

ModusToolbox™ CAPSENSE™ Tuner user guide

ModusToolbox™ tools package version 3.0.0

CAPSENSE™ Tuner version 5.0

About this document

Scope and purpose

The CAPSENSE™ Tuner is used to tune CAPSENSE™ applications.

Intended audience

This document helps application developers understand how to use the CAPSENSE™ Tuner as part of creating a ModusToolbox™ application.

Document conventions

Convention	Explanation
Bold	Emphasizes heading levels, column headings, menus and sub-menus
<i>Italics</i>	Denotes file names and paths.
<code>Courier New</code>	Denotes APIs, functions, interrupt handlers, events, data types, error handlers, file/folder names, directories, command line inputs, code snippets
File > New	Indicates that a cascading sub-menu opens when you select a menu item

Abbreviations and definitions

The following define the abbreviations and terms used in this document:

- Application – One or more projects related to each other.
- CAPSENSE – capacitive sensing
- Configurator – A GUI-based tool used to configure a resource.
- CSD – self-capacitance sensing method
- CSX – CAPSENSE™ Transmit/Receive (CAPSENSE™ with two electrodes: Tx and Rx), mutual capacitance sensing method
- IDE – integrated development environment
- ISX –inductive sensing method
- CSD HW – CAPSENSE™ Sigma Delta - 4th generation hardware (HW) block
- MSC HW – multi sensing converter – 5th generation hardware (HW) block
- MSCLP HW – multi sensing converter low power – 5th generation LP hardware (HW) block
- Peripheral – Any external analog or digital device that provides an input and output for the computer.
- PSoC™ – programmable system-on-chip
- SNR – signal-to-noise ratio

About this document

- Widget – A CAPSENSE™ functional unit consisting of one sensor or a group of similar sensors, implementing a specific higher-level functionality such as Button, Proximity Sensor, Linear Slider, Radial Slider, Matrix Buttons or Touchpad.

Reference documents

Refer to the following documents for more information as needed:

- [Eclipse IDE for ModusToolbox™ user guide](#)
- [CAPSENSE™ Configurator user guide](#)
- [Device Configurator user guide](#)
- [MTB CAT1 Peripheral driver library](#)
- [MTB CAT2 Peripheral driver library](#)
- Device datasheets
- Device technical reference manuals

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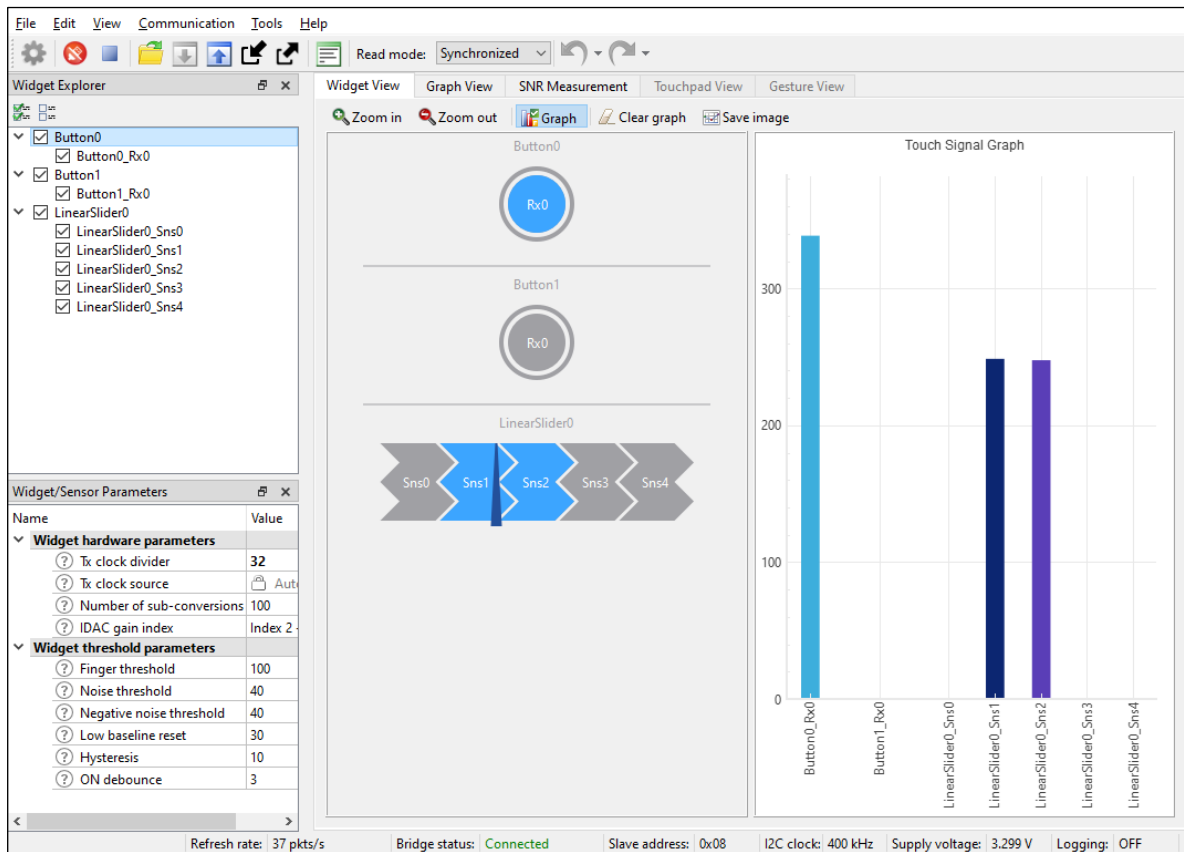
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Overview

1 Overview

The CAPSENSE™ Tuner is a stand-alone tool included with the ModusToolbox™ software. The tool is used to tune CAPSENSE™ applications.

Prior to using the CAPSENSE™ Tuner, create a CAPSENSE™ application and program it into the device. Refer to the [CAPSENSE™ Configurator guide](#) and the [CAPSENSE™ middleware documentation](#) for help. Your application must contain the CAPSENSE™ Middleware and a communication interface (I²C or UART). The Tuner works with the KitProg3, MiniProg4, and UART devices.



Launch the CAPSENSE™ Tuner

2 Launch the CAPSENSE™ Tuner

There are several ways to launch the CAPSENSE™ Tuner, and those ways depend on how you use the various tools in ModusToolbox™. However, the easiest way is to launch it using the Device Configurator because the CAPSENSE™ Tuner requires a properly configured CAPSENSE™ application programmed into the device. Refer to the [Device Configurator guide](#) for more details.

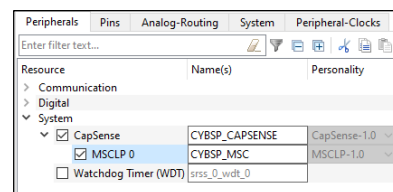
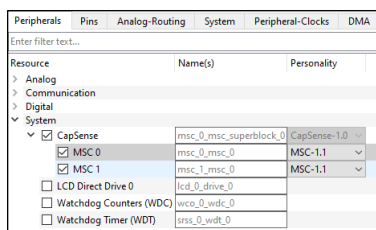
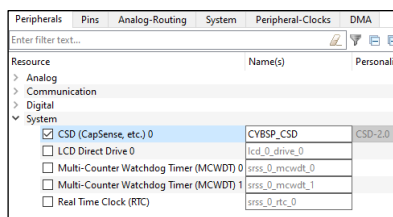
2.1 From the Device Configurator

You can launch the CAPSENSE™ Tuner from the Device Configurator. Refer to the [Device Configurator guide](#) for more details.

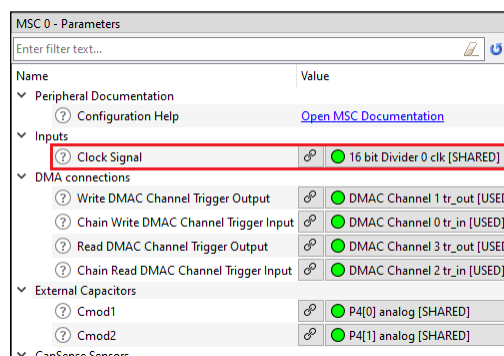
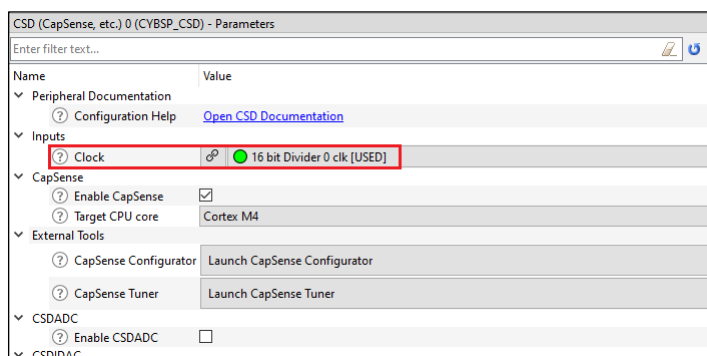
The process differs slightly depending on the hardware block:

- The 4th generation CAPSENSE™ – one CSD resource.
- The 5th generation CAPSENSE™ – two and more MSC resources.
- The 5th generation LP CAPSENSE™ – one MSCLP resource.

1. On the **Peripherals** tab, select the **CSD (CapSense)** resource or the **CapSense** and one or more **MSC** or **MSCLP** resources, as applicable for your device.

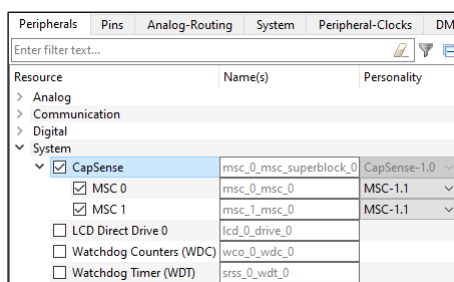


2. (Skip this step for MSCLP.) On the **Parameters** pane, select an appropriate input **Clock**.

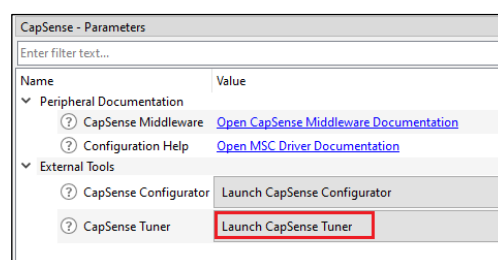
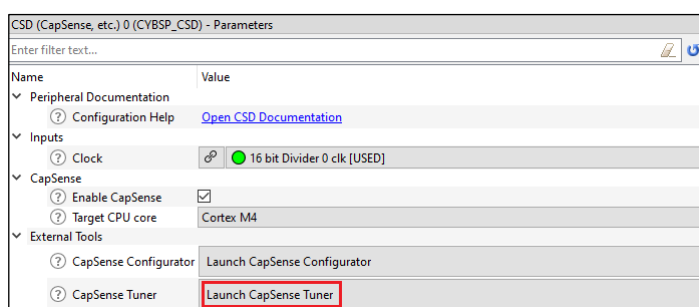


3. For the MSC and MSCLP HW blocks, select the **CapSense** resource category on the **Peripherals** tab.

Launch the CAPSENSE™ Tuner



- On the **Parameters** pane, click the **Launch CapSense Tuner** button.



2.2 make command

As described in the [ModusToolbox™ user guide](#) Build System chapter, you can run numerous `make` commands in the application directory, such as launching the CAPSENSE™ Tuner. After you have created a ModusToolbox™ application, navigate to the application directory and type the following command in the appropriate bash terminal window:

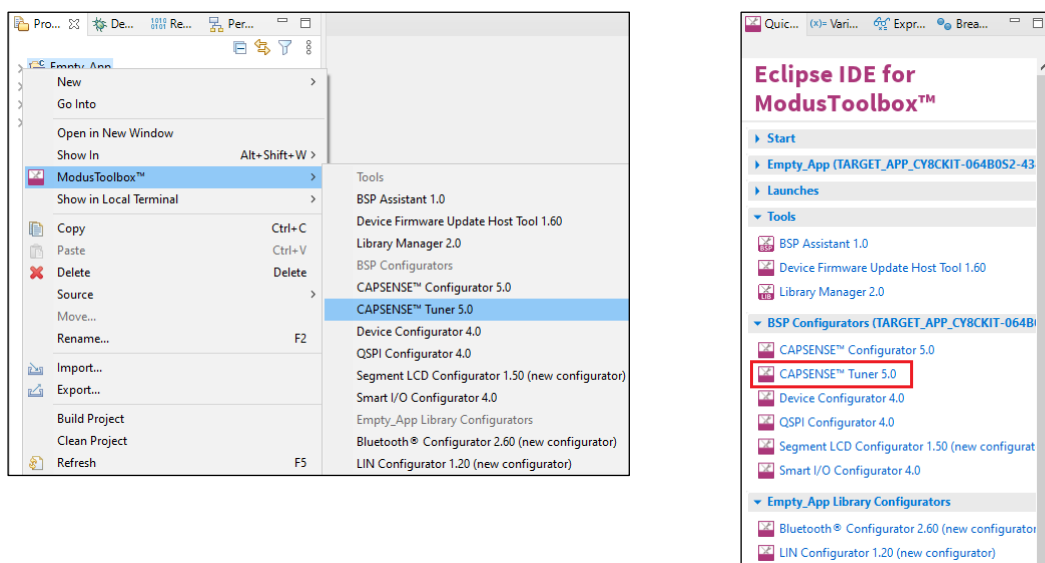
```
make capsense-tuner
```

This command opens the CAPSENSE™ Tuner GUI for the specific application in which you are working.

2.3 Eclipse IDE

If the selected application already includes a configuration (*design.cycapsense*) file, you can launch the CAPSENSE™ Tuner from the Eclipse IDE. Right-click on the project in the Project Explorer and select **ModusToolbox™ > CAPSENSE™ Tuner <version>**. You can also click the **CAPSENSE™ Tuner** link in the IDE Quick Panel. Refer to the [Eclipse IDE for ModusToolbox™ user guide](#) and [CAPSENSE™ Configurator user guide](#) for more details.

Launch the CAPSENSE™ Tuner



Note: These steps are the minimum required to launch the CAPSENSE™ Tuner. However, the Tuner will not work without a properly configured CAPSENSE™ application programmed into the device.

2.4 Executable (GUI)

You can launch the CAPSENSE™ Tuner GUI by running its executable as appropriate for your operating system (for example, double-click it or select it using the Windows **Start** menu). By default, the [CAPSENSE™ Tuner](#) is installed here:

`<install_dir>/ModusToolbox/tools_<version>/capsense-configurator<version>`

When run independently, the application opens without any information. You need to open a specific CAPSENSE™ application configuration file that was created by the CAPSENSE™ Configurator for the Tuner to work. See [Menus](#) for more information about opening a configuration file.

2.5 From the Command Line

You can run the Tuner from the command line. However, there are few reasons to do this in practice.

For information about the command-line options, run the Tuner using the `-h` option.

Quick start

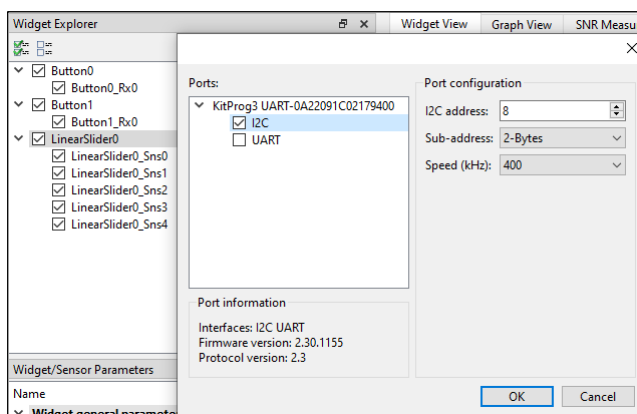
3 Quick start

This section provides a simple workflow for how to use the CAPSENSE™ Tuner.

1. Create a CAPSENSE™ application with a tuner communication interface, and program the application into the device. Refer to the [Eclipse IDE for ModusToolbox™ user guide](#) and the [CAPSENSE™ Configurator user guide](#) for more details.

Note: The simplest way to start with CAPSENSE™ Tuner is to use the [PSoC™ 6 CAPSENSE™ Buttons and Slider](#) code example configured to work on PSoC™ 6 MCU kits or [PSoC™ 4 MSC CAPSENSE™ CSD Button Tuning](#) to work on PSoC™ 4 MCU kits.

2. [Launch the CAPSENSE™ Tuner.](#)
3. Start Communication. Click **Connect** and select the available communication interface. In this case – “I2C.”



Note: Refer to the [KitProg user guide](#) for the supported configurations and modes. For this example, I2C address, sub-address, and speed must match the configuration.

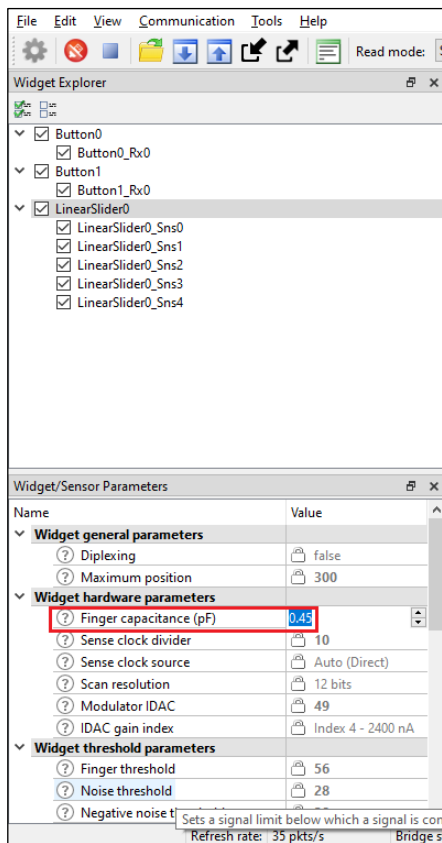
Note: For the I2C communication, the Tuner only supports the 2-Bytes Sub-address.

5. Click **Start** to extract data.



6. Touch the sensors on the hardware and notice the change in the sensor/widget status on [Widget View Tab](#).
7. Open the **Graph View** tab. Check the sensors in the Widget Explorer Pane to observe sensor signals in the graph. Touch the sensors and notice the signal change on the [Graph View Tab](#).
8. Change widget/sensor parameter values as needed. Then, apply the new settings to the device using the **Apply to Device** button.

Quick start



You can do this when using Manual or SmartSense (Hardware parameters only) modes for tuning:

- To edit the threshold parameters, use SmartSense (Hardware parameters only) mode.
 - To edit all the parameters, use Manual mode.
 - When SmartSense (Full Auto-Tune) is selected for CSD tuning mode, parameters are read-only (except the Finger Capacitance parameter).
9. Save the Tuner parameters. Click the **Apply to Project** button.
 10. Exit the Tuner application.

GUI description

4 GUI description

The CAPSENSE™ Tuner application contains [menus](#), a [toolbar](#), [panes](#), [tabs](#), and a [status bar](#), all used to tune a CAPSENSE™ application.

4.1 Menus

4.1.1 File

- **Open...** – Opens a <file_name>.cycapsense configuration file. This command is visible only when running the Tuner independently from the Eclipse IDE.
- **Apply to Device** – Commits changed values of a widget/sensor parameter to the device. This command becomes active if a value of any configuration parameter from the Tuner application changes (that is, if the parameter values in the Tuner and the device are different). This is an indication to apply the changed parameter values to the device. For the Simplex UART interface this command is grayed out.
- **Apply to Project** – Commits changed values of a widget / sensor parameter to the CAPSENSE™ project.
- **Open in System Explorer** – This opens your computer's file explorer tool to the folder that contains the *.cycapsense file.
- **Import...** – Imports a specified configuration file.
- **Export...** – Exports the current configuration file into a specified file.
- **Export Register Maps to PDF...** – Exports the current configuration register map in PDF format.
- **Recent files** – Shows recent files that you can open directly.
- **Exit** – Asks to save changes if there are any and closes the Tuner. Changes are saved to the configuration file.

4.1.2 Edit

- **Undo** – Undoes the last action or sequence of actions.
- **Redo** – Redoes the last undone action or sequence of undone actions.

4.1.3 View

- **Widget Explorer** – Hides or shows the Widget Explorer pane where widgets and sensors tree display.
- **Widget/Sensor Parameters** – Hides or shows the Widget/Sensor Parameters pane.
- **Gesture Event History** – Logs the detected gestures information. Displays in the View when any gesture is available.
- **Gesture Monitor** – Provides visual indication for a detected gesture. Displays in the View when any gesture is available
- **Toolbar** – Hides or shows the Toolbar. Enabled by default.
- **Reset View** – Resets the view to the default.

4.1.4 Communication

- **Connect** – Connects to the device via a communication channel selected in the Tuner Communication Setup dialog. If the channel was not previously selected, the Tuner Communication dialog is shown.
- **Disconnect** – Closes the communication channel with the connected device.
- **Start** – Starts reading data from the device.

GUI description

- **Stop** – Stops reading data from the device.

4.1.5 Tools












- **Tuner Communication Setup...** – Opens the configuration dialog to set up a communication channel with the device.
- **Options...** – Opens the configuration dialog to set up Tuner preferences: Display, SNR, Logging.

4.1.6 Help

- **View Help** – Opens the CAPSENSE™ Tuner guide (this document).
- **About CAPSENSE™ Tuner** – Opens the About box to display the version information, with links to open <https://www.infineon.com> and the current session log file.

4.2 Toolbar



Contains frequently used buttons that duplicate the main menu items:

-  Opens the configuration dialog to set up a communication channel with the device. The same as the **Tools > Tuner Communication Setup** menu command.
-  Connects to the device via a communication channel selected in the Tuner Communication Setup dialog. The same as the **Communication > Connect** menu command.
-  Closes the communication channel with the connected device. The same as the **Communication > Disconnect** menu command.
-  Starts reading data from the device. The same as the **Communication > Start** menu command.
-  Stops reading data from the device. The same as the **Communication > Stop** menu command.
-  Opens a configuration file. The same as the **File > Open** menu command.
-  Commits changed values of a widget/sensor parameter to the device. The same as the **File > Apply to Device** menu command.
-  Commits changed values of a widget / sensor parameter to the CAPSENSE™ project. The same as the **File > Apply to Project** menu command.
-  Imports a specified configuration file. The same as the **Import** menu command.
-  Exports the current configuration file into a specified file. The same as the **Export** menu command.
-  Starts or stops data logging into a specified file.
- Read mode – Selects the Tuner communication mode with a device. The following options are available (under the I2C communication interface):
 - Synchronized – When selected, application firmware periodically calls a corresponding Tuner function: `Cy_CapSense_RunTuner()`. The Tuner synchronizes data reading and firmware execution to preserve data coherency. CAPSENSE™ middleware waits for the Tuner read/write operation to be completed

GUI description

prior to execution of sensor scan and processing tasks. The Tuner does not read/write data until CAPSENSE™ middleware completes scanning and data processing tasks for all widgets in the application. The SNR and noise measurements are most accurate, and most tuning parameters can be edited in real time updating in this mode.

- Asynchronized – When selected, the Tuner reads data asynchronously with sensor scanning and data processing. Due to this, data coherency may be corrupted. So, the Tuner may read only partially updated sensor data. For example, the device completed scanning of only the first sensor in a row. At this moment, the Tuner reads data of the latest scan from the first sensor and data of previous scans from the remaining sensor. This can occur to all sensors, when the Tuner reads data prior to the completion of data processing tasks, such as baseline update and filter execution. SNR and noise measurements are less accurate due to non-coherent data reading and only a limited set of tuning parameters can be edited in real time in this mode.
Asynchronized mode may work unreliably with low power widgets configurations when the application is mostly in Deep Sleep. The Tuner may miss the time window when the device awakes and is able to communicate with the Tuner.

-  Undoes the last action or sequence of actions. The same as the **Edit > Undo** menu command.
-  Redoes the undone action or sequence of undone actions. The same as the **Edit > Redo** menu command.

4.3 Widget Explorer pane

The Widget Explorer pane contains a tree of widgets and sensors used in the CAPSENSE™ application. You can expand/collapse the Widget nodes to show/hide widget's sensor nodes. You can check/uncheck individual widgets and sensors in the Widget Explorer pane. The widget checked status affects its visibility in the [Widget View](#) and the position graph series in the [Graph View](#) while the sensor checked status controls the visibility of the sensor raw count / baseline / signal / status graph series in the [Widget View](#) and signals in the [Touch Signal Graph](#) on the [Widget View](#).

Selecting a widget or sensor in the Widget Explorer pane updates the selection in the Widget/Sensor Parameters pane.

Note: For CSX widgets, the sensor tree displays individual nodes (Rx0_Tx0, Rx0_Tx1 ...) contrary to the CAPSENSE™ Configurator where the CSX electrodes are displayed (Rx0, Rx1 ... Tx0, Tx1 ...).

Note: For MSC HW configurations with enabled Multi-frequency mode, there is a Median checkbox in the Widget Explorer for each sensor that shows a set of F0 values received from a kit in the [Graph View](#) tab.

4.4 Widget/Sensor parameters pane

The Widget/Sensor parameters pane displays the parameters of a widget or sensor selected in the Widget Explorer tree. The grid is similar to the grid on the Widget Details tab in the CAPSENSE™ Configurator. The main difference is that some parameters are available for modification in the Configurator, but not in the Tuner. When a parameter is selected, its description displays on the panel below the parameters list.

This pane includes the following parameters:

- Widget General Parameters – Cannot be modified from the Tuner because corresponding parameter values reside in the application flash widget structures that cannot be modified at runtime.

GUI description

- **Widget Hardware Parameters** – Cannot be modified for the CSD widgets when CSD tuning mode is set to SmartSense (Full Auto-Tune) or SmartSense (Hardware parameters only) in the CAPSENSE™ Configurator. In Manual tuning mode (for all widgets), any change to Widget Hardware Parameters requires hardware re-initialization performed only if the Tuner communicates with the device in Synchronized mode.
- **Widget Threshold Parameters** – Cannot be modified for the CSD widgets when CSD tuning mode is set to SmartSense (Full Auto-Tune) in the Configurator. In Manual tuning mode (for all widgets), threshold parameters are always writable (Synchronized mode is not required). The exception is the ON debounce parameter that also requires hardware re-initialization (in the same way as the hardware parameters).
- **Sensor Parameters** – Sensor-specific parameters. The Tuner application displays only Compensation IDAC or CDAC values. When the IDAC / CDAC auto-calibration is enabled, the parameter is read-only and displays values as calibrated by the firmware. When the auto-calibration is disabled, the IDAC / CDAC value entered in the CAPSENSE™ Configurator displays, and the parameter becomes writable in Synchronized mode.
- **Filter Parameters and Centroid Parameters** – Cannot be modified at runtime from the Tuner because, unlike the other parameters, these parameter values reside in the application flash widget structures that cannot be modified at runtime.
- **Gesture Parameters** – Synchronized communication mode must be selected to update the Gesture parameters during runtime from the Tuner application.

Note: The position filter parameters, Adaptive IIR filter parameters, and Gesture parameters reflect data stored in a loaded configuration file. Actual values may vary on a target device connected to the CAPSENSE™ Tuner.

4.5 Tabs

The application consists of the following tabs:

- [Widget View](#) – Displays the widgets, their touch status, and the touch signal bar graph.
- [Graph View](#) – Displays the sensor data charts.
- [SNR Measurement](#) – Provides the SNR measurement functionality.
- [Touchpad View](#) – Displays the touchpad heatmap.
- [Gesture View](#) – Displays the Gesture operation.

4.6 Status bar

The status bar at the bottom of the GUI displays information related to the communication state between the Tuner and the device. Some sections differ depending on the communication type as follows:

I2C interface

Refresh rate: 21 pkts/s	Bridge status: Connected	Slave address: 0x08	I2C clock: 400 kHz	Supply voltage: 3.295 V	Logging: OFF
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UART interface

Refresh rate: 42 pkts/s	Bridge status: Connected	Mode: Full duplex	Baud rate: 115200	Supply voltage: 3.296 V	Logging: OFF
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- **Refresh rate** – A count of read samples performed per second. The count depends on multiple factors: the selected communication channel, communication speed, and amount of time for a single scan.
- **Bridge status** – Either Connected, when the communication channel is active, or Disconnected otherwise.
- **Slave address** (I2C) – The address of the I2C slave configured for the current communication channel.
- **I2C clock** (I2C) – The data rate used by the I2C communication channel.

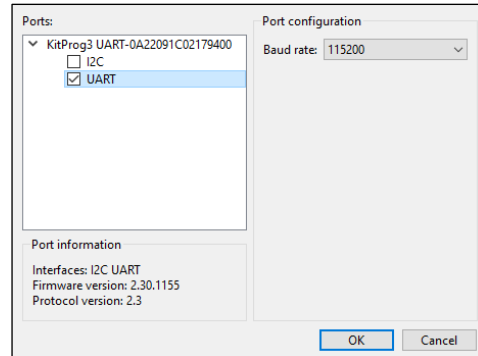
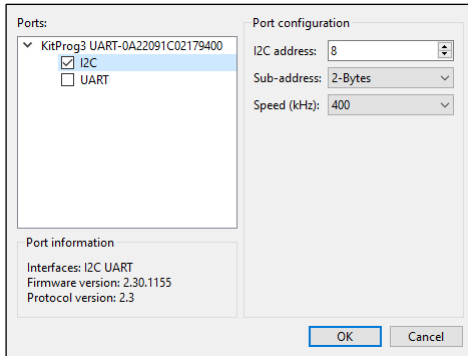
GUI description

- **Mode** (UART)
 - Full duplex mode – Provides data transmission in two reverse directions: - target device → tuner → target device. You can change the parameters of the widgets / sensors at runtime. To save the new configuration, click the **Apply to Device** button
 - Simplex mode – Provides data transmission in one direction: target device → tuner. You cannot change the parameters of the widgets / sensors at runtime.
- **Baud rate** (UART) – The data rate at which CAPSENSE™ operates with the current settings.
- **Supply voltage** – The supply voltage.
- **Logging** – Either ON (when the data logging to a file in progress) or OFF.

Tuner Communication Setup

5 Tuner Communication Setup

The Tuner Communication Setup dialog is used to establish communication between the Tuner and target device. The Tuner supports I2C and UART communication interfaces.



Select **Tools > Tuner Communication Setup...** on the menu to open the dialog or click the **Tuner Communication Setup** button. The dialog opens automatically after clicking the **Connect** button if no device was previously selected.

Select the device and communication interface by checking the item with the interface name. Change the interface configuration parameters to match the configuration of the communication peripheral in the application.

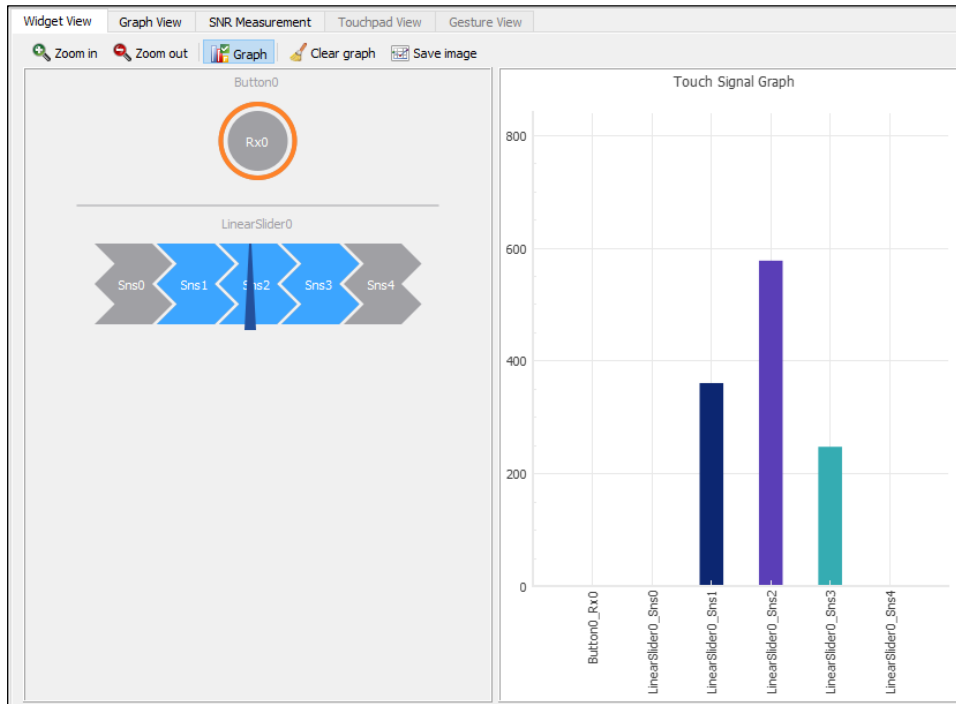
Note: *The parameters in the Tuner Communication Setup dialog must be identical to the parameters of the I2C or UART driver in the application.*

Note: *Recommended – enable the UART Flow control on the target device for bitrates equal or higher than 1000000.*

Widget View tab

6 Widget View tab

The **Widget View** provides a visual representation of all widgets selected in the [Widget Explorer Pane](#). If a widget consists of more than one sensor, individual selected sensors are highlighted in the [Widget Explorer Pane](#) and [Widget/Sensor Parameters Pane](#).



The Widget and/or sensors are highlighted when the device reports their touch status as active.

Some additional features are available depending on the widget type.

6.1 Toolbar

The toolbar provides quick access to different configuration options that affect the Widget View display.

- Zoom in – Zooms in the widgets. Press the [**Esc**] key to undo zoom.
- Zoom out – Zooms out the widgets. Press the [**Esc**] key to undo zoom.
- Graph – Shows or hides the Touch Signal Graph.
- Clear graph – Clears the Touch Signal Graph.
- Save image – Opens the dialog to save the Widget View tab as an image. To save the whole main window as an image, press and hold the [**Ctrl**] key. The supported formats: .PNG, .JPG, BMP.

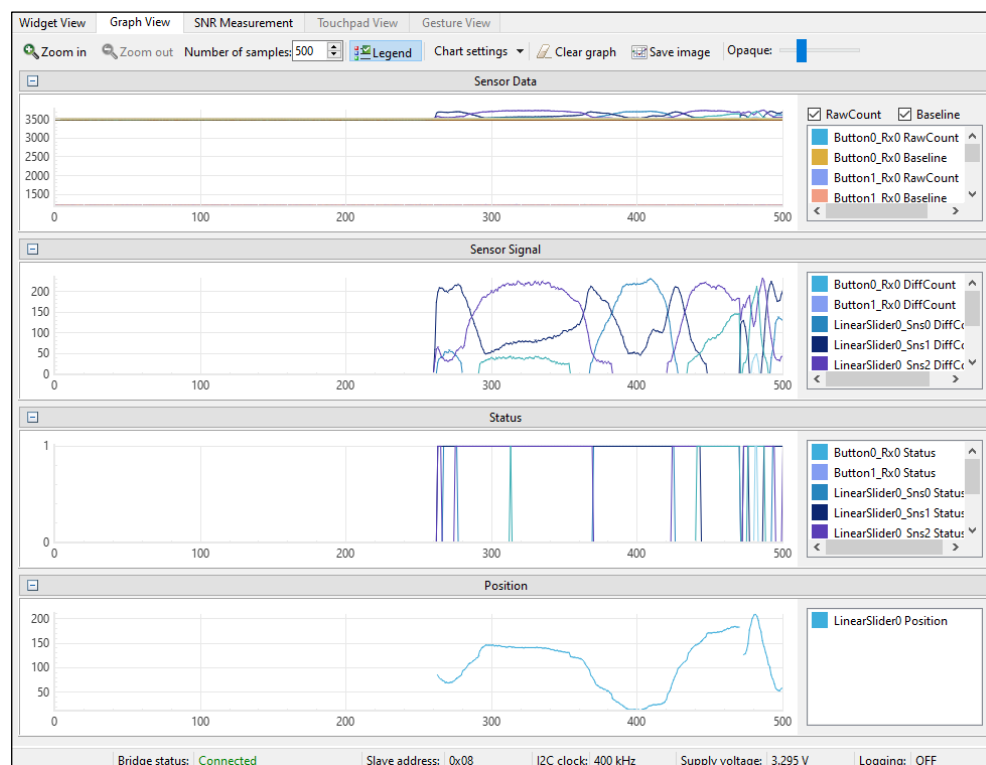
6.2 Touch Signal Graph

The Widget view also displays the Touch Signal Graph. This graph contains a touch signal level for each sensor selected in the [Widget Explorer Pane](#).

Graph View tab

7 Graph View tab

The Graph View displays graphs for the sensors selected in the [Widget Explorer Pane](#).



The following graphs are available:

- **Sensor Data** – Displays RawCount and Baseline. Click a corresponding check box to see them. Under Multi-frequency mode, RawCount and Baseline are available for three channels: 0, 1, 2.
- **Sensor Signal** – Displays signal differences.
- **Status** – Displays a sensor status (Touch/No Touch).
- **Position** – Displays touch positions for the Linear Slider, Radial Slider, and Touchpad widgets.

Note: For 5th generation CAPSENSE™ configurations with enabled Multi-frequency mode, there is a Median graph on the Sensor Signal graph for each sensor.
For Multi-frequency mode, three varieties are scanned for each sensor at three different frequencies and three different raw-counts are obtained for the same sensor. The sensor state is estimated by one median value calculated from the obtained three raw-counts.
A Median graph shows a set of F0 values received from a kit. The graph becomes visible if at least one of the graphs F0, F1, F2 is visible. Then, the Tuner calculates the actual value of F0 from received data.

7.1 Toolbar

The toolbar provides quick access to different configuration options that affect the Graph View display.

- **Zoom in** – Zooms in all graphs synchronously along the X axis. Press the [**Esc**] key to undo zoom.
- **Zoom out** – Zooms out all graphs synchronously along the X axis. Press the [**Esc**] key to undo zoom.
- **Number of samples** – Defines the total amount of data samples shown on a single graph.
- **Legend** – Shows or hides the sensor series descriptions (with names and colors) in graphs.

Graph View tab

- Chart settings – Opens the menu for editing the chart line series parameters.
- Clear graph – Clears all graphs.
- Save image – Opens a dialog to save the Graph View tab as an image. To save the whole main window as an image, press and hold the [Ctrl] key. The supported formats: .PNG, .JPG, .BMP.
- Opaque – The level of opacity of the area below the line series.

7.2 Graph functionality

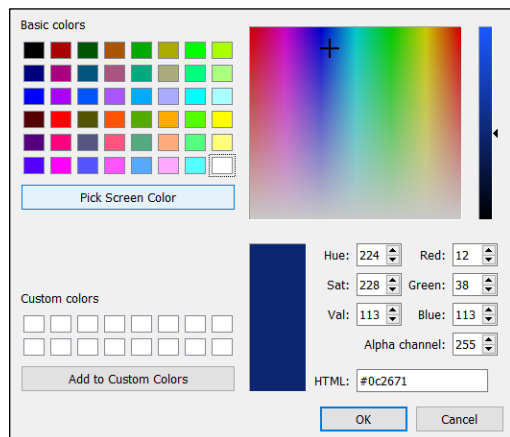
The Graph functionality includes:

- **Highlighting** – If you click a sensor line series on the graph, the corresponding sensor series highlights on the Legend pane. Likewise, if you click a sensor series on the Legend pane, it highlights a sensor line series on the graph. To highlight lines for all graphs at the same time, press and hold the [Ctrl] key. To select multiple sensors in the other View tabs, press and hold the [Alt] key.
- **Pan and Zoom** – Allow you to examine graphs in more detail. Use a mouse drag for pan. Press and hold the [Shift] key to select the area you need to examine. Press and hold the [Ctrl] key to examine all the graphs simultaneously.

Use the mouse wheel for Zoom. The [Ctrl] key + mouse wheel zooms all graphs simultaneously. Press the [Esc] key to undo zoom and pan for all graphs.

- **Context menu** – Provides the options to change the appearance of graphs. To display the menu, right-click one of the charts – Sensor Data, Sensor Signal, Status, Position – or its legend.
 - The context menu options:
 - Increase series line width
 - Decrease series line width
 - Increase selected series line width
 - Decrease selected series line width
 - Zoom in
 - Zoom out.
 - The context menu options for selected graphs also contains:
 - Line style
 - Scatter shape
 - Color
- **Color** – To change a sensor series color on the Legend pane, either double-click or right-click the sensor and select the Color option from the displayed menu. The “Please choose a color for ...” dialog displays. You can change the color for the graph lines of the same sensor(widget) on all the charts of the Graph View and on the Touch Signal Graph of the Widget View simultaneously.

Graph View tab

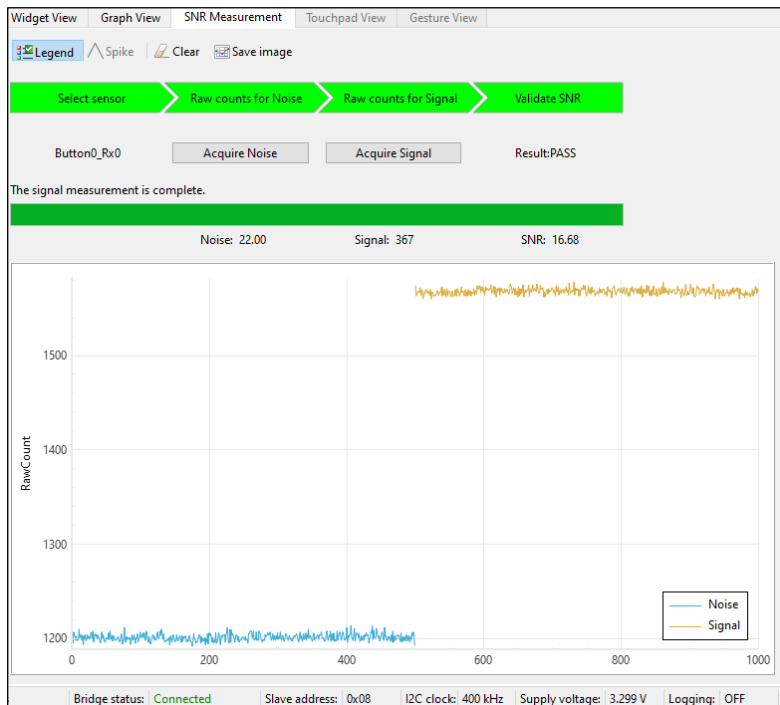


Select a color and click **OK**. To select a color for all the graphs at the same time, press and hold the **[Ctrl]** key while clicking.

SNR Measurement tab

8 SNR Measurement tab

The SNR Measurement tab allows measuring an SNR for individual sensors. It provides the user interface to acquire noise and signal separately and then calculates an SNR based on the captured data. The obtained value is then validated by a comparison with the required minimum (5 by default, can be configured in the Options dialog).



8.1 Toolbar

The toolbar provides quick access to different Tuner configuration options that affect the SNR Measurement graphs display:

- Legend – Shows or hides the legend on the graph.
- Spike – Highlights spikes on the graph.
- Clear – Clears a graph. Note that using this button while noise calculation is in progress will clear all acquired samples and the Tuner will wait for fresh samples to calculate noise.
- Save image – Opens the dialog to save the SNR Measurement tab as an image. To save the whole main window as an image, press and hold the [Ctrl] key. The supported formats: .PNG, .JPG, BMP.

8.2 SNR Measurement procedure

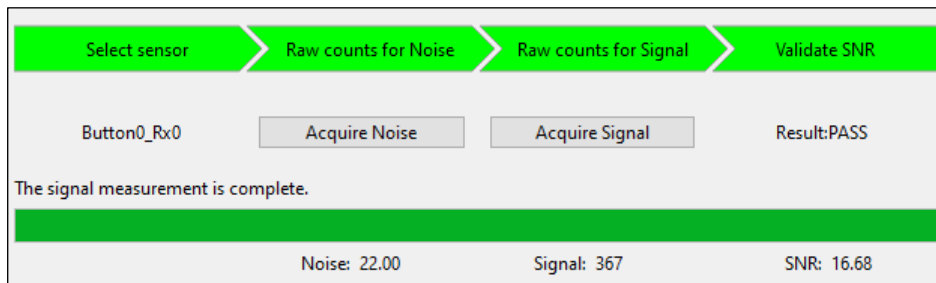
1. Click **Connect** to the device and then **Start** communication on the toolbar.
2. Switch to the SNR Measurement tab.
3. Select the sensor by clicking it on the Widget Explorer pane and observe the **Select sensor** block become green.
4. Ensure no touch is present on the selected sensor.
5. Click **Acquire Noise** and wait for the required count of samples to be collected. Observe the **Raw counts for Noise** block become green after the action completes.

SNR Measurement tab

6. Observe the Noise parameter be updated with the calculated noise average value.
7. Touch the selected sensor to produce a signal on it.
8. Click **Acquire Signal** and wait for the required count of samples to be collected. Observe the **Raw counts for Signal** block become green after the action completes.
9. Observe the Signal parameter be updated with the calculated signal average value.
10. Observe the SNR parameter be updated with the SNR. The **Validate SNR** block becomes green if the result is PASS, if FAIL – red.

8.3 SNR measurement pane

The SNR Measurement procedure pane indicates the SNR measurement stages. The status is defined by the background color: green means the stage is successfully completed.



The progress bar provides graphical guidance to the user to complete the SNR measurement. The bar displays the progress and user-addressed relevant messages.

The measured noise, signal, and SNR values are displayed below the progress bar. The SNR value is calculated as Signal divided by Noise rounded up to 2 decimal points.

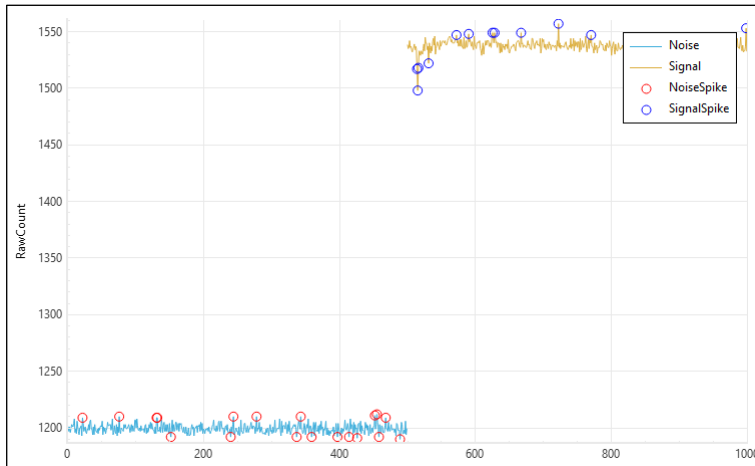
The result has the following meaning:

- a. PASS – The SNR is above the required limit (green).
- b. FAIL – The SNR is below the required limit (red).
- c. N/A – The SNR cannot be calculated because noise/signal samples are not collected yet (grayed out).

SNR Measurement tab

8.4 Graph chart

The graph chart displays the measured sensor noise and signal. Noise and signal spikes displayed on the chart are the points ignored during the SNR calculation.



Click the **Legend** button to make it visible or invisible.

- **Context menu** – Provides the options to change the appearance of graphs. To display the Context menu, right-click any chart.

The options:

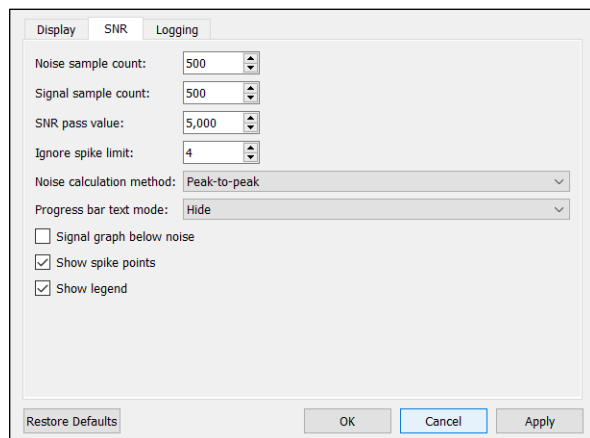
- Increase series line width
- Decrease series line width
- Increase selected series line width
- Decrease selected series line width
- Position of Legend (six directions)
- Legend
- Spike
- Clear
- Save image

The context menu options for selected graphs also contains:

- Line style (for Noise and Signal only)
- Scatter shape
- Set color for ...

SNR Measurement tab**8.5 SNR options**

SNR parameters can be modified in the options dialog. See [Tuner Configuration Options](#) for descriptions of other tabs on this dialog.



The image shows the 'SNR' tab of the 'Tuner Configuration Options' dialog box. It contains several settings: 'Noise sample count' set to 500, 'Signal sample count' set to 500, 'SNR pass value' set to 5,000, and 'Ignore spike limit' set to 4. The 'Noise calculation method' is set to 'Peak-to-peak' and the 'Progress bar text mode' is set to 'Hide'. There are three checkboxes: 'Signal graph below noise' (unchecked), 'Show spike points' (checked), and 'Show legend' (checked). At the bottom, there are buttons for 'Restore Defaults', 'OK', 'Cancel', and 'Apply'.

- Noise sample count – The count of samples to acquire during the noise measurement operation.
- Signal sample count – The count of samples to acquire during the signal measurement operation.
- SNR pass value – The minimal acceptable value of the SNR.
- Ignore spike limit – Ignores a specified number of the highest and the lowest spikes at noise / signal calculation. That is, if you specify number 3, then three upper and three lower raw counts are ignored separately for the noise calculation and for the signal calculation.
- Noise calculation method – Allows selecting the method to calculate the noise average. The following methods are available for selection:
 - Peak-to-peak (by default) – Calculates noise as a difference between the maximum and minimum value collected during the noise measurement.
 - RMS – Calculates noise as a root mean-square of all samples collected during the noise measurement.
- Progress bar text mode – This label is shown with the progress bar:
 - Hide (by default) – No label.
 - Percent – The number of samples in percent acquired during the signal measurement operation.
 - Value – The number of samples acquired during the signal measurement operation.

Note: *This option is not available on Mac OS.*

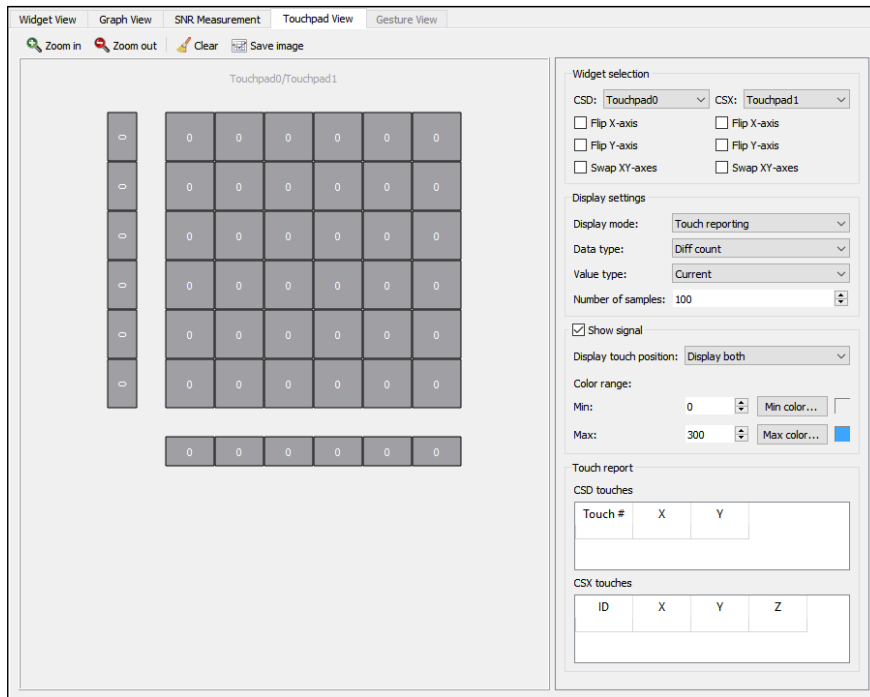
- Signal graph below noise – Displays the signal series below the noise threshold on the graph.
- Show spike points – Highlights the spike points on the graph.
- Show legend – Shows the graph legend. The Legend has the context menu to change its position. Right-click the Legend to see the menu.

Touchpad View tab

9 Touchpad View tab

This tab visually represents signals and positions of a selected touchpad widget in the heatmap form. Only one CSD and one CSX touchpad can be displayed at a time.

Note: *The Touchpad View tab is disabled when there are no touchpad widgets in the configuration.*



9.1 Toolbar

- Zoom in – Zooms in the Touchpad widget. Press the [Esc] key to undo zoom.
- Zoom out – Zooms out the Touchpad widget. Press the [Esc] key to undo zoom.
- Clear – Clears the touchpad.
- Save image – Opens a dialog to save the Touchpad View tab as an image. To save the whole main window as an image, press and hold the [Ctrl] key. The supported formats are: .PNG, .JPG, .BMP.

9.2 Widget selection

Consists of the configuration options for mapping the physical touchpad orientation to the identical representation in the heatmap:

- CSD combo box – Selects any CSD touchpad to display in the heatmap.
- CSX combo box – Selects any CSX touchpad to display in the heatmap.
- Flip X-axis – Flips the displayed X-axis to match the orientation of a physical touchpad.
- Flip Y-axis – Flips the displayed Y-axis to match the orientation of a physical touchpad.
- Swap XY-axes – Swaps the X- and Y-axes for the touchpad.

Touchpad View tab

9.3 Display settings

Manages heatmap data to display. These options are applicable for the CSX touchpad only.

- Display mode – The drop-down menu with 3 options for the display format:
 - Touch reporting – Shows current detected touches only.
 - Line drawing – Joins the previous and current touches in a continuous line.
 - Touch Traces – Plots all the reported touches as dots.
- Data type – The drop-down menu to select the signal type to display: Diff count, RawCount, and Baseline. Under Multi-frequency mode, RawCount and Baseline are available for three channels: 0, 1, 2.
- Value type – The drop-down menu to select the type of a value to display:
 - Current – The last received value.
 - Max hold – The maximum value out of latest “Number of samples” received.
 - Min hold – The minimum value out of latest “Number of samples” received.
 - Max-Min – The difference between maximum and minimum values.
 - Average – The average value of latest “Number of samples” received.
- Number of samples – Defines a length of history of data for the Line Drawing, Touch Traces, Max hold, Min hold, Max-Min, and Average options.

9.4 Show signal

Enables displaying data for each sensor if checked, otherwise displays only touches. This option is applicable for the CSX touchpad only.

- Display touch position – Selects the touchpad from which data is displayed in the heatmap. The three options:
 - Display only CSX
 - Display only CSD
 - Display both
- Color range – Defines a range of sensor signals within which the color gradient is applied. If a sensor signal is outside the range, a sensor color is either minimum or maximum out of the available color palette.

9.5 Touch report

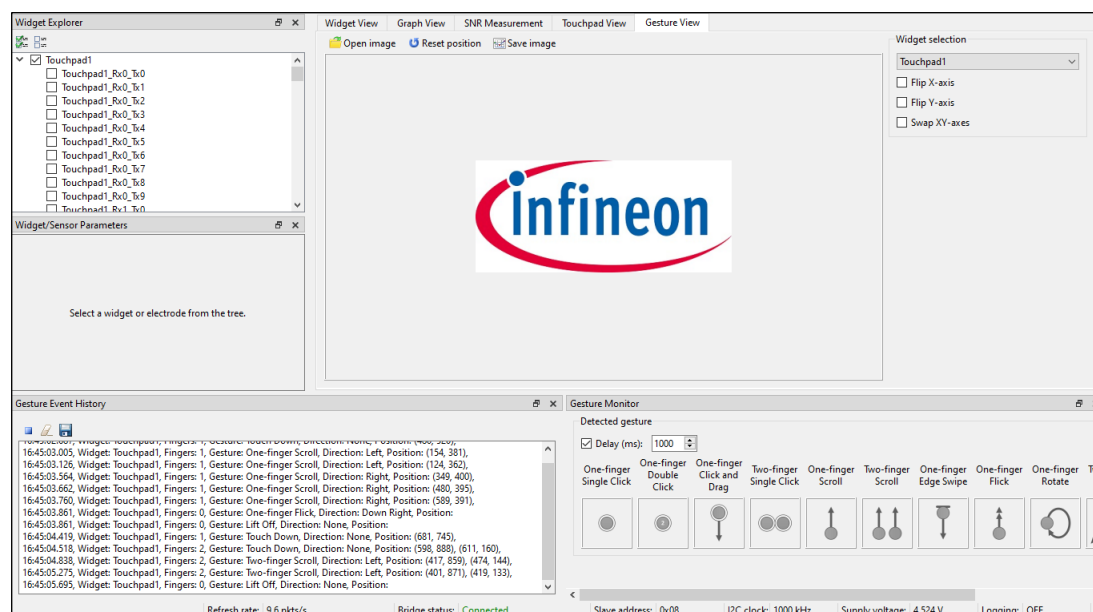
- CSD touches table – Displays the current X and Y touch position (Z value is always 0) of the detected touches on the CSD touchpad. If the CSD touchpad is neither configured nor touch is detected, the touch table is empty. When two-finger detection is enabled for a CSD touchpad, then two touch positions are reported.
- CSX touches table – Displays the current X and Y touch position and Z values (amplitude) of the detected touches on the CSX touchpad. If the CSX touchpad is neither configured nor touches is detected, the touch table is empty. The middleware supports simultaneous detection up to three touches for a CSX touchpad touch, so the touch table displays all the detected touches.

Gesture View tab

10 Gesture View tab

This tab visually represents evaluation and tuning of gestures (from one widget at a time).

Note: *The Gesture View tab is disabled when there is no gesture widget in the configuration.*



Note: *Synchronized communication mode or UART communication is recommended for Gesture validation, to make sure no gesture event such as a touchdown or lift-off is missed during communication.*

10.1 Toolbar

- Open image – Opens a custom image.
- Reset position – Resets the image position and zoom. The image is moved to the center of the panel.
- Save image – Opens a dialog to save the Gesture View tab as an image. To save the whole main window as an image, press and hold the [Ctrl] key. The supported formats: .PNG, .JPG, .BMP.

10.2 Widget selection

Allows selecting a widget and controls that the display in the Tuner matches the orientation physical widget on hardware.

- Combo box – Selects the widget with Gesture enabled to display the Gesture from it on this pane.
- Flip X-axis – Flips the direction of the X-axis to match the orientation of a physical widget.
- Flip Y-axis – Flips the direction of the Y-axis to match orientation of a physical widget.
- Swap XY-axes – Swaps the X- and Y-axes to match orientation of a physical widget.

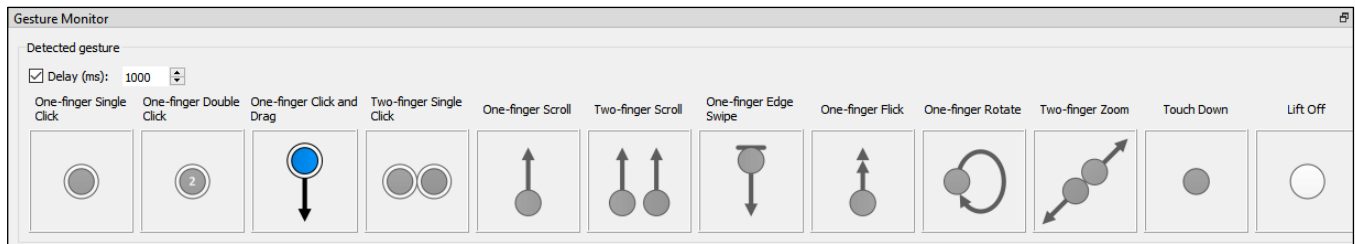
10.3 Image pane

An image reacts to the detected gestures (scroll and zoom) and moves around the pane. You can change the image by clicking the **Open image** tool button.

Gesture View tab

10.4 Gesture Monitor

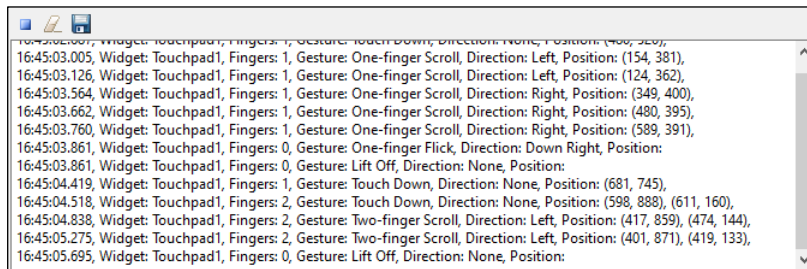
Provides visual indication for a detected gesture.



If the Delay checkbox is enabled, a Gesture picture is displayed only for the specified time-interval. If disabled, the last reported gesture picture is displayed until a new Gesture is reported.

10.5 Gesture Event history

Logs the detected gestures information.

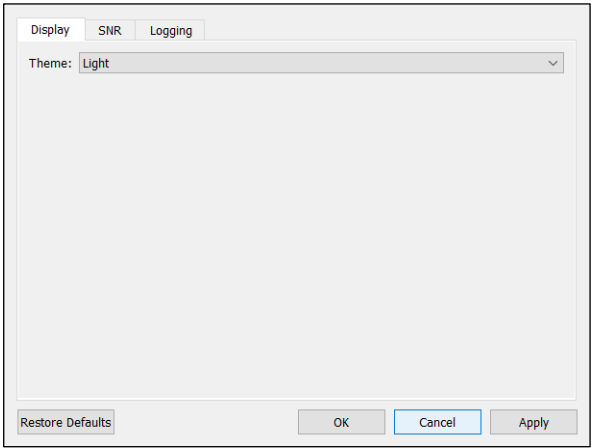


Tuner Configuration options

11 Tuner Configuration options

The Tuner application allows setting different configuration options with the options dialog. The settings are divided into groups.

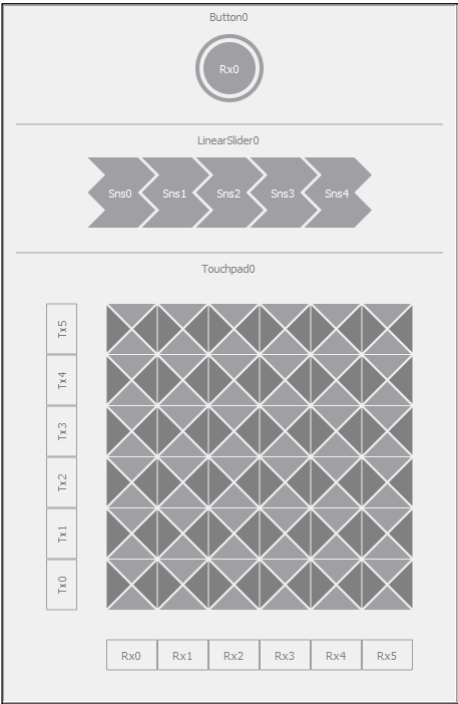
11.1 Display options



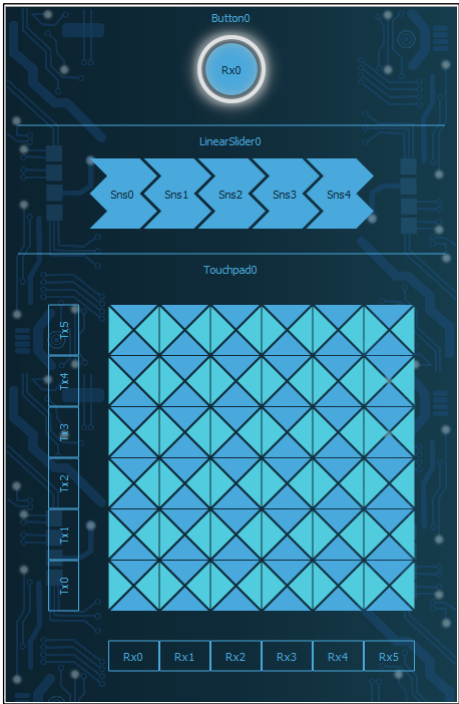
11.1.1 Theme

Defines the visual style of widgets.

Light theme

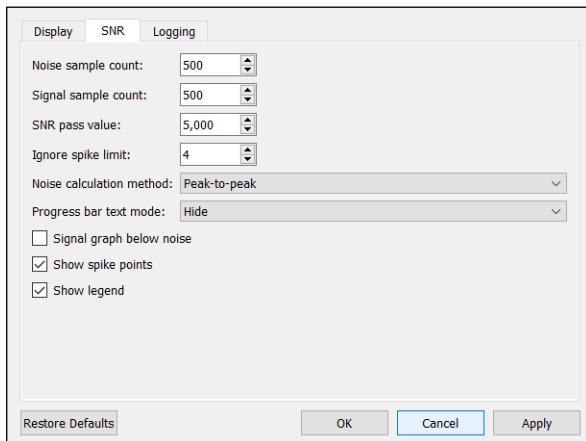


Dark theme



Tuner Configuration options

11.2 SNR options

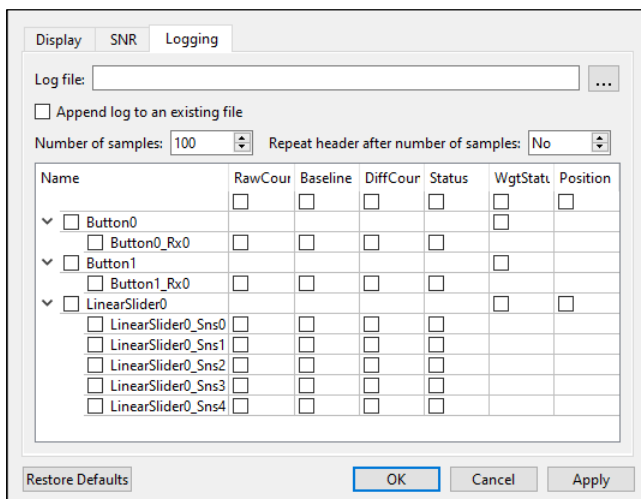


The SNR options dialog box contains the following settings:

- Display: SNR (selected)
- Logging: (disabled)
- Noise sample count: 500
- Signal sample count: 500
- SNR pass value: 5,000
- Ignore spike limit: 4
- Noise calculation method: Peak-to-peak
- Progress bar text mode: Hide
- ☐ Signal graph below noise
- ☒ Show spike points
- ☒ Show legend
- Buttons: Restore Defaults, OK, Cancel, Apply

See the [SNR options](#) section for a description of this tab.

11.3 Logging options



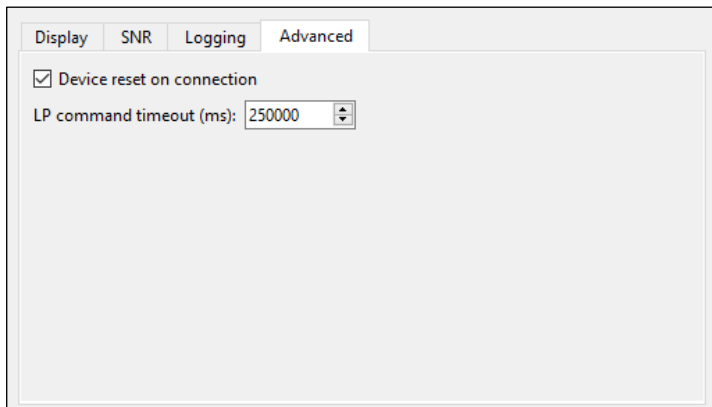
The Logging options dialog box contains the following settings:

- Display: Logging (selected)
- SNR: (disabled)
- Log file: (empty text box with browse button)
- ☐ Append log to an existing file
- Number of samples: 100
- Repeat header after number of samples: No
- Data configuration table:

Name	RawCour	Baseline	DiffCour	Status	WgtStat	Position
<input checked="" type="checkbox"/> Button0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Button0_Rx0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> Button1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Button1_Rx0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input checked="" type="checkbox"/> LinearSlider0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> LinearSlider0_Sns0	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> LinearSlider0_Sns1	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> LinearSlider0_Sns2	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> LinearSlider0_Sns3	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> LinearSlider0_Sns4	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Buttons: Restore Defaults, OK, Cancel, Apply

- Log file – Selects a csv file and its location to store information.
- Append log to an existing file – If this option is enabled, the selected file cannot be overwritten and expanded with new data. When this option is not enabled, the selected file can be overwritten.
- Number of samples – Defines a log session duration in samples. The header is repeated after a number of samples.
- Data configuration check box table – Selects data to collect into a log file.

Tuner Configuration options**11.4 Advanced options**

- Device reset on connection – If this option is enabled, the target reset is performed on connect and disconnect for 5th generation LP CAPSENSE™ devices which helps to establish connection even if the device was in the deep sleep mode.
- LP command timeout (ms) – defines the timeout for read and write commands for 5th generation LP CAPSENSE™ devices. During this time the Tuner will repeatedly try to read / write data until the device wakes up from the deep sleep and operation succeeds. Default: 250000 ms.

Troubleshooting

12 Troubleshooting

Problem	Workaround
On common Linux distributions, the serial UART ports (usually /dev/ttySx or /dev/ttyUSBx devices) belongs to the root user and to the dialout group. Standard users are not allowed to access these devices.	<p>An easy way to allow the current user access to the Linux machine's serial ports is by adding the user to the dialout group. This can be done using the following command:</p> <pre>\$sudo usermod -a -G dialout \$USER</pre> <p>Note: <i>For this command to take effect, you must log out and then log back in.</i></p>
On macOS, the CAPSENSE™ Tuner can't be launched from the Launchpad.	Launch the Tuner from within the Device Configurator or use the command line option.
On common Linux distributions, the Tuner forbids communication interface selection after re-plugging KitProg during communication.	Refer to the “Installation Procedure on Ubuntu Linux (x64)” section in the <i>Cypress Programmer 2.1 CLI User Guide</i> .
KitProg3 UART is accessible but not able to read data on Linux kernel 4.15 and above or Mac OS X 10.13 and above.	<p>Use third-party UART to USB bridge.</p> <p>Update the KitProg3 firmware to version 1.11.243 or above.</p>
Unstable connection with a device that operates in Low power mode.	<p>The Tuner requires a working communication channel (I2C, UART) for devices operating in Low power mode (for example, configurations with Low Power widgets).</p> <p>The following are the limitations necessary for maintaining the successful connection of the Tuner with a device:</p> <ol style="list-style-type: none"> 1) The PSoC™ side firmware ensures that after the device exits Deep Sleep mode, the device stays in the active state with the working communication channel, which enables the Tuner to receive at least one packet with valid data. 2) The device sleeps less than the Tuner defined timeout (see the LP command timeout in the Tuner Configuration Options dialog, Advanced tab).

Note: *The Tuner provides information about the root cause of connection to KitProg issue in an operation log. The operation log location can be found in the About CAPSENSE™ Tuner box.*

Version changes

13 Version changes

This section lists and describes the changes for each version of this tool.

Version	Change descriptions
1.0	New tool.
1.1	Added UART interface.
	Added possibility to save different views as images.
	Added zoom and pan functionality for graphs.
	Fixed minor issues.
2.0	Added "IDAC gain index" parameter.
	Changed the data storage location from a header (.h) file to an XML-based *.cycapsense file.
	For backward compatibility, the configurator is still able to load the header (.h) file that contains the legacy format configuration. But, if the legacy header (.h) with the configuration is passed via a command-line parameter, a message appears saying that the .h file is not supported.
	Added the Import and Export options to the File menu that enable importing and exporting the configuration file from and into the external file.
	Added the Reset View command to the View menu that resets the view to the default.
	Added Multi-frequency support that enables selecting RawCount and Baseline.
	Added the UART option description in Status Bar.
	Changed generation of the middleware initialization structure according to the changes in CapSense v2.0 middleware (related to added fields for flash memory optimization, fixed defect with RawCount filters config, IDAC gain index, etc.).
	Added support for selecting multiple sensors in some view and reflecting the selection in other views.
	Added handling of invalid command line arguments.
3.0	Added highlighting of modified properties in the property grid with bold.
	Added a warning if opening a broken configuration file.
3.10	Fixed memory leaks.
	Fixed Graph View issues under high load of application.
	Added the Undo / Redo feature.
	Changed the list of UART baud-rate possible values to match the values supported by KitProg. The highest rate is 3000000.
	Updated versioning to support patches.
3.11	Added a popup notification when the Apply to device command completes.
	Increased the communication speed between the device and Tuner when using the I2C interface.
	Improved the tool performance for loading large configurations.
	Fixed the issue with applying changes to the device when using the UART communication interface: now, many changes (>16) are applied correctly.
3.15	Updated versioning to support the updated backend, for detail, see Device Configurator user guide.
4.0	Removed from the GUI the possibility to change several UART settings (data bits, stop bits, parity) in order to match KitProg-supported values. The values used: data bits = 8, stop bits = 1, parity = none.
	Optimized the I2C interface communication to increase the speed.
	Added support for the PSoC 4100S Max family.
	Added support for the CAPSENSE™ Middleware Library 3.0.
4.0	Added a CSX touchpad sensor status display on the Graph view.
	Logging data from the device: removed the header duplication from the bottom of the pages of the file.

Version changes

Version	Change descriptions
	Changed the operation log file location. The new location can be found in the About CapSense Tuner dialog.
5.0	Added support for the 5 th generation LP CAPSENSE™ devices.
	Added support for the CAPSENSE™ Middleware Library 4.0.
	Changed the device library file from xml to <i>props.json</i> .
	Added the possibility to use the Tuner with USB UART bridges from other vendors.
	Added a set of auxiliary chart commands on the Graph and SNR views.
	Added a panel to display widget and sensor parameters description.

Revision history**Revision history**

Revision	Date	Description
**	11/26/2018	New doc.
*A	12/05/2018	Documents were updated with changes requested in BVI-353.
*B	02/26/2019	Updated to version 1.1.
*C	10/16/2019	Updated to version 2.0.
*D	11/01/2019	Added section for launching from Device Configurator.
*E	03/27/2020	Updated to version 3.0.
*F	09/01/2020	Updated to version 3.10.
*G	12/14/2020	Updated to version 3.11.
*H	03/11/2021	Updated to version 3.15.
*I	09/29/2021	Updated to version 4.0.
*J		Updated to version 5.0

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