AWRL6844 Real-Time Demo:
CPD/SBR Point Cloud Performance Tuning

Low Power Radar - Body and Chassis
October, 2025

Step 1: Phase Calibration

- Applying phase calibration is crucial to improve system performance.
  - Users can find the instruction at the SDK L users guide at: https://dev.ti.com/tirex/explore/content/MMWAVE_L_SDK_06_00_05_01/docs/api_guide_xwrL684x/MMWAVE_DEMO.html#Rx_Gain_Measurement_Compensation

Texas Instruments xWRL684x MMWAVE-L-SDK 06.00.05

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Rx Channel Gain/Offset Measurement and Compensation

Because of imperfections in antenna layouts on the board there is a need to calibrate the sensor to compensate for bias in the range estimation and the receive channel gain and phase imperfections. The demo provides the ability to do the measurement and compensation.

Measurement Procedure Implementation

The measurement procedure is configured using a CLI command measureRangeBiasAndRxChanPhase. The following is the command syntax:

measureRangeBiasAndRxChanPhase {enabled} {targetDistance} {searchWindow}

- where enabled - is the flag to enable the procedure, targetDistance - is the distance of the strong target in front of the sensor at the bore site (in meters), searchWindow - is the search window (in meters).

The procedure is implemented by the function mmwDemo_rangeBiasRxChPhaseMeasure(). It is called in the processing chain after the range processing DPU. The input to the procedure is a radar cube. The measurement procedure first calculates the range profile as the sum of the magnitude squares across all antennas on the range FFTs. Then it searches for the peak in the zone $X-D/2 \le range \le X+D/2$ where D = searchWindow and X = targetDistance.

The procedure then estimates the peak position using the three point parabolic interpolation and the range bias as the difference between the peak position and the configured target distance X.

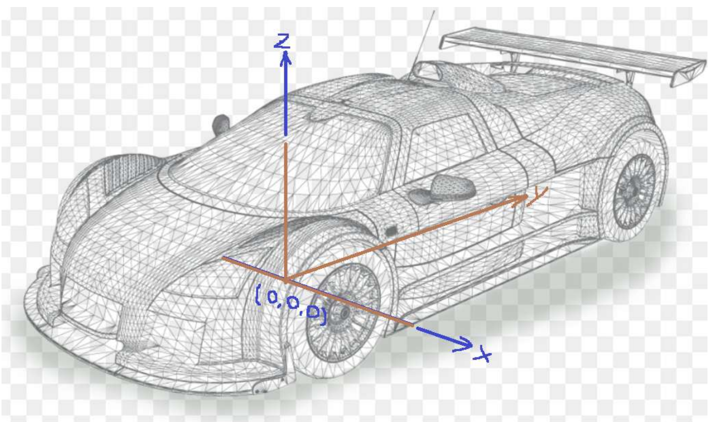
The Rx channel compensation coefficients are calculated according to following equations.

From the radar cube stored as a complex16 3D array $X[range][chirp][antenna]$, the received symbols are extracted at the range index i_{peak} of the peak position

Step 2: Carefully Choose the Mounting Position and Angle

Performance can be sensitive to mounting: Observe better performance when the mounting is mounted higher, and relatively closer to the 2nd row in the y direction. A good mounting is usually when the 1st row seats pose less blocking on the 2nd row target.

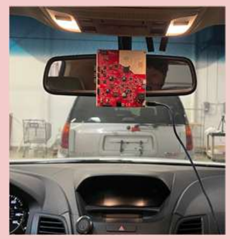
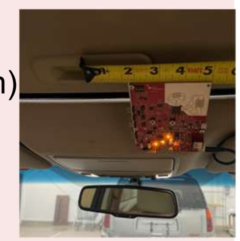
- To support different mounting position and angle, "sensorPosition" CLI command is used
  - Indicates the mounting offset in (x, y, z) and mounting rotation angle in x-y plane and x-z plane



CLI command	Parameters (in command order)
sensorPosition	
xOffset	offset in x direction, in meter
yOffset	offset in y direction, in meter
zOffset	offset in z direction, in meter
azimTilt	Counter-Clockwise rotation angle in x-y plane, in degree
elevTilt	Counter-Clockwise rotation angle in x-z plane, in degree

Step 2-1: Program *sensorPosition* CLI to Match the Mounting

Mounting Examples

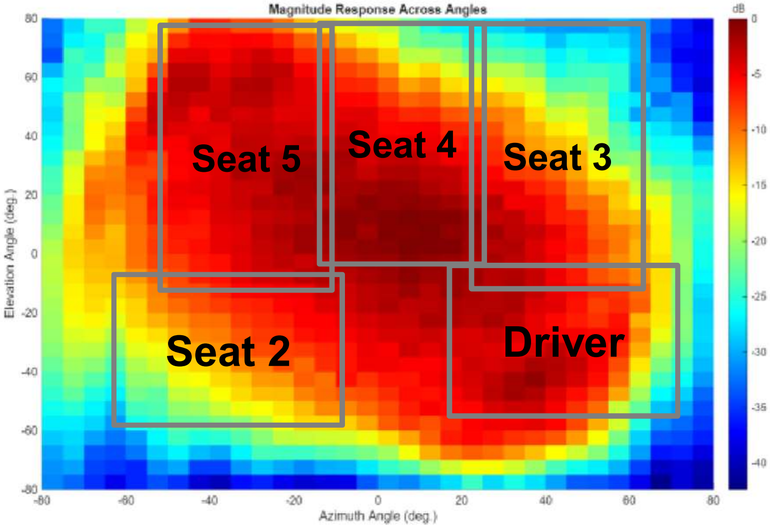
Front Mount sensorPosition 0 0.4 0.8 0 0 (x = 0, y = 0.4, z = 0.8m) and facing forward without any rotation 	Middle Overhead Mounting sensorPosition 0 1.2 1.1 0 -90 (x = 0, y = 1.2m, z = 1.1m) rotated down 90 degrees to face the floor 
Front Console Mount sensorPosition 0 0.7 1.08 0 -60 (x = 0, y = 0.7m, z = 1.08m) rotated down 60 degrees from the forward position 	Front Console Mount with offset sensorPosition -0.1 0.7 1.08 0 -60 (x = -0.1, y = 0.7m, z = 1.08m) rotated down 60 degrees from the forward position 

Step 2-2: Understand Antenna Performance

We observed an asymmetric antenna performance on the AWRL6844EVM

❖ A 2D antenna radiation gain pattern is displayed in the figure below. We also mark the seat zones roughly based on the regular front mounting.

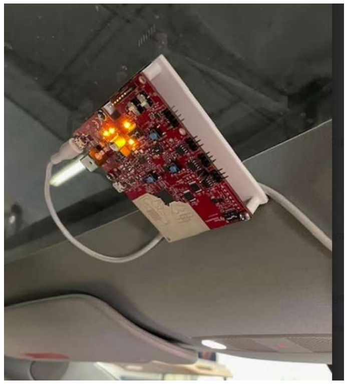
❖ With this mounting, the seat 2 and seat 3 zones experience much lower antenna gain, especially in seat 3.



Step 2-3: Consider Rotating EVM to Reduce Antenna Limitation

- We have observed slightly better performance in the CPD and SBR demo when applying an alternate antenna mounting position shown below. We have been using this alternate mounting for our test report.
- A fundamental fix would be a redesign of the antenna.

Regular mounting
sensorPosition 0 0.7 1.05 0 -60

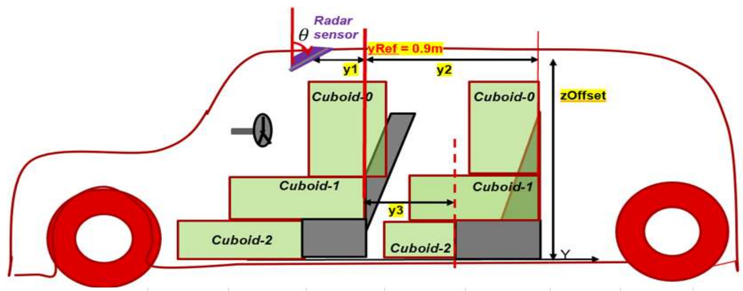


Rotate EVM 180 degrees,
sensorPosition 0 0.7 1.05 180 -120

Step 3: Adapt to a New Testing Car

Measure the car and use zoneDefinitionGenTool.xlsx to update the mounting location and zone definition

yRef	0.9
Measurement relative to yRef	
y1	0.2
y2	1.05
y3	0.4
θ (sensor rotation angle)	59
Height measurement	
Sensor height zOffset	1.1
Ceiling height	1.2
1st row seat height	0.3
2nd row seat height	0.35
leg height	0.6
seat depth and leg/footwell room measurement	
1st row chair slope depth (d	0.16
1st row chair depth	0.5
1st row leg room	0.3
1st row footwell depth	0.6
2nd row chair depth	0.6
2nd row leg room	0.2
2nd row footwell depth	0.3
Seat height expand margin	0
% footwell and 2nd-row rear facing area can use som	
2nd row footwell expand ma	0.1
2nd row rear facing expand	0

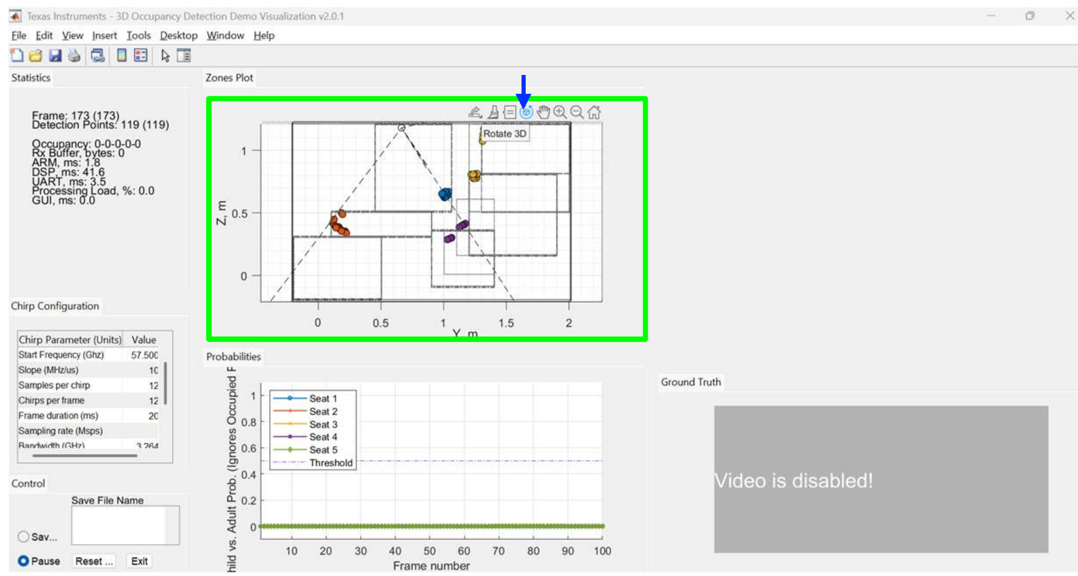


39										
40		xOffset	yOffset	zOffset	azimTilt	ElevTilt				
41	sensorPosition	0	0.7	1.1	0	-59				
42	%sensorPosition	0	0.7	1.1	180	-121				
43										
44				xMin	xMax	yMin	yMax	zMin	zMax	
45	% Driver seat									
46	cuboidDef	0	0	0.15	0.7	0.45	1.06	0.6	1.2	%body
47	cuboidDef	0	1	0.15	0.7	0.1	0.9	0.3	0.6	%leg
48	cuboidDef	0	2	0.15	0.7	-0.2	0.5	-0.2	0.3	%footwell
49	% passenger seat									
50	cuboidDef	1	0	-0.7	-0.15	0.45	1.06	0.6	1.2	%body
51	cuboidDef	1	1	-0.7	-0.15	0.1	0.9	0.3	0.6	%leg
52	cuboidDef	1	2	-0.7	-0.15	-0.2	0.5	-0.2	0.3	%footwell
53	% 2nd row driver side									
54	cuboidDef	2	0	0.2	0.7	1.4	1.95	0.6	1.2	%body
55	cuboidDef	2	1	0.2	0.7	1.1	1.95	0.35	0.6	%leg
56	cuboidDef	2	2	0.2	0.7	0.9	1.4	-0.1	0.35	%footwell

Step 3-1: Fine adjustment to the zone definition

- Testing in the empty car, check the point cloud, and trim the zone to avoid the point cloud.

Rotate the point cloud in the visualizer to find its location, then trim the zone definition in the configuration file accordingly. Restart the visualizer to reload the configuration file, and you should see that the point cloud becomes cleaner in an empty car.



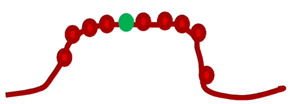
Step 4: Tune the point cloud through CFAR parameter

Starting parameter for SBR:

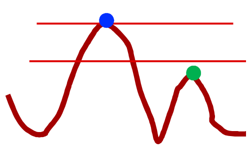
dynamicRACfarCfg 5 15 1 1 8 8 4 6 4 1 8.00 6.00 0.50 1 15

- If CFAR threshold K0 (on range dimention) is set too high, little/no point cloud can be obtained with the weak target (such as baby rear-facing scene or baby in footwell); *Reduce this value to get more point clouds detected especially for the weak target*
- If CFAR threshold K0 (on range dimention) is set too low, an excessive point clouds can be observed on non-occupied seats (due to multipath or noise)

  CFAR Threshold K1 (on angle dimension): not very sensitive to weak or strong target detection.
- Average window: Prefer to set to 8 to have fewer false detections due to the noise
- Guard interval: Setting it longer can be helpful to detect a group of continuous peaks (an example here: the green bin can't be detected if the guard interval is less than 4).



- Sidelobe threshold: multiple angle peaks in the same range bin, a relative threshold for detecting the lower peak. (As an example, the green angle bin will not be detected if its relative energy level to the blue angle bin is lower than the sidelobe threshold) This parameter can affect multi-target detection in the same range bin.



- rangeRefIdx to apply Dynamic threshold: the range threshold will be dynamically increased for the range bins between (1, rangeRefIdx)

Step 4-1: Tune the setting in dynamicRACfarCfg

CFAR parameters	Description	Default setting	SBR	CPD
leftSkipSizeRange	range bin start index (first range bin processed by CFAR)	5	Default	Default
rightSkipSizeRange	range bin end skip (ending range bins not processed by CFAR)	15	Default	10
leftSkipSizeAngle	angle start index (first angle bin processed by CFAR)	1	Default	Default
rightSkipSizeAngle	angle end skip (ending angle bins not processed by CFAR)	1	Default	Default
searchWinSizeRange	search window size - "far" range	8	Default	Default
searchWinSizeAngle	search window size - angle	8	Default	Default
searchWinSizeNear	search window size - "near" range	=searchWinSizeRange	Set to 4	Default
guardSizeRange	guard window size - "far" range	6	Default	6 ~ 10
guardSizeAngle	guard window size - angle	4	Default	Default
guardSizeNear	guard window size - "near" range	= guardSizeRange	Set to 1	Default
threRange	"K0" cross range detection threshold applied to first search pass	8.0	Default	7.5 or 7
threAngle	"K0" cross angle detection threshold used in the 2^{nd} search pass	6.0	Default	6.0 or 5.5
threSidelobe	"sidelobe" threshold used in the second search pass	0.5	Default	Default
enSecondPass	second search pass enable flag	1	Default	Default
rangeRefIndex	The CFAR threshold "K0" will be adjusted for shorter range bins based on K0*(refRangeBinIdx/rangeBinIdx)^2.	15	Default	1: disable dynamic CFAR

Step 4-2: Tune the setting in dynamic2DAngleCfg

dynamic2DAngleCfg 5 1 1 1.00 10.00 2

CFAR parameters	Description	Default setting	SBR	CPD
zoominFactor	zoom-in Factor for finer angle estimation: 5 is recommended	5	Default	Default
zoominNumOfNeighbors	Number of coarse neighboring angle bins of zoom-in. Only 1 is supported	1	Default	Default
peakExpSamples	Number of samples on each side to expand the peak of the zoomed-in azimuth-elevation heatmap, 1 is recommended.	1	Default	Default
peakExpRelThr	The relative threshold in the linear scale to include the peak's neighbor as a detection. This parameter is calculated based on the sharpness of the peak.	1.0	Default	Default
peakExpSNRThr	Linear SNR threshold for the peak to enable the peak expansion in the zoomed-in heatmap.	10.0	Default	Set to 7.0 or above to allow more peak expansion
localMaxCheckFlag	0: No local maximum check. 1: If the coarse peak is not a local maximum in the elevation domain, exclude it from the detection. 2: If the coarse peak is not a local maximum in both elevation and azimuth domains, exclude it from the detection.	2	Default	Default