

# **Time Calibrator**

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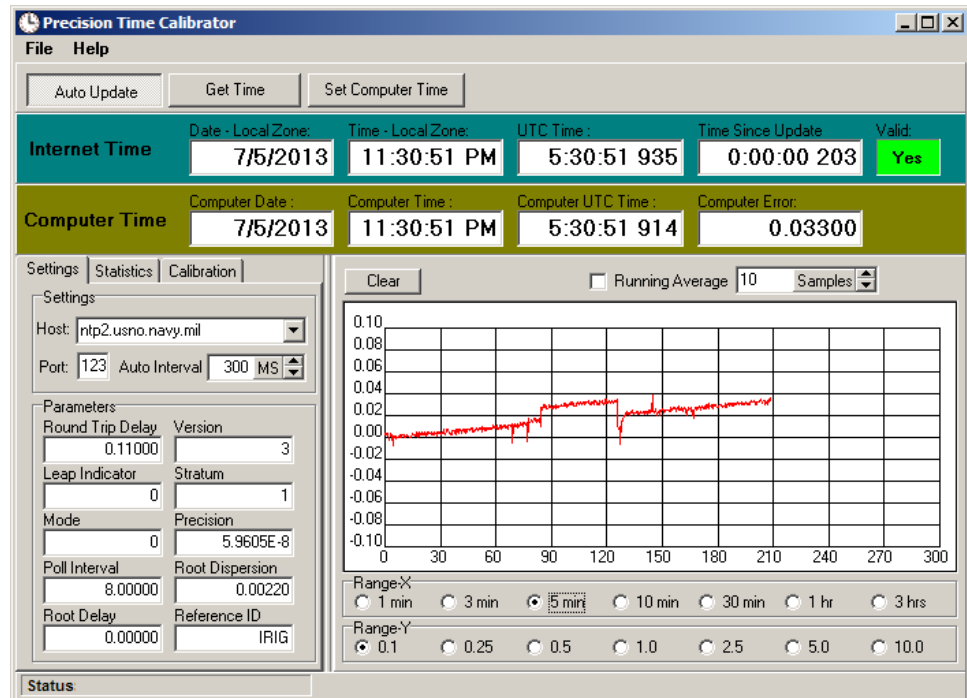
**Part**



# 1 Index

The Precision Time Calibrator is a tool for analyzing and controlling the performance of the Real Time clock in a PC. The program queries atomic clocks on the internet and compares these high precision time bases to the current time in your computer. It then displays any error between your computer and the atomic clocks. The display shows the absolute error as well as the a graph of how the error changes over time. This makes it easy to see exactly how much the clock on a PC drifts over time and allows you to make adjustments to correct for drift.

- Requirements
- Getting Started
- Tool Bar
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- Settings/  
Parameters
- Statistics
- Calibration
- Graph
- Time Servers



## 1.1 Requirements

**Requirements.** The Precision Time Calibrator requires a connection to the Internet to operate. If you have a dial-up connection, you may have to initiate a connection before you run the program.

## 1.2 Getting Started

**Getting Started.** After you have started the program, press the Auto-Update button. The program will begin requesting time information at regular intervals. As the information is received, the difference between the PC time and UTC will be displayed and graphed.

## 1.3 Tool Bar

**A. Tool Bar.** The Tool Bar runs along the top of the window and contains buttons that control the operation of the program.



Here is a description of the buttons:

1. **Auto Update Button.** When this button is in the down position, the program automatically requests time data at regular intervals. (Setting the interval is described below.)
2. **Get Time Button.** Pressing this button retrieves one time sample from the Internet.
3. **Set Local Time.** Pressing this button causes the program to synchronize the PC clock to the Internet Time. Synchronization will be to within a few milliseconds of UTC time.

## 1.4 Time Displays

**Time Displays.** The Time Display section shows detailed information about Internet time and the Computer Time.

<b>Internet Time</b>	Date - Local Zone: 7/5/2013	Time - Local Zone: 11:18:37 PM	UTC Time : 5:18:37 031	Time Since Update 0:00:00 204	Valid: Yes
<b>Computer Time</b>	Computer Date : 7/5/2013	Computer Time : 11:18:37 PM	Computer UTC Time : 5:18:37 393	Computer Error: 0.10500	

Here is a description of each item:

**I. Internet Time.** The Internet Time section shows time data from the the most recent internet time request. The time will be static unless the Auto Update button on the Tool Bar is down.

1. **Date - Local Zone.** This item displays the Internet date adjusted to the local Windows time-zone settings.
2. **Time- Local Zone .** This item displays the Internet time adjusted to the local Windows time-zone settings.
3. **UTC Time.** This item displays "Coordinated Universal Time" based on the values returned time servers.
4. **Time Since Update.** This value is the time since the computer received its last update from an Atomic Clock Time server. The value is displayed in hours, minutes, seconds and milliseconds.
4. **Valid.** This indicates where the last time received by the program was valid. Time samples can be invalid if the data is corrupted during transmission, the time-server does not respond or if there is problem with the time-server. They can also be invalid if there is no Internet connection.

**II. Computer Time.** The Computer Time section shows the time data from your computer's "Real Time Clock." The display is updated at the rate specified in Settings Section.

**1. Computer Date.** This item displays the computer date adjusted to the local Windows time-zone settings.

**2. Computer Time .** This item displays the computer time adjusted to the local Windows time-zone settings.

**3. Computer UTC Time.** This item displays "Coordinated Universal Time" based on the computer's Real-Time clock.

**4. Computer Error.** This items shows the difference between the computers clock and an Internet Atomic Clock. The Value is specified in seconds.

## 1.5 Settings/Parameters

The Settings page is divided into two sections. Here is a description of each:

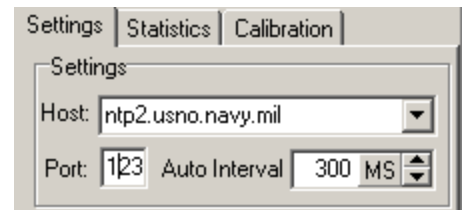
**I. Settings.** The Settings Section controls how the time information is retrieved. Here is a description of each item:

**1. Host.** This list contains a number of valid "Time Servers". Each Time Server will return valid time information, although some are more accurate. Currently, the list is sorted so the most accurate servers are at the top of the list.

**2. Port.** This item is the port number through which time information is requested. For most applications, this number will always be 123.

**3. Interval.** This value is the interval between sample requests in milliseconds. The more often the time server is queried, the more accurate the display. However, due to Internet delays, it may be difficult to query a server more often than the four time per second or 250 milliseconds.

Some servers such as the NIST government servers, limit how rapidly you can query these servers. Typically



**II. Parameters.** The parameters section displays values returned from the time server or calculated based on time-server data.

Here is a description of each item:

**1. Round Trip Delay.** This is the time it takes for a request to travel to the server and return to the PC. This information is used compensate for delays to accurately display the time and set the PC clock.

**2. Local Error.** This is the difference between the PC clock time and time server time in seconds.

**3. Leap Indicator.** This item is used to indicate that a leap second will be inserted/deleted in the last minute of the current day. The code values have the following meanings:

Value	Meaning
0	no warning
1	last minute has 61 seconds
2	last minute has 59 seconds)
3	alarm condition (clock not synchronized)

**4. Version.** This item indicates the version of the Network Time Protocol being used. The current version is 3.

**5. Mode.** This item indicates the mode of the server. The mode values have the following meanings:

Code	Meaning
0	reserved
1	symmetric active
2	symmetric passive
3	client
4	server
5	broadcast
6	reserved for NTP control message
7	reserved for private use

**6. Stratum.** This is indication of the quality of the time source. Stratum-1 clocks are directly connected to a high accuracy time source such as an atomic clock. Stratum-2 clocks are connected to Stratum-1 clocks over a network. Likewise, Stratum-3 clocks are connected to Stratum-2 clock via a network. Higher stratum numbers indicate less accuracy and level adds about 10-100 milliseconds of error.

**7. Poll Interval.** This item displays the minimum interval between messages that the server will support.

**8. Precision.** This item displays the precision of the clock or oscillator that provides the time for a reading. For example, 9.3132E-10 would indicate a 1-gighertz clock ( $1/9.3132E-10 = 1,024,002,830,8300.$ )

**9. Root Delay.** This is item indicates the total roundtrip delay to the primary reference source.

**10. Reference ID.** For Stratum levels of two and above the field displays the IP address of the clock. For Stratums 0 and 1 the item indicates the type of clock that is used as the time reference. Here is a list of codes in use:

Parameters	
Round Trip Delay	Version
0.11000	3
Leap Indicator	Stratum
0	1
Mode	Precision
0	5.9605E-8
Poll Interval	Root Dispersion
8.00000	0.00229
Root Delay	Reference ID
0.00000	IRIG



Stratum	Reference ID	Description
0	CND	DCN routing protocol
0	NIST	NIST public modem
0	TSP	TSP time protocol
0	DTS	Digital Time Service
1	ATOM	Atomic clock (calibrated)
1	VLF	VLF radio
1	LORC, OMEG	Radionavigation services
1	GOES	GOES UHF environment satellite
1	GPS	GPS UHF satellite positioning
1	ATOM	Atomic clock
1	PPS	Precision pulse-per-second source
1	ACTS	Automated Computer Time Service
1	TIME	UDP/Time Protocol
1	TSP	Unix Time Service Protocol
1	DTSS	Digital Time Synchronization Service
1	CHU, DCF77, MSF, TDF, WWV, WWVB, WWVH	Radio time services

## 1.6 Statistics

**Statistics.** The program captures the error data over time so that statistical information about the PC clock can be produced. Here is a description of the statistical controls:

- 1. Calculate Button.** Pressing the Calculate Button calculates all statistics on the samples that have been gathered.
- 2. Clear Button.** Pressing the Clear Button clears all accumulated samples.
- 3. Min/Max.** This item displays the Minimum and Maximum error value found in the samples.
- 4. Count.** This item displays a count of the total number of samples gathered.
- 5. Mean.** This item displays the average or mean of all the samples gathered. This display is only updated when the Calculate Button is pressed.
- 6. STD.** This item displays the Standard Deviation of all the samples gathered. This display is only updated when the Calculate Button is pressed.

## 1.7 Calibration

**Calibration Page.** The calibration Page contains tools that allow you to adjust Windows time information so it is more accurate. The Windows system clock is incremented periodically to advance the system clock. By varying the amount the clock is increments, you can speed up and slow down the clock. The following controls are available for adjusting the Windows clock:

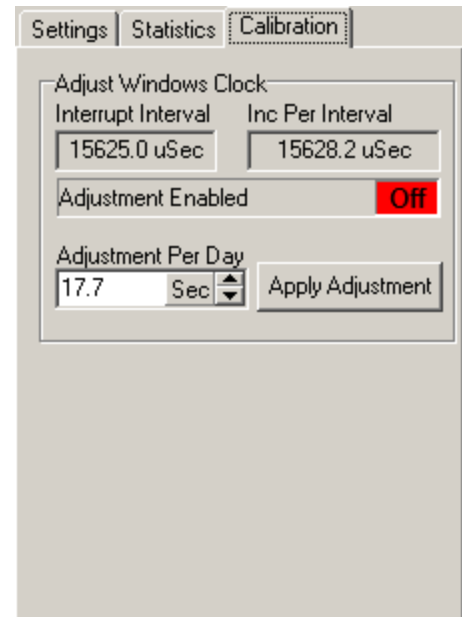
**1. Interrupt Interval.** The Windows clock is incremented through a regularly occurring interrupt. This item displays the interval between interrupts in microseconds.

**2. Inc Per Interval.** This item displays the number of microseconds the clock is incremented at each interrupt. If there is not adjustments, the increment will be the same as the interrupt interval. To increase the clock speed you would increase the number of microseconds. To slow the clock, you would use a smaller number of microseconds.

**3. Adjustment Enabled.** This option displays or sets the whether the adjustment options is enabled or disabled. Clicking on control will toggle the value. Pressing the "Apply Adjustment" button will set Windows to match the value.

**4. Adjustment Per Day.** This options allows adjust the time in units of seconds per day. Changing this options changes the "Inc Per Interval" proportionally. Pressing the "Apply Adjustment" button will set Windows to match the value.

**5. Apply Adjustment Button.** Pressing this button sends the values described above to Windows.

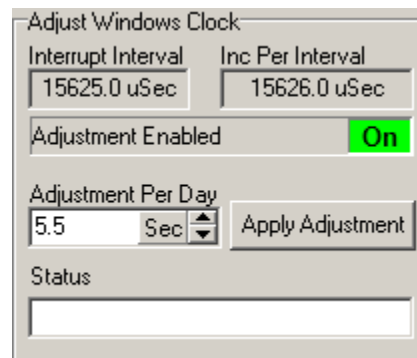
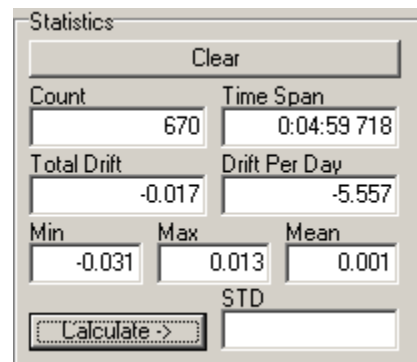


**Calibration Procedure.** To Calibrate the Windows Clock, you start by looking at the "Drift Per Day" value on the Statistics Page. It is a good idea to press the Clear Button and allow the Drift to settle for 5 or 10 minutes so that random variations in the Drift will averaged out.

The example to the right shows that a Drift Per Day of about -5.5 second per day. This means the close will lose 5.5 second during the course of a day.

Since the clock is losing 5.5 second per day, we need to adjust the clock so it adds 5.5 seconds to the clock during the course of the day.

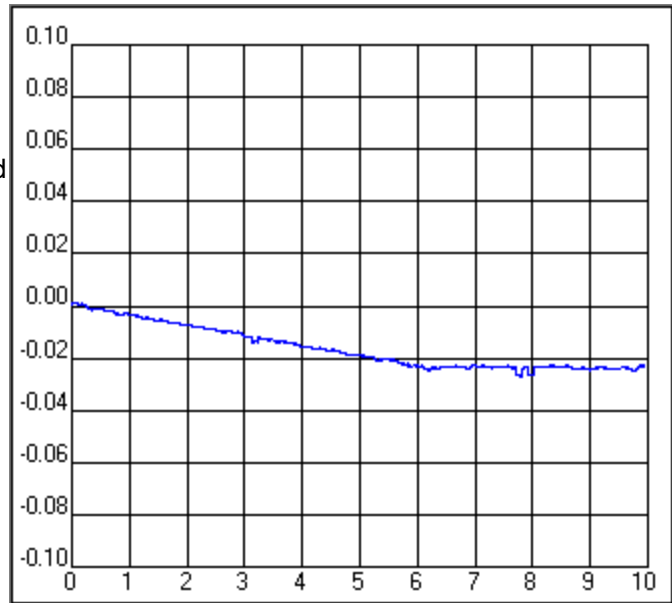
The example to right shows an adjustment that adds 5.5 seconds to the clock every day. Once the value is set, click on the "Adjustment Enabled" option so the displays "On." Finally, press the "Apply Adjustment" button. The program will then set the Windows clock to add the proper number of nanoseconds to add 5.5 seconds per day.



The graph to the right shows the time-error before and after the 5.5 second adjustment has been added. As you can see, the error is slowly drifts to -0.02 over the first five minutes of the graph. Once the adjustment has been applied, the clock stops drifting and maintains the same error level for second half of the graph plot.

You can use the graph to fine-tune your adjustment. For example, if the clock continues to drift after an adjustment has been applied, you can make small incremental changes to the adjustment to cancel out all error.

Note that certain high intensity activities on the computer can effect the error levels. For example, if you are running a high frame-rate computer game, delays in the clock updates can cause the clock to temporarily report larger errors. In general, it is best shut down other programs while you are calibrating the clock.



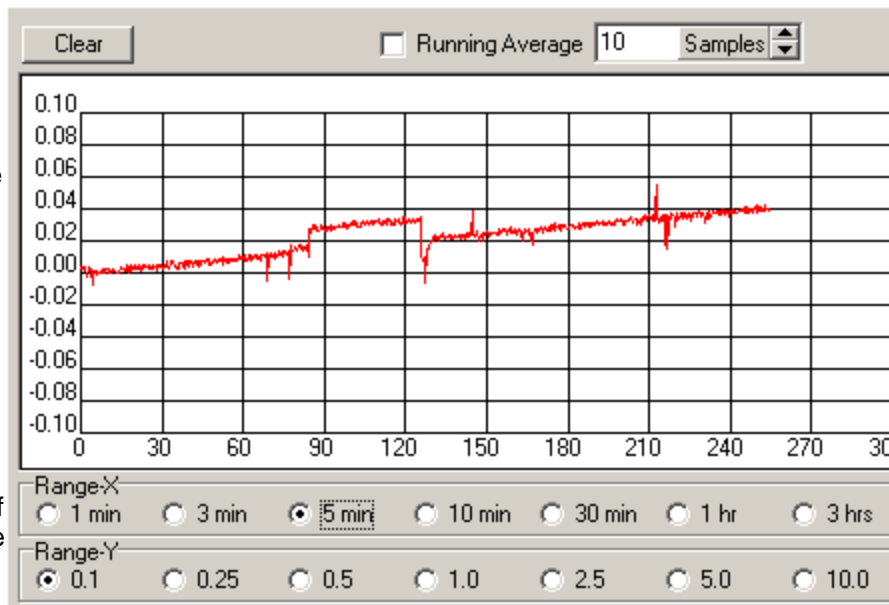
## 1.8 Graph

**Graph.** The Graph displays the PC Clock error over time. The x-axis displays the time in seconds and the y-axis displays error in seconds.

**1. Clear Button.** Pressing the Clear Button clears the graph.

**2. Running Average.** Enabling this option causes the graph to display a running average of the errors. This allows you to smooth out random noise in the graph. The number of samples over which the values are averaged is specified in the "Samples" box.

**3. Range-X / Range-Y.** The Range-X and Range-Y controls set the range of the graph. This allows you to zoom in and out of to view more or less detail in the graph.



## 1.9 Time Servers

**Time Servers.** The internet has a number of special web sites that work as Time Servers. These Time Servers are often tied to Atomic Clocks or other high-accuracy time sources.

These servers can be queried by any computer that has access to the internet to get highly accurate time data. The data transmitted by Time Servers even contains special information that allows the computer to compensate for the time it takes the signal from the Time Server to your computer.

The program maintains a list of valid time servers. Each server has different characteristics. Some servers are more accurate; the accuracy information is displayed in the Parameters section. Other servers only allow a limited of queries which makes them unsuitable for high frequency, repeated monitoring.