mmWave Demo Visualizer

This user's guide presents the TI Gallery app – mmWave Demo Visualizer – for configuring mmWave sensors and visualizing point cloud objects generated by the mmWave SDK demo. The mmWave Demo Visualizer app is meant to be used in conjunction with the mmWave SDK demo running on the TI EVM for mmWave devices. The app can also be reached at the TI Gallery website – search for mmWave_Demo_Visualizer. The mmWave Demo Visualizer app is browser-based and can be run on any PC operating system (Windows®, Linux®, or macOS®), and TI recommends running the app using the Chrome® browser for the best plotting performance.

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1 Setup Instructions

1.1 Browser Setup (First Time Only)

If this is your first time using this app, you may be prompted to install a browser extension and the TI Cloud Agent Application (see Figure 1).
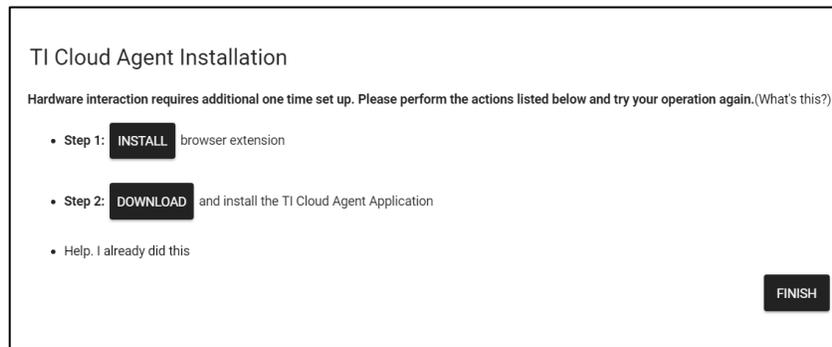
Figure 1. TI Cloud Agent Installation (First Time Setup)

1.2 mmWave Device Setup

Follow the instructions in the mmWave SDK User's Guide to run the mmWave demo and connect to the PC where the app will be running.

1.3 Serial Port Setup

1. First follow the first-time setup instructions previously described before following the steps here. If the mmWave device is connected by the USB cable to the PC running this app, then you can locate the following COM ports using the Device Manager on a Windows PC (see Figure 2).

   a. XDS110 Class Application/User UART → This is the port where the CLI (command line interface) runs for all the various demos. This port is called the CFG_port.

   b. XDS110 Class Auxiliary Data port → This is the port on which binary data generated by the processing chain in the mmWave demo will be received by the PC. This binary data contains the detected object list and its properties (range, Doppler, angle, and so on). This port is called the visualization port or Data_port.
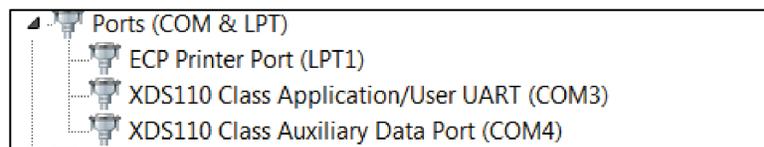
Figure 2. Device Manager Ports

2. In the browser app, navigate to Menu → Options → Serial Port and set up the COM ports in the pop-up window as follows (see Figure 3).

   a. CFG_port: Use the COM port number for *XDS110 Class Application/User UART* and set Baud: 115200

   b. Data_port: Use the COM port *XDS110 Class Auxiliary Data Port* and set Baud: 921600
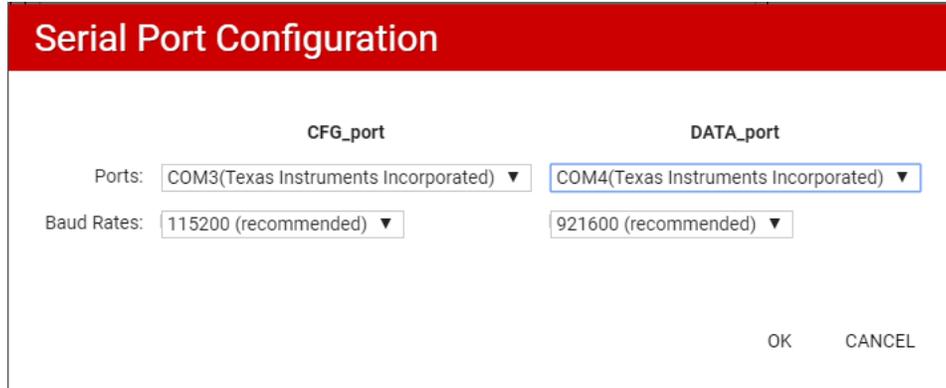
Figure 3. Serial Port Configuration in App

3. Click the CONFIGURE button and the control should go back to the main browser window.

4. At this point, the app automatically tries to connect to the target (mmWave Sensor), see Figure 4.
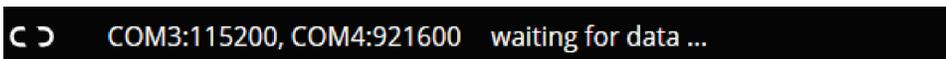
Figure 4. COM Port Status When Correct Ports Are Configured

5. If the app does not connect or the connection fails, try to connect to the target by clicking in the bottom-left corner of the app (see Figure 5).
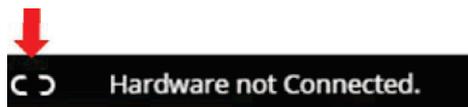
Figure 5. COM Port Status When Ports Are Not Connected

2 CONFIGURE Tab

This tab lets users select the parameters for configuring the mmWave device. In this document, the subsection numbers dictate a certain sequence of programming so that precedent parameters are set first followed by dependent parameters. Users can follow any sequence in configuring the settings, but note that certain knobs, sliders, and drop-downs influence the values of other dependent parameters, and you may have to readjust dependent parameters to obtain the desired selection.

2.1 Platform

This is a drop-down menu that prompts users to select the correct mmWave device to which the app is connected to through the serial port. If you are trying to just *save config to PC*, then select the mmWave device for which the desired configuration must generate.

2.2 SDK Version

This is a drop-down menu that prompts users to select the matching SDK version as the one running on the mmWave device. If the version does not match, then the GUI prompts an error when using the *Send Config to mmWave Device* button or *Load config from PC and send* button. However, there is no such check done when using the *Save config to PC* button, and users can choose the SDK version for which the compatible configuration should be generated.

2.3 Azimuth Resolution (Degrees)

This is a drop-down menu that prompts users to select the azimuth resolution and elevation (xWR14xx devices only) configuration for TI mmWave EVMs. The options for setting the azimuth resolution follow:

- 15º (4 RX, 2 TX)
- 30º (4 RX, 1 TX)
- 60º (2 RX, 1 TX)
- None (1 TX, 1 RX)
- 15º + Elevation (4 RX, 3 TX, for xWR14xx devices only)

Effects on other user knobs:

- Affects the possible minimum and maximum values for all sliders in the *scene selection*.
- When elevation is selected for xWR14xx devices, the *Scatter Plot* selection results in a 3D plot in the plots tab.

CLI command details: defines RX and TX antenna mask in the channelCfg command and creates the chirpCfgs.

> **NOTE:** Users must reboot the mmWave device when switching between options in this menu.

2.4 Desirable Configuration

This is a drop-down menu that prompts users to select the parameter that they are most concerned about, to tune the system resources towards that configuration. For more details, see Section 2.6. When the user selects a value in this menu, all the sliders, text boxes, checkboxes, and drop-downs (except for Platform) get reset to their default values (equivalent to pressing a Reset Selection button).

2.5 Frequency Band (GHz)

This is a drop-down menu that prompts users to select the frequency band of operation. The mmWave sensors support two choices: wide band (4 GHz spanning 77 to 81 GHz) and narrow band (1 GHz spanning 76 to 77 GHz).

CLI command details: defines the start frequency in GHz in the profileCfg command.

2.6   Scene Selection – Best Range Resolution

This section guides users through the sequence of selections they should follow when Best Range Resolution is selected under the Desirable Configuration menu.

2.6.1   Frame Rate (fps)

This is a slider that prompts users to select the rate at which the measurement data must be shipped out of the mmWave device.

Effects on other user knobs:

• Controls the minimum value on the Maximum Radial Velocity slider.
• Faster rates limit the number of plots and measurement data that can be captured from the mmWave device. For more details, see Section 2.9.

CLI command details: defines frame duration (frame periodicity in ms) in the frameCfg command.

2.6.2   Range Resolution (m)

This is a slider that prompts users to select the desired range resolution in meters. Select the value based on the minimum amount of separation you expect between the detected objects or points in the point cloud. Because this is the Best Range Resolution configuration, the slider presents options only for the best possible range resolution for the user-selected frequency band.

Effects on other user knobs:

• Relatively lower or finer Range Resolution selected by this slider provides options for longer Max Unambiguous Range but lower values for Maximum Radial Velocity.
• Relatively higher or coarser Range Resolution selected by this slider provides options for shorter Max Unambiguous Range but higher values for Maximum Radial Velocity.

This slider allows for minor tweaking in the centimeter units, to help users attain desired fine tuning of configuration for the Max Unambiguous Range and Maximum Radial Velocity.

CLI command details: defines frequency slope constant and Ramp end time in µs in the profileCfg.

2.6.3   Maximum Unambiguous Range (m)

This is a slider that prompts users to select the desired Maximum Unambiguous Range in meters. Select the value based on the farthest distance you expect to see objects detected. See Section 4.3 to understand the Radar cross section and the actual range at which objects equal to the radar cross section can be theoretically detected by mmWave technology.

Effects on other user knobs:

• Setting this slider to lower values provides more options for the Radial Velocity Resolution, versus setting this slider to higher values providing less options for the Radial Velocity Resolution.

CLI command details: defines number of ADC samples and ADC sampling frequency in ksps in the profileCfg command.

2.6.4   Maximum Radial Velocity (m/s)

This is a slider that prompts users to select the desired Maximum Radial Velocity in meters/second. Select the value based on the maximum radial velocity you expect targets to be moving in within the radar field of view.

Effects on other user knobs:

• Radial Velocity Resolution is directly proportional to the Maximum Radial Velocity setting. Setting this slider to lower values provides finer Radial Velocity Resolution versus setting this slider to higher end of values provides coarser Radial Velocity Resolution.

CLI command details: defines idle time in µs in the profileCfg command.

2.6.5 Radial Velocity Resolution (m/s)

This is a drop-down menu that prompts users to select the desired Radial Velocity Resolution in meters/second.

Effects on other user knobs:

• This knob is the lowest dependent parameter in this configuration and gets constrained by all the preceding parameters.

CLI command details: defines number of loops in the frameCfg command

2.7 Scene Selection – Best Velocity Resolution

2.7.1 Frame Rate (fps)

This is a slider that prompts users to select the rate at which measurement data must be shipped out of the mmWave device.

Effects on other user knobs:

• As the Best Velocity Resolution configuration, it controls the Radial Velocity Resolution, and sets it to the best possible value for the chosen frame rate.

• Controls the minimum value on the Maximum Radial Velocity slider.

• Faster rates limit the number of plots and measurement data that can be captured from the mmWave device. For more details, see Section 2.9.

CLI command details: defines frame duration (for example, frame periodicity in ms) in the frameCfg command.

2.7.2 Azimuth Resolution (Degrees)

This is a drop-down menu that prompts users to select the azimuth resolution and elevation (xWR14xx devices only) configuration for TI mmWave EVMs. The options are as follows:

• 15º (4 RX, 2 TX),
• 30º (4 RX, 1 TX)
• 60º (2 RX, 1 TX)
• None (1 TX, 1 RX)
• 15º + Elevation (4 RX, 3 TX, for xWR14xx devices only)

Effects on other user knobs:

• Affects the possible minimum and maximum values for all sliders in the scene selection.

• When elevation is selected for xWR14xx devices, the Scatter Plot selection results in a 3D plot in the plots tab.

CLI command details: defines the RX and TX antenna mask in the channelCfg command and creates the chirpCfgs.

2.7.3 Radial Velocity Resolution (m/s)

As a Best Velocity Resolution configuration, the Radial Velocity Resolution is set to the best possible value for the chosen frame rate.

2.7.4 Maximum Radial Velocity (m/s)

This is a slider that prompts users to select the desired Maximum Radial Velocity in meters/second. Select the value based on the maximum radial velocity you expect the targets to be moving in within the radar field of view.

Effects on other user knobs:

Based on the system resources diverted to fulfill the user-selected value for Maximum Radial Velocity, options for Range Resolution are affected in this configuration.

- Higher values for Maximum Radial Velocity selected by this slider provides only coarser options for Range Resolution and short-range options for Max Unambiguous Range.
- Lower values for Maximum Radial Velocity selected by this slider provides more finer options for Range Resolution and long-range options for Max Unambiguous Range.

CLI command details: defines the number of loops in the frameCfg command.

2.7.5 Range Resolution (m)

This is a slider that prompts users to select the desired range resolution in meters. Select the value based on the minimum separation you expect between the detected objects or points in the point cloud.

Effects on other user knobs:

- Relatively lower or finer Range Resolution selected by this slider provides options for shorter Max Unambiguous Range.
- Relatively higher or coarser Range Resolution selected by this slider provides options for longer Max Unambiguous Range.

CLI command details: Range Resolution and Max Unambiguous Range define the number of ADC samples, frequency slope constant, Ramp end time in µs, idle time in µs, and ADC sampling frequency in ksps in the profileCfg command.

2.7.6 Maximum Unambiguous Range (m)

This is a slider that prompts users to select the desired Maximum Unambiguous Range in meters. Select the value based on the farthest distance you expect to see objects detected. See Section 4.3 to understand the radar cross section and the actual range at which objects equal to the radar cross section can be theoretically detected by mmWave technology.

Effects on other user knobs:

- Moving this slider fine-tunes the user-selected Range Resolution value.

CLI command details: Range Resolution and Max Unambiguous Range define the number of ADC samples, frequency slope constant, Ramp end time in µs, idle time in µs, and ADC sampling frequency in ksps in the profileCfg command.

2.8 Scene Selection – Best Range

2.8.1 Frame Rate (fps)

This is a slider that prompts users to select the rate at which measurement data must be shipped out of the mmWave device.

Effects on other user knobs:

- Controls the minimum value on the Maximum Radial Velocity slider.
- Faster rates limit the number of plots and measurement data that can be captured from the mmWave device. For more details, see Section 2.9.

CLI command details: defines the frame duration (for example, frame periodicity in ms) in the frameCfg command.

2.8.2 Azimuth Resolution (Degrees)

This is a drop-down menu that prompts users to select the azimuth resolution and elevation (xWR14xx devices only) configuration for TI mmWave EVMs. The options are as follows:

- 15º (4 RX, 2 TX)
- 30º (4 RX, 1 TX)
- 60º (2 RX, 1 TX)
- None (1 TX, 1 RX)
- 15º + Elevation (4 RX, 3 TX, for xWR14xx devices only)

Effects on other user knobs:

- Affects the possible minimum and maximum values for all sliders in the scene selection.
- When elevation is selected for xWR14xx devices, the Scatter Plot selection results in a 3D plot in the plots tab.

CLI command details: defines the RX and TX antenna mask in the channelCfg command and creates the chirpCfgs.

2.8.3 Maximum Unambiguous Range (m)

This is a slider that prompts users to select the desired Maximum Unambiguous Range in steps of 5 meters. Select the value based on the farthest distance you expect to see objects detected. See Section 4.3 to understand the radar cross section and the actual range at which objects equal to the radar cross section can be theoretically detected by mmWave technology.

Effects on other user knobs:

- Setting this slider to lower values provides less but finer options for Range Resolution, versus setting this slider to higher values providing more but coarser options for the Range Resolution.

CLI command details: defines the frequency slope constant in the profileCfg command.

2.8.4 Range Resolution (m)

This is a slider that prompts users to select the desired range resolution in meters. Select the value based on the minimum amount of separation you expect between the detected objects or points in the point cloud.

Effects on other user knobs:

- Coarser values for Range Resolution selected by this slider provides more options and higher values for Maximum Radial Velocity.
- Finer values for Range Resolution selected by this slider provides less options and lower values for Maximum Radial Velocity.

Based on the system resources diverted to fulfill the user-selected value for Range Resolution, options for Maximum Radial Velocity are affected in this configuration.

CLI command details: defines the number of ADC samples, Ramp end time in µs, and ADC sampling frequency in ksps in the profileCfg command.

2.8.5 Maximum Radial Velocity (m/s)

This is a slider that prompts users to select the desired Maximum Radial Velocity in meters/second. Select the value based on the maximum radial velocity you expect the targets to be moving in within the radar field of view.

Effects on other user knobs:

Radial Velocity Resolution is directly proportional to the Maximum Radial Velocity setting. Setting this slider to lower values provides finer Radial Velocity Resolution, versus setting this slider to higher values providing coarser Radial Velocity Resolution.

CLI command details: defines the idle time in µs in the profileCfg command.

2.9 Plot Selection

This section prompts users to select the plots they want to see on the Plots tab. For the best performance, depending on the scene parameters that are selected by the user, selecting more than two plots may require a frame rate around 10 fps. Selecting heatmaps requires the frame rate to be 1-3 fps, otherwise the target (mmWave sensor) will not have enough frame duration to ship out data every frame over the UART.

2.9.1 Scatter Plot

This lets users enable the detected objects list to be sent out by the target (mmWave sensor) device and display it on the Scatter plot and Doppler-Range plot on the plots tab.

CLI command details: defines the detected-objects parameter in the guiMonitor command.

2.9.2 Range Profile

This lets users enable the log-magnitude range profile data at zero Doppler to be sent out by the target (mmWave sensor) device and display it on the Range Profile plot on the plots tab.

CLI command details: defines the log-magnitude range parameter in the guiMonitor command.

2.9.3 Noise Profile

This lets users enable the log magnitude noise profile data to be sent out by target (mmWave sensor) device and display it on the Noise profile graph (green color) in the same Range Profile plot window on the plots tab.

CLI command details: defines the noise profile parameter in the guiMonitor command.

2.9.4 Range Azimuth Heat Map

This lets users enable the zero Doppler radar cube matrix for all range bins and all antennas to be sent out by the target (mmWave sensor) device and display it on the Range azimuth heatmap plot on the plots tab. This requires the frame rate to be 1 fps otherwise the target (mmWave sensor) will not have enough frame duration to ship out data every frame over the UART.

CLI command details: defines the range-azimuth heat map parameter in the guiMonitor command.

2.9.5 Range Doppler Heat Map

This lets users enable the entire detection matrix to be sent out by the target (mmWave sensor) device and display it on the range-doppler heatmap plot on the plots tab. This requires the frame rate to be 1 fps otherwise the target (mmWave sensor) will not have enough frame duration to ship out data every frame over the UART.

CLI command details: defines the range-doppler heat map parameter in the guiMonitor command.

2.9.6 Statistics

This lets users enable the statistics information to be sent out by the target (mmWave sensor) device and to show the CPU load plot on the plots tab.

CLI command details: defines the statistics parameter in the guiMonitor command.

2.10 User Selected Configuration

When the user has selected the parameters in the previous section, they can now take the following actions.
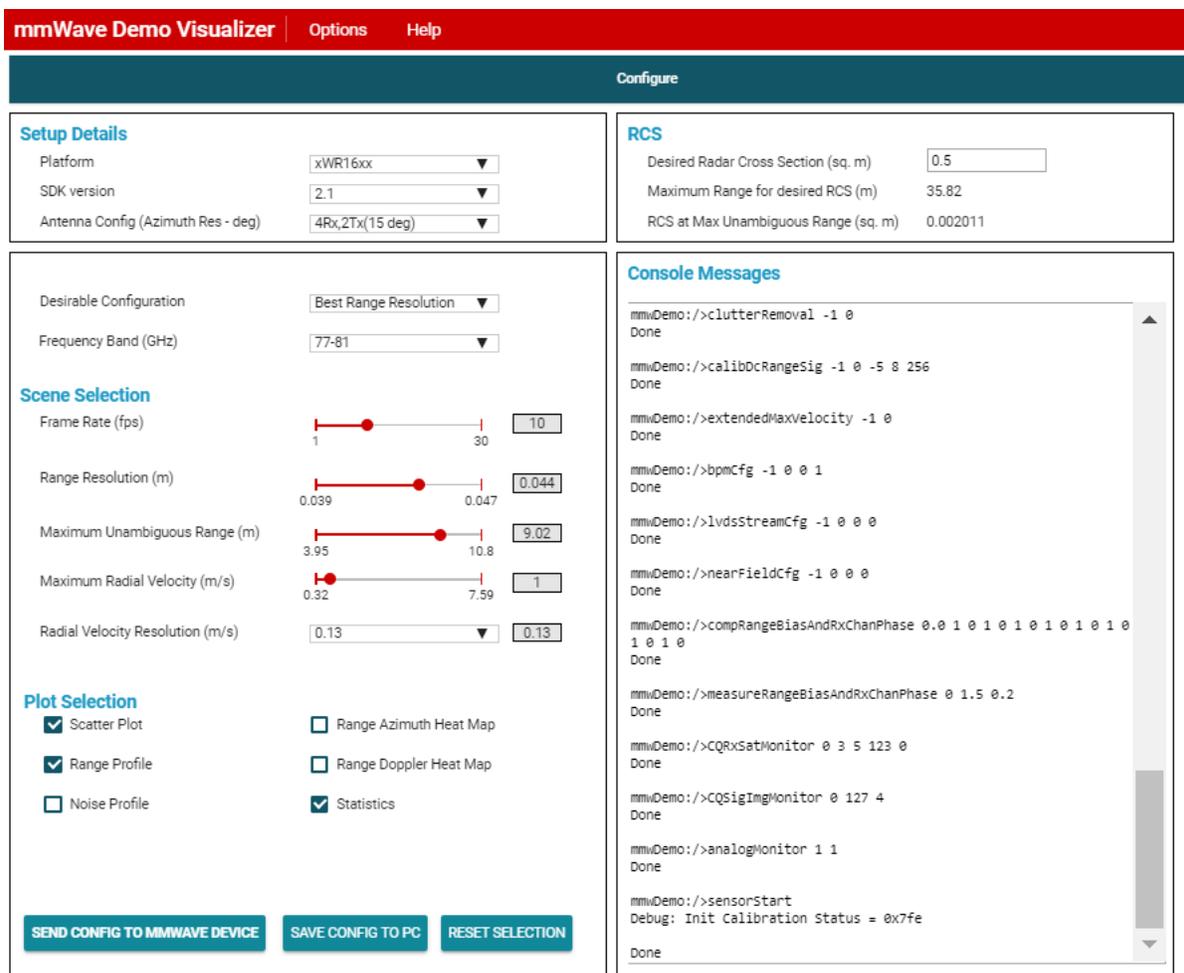
2.10.1 Send Configuration to mmWave Device

This lets users send the generated configuration (CLI) commands to be sent to the target (mmWave sensor) device. This command operates successfully only if the following are met:

- Valid serial ports have been configured as shown in the setup section.
- Target (mmWave sensor) device is booted up and running the mmWave demo from the same SDK version as selected in the *SDK version* drop down menu.

Users can see the commands echoed back on the Console Messages display with the feedback that is received from the target for every line of commands sent. These console messages are a great help when debugging issues or getting familiar with the CLI commands. A successful execution of this button results in the last command *sensorStart* to be sent to the device and a response *Done* to be received from the device.

Another indication of successful connectivity to the target device is the black status bar on the bottom of the page shows two valid COM ports and the status says Hardware Connected (see Figure 6). After successful execution, users can switch to the Plots tab to view the requested plots.

Figure 6. Valid Configuration

If the last two lines in the console messages contain any other lines than these, it means either the device generated an error, the device stopped responding, or the commands did not go through completely and the user must try again. For more details, see Section 5.

2.10.2 Saving Configuration to PC

This lets users save the generated configuration (CLI) commands in a .cfg file on the user's PC. Users can then read and modify this file as per their needs. This file can also later be used to send the configuration to the device using the advanced option Load Config from PC and Send button on the plots tab. For more details on the format and content of this generated file, see the *mmWave SDK User's Guide*. The top section of this file contains metadata detailing the settings of the user knobs.

2.10.3 Reset Selection

This lets users reset the sliders, checkboxes, textboxes, and drop-downs to their original reset values, except for the platform drop-down.

3 PLOTS Tab

When users have successfully configured the device using either the *Send Config to mmWave Device* or *Load Config from PC and Send* button, they can begin to see data being plotted on the requested plots. If no data is shown on the plots. For more details, see Section 5.

3.1 X-Y Scatter Plot

This plot shows the detected objects in the X-Y domain (see Figure 7). For the advanced frame, this plot shows the union of points detected in all subframes of a given frame.

> **NOTE:** Select Scatter Plot in the configure tab and configure the device accordingly to view this plot.

The X- and Y-axis can be controlled using the Range Width and Range Depth text boxes. Use the stop button to stop plotting and then you can change these settings. When the settings are changed, resume plotting using the start button. The maximum value users can select is limited by the Maximum Unambiguous Range achievable by the current configuration.
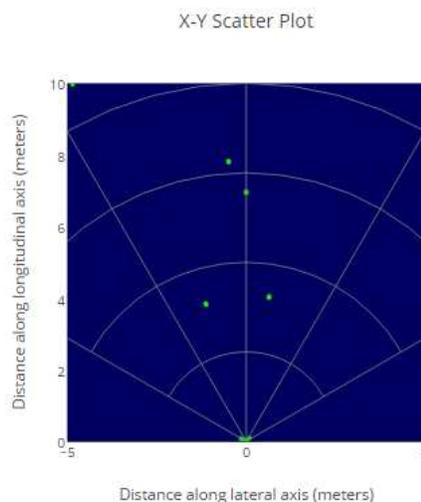

Figure 7. X-Y Scatter Plot for Detected Objects

3.2   Doppler Range Plot

This plot shows the detected objects using the range and Doppler coordinates (see Figure 8). For the advanced frame, this plot shows the union of points detected in all subframes of a given frame.

> **NOTE:** Select Scatter Plot in the Configure tab and configure the device accordingly to view this plot.

The X-axis can be controlled using the Range Width and Range Depth text boxes. Use the stop button to stop plotting and then you can change these settings. When changed, resume the plotting using the start button. The maximum value users can select is limited by the Maximum Unambiguous Range achievable by the current configuration.
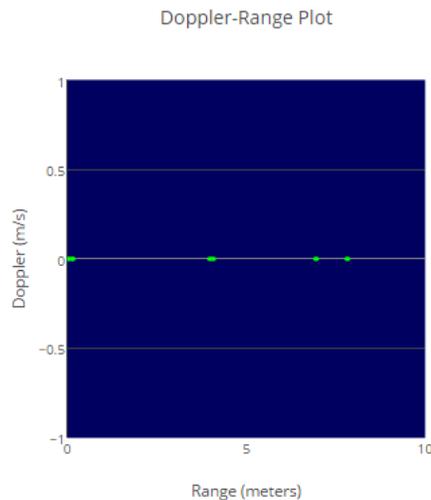

Figure 8. Doppler Range Plot for Detected Objects

3.3 Range Profile

This plot shows the range profile at the 0th Doppler (static objects) using the blue line and noise profile (if enabled) using green line (see Figure 11). By default, this graph shows the log values. The detected objects in the 0th Doppler range bin are shown as orange cross marks over the blue Range Profile plot line (see Figure 9 and Figure 10). For the advanced frame, this plot shows the range profile for the first subframe, which has this plot enabled in the guiMonitor command (the plot title reflects this subframe number). When the range bias is supplied using the compRangeBiasAndRxChanPhase command, the GUI internally uses the range bias to correct the range in meters, as calculated from rangeIdx, shipped by the mmWave device. The range and noise profile sent by the mmWave device is compensated for all the 1D and 2D FFT gains and the incoherent combining gain across the antennas, as per the mmWave demo processing chain, before plotting.

NOTE: Select Range Profile and Noise Profile in the Configure tab and configure the device accordingly to view this plot.

The linear scale for the Y-axis can be selected by unchecking the Range Profile Log Scale checkbox. The maximum limit for the Y-axis in the linear domain can be selected by the user with the Range Profile Y-max text box. Use the stop button to stop plotting and then you can change these settings. Once the settings are changed, resume plotting using the start button.
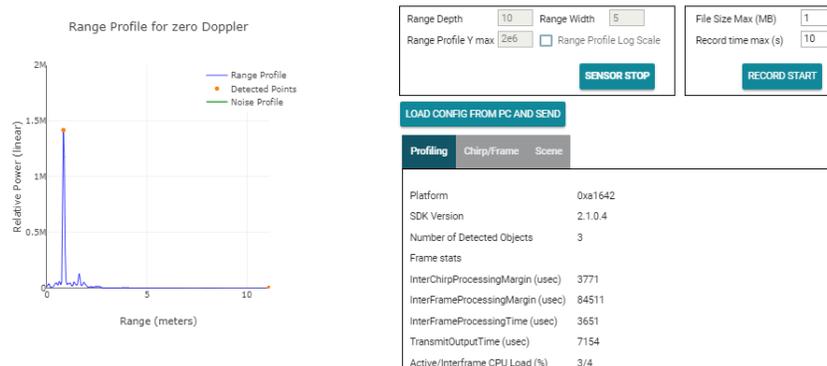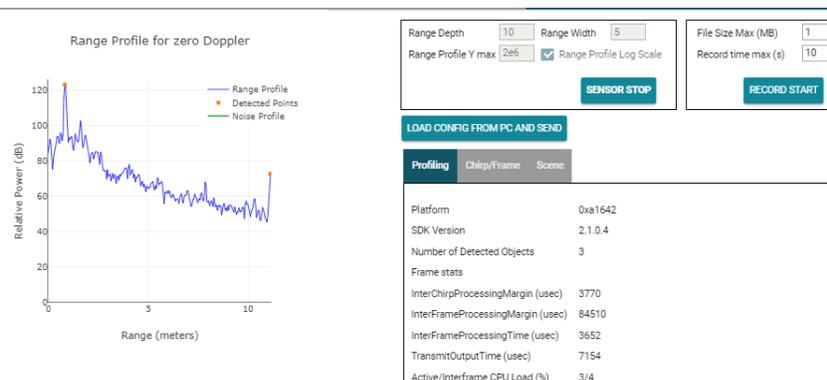

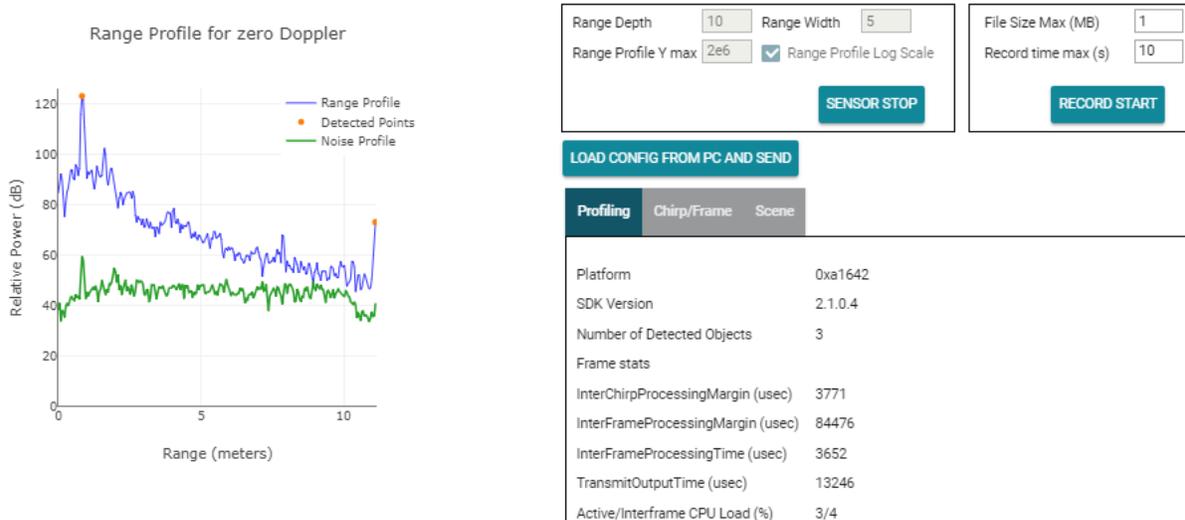**Figure 9. Range Profile in Linear Scale**

Figure 10. Range Profile in Log Scale

Figure 11. Range and Noise Profile in Log Scale

3.4 *CPU Load*

This plot displays the CPU load for the data processing chain during the active or chirping section of a given frame/subframe and during the nonactive or interframe/intersubframe section of the frame/subframe (see Figure 12). The CPU load is expressed as a percentage of these active and inactive durations and therefore varies for a given profileCfg, but with a different frame rate. For xWR14xx devices, this plot shows the CPU load for the Cortex®-R4F. For xWR16xx devices, this plot shows the CPU load for the C674x DSP core (where data path processing happens). For the advanced frame, this plot shows the CPU load for the first subframe, which has this plot enabled in the guiMonitor command (the plot title reflects this subframe number).

NOTE: Select Statistics in the Configure tab and configure the device accordingly to view this plot.
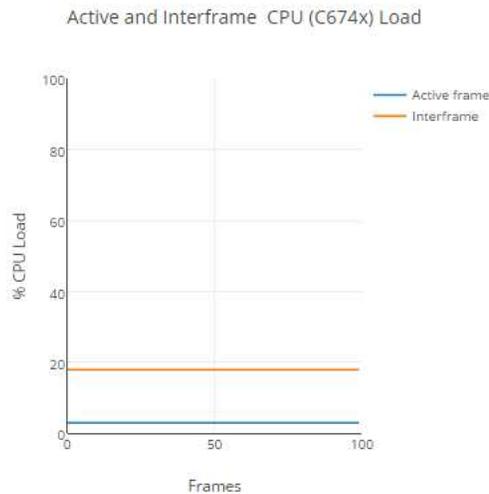

Figure 12. CPU Load for Frame Rate = 30 fps (Example)

3.5 *Range-Doppler Heatmap*

This plot displays the entire radar cube matrix in Range and Doppler coordinates using the heatmap plot (see Figure 13). For the advanced frame, this plot shows the heatmap for the first subframe which has this plot enabled in the guiMonitor command (the plot title reflects this subframe number). When the range Bias is supplied using the compRangeBiasAndRxChanPhase command, the GUI internally uses the range bias to correct the range in meters, as calculated from rangeIdx, shipped by the mmWave device.

> **NOTE:** Select Range Doppler Heat Map in the Configure tab and configure the device accordingly to view this plot.
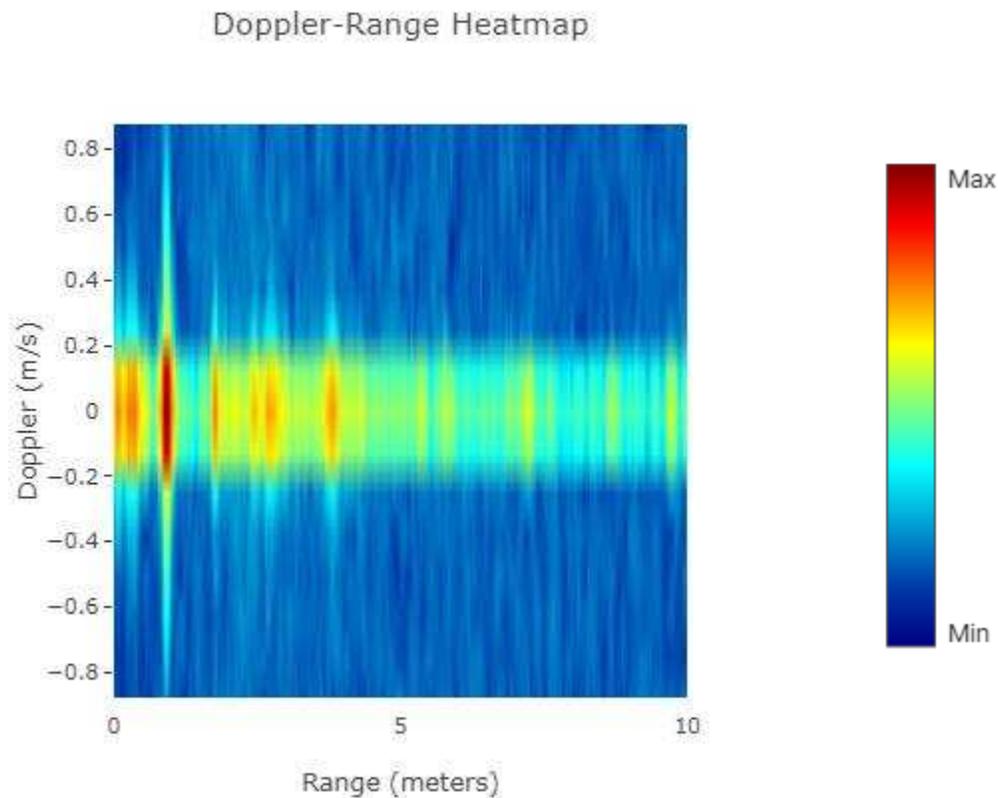

Figure 13. Doppler Range Heatmap

3.6 Range-Azimuth Heatmap

This plot displays the radar cube matrix for zero Doppler only but across all range bins and all antennas (see Figure 14). For the advanced frame, this plot shows the heatmap for the first subframe, which has this plot enabled in the guiMonitor command (the plot title reflects this subframe number). When the range bias is supplied using the compRangeBiasAndRxChanPhase command, the GUI internally uses the range bias to correct the range in meters, as calculated from rangeIdx, shipped by the mmWave device.

> **NOTE:** Select Range Azimuth Heat Map in the Configure tab and configure the device accordingly to view this plot.
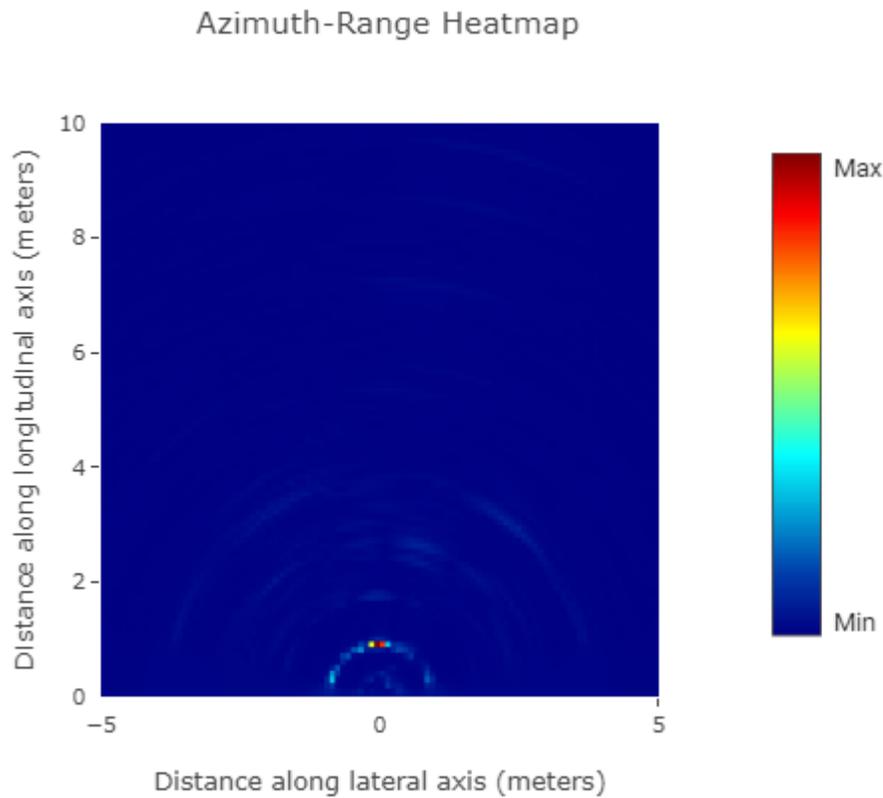

Figure 14. Azimuth-Range Heatmap (Example)

3.7 3-D Scatter Plot

This is available only for xWR14xx devices, when Elevation is selected in the Scene Selection configuration. This plot displays the detected objects in 3-D space (see Figure 15).

NOTE: Select Scatter Plot and 15 + Elevation in the Configure tab and configure the device (xWR14xx) accordingly to view this plot.
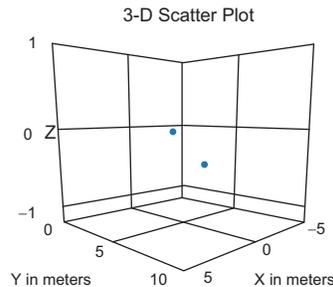

Figure 15. 3-D Scatter Plot

3.8 Display Parameters

This is the informational data presented on the plots tab for user reference. Use the embedded tabs to switch between the type of information that is needed.

3.8.1 Profiling Parameters

When this display tab is selected, the screen shows the following information (see Figure 16).

- Platform: the hexadecimal string that is output by the mmWave sensor device.
- SDK version: the version of the software that is currently running on the mmWave sensor device.
- Number of Detected Objects: a continuously updating field (new measurement every frame) that shows the number of detected objects for a given frame.
- Frame Stats or Stats for Subframe: In the case of advanced frame configuration, this lists the subframes (separated by command) for which the following stats are displayed. In the case of legacy frame configuration, there is only one construct of the frame and the following stats apply for the whole frame.
  – InterChirpProcessingMargin: a continuously updating field (new measurement every frame) that shows the time, in microseconds, that is left in a given (chirp + interchirp) duration after the chirp processing. The field has the value that is the average value across all chirps in a given frame, or values separated by commas which are the average value across all chirps in a given subframe.
  – InterFrameProcessingMargin: a continuously updating field (new measurement every frame) that shows the time, in microseconds, that is left in a given frame/subframe after all the frame/subframe processing is completed.
  – InterFrameProcessingTime: a continuously updating field (new measurement every frame) that shows the time, in microseconds, that was consumed for frame/subframe processing after the active chirps were completed.
  – TransmitOutputTime: a continuously updating field (new measurement every frame) that shows the time, in microseconds, for the requested output (controlled using the selections in the Plot Selection section of the Configure tab) to be shipped out over the UART from the mmWave device to the PC.
  – Active/Interframe CPU Load (%): a continuously updating field (new measurement every frame) that shows the percentage CPU load during active chirping time within the frame/subframe and the interframe/intersubframe time. These values are also reflected on the CPU Load plot for the frame, or the first selected subframe in the guiMonitor command.

Figure 16. Display Parameters – Profiling

3.8.2 Scene Parameters

When this display tab is selected, the scene parameters are calculated back from the actual configuration that was sent to the device (see Figure 17). These values should approximately match the Configure tab values if the *Send config to MMwave device* button was used to configure the device. In the case of advanced configuration, the values for the different subframes are shown separated by commas for each of the fields.

Figure 17. Display Parameters – Scene

3.8.3 Chirp/Frame Parameters

When this display tab is selected, the chirp/ frame parameters are taken from the actual configuration that was sent to the device and displayed (see Figure 18). In the case of advanced configuration, the values for the different subframes are shown separated by commas for each of the fields.

Profiling	**Chirp/Frame**	Scene
Start Frequency (Ghz)	77	
Slope (MHz/us)	70	
Samples per chirp	256	
Chirps per frame	32	
Sampling rate (Msps)	5.2090	
Sweep Bandwidth (GHz)	3.4402	
Frame periodicity (msec)	100	
Transmit Antennas	2	
Receive Antennas	4	

Figure 18. Display Parameters - Chirp/Frame

3.9 Real-Time Tuning

The "object detection" section from the CONFIGURE tab in past Visualizer releases have been moved to the PLOTS tab to enable real-time tuning of the mmwave processing chain. The effect of these knobs can be seen in real time in the various plots that are displayed. This knob is only available for single profile based legacy frames. When using advanced frame configuration, one could acheive the same functionality via the "Advanced commands" tab. The settings in this tab are reset everytime the user either sends a new complete configuration from CONFIGURE tab or loads a new configuration from a file using "LOAD CONFIG FROM PC AND SEND".

NOTE: With these controls moving to PLOTS tab, the CONFIGURE tab now carries the default for these commands for the initial configuration of the sensor.

3.9.1 Group Peaks From Same Object

This is a set of checkboxes – one for enabling peak grouping in the range direction and one for enabling peak grouping in the Doppler direction. With the peak-grouping scheme enabled, instead of reporting a cluster of detected neighboring points, only one point, the highest one, is reported. This reduces the total number of detected points per frame. The effect of this can be seen in scatter plots (see Section 3.9.2).
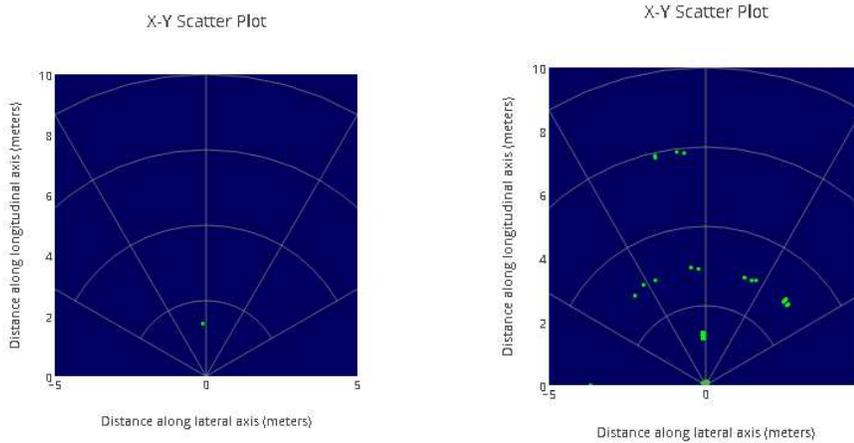
CLI command details: defines the peakGrouping command.

Figure 19. Range Peak Grouping Disabled (Left) and Enabled (Right)

3.9.2   Static Clutter Removal

This checkbox lets users eliminate static clutter from the scene. Use this option only when trying to detect moving objects in the scene and static objects need to be masked out.

CLI command details: defines the clutterRemoval command.

3.9.3   Range Detection Threshold (0 to 100 dB)

This textbox lets users enter the threshold for the CFAR (object detection) algorithm in the range direction. Tune this value as per your setup in the radar field of view (for example, clutter, distant object, and so on).

CLI command details: defines the cfarCfg command. The dB value is converted to the threshold value in the CLI using the following:

xWR14xx – CFAR threshold scale is in Q9 format.

Linear scale:
$$T_{Lin} = 2^{T_{CLI}/512} \tag{1}$$

Scale in dB:
$$T_{dB} = 20 \log_{10} 2^{T_{CLI}/512} = 6 \times T_{CLI} / 512 \tag{2}$$

Threshold in CLI:
$$T_{CLI} = 512 \times T_{dB} / 6 \tag{3}$$

xWR16xx – CFAR threshold scale is in Q8 format.

Linear scale:
$$T_{Lin} = 2 \, (T_{CLI} / 256 \times NumVirtAntennas) \tag{4}$$

Scale in dB:
$$T_{dB} = 20 \log_{10} 2(T_{CLI} / 256 \times NumVirtAntennas) = 6 \times (T_{CLI} / 256 \times NumVirtAntennas) \tag{5}$$

Threshold in CLI:
$$T_{CLI} = 256 \times NumVirtAntennas \times T_{dB} / 6 \tag{6}$$

3.9.4   Doppler Detection Threshold (0 to 100 dB)

This textbox lets users enter the threshold for the CFAR (object detection) algorithm in the doppler direction. This feature is currently supported only in xWR16xx devices. For more details that apply for this parameter, see Section 3.9.3.

3.10 Advanced Commands

This tab allows user to send dynamic commands to the mmwave device while the sensor is running to influence the output of processing chain. The list of commands supported on the device can either be looked up in the mmWave SDK User Guide or by clicking the small help (?) button near the title "Advanced Command". Multiple commands can be typed here before hitting the send command. This tab will be handy to manipulate other parameters of CFAR command (in addition to threshold that is exposed via real time tuning tab), and so forth. When commands are sent using this tab, real time tuning tab is also updated to reflect these new settings.

Special note about "Range and Angle Bias Compensation Configuration":

This tab lets users enter the command for the range and angle bias compensation as well. See the mmWave SDK user's guide for how to obtain the values for this field. On receiving this command, the mmWave device corrects the x and y values with the user-supplied bias, but rangeIdx (which is the FFT index) is not corrected. In our case, the visualizer GUI handles adjusting the value when rangeIdx is converted into the corresponding value in meters for the range profile plot and other heatmaps. If this functionality is not desired, then the command must be given with Range Bias = 0, Rx phase bias set with Real = 0, and Imaginary = 1, for all the applicable virtual antennas (this is also the default from the CONFIGURE tab)

4 Advanced Options

4.1 Load Configuration From PC

Users can configure the device from their own configuration file or the saved app-generated configuration file (see Section 2.10.2) by using the LOAD CONFIG FROM PC AND SEND button on the PLOTS tab. Ensure the first two commands in this config file are sensorStop followed by flushCfg.

When loading the configuration, using this button will not change the user input knobs in the CONFIGURE tab. If the user wishes to change the configuration loaded using this option, then user must hand edit the config file while referencing to the CLI command documentation in the mmWave SDK User's Guide.

The console messages window on the CONFIGURE tab continues to show the progress and feedback of the commands and device interaction even when this option is selected. The description and behavior of the PLOTS tab is similar to what is described in the previous section.

NOTE: The advanced frame configuration or the range/angle bias measurement procedure can be initiated only by using this button. The configure tab does not provide these capabilities.

4.2 Getting the Version

Users can navigate to Help → About to get the app version that is currently running on the browser and the SDK version that is running on the connected mmWave sensor device (see below).

```
*****************************
Connected device
*****************************
Platform : xWR16xx
mmWave SDK Version      : 02.01.00.04
Device Info             : AWR16xx non-secure ES 02.00
RF H/W Version          : 02.00.00.01.17.10.05
RF F/W Version          : 01.01.06.07.18.08.01
mmWaveLink Version      : 01.02.00.00
Lot number              : 7540002
Wafer number            : 1
Die coordinates in wafer  : X = 11, Y = 45
**********************
```

The SDK version is shown only when the mmWave sensor device is properly connected to this app using the serial/COM port and a functional demo is running on the target. Checking the version is a good troubleshooting mechanism to determine whether the mmWave device is up and running (see below).

```
*****************************
Connected device
*****************************
Retreiving version information ...
Please connect hardware
*********************
```

4.3 RCS

This is the small section in the CONFIGURE tab used for calculations and informative purposes.

4.3.1 Desired Radar Cross Section (sq. m)

This textbox prompts users to select the desired RCS for getting the Maximum Range at which an object of this RCS is likely to be detected, based on the scene and object detection parameters selected on the left-hand side. Hints for approximate values follow:

- Truck → 100 sq. m
- Car → 10 sq. m
- Motorcycle → 3.2 sq. m
- Adult → 1 sq. m
- Child → 0.5 sq. m

The value for Maximum Range calculated based on this input is shown in the Maximum Range for desired RCS (m) display box.

4.3.2 Maximum Range for Desired RCS (m)

This is for information purposes only, to guide users in setting the slider value for Maximum Unambiguous Range accordingly. This value is calculated based on the user input in the Desired Radar Cross Section (sq. m) and the scene and object detection parameters selected on the left-hand side.

4.3.3 RCS at Maximum Unambiguous Range (sq. m)

This is for information purposes only, to guide users in setting the slider value for Maximum Unambiguous Range accordingly. This value is calculated based on the user input selected in the Maximum Unambiguous Range and other scene and object detection parameters selected on the left-hand side.

4.4 Concurrent Recording of Processed Stream From mmWave Device

If users want to save the incoming processed stream from the mmWave device for some offline analysis while its getting plotted, they can use the *Record Start* button in the plots tab. The recording can be started while the device is in stopped state and unconfigured (for example, after a fresh reboot and/or the sensor is stopped using the *Sensor Stop* button), or while the device is running and actively outputting data. The data is saved to a timestamped file in binary format on the device. The data keeps accumulating in the file until one of the following conditions are met:

- User presses the Record Stop button
- File size exceeds the limit set in the user-configurable field, File Size Max (MB).
- File accumulated data for at least the time set in the user-configurable field, Record time max(s).

The data saved in this file is the exact same data and format that is transmitted out of the mmWave device over the DATA_port. Users should see the mmWave demo doxygen in the mmWave SDK package to understand the format of the data and how to parse it.

NOTE: This feature requires the browser version to be at least as mentioned here: ti-widget-streamsaver.

---

5   Troubleshooting

5.1   *Console Message: Errors Returned by Device*

If the user selected invalid parameters in the user generated configuration file or the sliders in the CONFIGURE tab generate an invalid configuration, then the mmWave sensor device reports back an error. This error can be seen as Error -1 in the Console Messages or as a red error message above the SEND CONFIG TO MMWAVE DEVICE button. Users must correct the source of the error (fix the user-generated config file, move the sliders, and so on) and try again. Additionally, if the mmWave device encounters fatal conditions during configuration or realtime, then it communicates back to the user through asserts, and those messages (file and line numbers) are also displayed in the Console Messages window. Because these are fatal conditions, user must browse to that file and line number to understand the cause for the error. To recover from this, users must reboot the mmWave device, connect the ports using the Visualizer, and perform reconfiguration.

5.2   *Serial Port Status Message: Not Switching to Hardware Connected or Both Ports Are Not Showing Up*

A successful connection results in two COM ports displaying in the bottom status bar, and a Hardware Connected or Waiting for Data.. message (see Figure 20).

Figure 20. Serial Port Status Message

If the user does not see the previous message, then the following common errors could be the root cause:

- The mmWave device is not powered on and running the demo
- Incorrect COM port numbers were selected in Options → Serial port.
- Another application (for example, Tera Term) has those COM ports open and the app is unable access to these ports.
- The device was just rebooted while the app was running.

Once previously mentioned errors are corrected, use the small icon (a broken link or exclamation icon) at the bottom of the screen to disconnect and connect the ports again.

5.3   *Console Message: sensorStart Message Not Sent to Host*

If the user sees some messages appear in the console messages, but not all of them and the last message is not sensorStart, then the following common errors could be the root cause:

- Commands sent earlier generated an error. User must correct the source of error (fix the user-generated configuration file, move the sliders, and so on) and try again.
- Commands sent earlier caused the software running on the device to crash and an assert or exception message is displayed. Users can connect the Code Composer Studio™ (CCS) debugger to the target device to debug this situation further. In the absence of CCS, reboot the device and start again. If the device still does not work for a given config, check the config against the mmWave SDK user's guide.
    – One reason could be that the number of plots selected caused the shipment of the output data to exceed one frame duration.
- Sometimes the UART on the target device does not receive all the characters or messages (for example, the PC sends configuration data over the UART faster than the device can process). Just repeat the action (Send Config.. or Load Config..) and try again.

5.4 Warning for Plots and Frame Rate

The following are some guidelines for selecting the plots and frame rate:

- If heatmap is selected, reduce the frame rate to less than 5 fps. (If this suggestion is not followed, then the target mmWave device intentionally halts and the user must reboot the device).
- If heatmap is not selected but all other plots are selected, then depending on the scene parameters selected, the GUI performance can be sluggish and the user should ideally select 10 fps as the frame rate.

5.5 Configuration Successful, but Plots Not Updating

One of the commands sent caused the software running on the device to crash and an assert or exception message is displayed in the console messages. Users can connect the CCS debugger to the target device to debug this situation further. In the absence of CCS, reboot the device and start again. If the device still does not work for a given config, check the config against the mmWave SDK user's guide. One reason could be that the number of plots selected caused the shipment of the output data to exceed one frame duration.

6 Customizng the mmWave Demo Visualizer

Users can login to the gallery, locate the Visualizer app tile, and click the *Import to the GUI composer* icon, to import the application in their GC workspace. Beyond this, users have access to GUI composer resources to customize the demo according to their needs. A quick overview of the mmWave Demo Visualizer specific files follows:

- mmWave.js: Main file that communicates with the GUI composer framework, communicates to the mmWave device using the configured COM ports, processes GUI-generated actions, and plots the data generated by the mmWave device
- input_validations.js: validates the CLI configuration before it is sent to the mmWave device
- dynamic_tuning.js: implementation of "real time tuning" tab and "advanced commands" tab
- input.js: Handles all the backend computations behind the CONFIGURE tab
- Index.gui: Auto-generated file that handles the layout of the Visualizer app
- Helper utilities: Delaunay.js, fft.js, math.js, math_griddata.js, and myutil.js

Useful references follow:

- GUI Composer Getting Started
- GUI Composer User's Guide

7   Offline Version of the Visualizer

TI recommends always using the online/cloud version of the Visualizer for the mmWave experience with the TI devices, but TI does understand that users may not always have access to an internet connection while trying to evaluate the mmWave devices, especially in the field trial. For such cases, a link for the offline version is available under Help → Download or Clone Visualizer. The link takes users to a tiled display of the application. Click on the down arrow inside the application tile, as shown in Figure 21, and download the installer for your operating system (see Figure 22).

Figure 21. Download Icon

When run on the PC, this installer connects to the internet to fetch the compatible GC runtime engine. If users do not have internet connectivity during the installation process (for example, installer was copied from an internet-connected machine to a remote PC), then users must also download the GC runtime engine from the same link (see Figure 22).

Figure 22. Screen Pop-Up for Download Options

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.