to each other, the shift is small and changes are small. For large distances between locations, the shift can be large and can change significantly over time.

The instantaneous phase shift between Phoenix and San Diego for a series of consecutive GPS days is illustrated in the Appendix. Over the 8 day period, the static phase shift varied from about 305 to 335 degrees. From month-to-month, the variation will most likely be even larger. This illustrates why recent field probe measurements from phase identified locations must be available to determine the current offsets.

For Primary phase attributes, a phase error of plus or minus 60 degrees is required before an incorrect phase attribute is indicated. Therefore, static phase shifts on the order of those illustrated in the Appendix are not a problem for Primary attribute identifications.

For Secondary attribute identifications, only a plus or minus 15 degree phase error is required to indicate the wrong Secondary attribute. Caution must be exercised when using a remote base station to identify Secondary attributes.

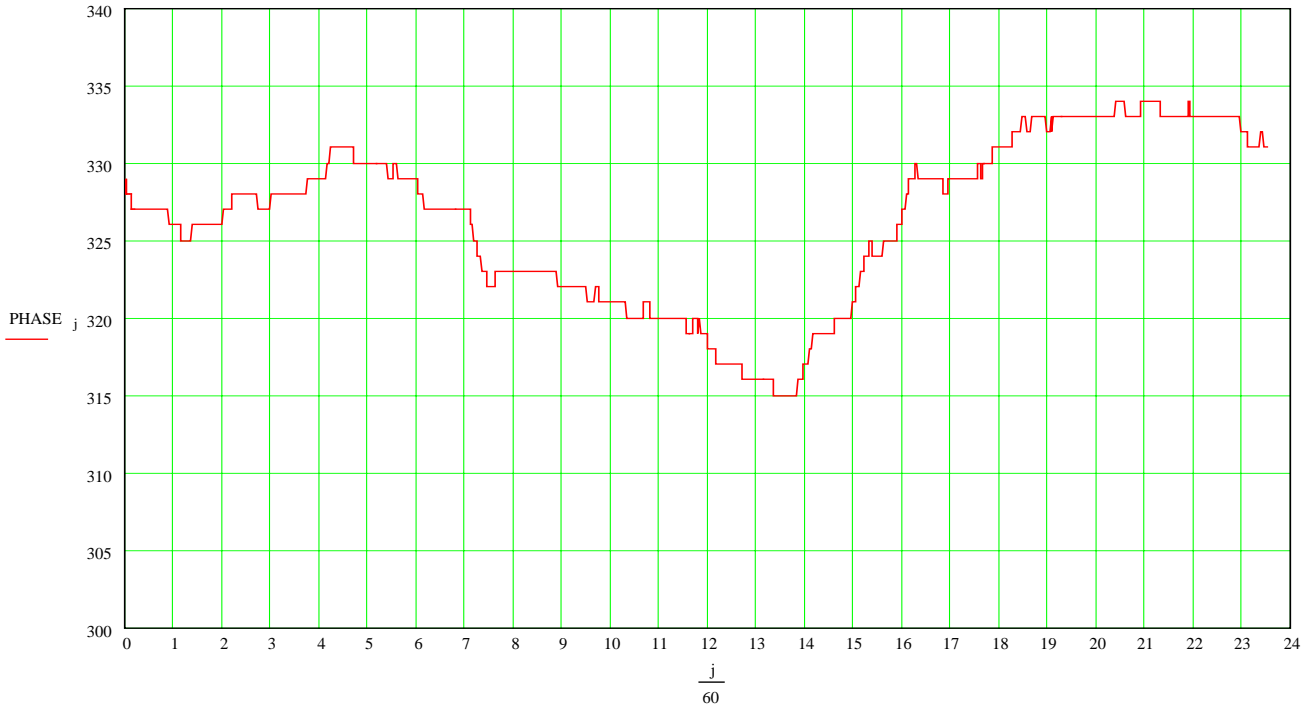
Since static phase changes slowly during the day, the following technique can be used when entering many Secondary measurements gathered throughout the day into the base station software. Enter the Secondary sequences in the time order in which they were gathered. Observe the PhaseError1 values as you identify the attributes. If it starts to grow in one direction, modify the offsets to keep the error low. For example, suppose the initial errors were on the order of -2 degrees when you started gathering data and grew to -10 degrees a few hours later. Simply add -10 to the existing offsets and continue. This will reset the errors back to zero again and greatly reduce the probability of a particular measurement exceeding -15 degrees and thus indicating the adjacent lagging attribute instead of the correct one.

Keep in mind that rare fault conditions on the grid can temporarily cause large immediate static phase shifts for distant remote base stations. Examples of the phase shifts that can occur are described in reference 1. These large shifts could invalidate a few of the phase measurements taken near the time of the disturbance. However, they would probably be indicated by unusually large PhaseError1 values. If you learn about a large grid disturbance between you and a remote base station, be cautious of any data taken near the time of the disturbance. Fortunately, such disturbances are rare.

References

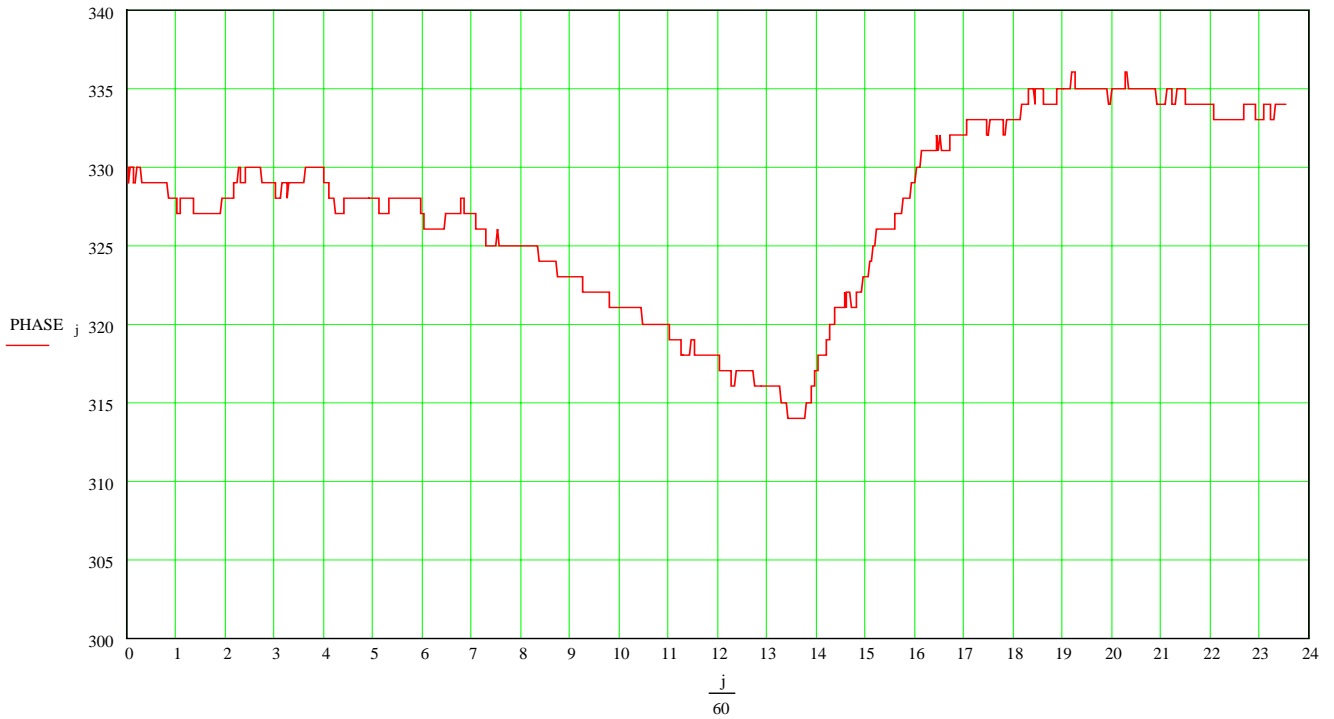
1. "Monitoring the Power Grid"; Bhargava & Rodriguez; Transmission & Distribution World, December 2004.

Appendix



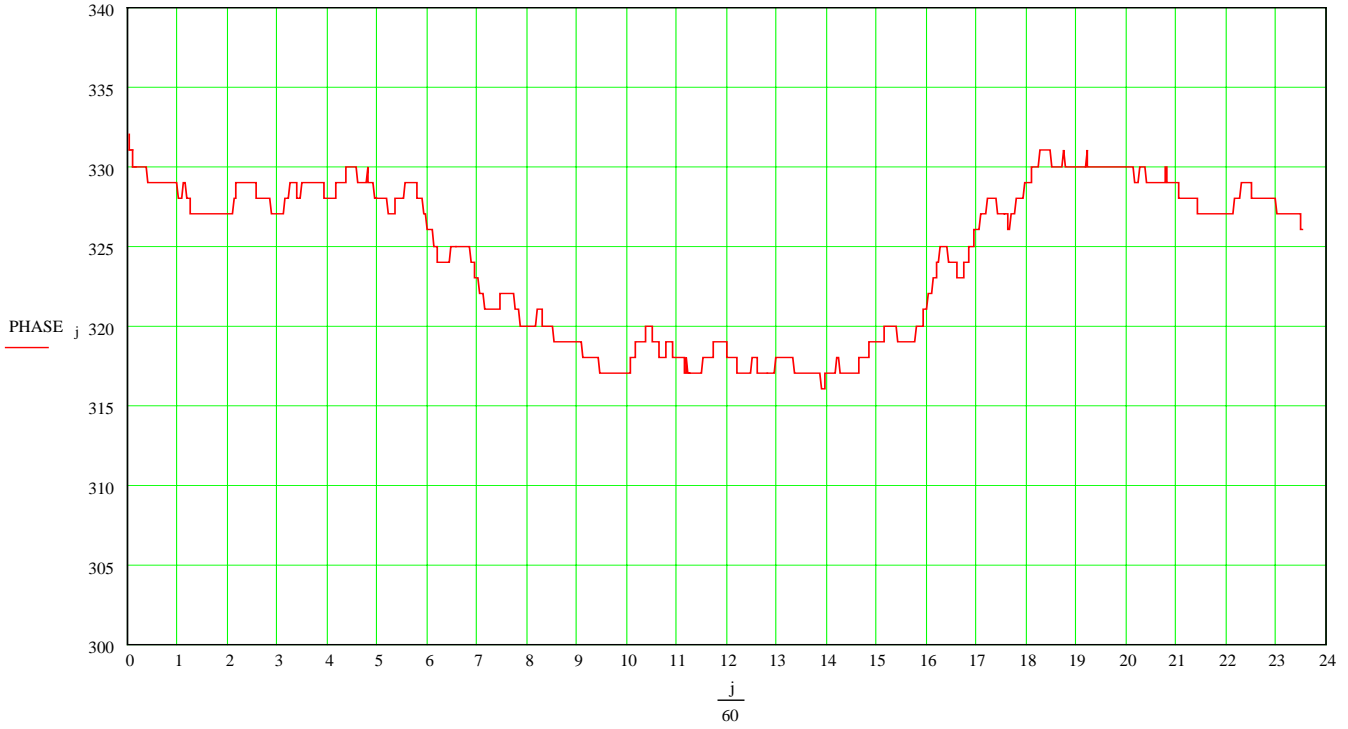
Phoenix to San Diego

Hours of GPS day 1313_4



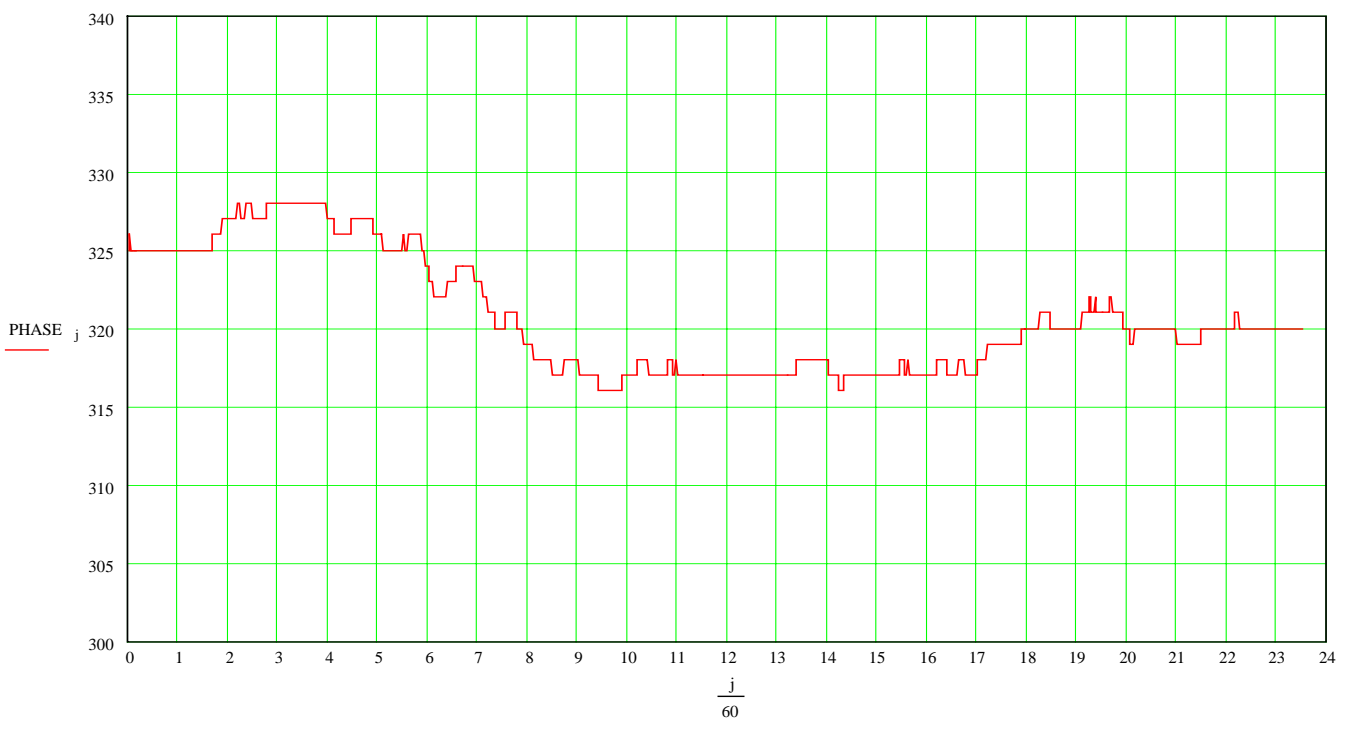
Phoenix to San Diego

Hours of GPS day 1313_5



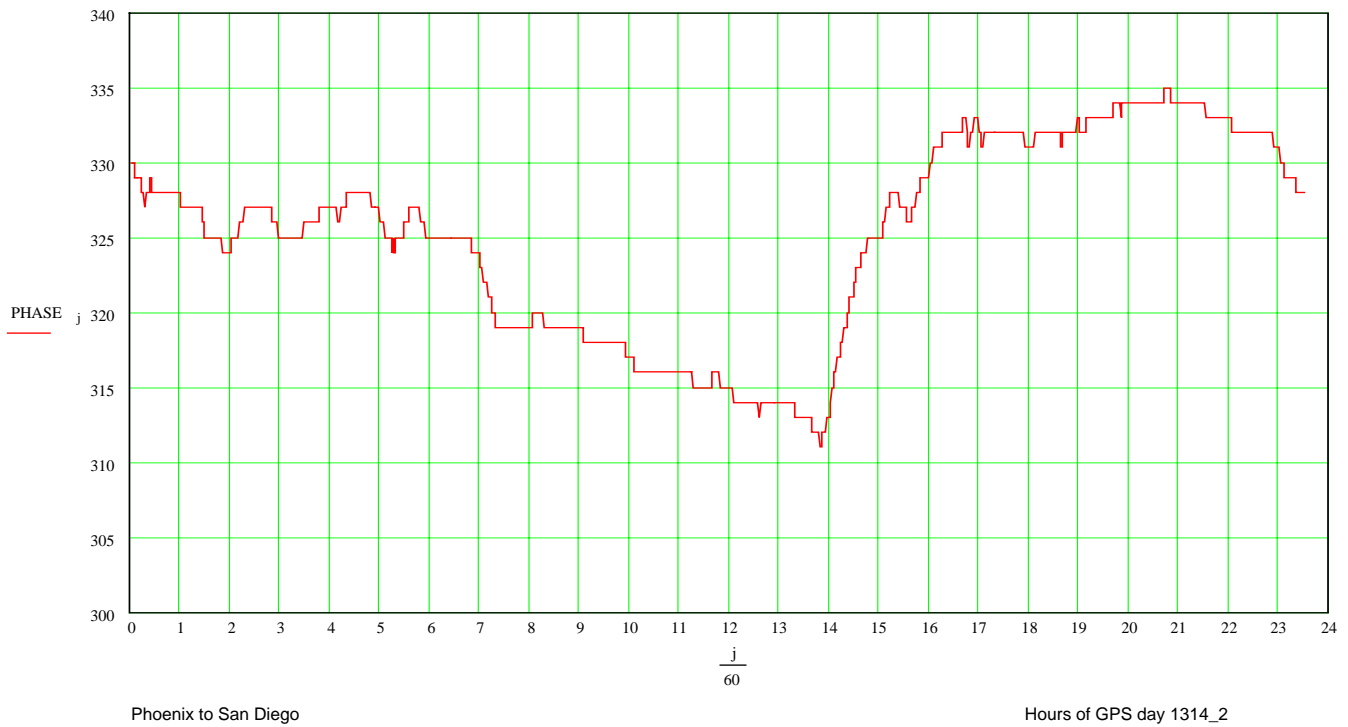
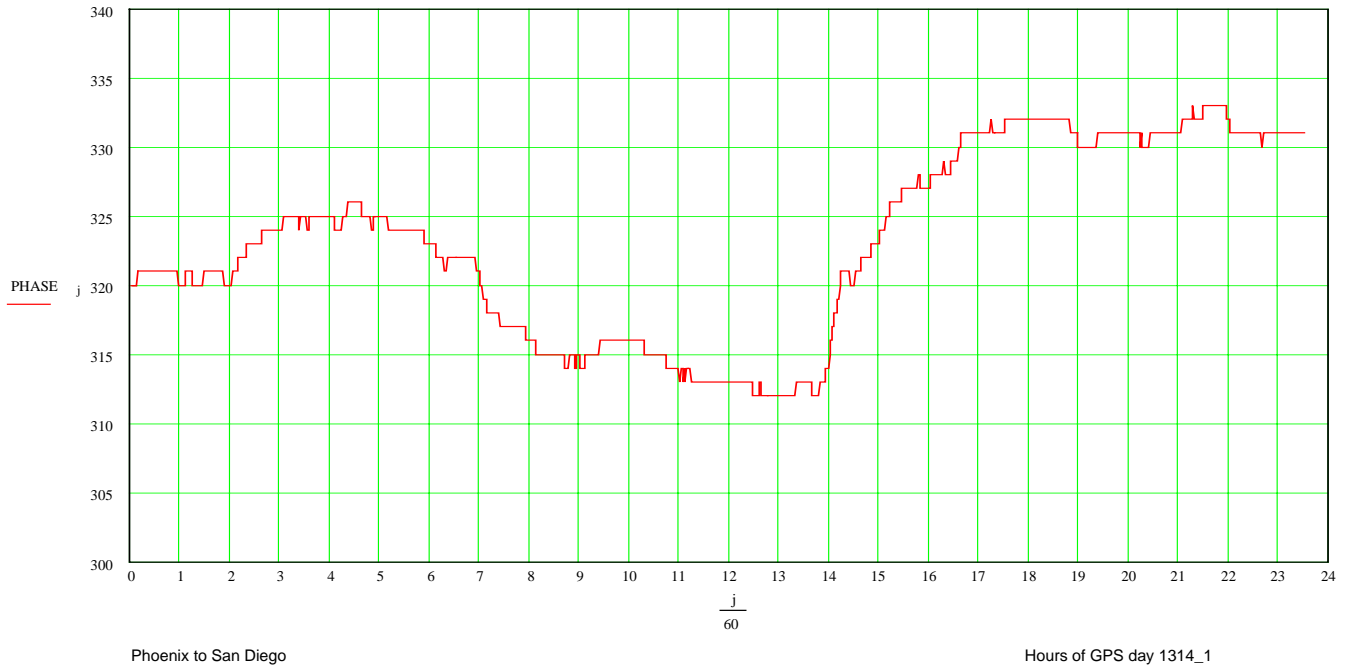
Phoenix to San Diego

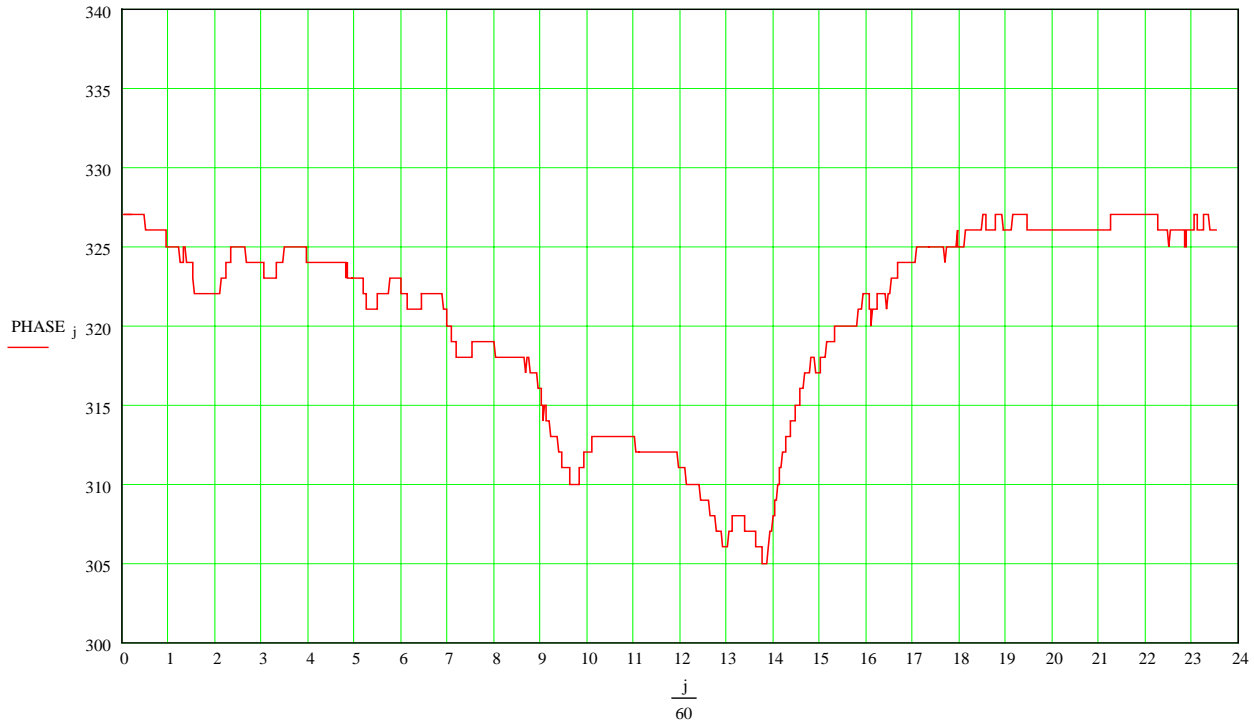
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Phoenix to San Diego

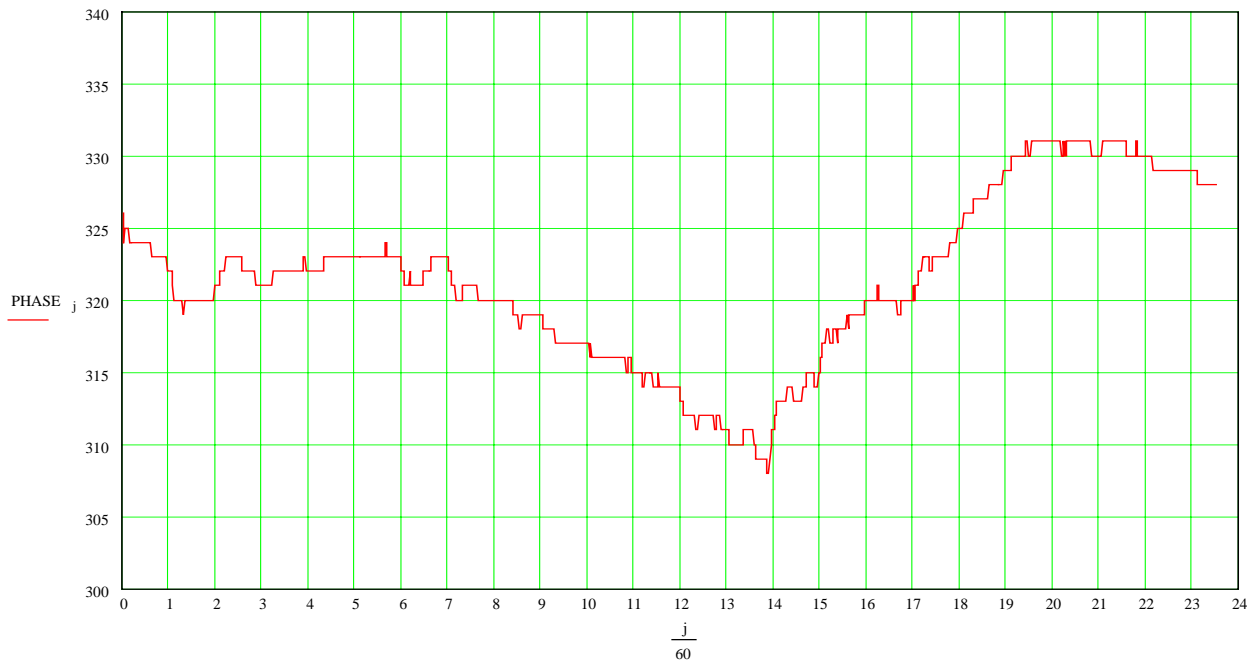
Hours of GPS day 1314_0





Phoenix to San Diego

Hours of GPS day 1314_3



Phoenix to San Diego

Hours of GPS day 1314_4