# Clockstudio™ Software User's Guide

# Preface

## NOTICE TO CUSTOMERS

**All documentation becomes dated, and this manual is no exception. Microchip tools and documentation are constantly evolving to meet customer needs, so some actual dialogs and/or tool descriptions may differ from those in this document. Please refer to our website (www.microchip.com) to obtain the latest documentation available.**

**Documents are identified with a "DS" number. This number is located on the bottom of each page, in front of the page number. The numbering convention for the DS number is "DSXXXXXXXXA", where "XXXXXXX" is the document number and "A" is the revision level of the document.**

**For the most up-to-date information on development tools, see the MPLAB® IDE online help. Select the Help menu, and then Topics, to open a list of available online help files.**

## CONVENTIONS USED IN THIS GUIDE

This manual uses the following documentation conventions:

### DOCUMENTATION CONVENTIONS

| Description | Represents | Examples |
|---|---|---|
| **Arial font:** | | |
| Italic characters | Referenced books | *MPLAB® IDE User's Guide* |
| | Emphasized text | ...is the *only* compiler... |
| Initial caps | A window | the Output window |
| | A dialog | the Settings dialog |
| | A menu selection | select Enable Programmer |
| All caps | An operating mode, alarm state, status, or chassis label | ALARM |
| Quotes | A field name in a window or dialog | "Save project before build" |
| Underlined, italic text with right angle bracket | A menu path | *File>Save* |
| Bold characters | A dialog button | Click **OK** |
| | A tab | Click the **Power** tab |
| N'Rnnnn | A number in verilog format, where N is the total number of digits, R is the radix and n is a digit. | 4'b0010, 2'hF1 |
| Text in angle brackets < > | A key on the keyboard | Press <Enter>, <F1> |

# Clockstudio Software User's Guide

**DOCUMENTATION CONVENTIONS**

| Courier New font: | | |
|---|---|---|
| Plain Courier New | Sample source code | `#define START` |
| | Filenames | `autoexec.bat` |
| | File paths | `c:\mcc18\h` |
| | Keywords | `_asm, _endasm, static` |
| | Command-line options | `-Opa+, -Opa-` |
| | Bit values | `0, 1` |
| | Constants | `0xFF, 'A'` |
| Italic Courier New | A variable argument | *file*`.o`, where *file* can be any valid filename |
| Square brackets [ ] | Optional arguments | `mcc18 [options]` *file* `[options]` |
| Curly brackets and pipe character: { \| } | Choice of mutually exclusive arguments; an OR selection | `errorlevel {0|1}` |
| Ellipses... | Replaces repeated text | `var_name [, var_name...]` |
| | Represents code supplied by user | `void main (void)`<br>`{ ...`<br>`}` |

## WARNINGS, CAUTIONS, RECOMMENDATIONS, AND NOTES

Warnings, Cautions, Recommendations, and Notes attract attention to essential or critical information in this guide. The types of information included in each are displayed in a style consistent with the examples below.

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### WARNING

**To avoid serious personal injury or death, do not disregard warnings. All warnings use this style. Warnings are installation, operation, or maintenance procedures, practices, or statements, that if not strictly observed, may result in serious personal injury or even death.**

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### CAUTION

**To avoid personal injury, do not disregard cautions. All cautions use this style. Cautions are installation, operation, or maintenance procedures, practices, conditions, or statements, that if not strictly observed, may result in damage to, or destruction of, the equipment. Cautions are also used to indicate a long-term health hazard.**

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**Note:** All notes use this style. Notes contain installation, operation, or maintenance procedures, practices, conditions, or statements that alert you to important information, which may make your task easier or increase your understanding.

## WHERE TO FIND ANSWERS TO PRODUCT AND DOCUMENT QUESTIONS

For additional information about the products described in this guide, please contact your Microchip representative or your local sales office. You can also contact us on the web at https://microchip.my.site.com/s/.

When this manual is updated the latest version will be available for downloading from Microchip's web site. Manuals are provided in PDF format for ease of use. After downloading, you can view the manual on a computer or print it using Adobe Acrobat Reader. Manual updates are available at: www.microchip.com.

## RELATED DOCUMENTS AND INFORMATION

See your Microchip representative or sales office for a complete list of available documentation. To order any accessory, contact the Microchip Sales Department. If you encounter any difficulties installing or using the product, contact Microchip Frequency and Time Systems (FTS) Services and Support:

**North and South America**

Microchip FTS

3870 North First Street San Jose, CA

95134-1702

Toll-free in North America: 1-888-367-7966, Option 1

Telephone: 408-428-7907

Email: sjo-ftd.support@microchip.com

**Europe, Middle East, and Africa (EMEA)**

Microchip FTS Altlaufstrasse 42

85635 Hoehenkirchen-Siegertsbrunn

Germany

Telephone: +49 700 3288 6435

Fax: +49 8102 8961 533

Email: sjo-ftd.support@microchip.com

**South Asia**

Microchip Operations (M)

Sdn Bhd Level 15.01, 1 First Avenue, 2A

Dataran Bandar Utama, Damansara,

47800 Petaling Jaya, Selangor, Malaysia

Toll-free in North America: 1-888-367-7966, Option 1

Telephone: 408-428-7907

Email: sjo-ftd.support@microchip.com

## THE MICROCHIP WEBSITE

Microchip provides online support via our website at www.microchip.com. This website is used as a means to make files and information easily available to customers. Accessible by using your favorite Internet browser, the website contains the following information:

• **Product Support** – Data sheets and errata, application notes and sample programs, design resources, user's guides and hardware support documents, latest software releases and archived software

# Clockstudio Software User's Guide

- **General Technical Support** – Frequently Asked Questions (FAQs), technical support requests, online discussion groups, Microchip consultant program member listing
- **Business of Microchip** – Product selector and ordering guides, latest Microchip press releases, listing of seminars and events, listings of Microchip sales offices, distributors and factory representatives

## CUSTOMER SUPPORT

Users of Microchip products can receive assistance through several channels:

- Distributor or Representative
- Local Sales Office
- Field Application Engineer (FAE)
- Technical Support

Customers should contact their distributor, representative or field application engineer (FAE) for support. Local sales offices are also available to help customers. A listing of sales offices and locations is included in the back of this document.

Technical support is available through the website at:
http://www.microchip.com/support.

## DOCUMENT REVISION HISTORY

### Revision A (October 2022)

- Initial release of this document as Microchip DS50003423A.

### Revision B (September 2023)

- Revised for software release 1.1 with support for 5071A and 5071B cesium instruments.

# CLOCKSTUDIO SOFTWARE USER'S GUIDE

# Table of Contents

# Clockstudio Software User's Guide

# Chapter 1. Introduction

## 1.1 PRODUCT DESCRIPTION

The Clockstudio™ software is a standalone graphical user interface (GUI) intended for communication and control of Microchip Atomic Clock products. It allows a user to quickly familiarize themselves with the capabilities of these products rather than entering text-based commands via a primitive command line interface. The charting capabilities are a powerful tool for experimentation and investigating device performance under specific conditions.

See the Appendix section: Supported Instruments for a list of supported clocks products.

## 1.2 PRODUCT FEATURES

- Communicate with multiple devices via a single interface
- Configure device settings (Frequency, 1PPS Disciplining parameters, Time of Day, etc)
- Monitor "real-time" device telemetry in tabular form
- Display device telemetry as a chart
- Load and display previously saved data
- Import data from other text-based files
- Export data for further analysis (such as Microchip's TimeMonitor software tool)

## 1.3 BASIC GUI LAYOUT

When the application is launched, the user will see a Start tab in the main window with the File menu above it (Figure 1-1). From here, a user can decide to connect to an atomic clock or open an existing data file. This action will open a new tab with four main areas:

- On the left side is a Toolbar menu
- The right side (main portion of active tabbed window) will present a different view dependent upon the tool selected from the toolbar
- North Region – The top part of the tabbed window contains the Title bar
- South Region – The bottom part of the application window contains the Status bar

# Clockstudio Software User's Guide
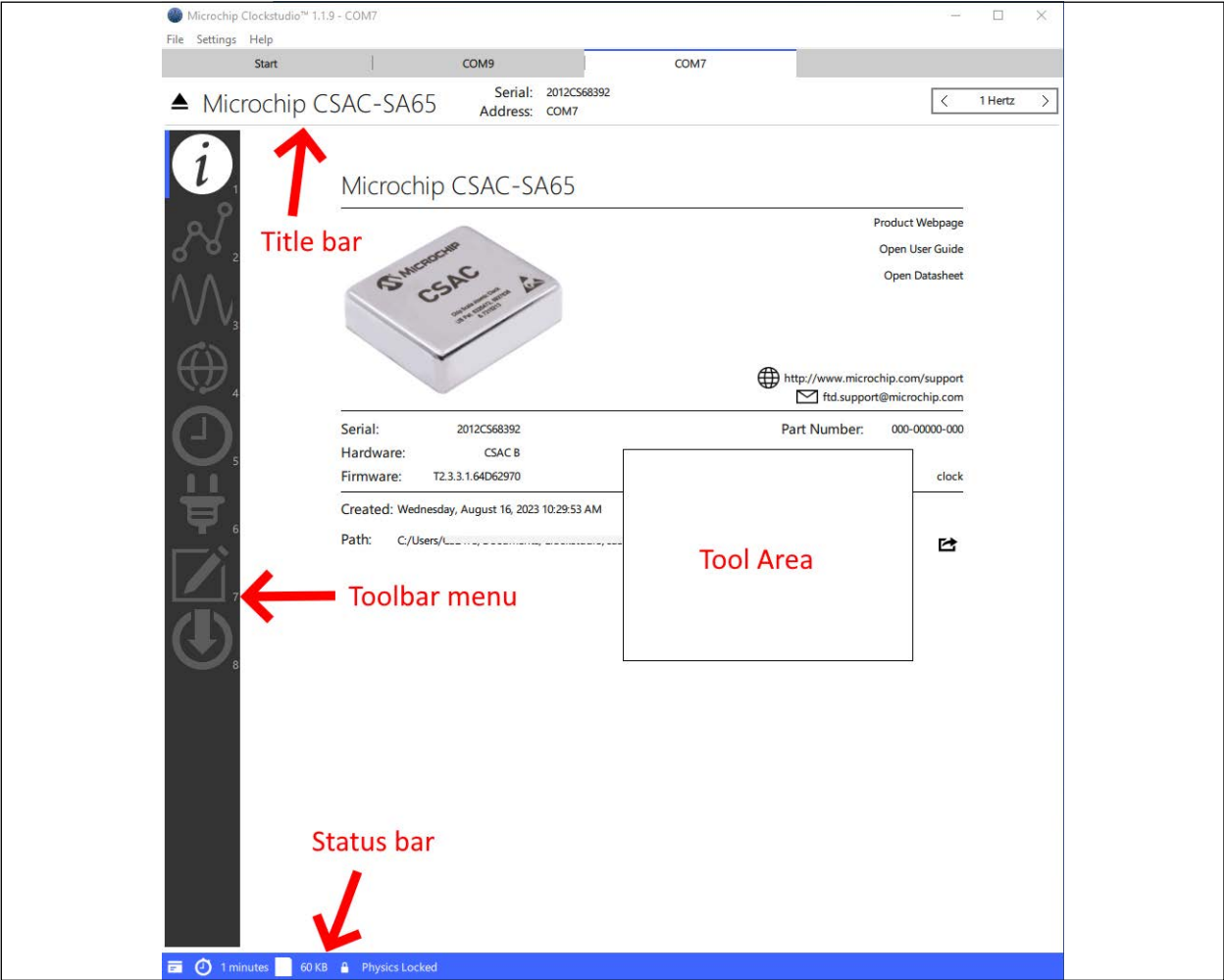


FIGURE 1-1:        Basic Areas of the GUI, Labeled.

# Chapter 2. Operation

A user primarily interacts with the application via mouse (such as selecting from drop-down menus and toggling radio buttons) and secondarily with the keyboard (to set device-specific parameters or enter commands via the console feature, for example). The application was designed to run on Windows 10 and 11 based systems.

This User Guide divides the GUI in to eight main features, described in the following sections:

- File menu: describes file loading and saving
- Settings menu: lists modifiable Clockstudio™ application settings
- About menu: contains general Clockstudio software version information
- Start tab: initiate communication with a device, open a file, or link to a product support URL
- Title bar: overview of the connected device
- Toolbar: lists available interactive features of a device
- Status bar: contains the console along with active data file information
- Charting: description of how to plot telemetry parameters

## 2.1   FILE MENU

The File menu is always present at the top of the application and contains a number of file operations, as described in the below sections. The Clockstudio program uses file extension `.ctdb` for data files. New data files are created whenever a new connection is established and they are saved in the following Windows directory by default:

`C:\Users\<user>\Documents\Clockstudio`

The directory and other data file acquisition options can be modified. See Preferences for more information.

### 2.1.1   Open Telemetry…

Opens a file browser to select a previously saved file for analysis. When a file is opened, a new tab appears in the Clockstudio application, labeled with the filename. The Title bar, Toolbar, and Status bar will also populate in this tab. Supported extensions are `.ctdb`, `.csv`, and `.phd`.

### 2.1.2   Open Recent

Displays a list of recently opened data files.

### 2.1.3   Export Telemetry…

Files may be exported in `.csv` format or also in a `.txt` format readable by Microchip TimeMonitor software.

### 2.1.4   Rename Telemetry…

Available when connected to a device. This feature is useful for moving the data file during an active data capture.

### 2.1.5 Quit

Exits the Clockstudio application.

## 2.2 SETTINGS MENU

The Settings menu is always present at the top of the application and contains the Preferences tab.

### 2.2.1 Preferences

The Preferences tab allows a user to adjust the telemetry capture settings. Default settings can be adjusted, including the location for storing data files, file naming convention, and the polling rate.

Visual display settings can also be adjusted, including chart density (resolution).

## 2.3 HELP MENU

### 2.3.1 About Clockstudio…

Describes the release version and links to third party license information.

### 2.3.2 User Guide

Links to the Clockstudio software user guide.

## 2.4 START TAB

The Clockstudio™ software tool can communicate with multiple devices simultaneously, depending on system capabilities. When connecting to a device, a new tab will open with a "Connecting…" announcement briefly displaying at the top of the window. Each new tab is labeled with the address of the device.

If a connection cannot be established, the announcement will toggle between "Connecting…" and "No Device" until canceled by the user by clicking the **Pause** button next to the announcements. One can re-attempt to establish communication by clicking the **Play** button.

There are two options for connecting to a device with the Clockstudio software: Serial (COM) Port or TCP Host.

### 2.4.1 Serial Port

The pull-down menu will populate with all of the recognized COM ports. To establish communication, select one of the ports and click **Connect**.

### 2.4.2 TCP Host

The user may manually enter an IP address. To establish communication with a device, enter an address (IP: port) and click **Connect**.

Note: Currently supported products do not yet incorporate this feature. A TCP to Virtual COM Port adapter could be used to communicate remotely.

## 2.5 TITLE BAR

After establishing a new connection (or opening a telemetry file), a new tab will open with a Title bar located at the top. The Title bar will display the following device information:

### 2.5.1 Disconnect/Reconnect Button

This is visible only when a connection is available. It is recommended to manually disconnect Clockstudio from the device before physically disconnecting it.

### 2.5.2 Device Product Name

This displays the name of the device.

### 2.5.3 "Serial"

The device serial number is specific to each individual device and is read directly from the device's own saved "serial number" parameter.

### 2.5.4 Port "Address"

Lists the COM or IP address used to communicate with a device. This is defined when a user first connects with a device. See the Start Tab section for more information.

### 2.5.5 Data Polling Rate

Visible only when a connection is established. It can be adjusted from 10 Hz to 100 seconds, depending on device capabilities. Slower data rates are recommended for reducing file sizes. For example, changing the data rate from 1 second to 10 seconds will reduce the size by a factor of 10.

## 2.6 TOOLBARS

### 2.6.1 Common Tools

This section describes the tools in the Toolbar that are supported among all device types:

- Device Info Tool
- Telemetry Tool
- Firmware Upgrade Tool (supported devices only, connection required)
- Notes Tool

Most of these tools are available when opening a data file from disk and when connected to a live device.

#### 2.6.1.1 DEVICE INFO TOOL

This tool displays an image of the device or product associated with the current data file, as well as some basic information, including:

- Web links to product page, user guide, and data sheet
- Microchip FTS support email
- Device serial and part numbers
- Device firmware and hardware revisions
- Path and creation date of the data file

## 2.6.1.2    DEVICE TELEMETRY TOOL

The Device Telemetry Tool displays the device's telemetry and configuration parameters, with current values on the left side and selected time series charts on the right side.

When connected to a device, editable parameters are highlighted in blue. Click the blue number or checkbox on the left side of the tool to edit the value.

The user may view a parameter's value history as a time series chart by clicking the **right-pointing triangle icon** next to it (supported parameters only). Up to eight charts may be displayed simultaneously.
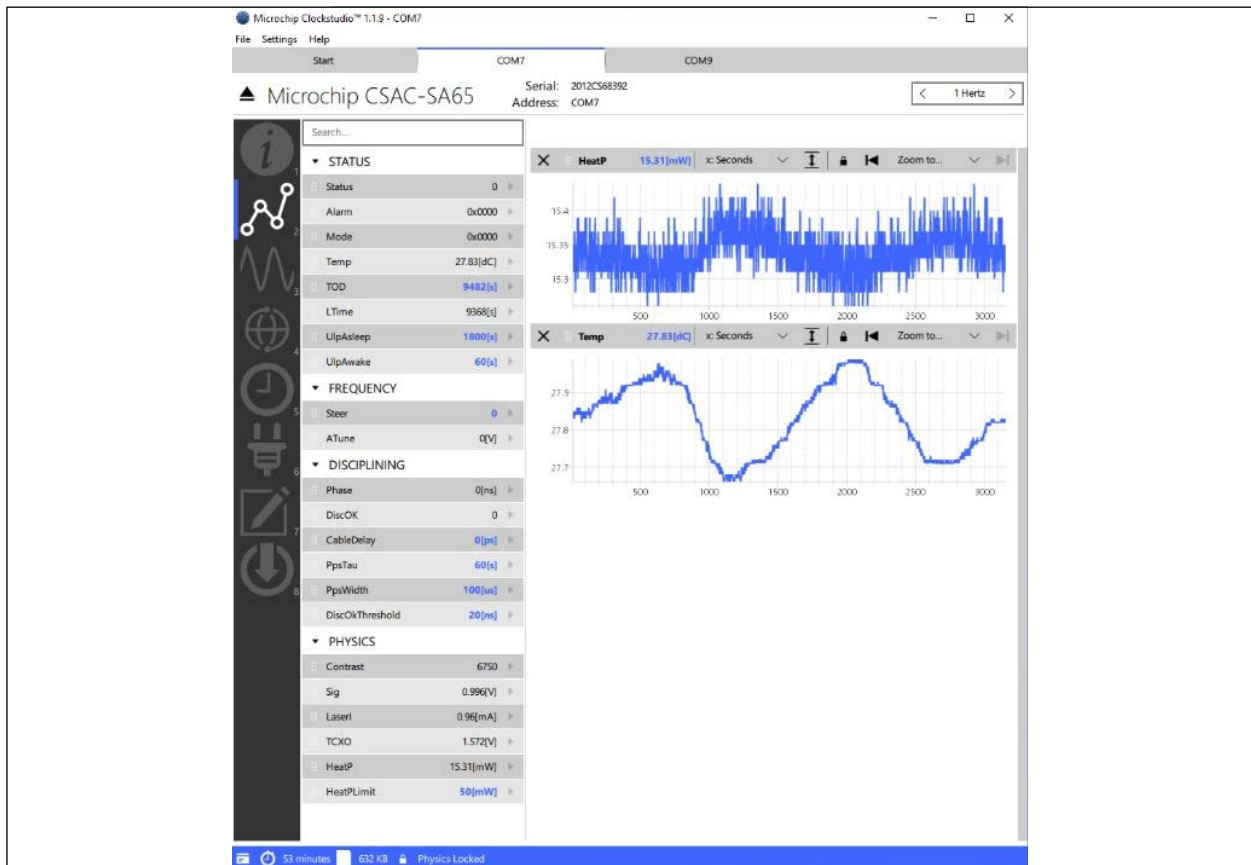


**FIGURE 2-1:**        *Device Telemetry Tool for CSAC-SA65.*

### 2.6.1.3    UPGRADE FIRMWARE TOOL

When connected to a supported device, the Upgrade Firmware Tool may be used to update its firmware.

Download the latest firmware release for your product from the Microchip customer support portal and then click **Browse** to select the file to load. During firmware transfer, the device will temporarily stop normal operation. After the upgrade, it will reset and resume operation.

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**CAUTION**

**If the transfer is interrupted, the device will not function properly until firmware is reloaded with a subsequent attempt. Reconnecting to the device will show "bsl" as the device's application on the Device Info Tool and telemetry will not be available.**

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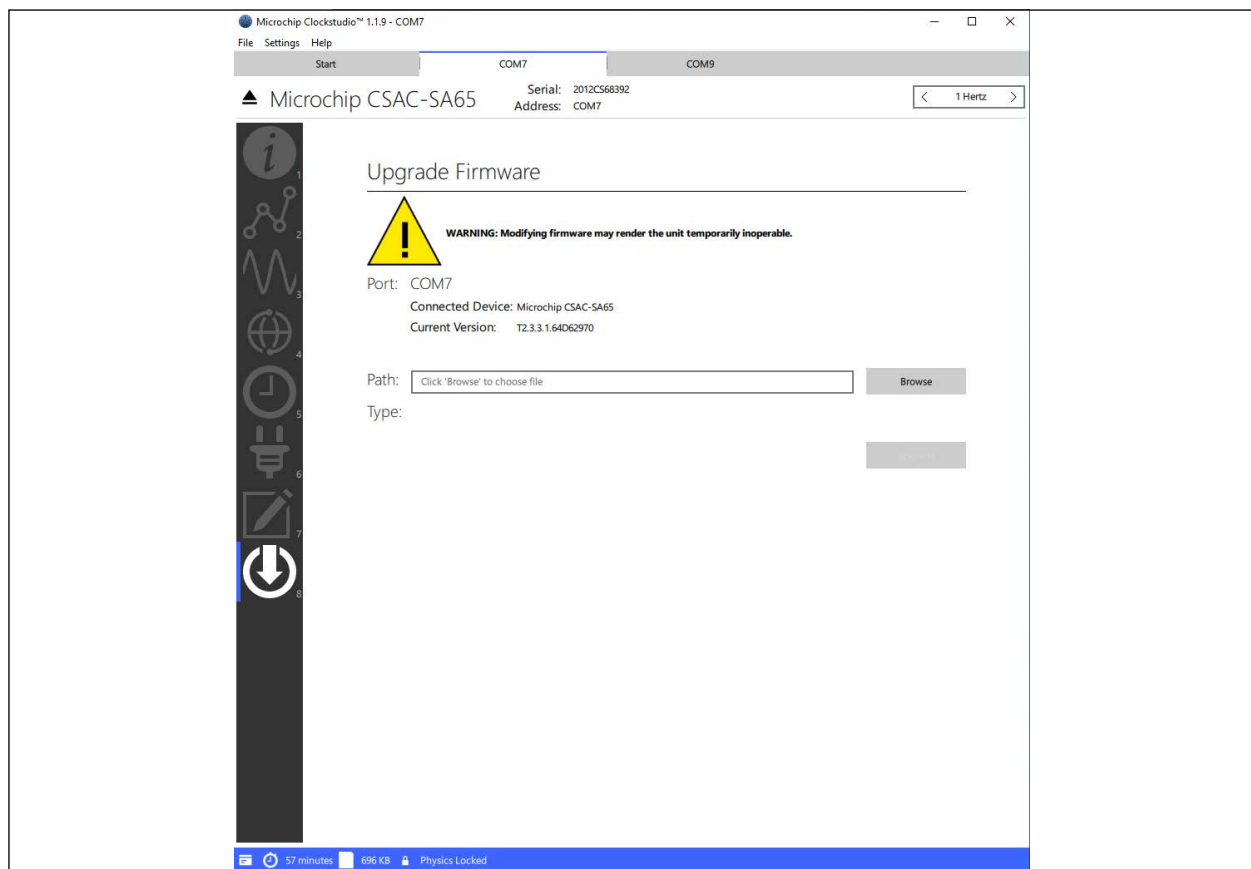


**FIGURE 2-2:**    *Upgrade Firmware Tool for CSAC-SA65.*

## 2.6.1.4    NOTES TOOL

The Notes Tool provides space to add remarks, using Markdown syntax, to the current data file. Visit www.commonmark.org/help for a guide to the Markdown syntax.

Notes can be added to a `.ctdb` format data file at any time; while capturing telemetry or later, when viewing the file. External data file formats are not supported.
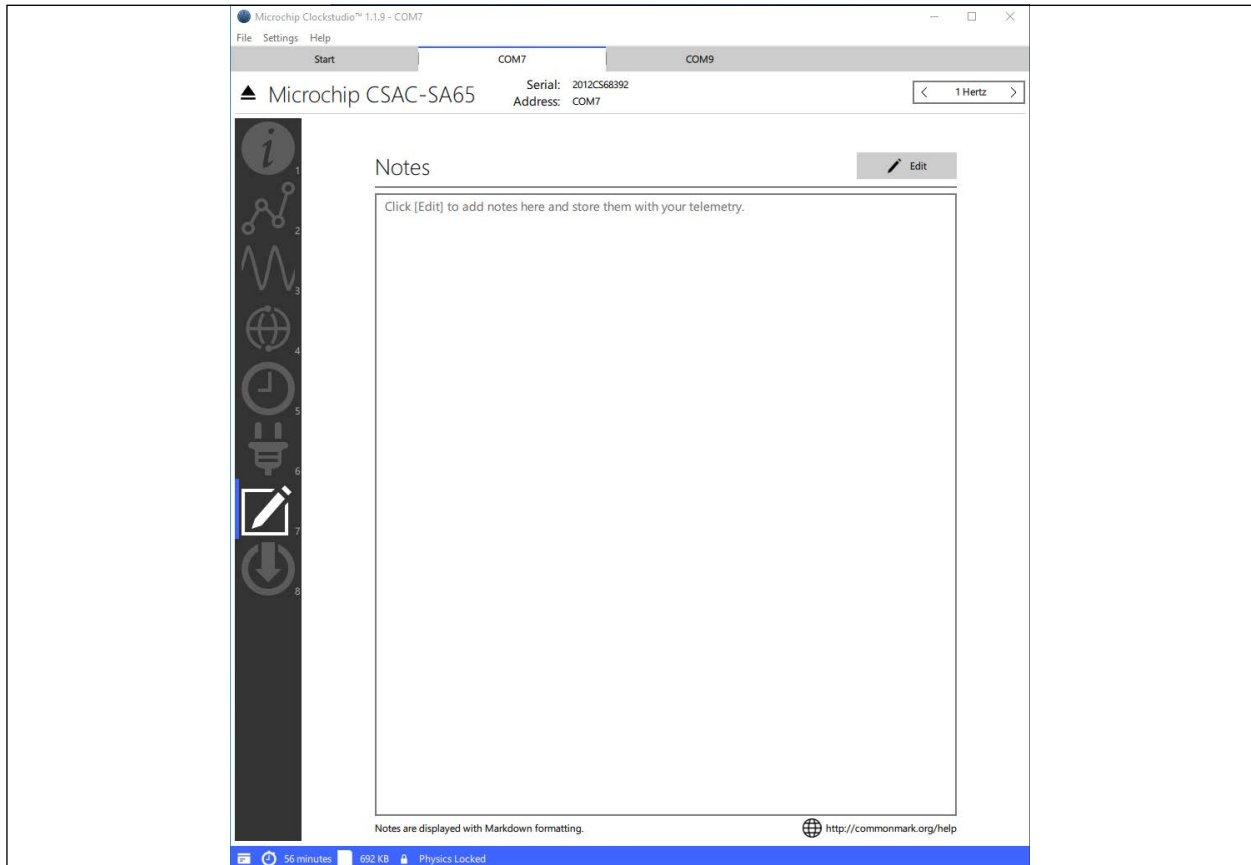


**FIGURE 2-3:**      *Notes Tool.*

### 2.6.2 CSAC Tools

When connected to a CSAC, the following tools are available:

- Device Info
- Device Telemetry
- Frequency Adjustment
- 1PPS Disciplining
- Time of Day
- Power Management
- Notes
- Upgrade Firmware



**FIGURE 2-4:** *Device Info Tool for CSAC-SA65.*

### 2.6.2.1    FREQUENCY ADJUSTMENT TOOL (SA.45s/SA65)

This tool allows the user to digitally tune the output frequency, configure analog tuning, and latch the frequency offset. Both absolute and relative frequency adjustments are supported. When enabled, analog tuning voltage measurements are reported. Latching the digital tune (or Steer) stores the frequency offset to internal flash, resetting the offset.

The "Steer" time series chart displays the CSAC's effective tuning history as fractional frequency in parts-per $10^{12}$.
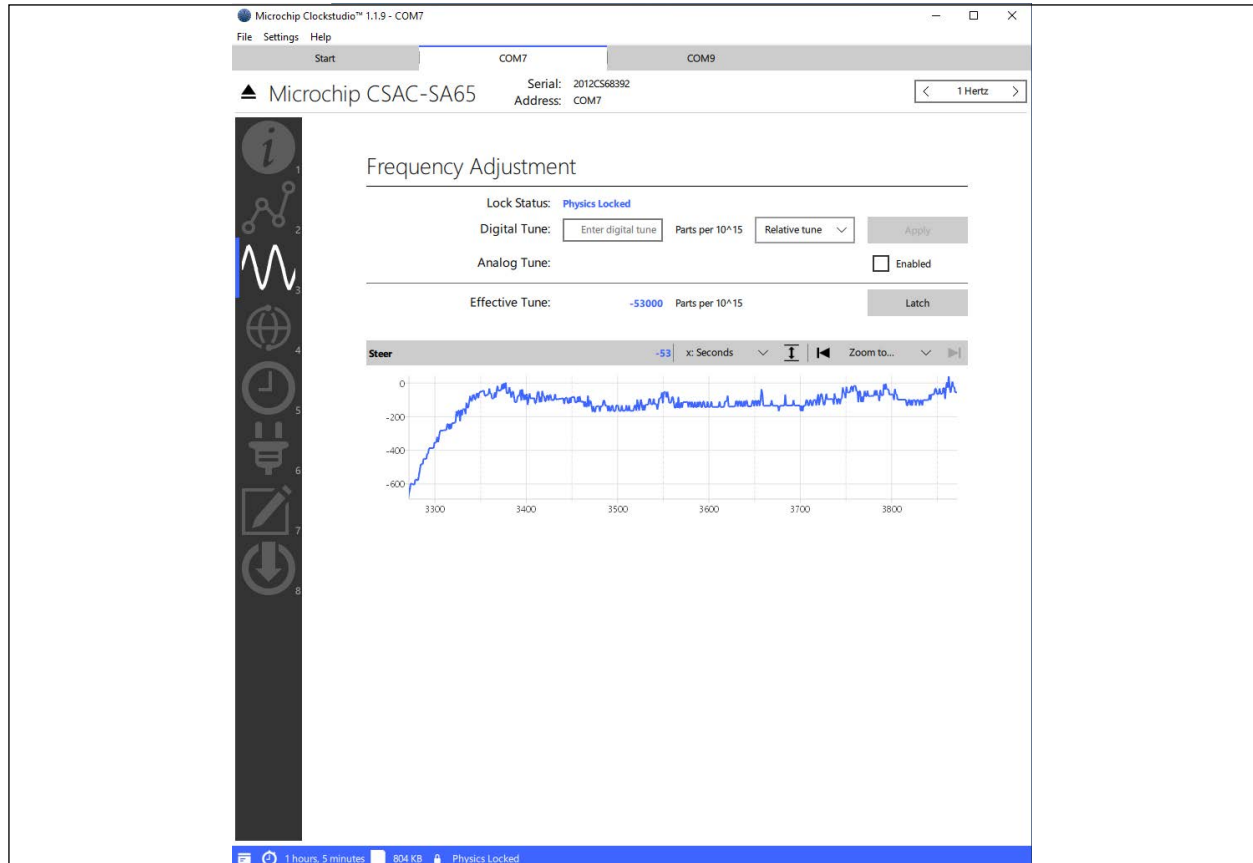


**FIGURE 2-5:**        *Frequency Adjustment Tool for CSAC-SA65.*

### 2.6.2.2 1PPS DISCIPLINING TOOL (SA.45s/SA65)

The 1PPS (Pulse-Per-Second) Disciplining Tool provides an interface for calibrating the frequency and 1PPS outputs. This tool allows access to 1PPS synchronization, output pulse width, and discipling servo configuration.

Phase measurements and digital tuning charts are displayed to aid the user's understanding of how the disciplining servo impacts the output frequency. Refer to the product user's guide for details and recommendations regarding 1PPS disciplining.
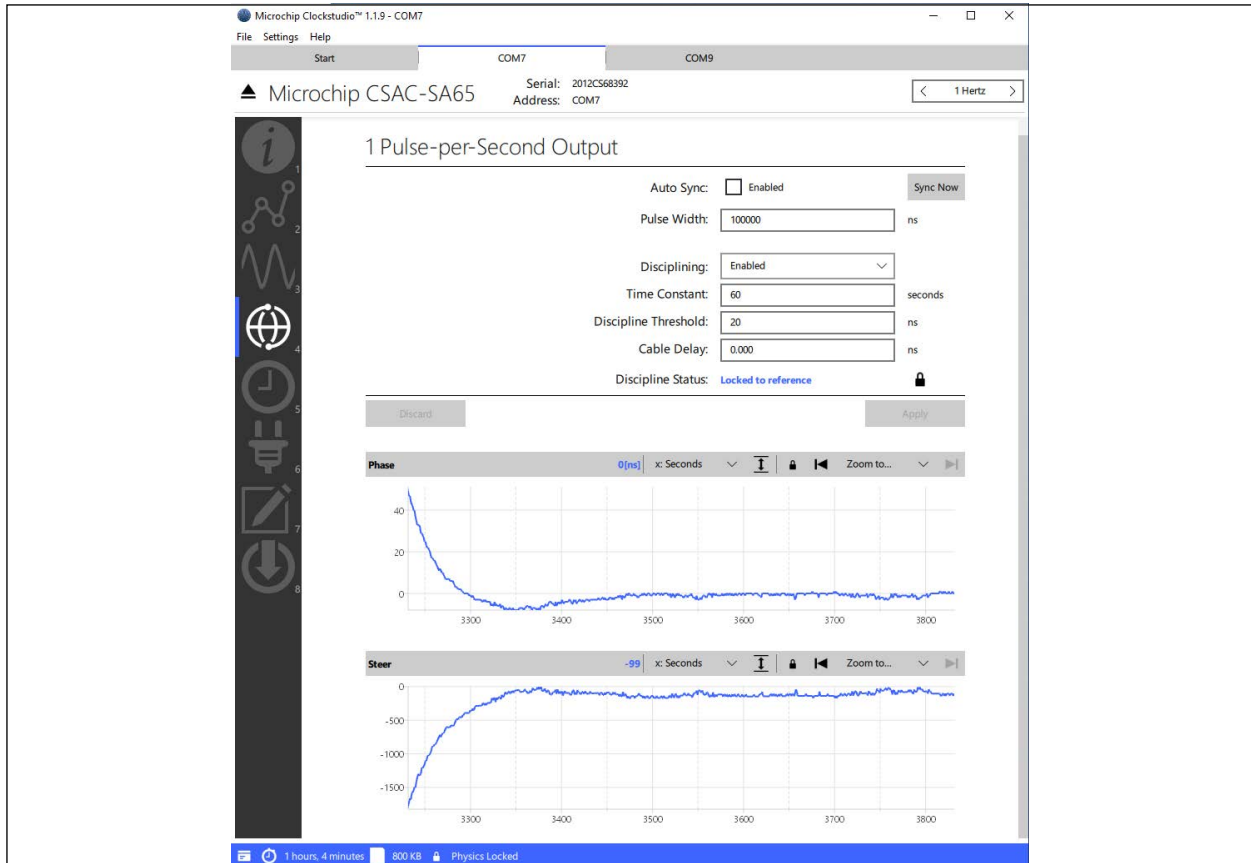


**FIGURE 2-6:** *1PPS Disciplining Tool for CSAC-SA65.*

### 2.6.2.3 TIME OF DAY (SA.45s/SA65)

The Time of Day Tool allows the user to manage the device's internal concept of time, represented as a count of seconds since an epoch. At power on, the device begins counting time of day from zero.

Applying the PC's time will automatically set the device's Time of Day as the count of seconds since the Linux epoch (UTC). The device time can be incremented/decremented with the "Hours" and "Seconds" buttons or set directly to an absolute number.
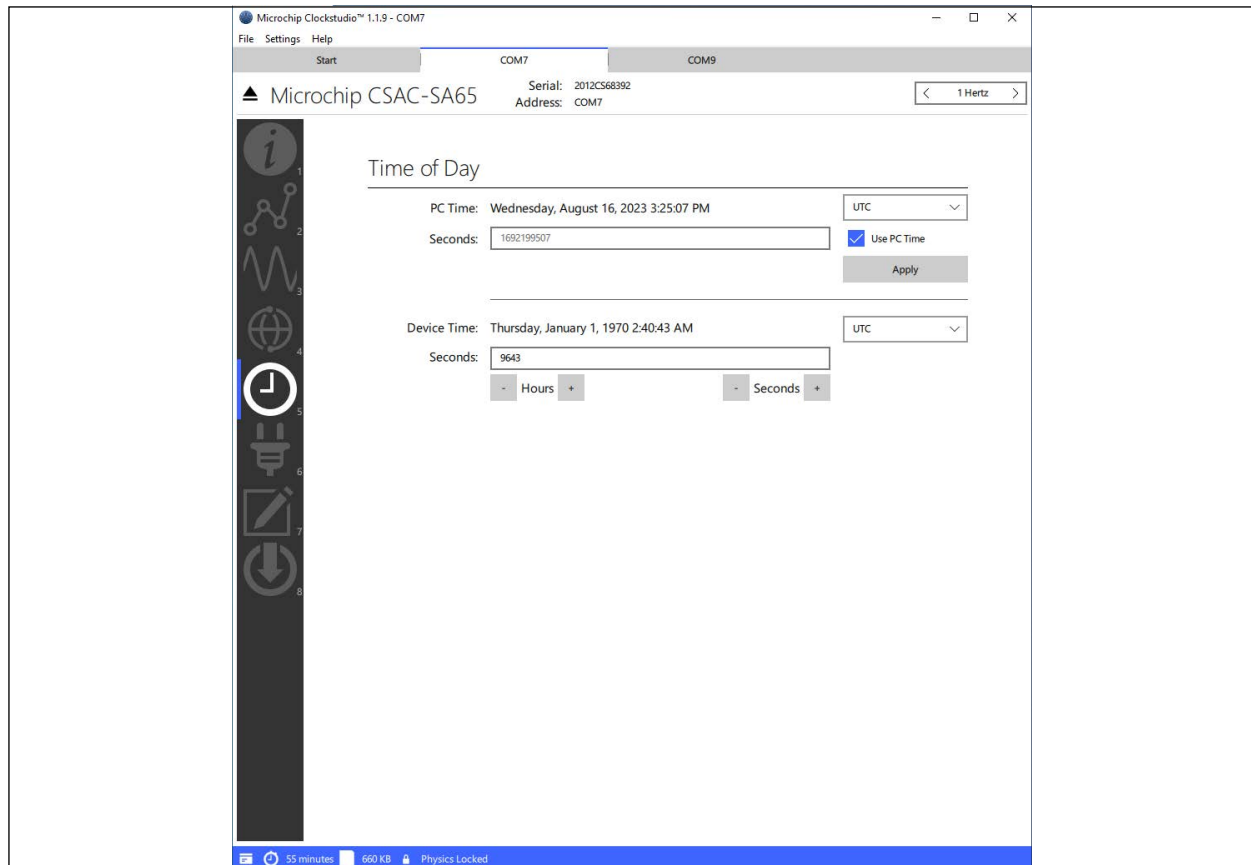


**FIGURE 2-7:** *Time of Day Tool for CSAC-SA65.*

### 2.6.2.4  POWER MANAGEMENT (SA.45s/SA65)

The Power Management Tool allows a CSAC's power consumption to be configured via Ultra-Low Power (ULP) mode and heater power limits. CSAC-SA65 devices contain a heater boost circuit to improve acquisition time at cold temperatures.

Refer to the CSAC user's guide for details regarding these features.
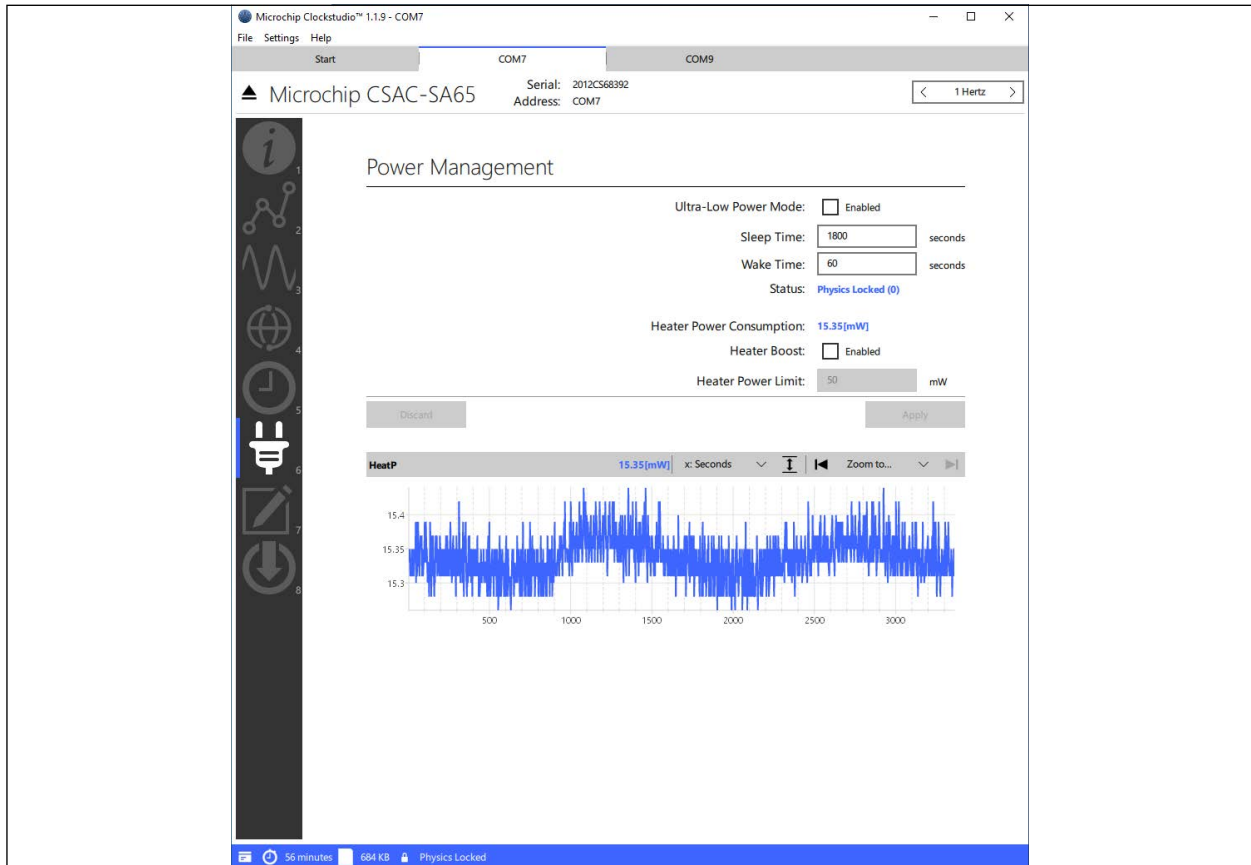


**FIGURE 2-8:**      *Power Management Tool for CSAC-SA65.*

### 2.6.3    MAC-SA5X Tools

When connected to a MAC, the following tools are available:

- Device Info
- Device Telemetry
- Frequency Adjustment
- 1PPS Disciplining
- Time of Day
- Notes
- Upgrade Firmware



**FIGURE 2-9:**        *Device Info Tool Connected to a MAC-SA5X.*

### 2.6.3.1 FREQUENCY ADJUSTMENT TOOL (MAC-SA5X)

This tool allows the user to digitally tune the output frequency, configure analog tuning, and latch the frequency offset.

The "EffectiveTuning" time series chart displays the MAC's effective tuning history as fractional frequency in parts-per $10^{15}$.
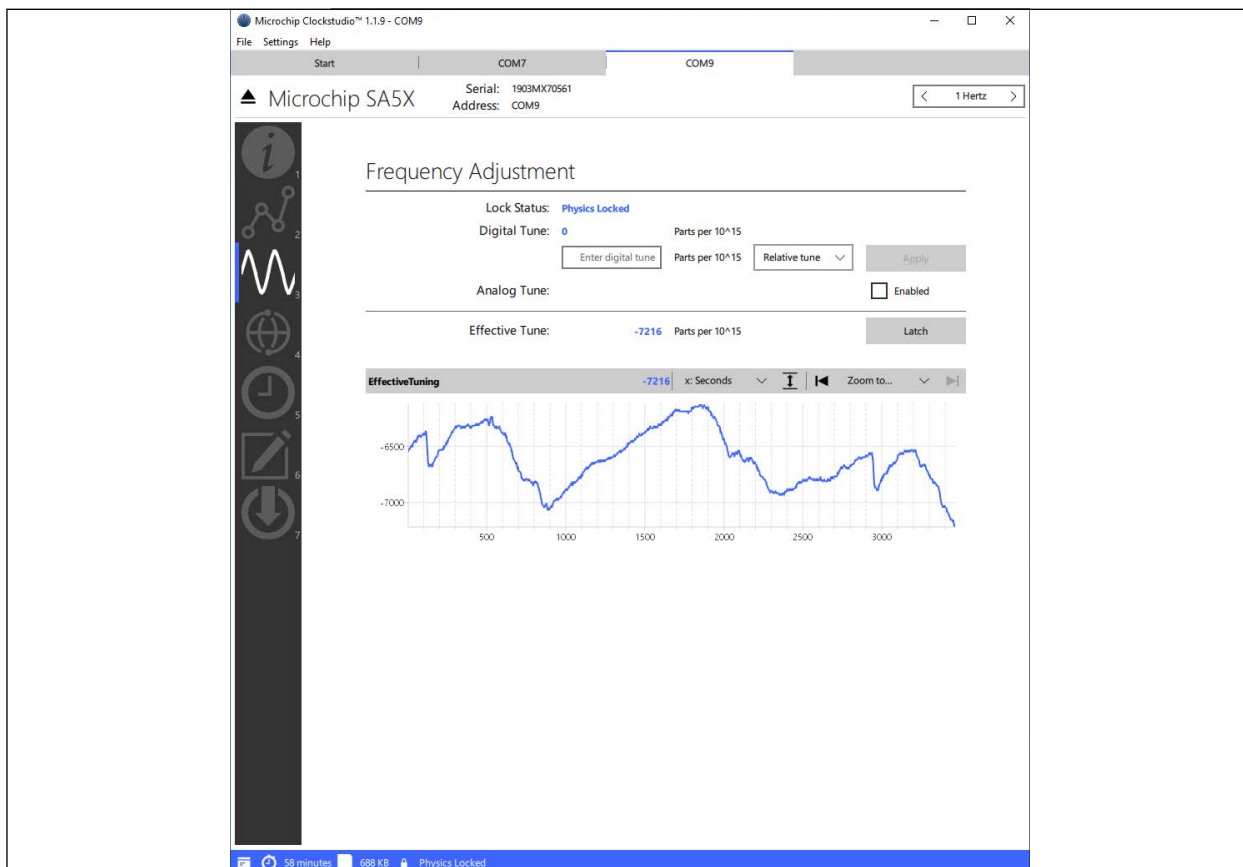


**FIGURE 2-10:** *Frequency Adjustment Tool for MAC-SA5X.*

### 2.6.3.2    1PPS DISCIPLINING TOOL (MAC-SA5X)

The 1PPS Disciplining Tool allows the user to configure synchronization, output pulse, and the disciplining servo. The tool assumes that the 1PPS input 0 is connected to the reference, versus the alternate input 1.

Refer to the product user's guide for details and recommendations regarding 1PPS disciplining servo settings.
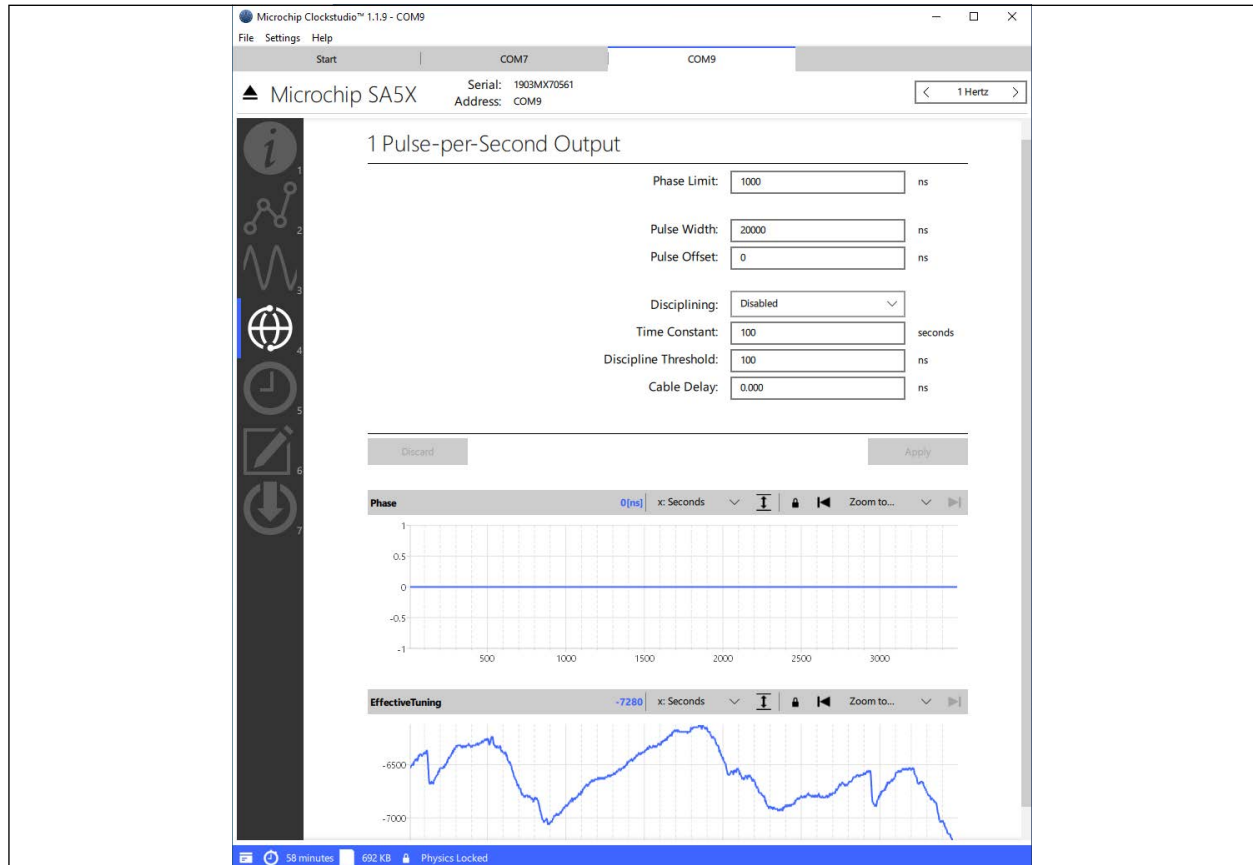


**FIGURE 2-11:**     *1PPS Disciplining Tool for MAC-SA5X.*

### 2.6.3.3    TIME OF DAY (MAC-SA5X)

The Time of Day Tool for the MAC operates the same as described for the CSAC. Refer to **Section 2.6.2.3 "Time of Day (SA.45s/SA65)"** for details.
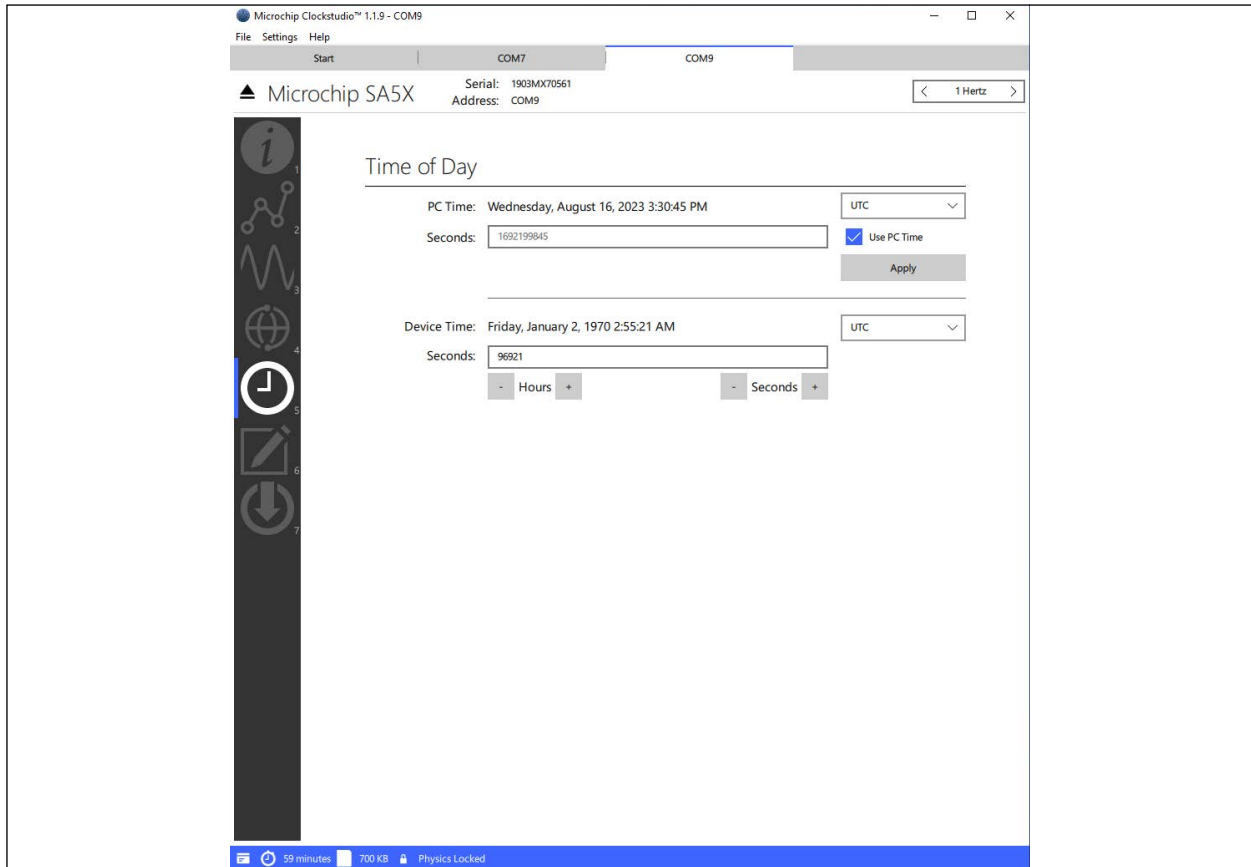


**FIGURE 2-12:**    *Time of Day Tool for MAC-SA5X.*

### 2.6.4    5071 Primary Frequency Standard Tools

The Clockstudio software tool supports remote operation of the A and B revisions of the 5071 Primary Frequency Standard. When connected to a 5071, the following tools are available:

• Device Info
• Device Telemetry
• Time of Day
• Device Configuration
• Event Log
• Notes
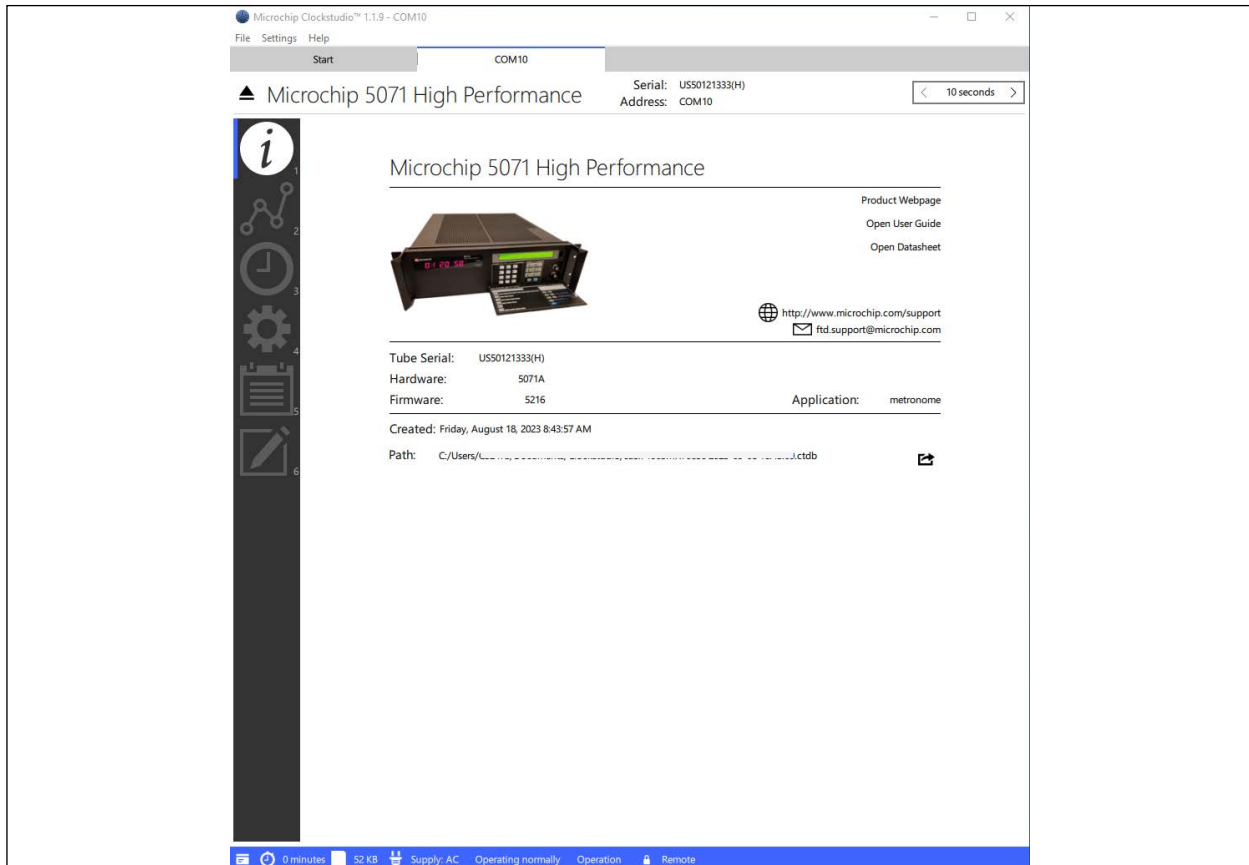


**FIGURE 2-13:**    *Device Info Tool for the 5071.*

### 2.6.4.1    TIME OF DAY TOOL

The Time of Day tool provides an interface to configure the 5071's precision time functions, including setting the date and time, enabling the front panel clock display, scheduling a leap second, and adjusting the phase of the 1PPS output.

The device's internal date (MJD) and time (24H) are aligned with UTC and can be set either from the PC's time or by manual entry. Refer to the 5071 User's Guide for more details.
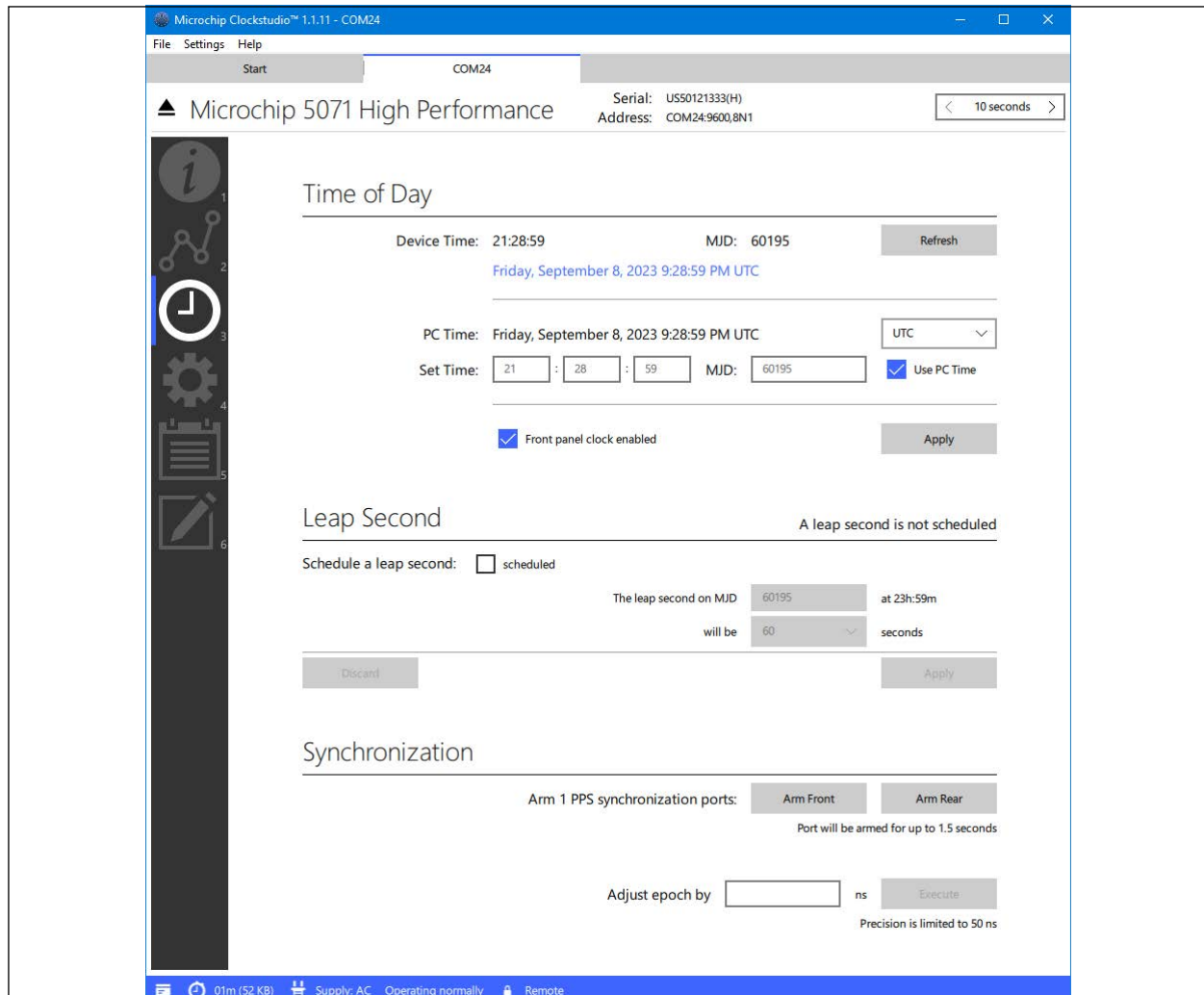


**FIGURE 2-14:**        *Time of Day Tool for the 5071.*

### 2.6.4.2 DEVICE CONFIGURATION TOOL

The Device Configuration Tool for the 5071 allows users to set the output frequency of the rear ports 1 and 2, configure the RS-232 serial port settings, and store these settings to persistent memory in the 5071. Stored settings will be maintained across power cycles.
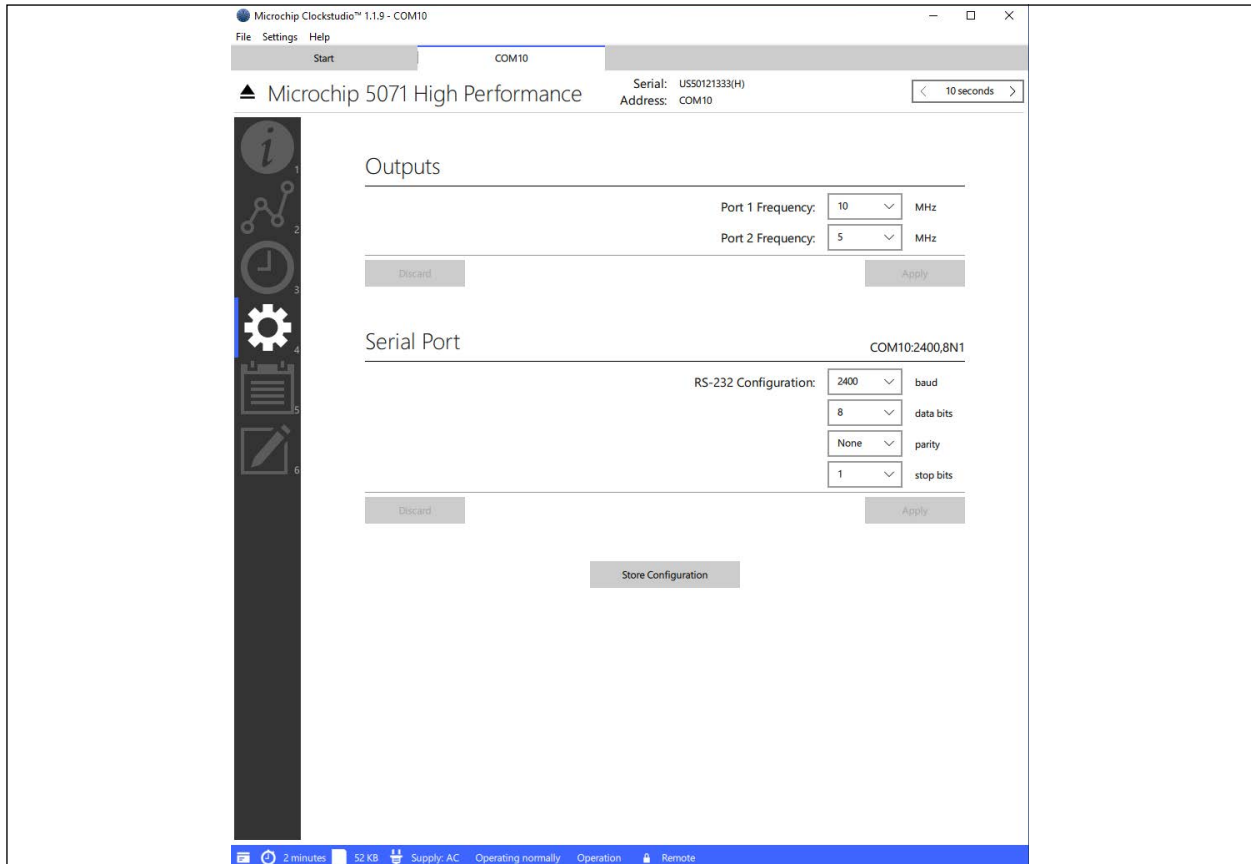


**FIGURE 2-15:** *Device Configuration Tool for the 5071.*

### 2.6.4.3    EVENT LOG TOOL

The Event Log Tool displays the 5071's internal event log. Each entry is displayed on a separate line and timestamped with the device's MJD and front panel clock time.

Click **Save** to store a copy of the displayed text into the data file's console log. It will be preserved alongside telemetry and notes in the current `.ctdb` data file. Click **Export…** to save a copy of the displayed text to a new text file.

The 5071's internal event log may be cleared by pressing and holding the **Clear Log** button for one full second. This operation cannot be undone; be sure that you want to permanently erase the device's event log.
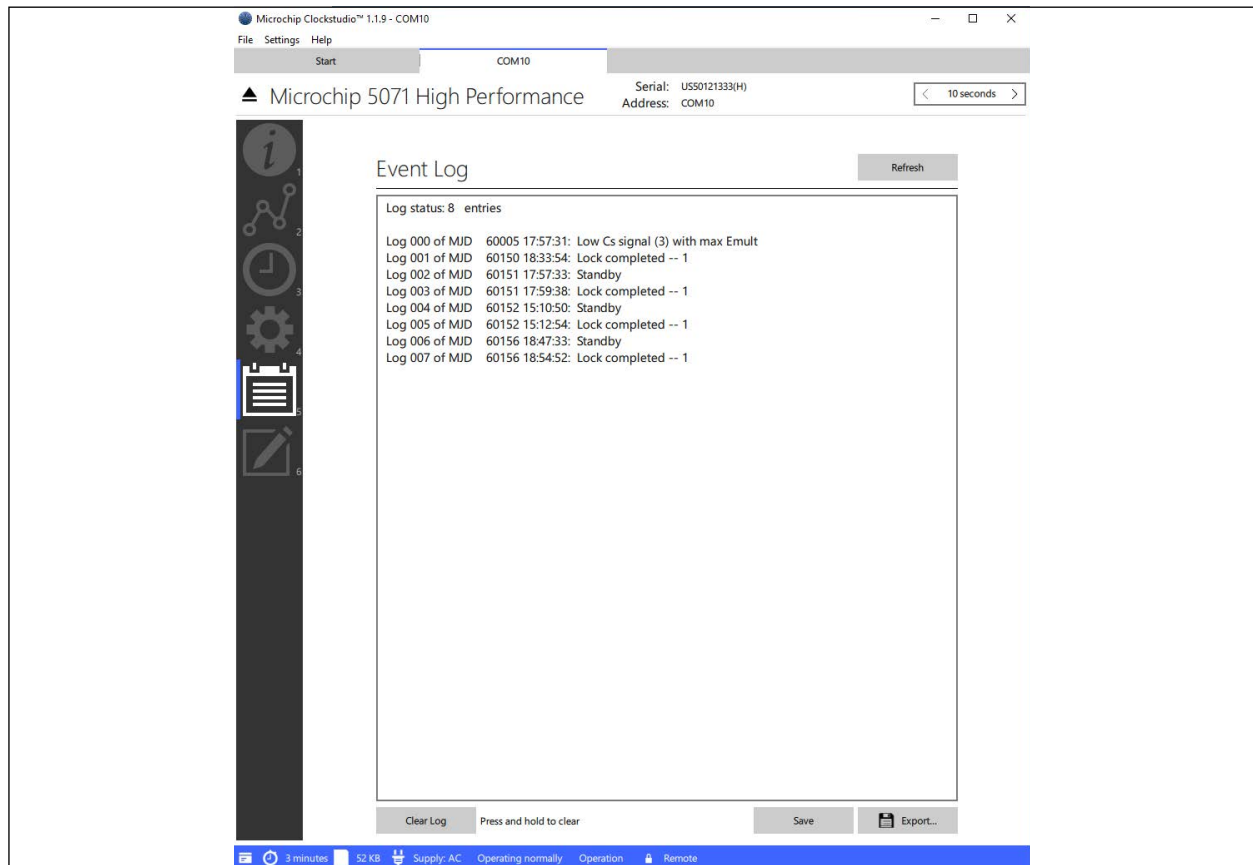


**FIGURE 2-16:**    *Event Log Tool for the 5071.*

## 2.7    STATUS BAR

The Status Bar is located at the bottom of the window. It displays data file statistics and important device status information.
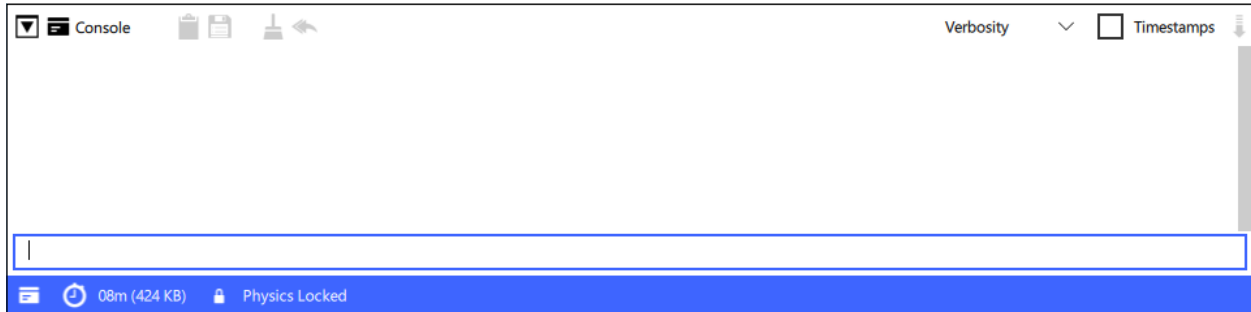


***FIGURE 2-17:***    *Status Bar Shown Below the Device Console.*

The following sections describe elements that appear on the status bar, depending on the product and connection status.

### 2.7.1    Toggle Console

A button to open and close the console window is located on the left side of the Status bar. The console allows the user to type commands directly to the device. Refer to the product user guide for details regarding its serial command syntax and usage.

### 2.7.2    Capture Duration (Stopwatch Icon)

Lists the capture duration and file size of the current telemetry file. Click to reveal the data file in an Explorer window.

### 2.7.3    Alarms (Alert! Icon)

If the connected device has any active alarms, "Alarms" will be shown on the status bar. The presence of critical/fault alarms will highlight the "Alarms" notification in red. Click "Alarms" to view a list of the active alarm bits and descriptions.



***FIGURE 2-18:***    *An Active Alarm for MAC-SA5X.*

### 2.7.4    Physics Status (Lock Icon) (CSAC, MAC)

Displays the status of the device's servo lock to the atoms. When the device has successfully acquired a lock, its output frequency will be stable and dependable.

### 2.7.5    Power Supply Status (Power Plug Icon) (5071)

Displays the 5071's current power source: AC, DC, or Battery. If the power source is low, the notification will be highlighted in red with a warning icon. See the 5071 user's guide for details regarding power supply.

### 2.7.6    Global Status (5071)

Displays the global operational status of the 5071, for example: "Standby," "Warming up," or "Operating normally." If the device encountered a fatal error, the status will be highlighted in red.

### 2.7.7 Operation Status Conditions (5071)

The **Operation** button is shown on the status bar when a bit is set in the 5071's operation status register. Click to view a list of the active status bits and descriptions. See the 5071 user's guide for details regarding the operation status register.

### 2.7.8 Questionable Data Conditions (5071)

The **Questionable** button is shown on the status bar when a bit is set in the 5071's questionable data register. Click to view a list of the active questionable data bits and descriptions. See the 5071 user's guide for details regarding the questionable data register.

### 2.7.9 Continuous Operation (5071)

When the 5071's continuous operation state is on or enabled, the **Continuous Operation** button is shown. The appearance of the button reflects the appearance of the **Continuous Operation** light on the front panel of the device: it blinks when enabled and then remains solid when it has been reset. Click the button while it is blinking to reset the continuous operation state. See the 5071 user's guide for details regarding the continuous operation light.

### 2.7.10 Remote (Lock Icon) (5071)

The **Remote** button is displayed on the status bar with a lock icon when the 5071's remote operation mode is enabled. This mode will be initially enabled by the application, locking the user from making any changes with the front panel of the device. Click the button at any time to disable the mode and unlock the front panel.

Remote operation mode will be automatically enabled when connecting over RS-232 again, or when making a change to the device state from the Clockstudio software tool.

See the 5071 user's guide for details regarding Remote Operation.

## 2.8 TIME SERIES CHARTS

This feature is available from the Device Telemetry tool. Newly added charts will be added to the top of the window, though the order may be changed by simply clicking on the chart title and dragging the chart to the desired location. Each chart has a menu bar at the top with the following features (from left to right):

- **X** button to close a chart
- Telemetry Parameter name (Chart Title)
- **Toggle** button for x-axis units
- **Toggle** button for Vertical scaling
- **Padlock** toggle button for synchronizing x-axis view range on all charts, or using independent range
- **Left-arrow** button to move x-axis range to beginning of data set
- **Right-arrow** button to move x-axis range to end of data set

### 2.8.1 Adding Charts

A user may view a particular parameter as a chart by clicking the **right-arrow** next to a given parameter within the telemetry list.

### 2.8.2    Adjusting the X-Axis

All charts have the same x-axis view range by default. Adjustment of one chart's view range will adjust the other charts accordingly. However, an individual chart may have an independent (unsynchronized) x-axis when the Padlock toggle button is set to display as unlocked (unsynchronized).

Range: A mouse scroll-wheel is the easiest way to expand or reduce a chart's x-axis view range. Alternatively, one may select a pre-defined range by using the "Zoom to…" drop down list within a chart's title bar menu or use the <+> and <–> keys, when focused. Use the <0> key to zoom all the way out.

Position: The x-axis range start position may be adjusted by a left mouse drag. Alternatively, one may press the left-arrow or right-arrow buttons within a chart's title bar menu to move the range to the beginning or end of a data set, respectively. Press the <Home> or <End> keys to jump to the beginning or end of the data series, respectively.

Units: The default x-axis units are in seconds. The units may be adjusted with the toggle button within a chart's title bar menu (Seconds, minutes, hours, days, or MJD).

### 2.8.3    Adjusting the Y-Axis

Range: The y-axis automatically adjusts to display the minimum and maximum y-values within the visible data range. The range can be changed by selecting the Vertical Scaling button within a chart's title bar menu.

### 2.8.4    Charting Tools

Right click on a chart to set the cursor. Next to the cursor, an informational pane will display the Y value of the telemetry at the selected time (X).
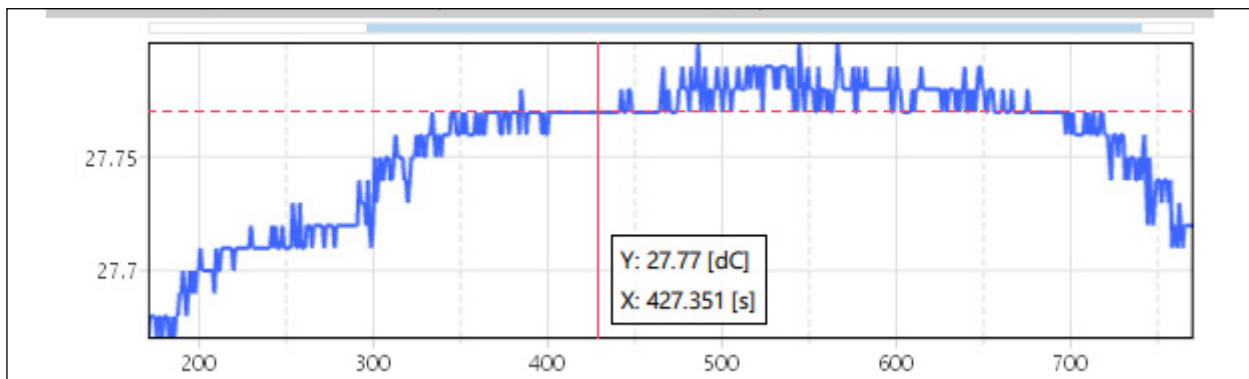


*FIGURE 2-19:*        *A Telemetry Cursor.*

Select a range with right mouse press and drag, to place two cursors on the chart. An informational pane will display the time between the two cursors "dX" and the average Y value "Avg" over the selected range. A thick blue line will also display the average visually, on the chart plotting area.
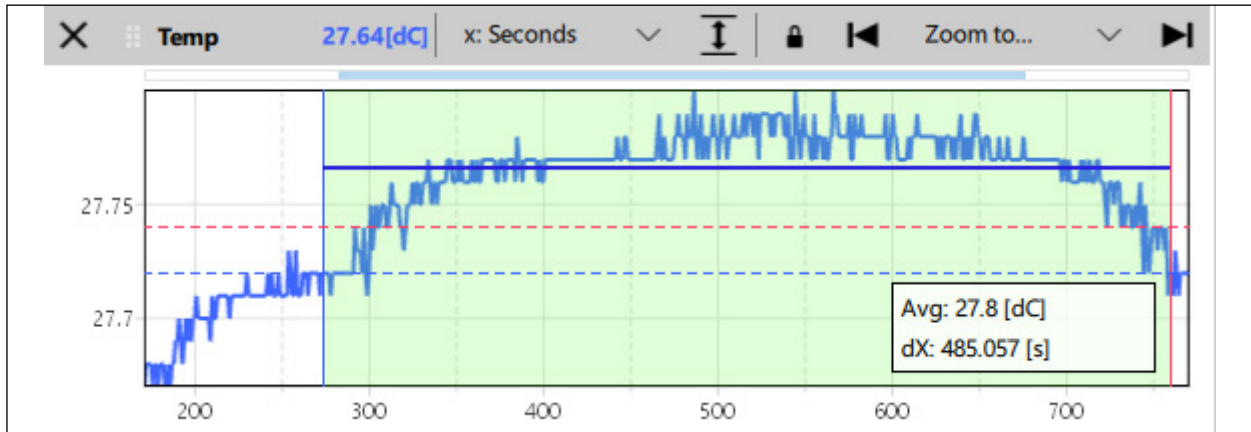
**FIGURE 2-20:** *Two Cursors with Average.*

When hovering over the informational pane with the mouse cursor, three additional buttons appear:

1. The **ellipsis** button toggles the displayed metric between Average and Slope.
2. The **plus** button zooms the chart view to the selected range.
3. The **X** button removes the cursors.
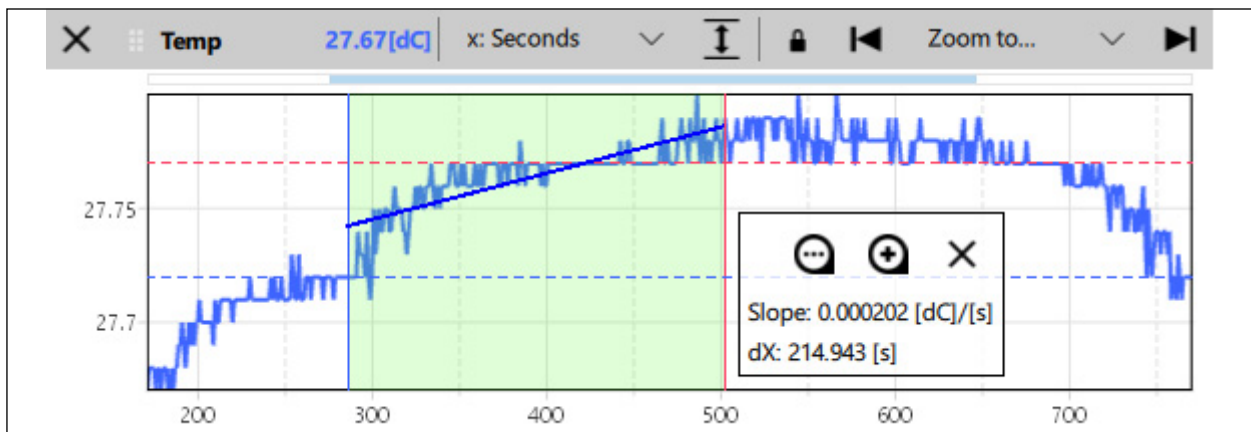


**FIGURE 2-21:** *A Selected Range Displaying the Slope Metric.*

# Appendix A. Supported Instruments

The user can find more info in the Clockstudio™ application itself, including links and more.

Supported devices include:

- Miniature Atomic Clock (MAC-SA5X): High performance Rb-based atomic oscillator.
- Chip Scale Atomic Clock (CSAC-SA45s and CSAC-SA65): Low-power atomic oscillator.
- Low Noise Chip Scale Atomic Clock (LN-CSAC): Low-power, low-noise atomic oscillator.
- 5071A and 5071B: Primary Frequency Standard.

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