# STUDY ON ACOUSTIC BEHAVIOR OF LOUDSPEAKER MOUNTED ON BIW FRAME

COMSOL CONFERENCE 2018 BANGALORE



Virtual Product

HARMAN



# INTRODUCTION

#### Scope:

To develop the Comsol App based on the fully parametric geometry models to study the Acoustic behavior of a Loudspeaker.

The BIW enclosure configurations are divided into 2 types

- 1. Single Beam enclosure configurations
- 2. Multi Beam enclosure configurations

#### Input:

BIW Enclosure and speaker geometry and design parameters.

#### Deliverables:

- I. SPL at 1m on-axis
- II. Cone displacement
- III. Impedance curve
- IV. SPL distribution inside the enclosure

#### V. Simulation Report

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#### Car subwoofer sample model



BIW frame



# **MODEL DETAILS**

#### The location of Single / Multi beam enclosure in BIW frame





# MODEL DETAILS

### The Single beam enclosure coupled with speaker in the middle





# **MODEL DETAILS**

The Multi beam enclosure coupled with coupling slots (openings) between beams





## **MULTI-BEAM CONFIGURATIONS**





### VERIFICATION MODAL ANALYSIS OF BIW FULL FRAME



- Considered only the Longitudinal modes because the frame Length is much larger than width/height of frame.
- The first standing wave/mode creates pressure anti-node at the closed ends as shown in the above image.
- When the Speaker is at middle so the first mode will not be excited and second mode only will be excited at 171.6 HZ.



#### VERIFICATION SPL AND DISPLACEMENT PLOTS

# SPL and Displacement plots of the speaker for Single Beam enclosure with speaker integrated at different locations







### VERIFICATION IMPEDANCE PLOTS

### Impedance plots for Single Beam enclosure with different lengths





# **COMSOL APPLICATION GUI**

#### Geometry creation and Pressure acoustic simulation with Comsol App

| BIV         Speaker Parameters         Solver Settings         Multi           Barn Length         200         mm         Mm         4407         F_Min         20         Hz           Speaker Position         00         mm         Kms         2610         N/m         F_Max         200         Hz           Speaker Position         00         mm         Kms         2610         N/m         F_Max         200         Hz           Rest Bedard Length         1000         mm         Coil Thickness         0.8         mm         Passare Distribution           Beam Height         100         mm         Coil Thickness         0.8         mm         Pressure Plots Att[Frequency bin]         20         Hz           Beam Height         100         mm         Coil Height         16         mm         Pressure Plots Att[Frequency bin]         20         Hz           CoupleBeams         CoupleAll_Bean         DCR         7.42         ohm         Compute           CoupleBoard Adptor Geometry         Membrane dia         100         mm         SetAdptortAdptortength         20         mm           Speaker Adaptor Geometry         20         mm         SetAdaptortWith         50         mm <tr< th=""><th>Level       Speaker Parameters       Solver Settings       Image: Control of Contro of Control of Contro of Control of Control o</th><th>)</th><th></th><th></th><th></th><th>BIW</th><th>Integration Stud</th><th>ły App</th><th></th><th></th><th></th><th>-</th></tr<> | Level       Speaker Parameters       Solver Settings       Image: Control of Contro of Control of Contro of Control of Control o  | )                     |                      |          |                | BIW            | Integration Stud | ły App |          |                         |         | -            |
|---|--|-----------------------|----------------------|----------|----------------|----------------|------------------|--------|----------|-------------------------|---------|--------------|
| BIW Geometry  Speaker Parameters  Solver Settings  Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data    Couplessue Data     Couplessue Data     Couplessue Data     Couplessue Data     Couplessue Data      Couplessue Data      Couplessue Data      Couplessue Data       Couplessue Data   | Speaker Parameters       Solver Settings       Image: Construction of the set of t   | File 🔻                |                      |          |                |                |                  |        |          |                         |         |              |
| Beam Length       2000       mm       Qms       4.407       F_Min       20       Hz         Speaker Position       00       mm       Xms       2610       N/m       F_Max       200       Hz         Speaker Position       00       mm       Xms       2610       N/m       F_Max       200       Hz         Speaker Position       00       mm       Coll 333       N/A       F_Step       5       Hz         RightBeam Length       1000       mm       Coll Thickness       0.8       mm       Plot Pressure Distribution         Beam Height       100       mm       Coil Thickness       0.8       mm       Pressure Plots At(Frequency bin)       20       Hz         SeamsType       Multi       mm       Coil Height       16       mm       Couples/All/Bean       DCR       7.42       ohm         CouplingSlotLocation1       00       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor/Width       20       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor/Width       50       mm       Mm       Seams       Seams       Seams       Seams       Seams <td< th=""><th>n Length 2000 mm Qms 4.407 F. Min 20 Hz<br/>ker Position 00 mm Qms 2100 N/m F. Max 200 Hz<br/>Bl 10.353 N/A F. Step 5 Hz<br/>Plot Pressure Distribution<br/>mm Coil Thickness 0.8 mm<br/>Pressure Plots At(Frequency bin) 20 Hz<br/>mm Coil Height 16 mm<br/>DCR 7.42 ohm<br/>plingSlotLocation 00 Membrane dia 100 mm<br/>Solution 00 Membrane dia 100 mm<br/>plingSlotLocation 2400 mm Sd 0.0079 mm2 BlW Integration Report<br/>kerAdaptor/Height 220 mm<br/>kerAdaptor/Height 220 mm<br/>kerAdaptor/Height 220 mm<br/>kerAdaptor/Height 220 mm</th><th>BIW Geometry</th><th></th><th></th><th></th><th>Speaker Paran</th><th>neters</th><th></th><th>Solver</th><th>Settings</th><th></th><th>Virtual WORK</th></td<>  | n Length 2000 mm Qms 4.407 F. Min 20 Hz<br>ker Position 00 mm Qms 2100 N/m F. Max 200 Hz<br>Bl 10.353 N/A F. Step 5 Hz<br>Plot Pressure Distribution<br>mm Coil Thickness 0.8 mm<br>Pressure Plots At(Frequency bin) 20 Hz<br>mm Coil Height 16 mm<br>DCR 7.42 ohm<br>plingSlotLocation 00 Membrane dia 100 mm<br>Solution 00 Membrane dia 100 mm<br>plingSlotLocation 2400 mm Sd 0.0079 mm2 BlW Integration Report<br>kerAdaptor/Height 220 mm<br>kerAdaptor/Height 220 mm<br>kerAdaptor/Height 220 mm<br>kerAdaptor/Height 220 mm  | BIW Geometry          |                      |          |                | Speaker Paran  | neters           |        | Solver   | Settings                |         | Virtual WORK |
| Speaker Position       00       mm       CreateGoom       Kms       2510       N/m       F_Max       200       Hz         LettBeam Length       1000       mm       CreateGoom       BI       10333       N/A       F_Step       5       Hz         Beam Width       1000       mm       Coil Thickness       0.8       mm       Pressure Plots AtlFrequency bin       20       Hz         Beam Height       100       mm       Coil Dia       40       mm       Pressure Plots AtlFrequency bin       20       Hz         Beam Stype       Multi       mm       Coil Height       16       mm       Couples       27.24       V       Couples       Couples       Voltage       2.724       V       CouplingSlotType       Couples       Nm       Sd       0.0079       mm       Sd       0.0079       mm       Sd       0.0079       mm       Sd       0.0079       mm       Sd       Sd       <  | ker Position 00 mm   Beam Length 1000   1000 mm   CreateGeon Bi   10333 N/A   F_Step 5   Hz   Bi 10333   N/A F_Step   5 Hz   Plot Pressure Distribution   Mmd 29:305   g Plot Pressure Distribution   Plot Pressure Distribution   N/Mmd 29:305   g Plot Pressure Distribution   Plot Pressure Distribution   N/Mmd 29:305   g Multi   100 mm   Nidth 100   mm Coil Thickness   0.001 mm   Coil Height 16   mm Coil Height   16 mm   plingSlot Coil All Bean   Voltage 2.724   V Voltage   omm Sd   0.0019 mm   BigSlotType Double   Voltage 2.724   Voltage 0.0019   mm Sd   0.0019 mm   KerAdaptovidteight 50   mm serAdaptovidt <td< th=""><th>Beam Length</th><th>2000</th><th>mm</th><th></th><th>Qms</th><th>4.407</th><th></th><th>F_Min</th><th>20</th><th>Hz</th><th></th></td<>  | Beam Length           | 2000                 | mm       |                | Qms            | 4.407            |        | F_Min    | 20                      | Hz      |              |
| edtBeam Length       1000       mm       CreateGeem       BI       10.353       N/A       F_Step       5       Hz         NightBeam Length       1000       mm       25.95       g       Plot Pressure Distribution         Beam Vidth       100       mm       Coil Thickness       0.8       mm       Pressure Plots At(Frequency bin)       20       Hz         Beam Height       100       mm       Coil Height       16       mm       Pressure Plots At(Frequency bin)       20       Hz         CoupleAll Bean ~       DCR       7.42       ohm       Compute       CoupleAll Bean ~       DCR       7.42       ohm         CoupleAll Bean ~       DCR       7.42       ohm       Compute       CoupleAll Bean ~       DCR       7.42       ohm         CoupleAll Bean ~       DCR       7.42       ohm       Compute       CoupleAll Bean ~       DCR       Report       Compute       Compute       CoupleAll Bean ~       DCR       Report       Compute       CoupleAll Bean ~       DCR       Report       Compute       Compute       CoupleAll Bean ~       DCR       Report       Compute       CoupleAll Bean ~       DCR       Report       Compute       CoupleAll Bean ~       DCR       Report <t< td=""><td>Beam Length 1000 mm CreateGeon BI 10.353 N/A F_5tep 5 Hz<br/>tBeam Length 1000 mm Mnd 29.505 g Plot Pressure Distribution<br/>n Width 100 mm Coil Thickness 0.8 mm Pressure Plots At(Frequency bin) 20 • Hz<br/>stype Multi • mm Coil Height 16 mm<br/>pleBeams Couple All Bean DCR 7.42 ohm<br/>pleBeams Couple All Bean DCR 7.42 ohm<br/>pleBeams Couple ↓ Voltage 2724 V<br/>Compute<br/>plingSlotLocation1 400 mm Sd 0.0079 mm2 BIW Integration Report<br/>Aker Adaptor Mathin 50 mm<br/>kerAdaptor Height 200 mm<br/>kerAdaptor Height 200 mm<br/>kerAdaptor Height 200 mm<br/>kerAdaptor Height 200 mm</td><td>Speaker Position</td><td>00</td><td>mm</td><td>A</td><td>Kms</td><td>2610</td><td>N/m</td><td>F_Max</td><td>200</td><td>Hz</td><td></td></t<>   | Beam Length 1000 mm CreateGeon BI 10.353 N/A F_5tep 5 Hz<br>tBeam Length 1000 mm Mnd 29.505 g Plot Pressure Distribution<br>n Width 100 mm Coil Thickness 0.8 mm Pressure Plots At(Frequency bin) 20 • Hz<br>stype Multi • mm Coil Height 16 mm<br>pleBeams Couple All Bean DCR 7.42 ohm<br>pleBeams Couple All Bean DCR 7.42 ohm<br>pleBeams Couple ↓ Voltage 2724 V<br>Compute<br>plingSlotLocation1 400 mm Sd 0.0079 mm2 BIW Integration Report<br>Aker Adaptor Mathin 50 mm<br>kerAdaptor Height 200 mm<br>kerAdaptor Height 200 mm<br>kerAdaptor Height 200 mm<br>kerAdaptor Height 200 mm  | Speaker Position      | 00                   | mm       | A              | Kms            | 2610             | N/m    | F_Max    | 200                     | Hz      |              |
| KightBeam Length       100       mm       Mmd       29.505       g       Plot Pressure Distribution         Beam Width       100       mm       Coil Thickness       0.8       mm       Pressure Plots Att[Frequency bin]       20       H         Beam Height       100       mm       Coil Dia       40       mm       Pressure Plots Att[Frequency bin]       20       H         Beam Kight       100       mm       Coil Height       16       mm       EcouplingSlotType       Double       Voltage       2.724       V       Compute         CouplingSlotLocation1       00       Membrane dia       100       mm       Compute       Compute         Spaker Adaptor/Kongth       20       mm       Sd       0.0079       mm2       BIW Integration Report         Spaker Adaptor/Kongth       20       mm       Seamer Adaptor/Kongth       20       mm         Spaker Adaptor/Kongth       20       mm       Export       Export       Export         Spaker Adaptor/Kongth       20       mm       Export       Export       Export         Spaker Adaptor/Kongth       20       mm       Export       Export       Export         Spaker Adaptor/Kongth       20       mm       <   | tBeam Length 1000 mm Mmd 29505 g Plot Pressure Distribution<br>NVidth 100 mm Coil Dia 40 mm Pressure Plots At[Frequency bin 20 • Hz<br>msType Multi mm Coil Dia 40 mm Pressure Plots At[Frequency bin 20 • Hz<br>msType Multi mm Coil Height 16 mm<br>pleBeams Couple_All_Beam DCR 7.42 vh<br>plingSlott.ccation.1 00 mm Sd 0.0079 mm2 BIW Integration Report<br>aker Adaptor Geometry<br>kerAdaptor Geometry<br>kerAdaptor Adaptor Som mm<br>kerAdaptor Midth 50 mm<br>kerAdaptor Adaptor Som mm<br>kerAdaptor Midth 50 mm<br>kerAdaptor Midth 50 mm<br>kerAdaptor Midth 20 mm  | .eftBeam Length       | 1000                 | mm       | CreateGeom     | BI             | 10.353           | N/A    | F_Step   | 5                       | Hz      |              |
| Beam Width       100       mm       Coil Thickness       0.8       mm       Plot Pressure Distribution         Beam Height       100       mm       Coil Dia       40       mm       Pressure Plots At(Frequency bin)       20       Hz         Beam Krype       Multi       mm       Coil Height       16       mm       Pressure Plots At(Frequency bin)       20       Hz         CoupleGall Elean       DCR       7.42       ohm       Image: CoupleGall Elean       00       Image: CoupleGall Elean       Elean       CoupleGall Elean       Elean       Elean       CoupleGall Elean       Elean<   | n Width 100 mm Coil Thickness 0.8 mm Plot Pressure Distribution<br>n Height 100 mm Coil Dia 40 mm Pressure Plots Att Frequency bin 20 • Hz<br>ns Type Multi • mm Coil Height 16 mm<br>pleBeams Couple All Bear • DCR 742 ohm<br>pleBeams Couple All Bear • DCR 742 ohm<br>plingSlott.ccation. 00 Membrane dia 100 mm<br>plingSlott.ccation. 400 mm Sd 0.0079 mm2 BIW Integration Report<br>sker Adaptor Geometry<br>kerAdaptor Height 200 mm<br>kerAdaptor Law Plate PressurePlot<br>VIII SD Impedance Displacement Surface PressurePlot<br>Q Q Q Q Q M M I • Y V M M I © III III IIII IIIIIIIIIIIIIIII  | RightBeam Length      | 1000                 | mm       |                | Mmd            | 29.505           | g      |          |                         |         |              |
| Beam Height       100       mm       Coil Dia       40       mm       Pressure Plots At(Frequency bin)       20       H         BeamsType       Multi       mm       Coil Height       16       mm         CoupleGeams       Couple_All_Beam       DCR       7.42       ohm         CoupleGolocation1       00       Mcmbrane dia       100       mm         CouplingSlotLocation1       00       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor Geometry       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor Writh       50       mm       mm       Separt       Separt       Separt         Geometry       SPL       Impedance       Displacement       Surface PressurePlot       Separt       Separt         Q       Q       P       P       Var       Imm       Separt       Separt   | n Height 100 mm Coil Dia 40 mm Pressure Plots At (Frequency bin) 20 • Hz<br>ns Type Multi • mm Coil Height 16 mm<br>pleBeams Couple All Bean • DCR 7.42 ohm<br>plingSlot Type Double • Voltage 2.724 V<br>Compute<br>plingSlot crating 400 mm Sd 0.0079 mm2 BIW Integration Report<br>Aker Adaptor Geometry<br>KerAdaptor Height 20 mm<br>kerAdaptor Height 20 mm<br>kerAdaptor Height 20 mm   | Beam Width            | 100                  | mm       |                | Coil Thickness | 0.8              | mm     |          | Plot Pressure Dis       | tributi | on           |
| BeamsType       Multi mm       Coil Height       16       mm         CoupleBeams       Couple_All_Beam       DCR       7.42       ohm         CoupleGollocation1       00       Voltage       2.724       V       Compute         CouplingSlotLocation1       00       Membrane dia       100       mm       CoupleGollocation2       400       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor Geometry       mm       Sd       0.0079       mm2       BIW Integration Report         Speaker Adaptor/Hight       20       mm       Secondary Structure       Keport         Geometry       SPL       Impedance       Displacement       Surface PressurePlot  | msType Multi mm Coil Height 16 mm<br>pleBeams Couple_All_Bean → DCR 7.42 ohm<br>plingSlott.oction.0 00 mm Sd 0.0079 mm2 BJW Integration Report<br>aker Adaptor Geometry<br>kerAdaptor Height 200 mm KerAdaptor Height 200 mm<br>kerAdaptor Height 200 mm KerAdaptor Height 200 mm KerAda  | Beam Height           | 100                  | mm       |                | Coil Dia       | 40               | mm     | Pressure | Plots At(Frequency bin) | 20      | ▼ Hz         |
| Couple@eams       Couple@all_Bean •       DCR       7.42       ohm         CouplingSlotType       Double •       Voltage       2.724       V       Compute         CouplingSlotLocation1       00       Membrane dia       100       mm       Compute         Spaker Adaptor Geometry       mm       5d       0.0079       mm2       BIW Integration Report         Spaker Adaptor/Length       200       mm       spakerAdaptor/Kength       200       mm         Spaker Adaptor/Height       200       mm       Execution       Execution       Execution         Geometry       SPL       Impedance       Displacement       Surface PressurePlot       Execution       Execution         Geometry       SPL       Impedance       Displacement       Surface PressurePlot       Execution   | pleBeams Couple All Bean Voltage 2,724 v<br>plingSlotType Double Voltage 2,724 V<br>plingSlotLocation1 00 Membrane dia 100 mm<br>plingSlotLocation2 400 mm Sd 0,0079 mm2 BIW Integration Report<br>aker Adaptor Geometry<br>kerAdaptor Leght 220 mm<br>kerAdaptor Height 220 mm<br>skerAdaptor Leght 220 mm<br>SPL Impedance Displacement Surface PressurePlot<br>Q Q R H V V I Z I I I I I I I I I I I I I I I I  | BeamsType             | Multi •              | mm       |                | Coil Height    | 16               | mm     |          |                         |         |              |
| CouplingSlotType Double Voltage 2.724 V<br>CouplingSlotLocation1 00 Mrm Sd 0.0079 mm BIW Integration Report<br>SpeakerAdaptorVicth 50 mm<br>speakerAdaptorHeight 200 mm<br>Geometry [SPL Impedance Displacement   Surface PressurePlot  | plingSlotType Double Voltage 2.724 V<br>plingSlotLocation1. 00 mm Sd 0.0079 mm2 BIW Integration Report<br>aker Adaptor Gometry<br>kerAdaptor double Sd 0.0079 mm2 BIW Integration Report<br>kerAdaptor Hight 220 mm<br>kerAdaptor Hight 220 mm<br>Membrane I Surface PresurePlot<br>Q Q R R V V V V R R III C R III C C C C C C C C C C C C  | CoupleBeams           | Couple_All_Bean      | •        |                | DCR            | 7.42             | ohm    |          |                         |         |              |
| CouplingSlotLocation1 00 Membrane dia 100 mm Compute<br>CouplingSlotLocation2 400 mm Sd 0.0079 mm2 BIW Integration Report<br>Speaker Adaptor Geometry<br>Speaker Adaptor Height 200 mm<br>Speaker Adaptor Height 200 mm<br>Geometry SPL Impedance Displacement Surface PressurePlot<br>Q Q 10 FF J2 V Ir Im II I III III IIII   | plingSlotLocation1 00 Membrane dia 100 mm Compute<br>plingSlotLocation2 400 mm Sd 0.0079 mm2 BIW Integration Report<br>aker Adaptor Geometry<br>kerAdaptor Height 200 mm<br>kerAdaptor Location2 kerAdaptor Height 200 mm<br>kerAdaptor Height 200 mm<br>KerAdapto | CouplingSlotType      | Double -             | -        |                | Voltage        | 2.724            | v      |          | =                       |         |              |
| CouplingSlotLocation2 400 mm Sd 0.0079 mm2 BIW Integration Report<br>Speaker Adaptor Geometry<br>mm<br>Speaker Adaptor Height 200 mm<br>Geometry SPL Impedance Displacement Surface PressurePlot  | plingSlotLocation2 400 mm Sd 0.0079 mm2 BIW Integration Report<br>aker Adaptor Geometry<br>kerAdaptor Height 200 mm<br>kerAdaptor Height 220 mm<br>metry SPL Impedance Displacement Surface PressurePlot<br>@ Q 19 H 4 + 12 Im 2 C @ @ @ @ }   | CouplingSlotLocation1 | 00                   | _        |                | Membrane dia   | 100              | mm     |          | Comput                  | •       |              |
| Speaker Adaptor Geometry     mm       speaker Adaptor (length 200 mm)     mm       speaker Adaptor (length 200 mm)     mm       generAdaptor (length 200 mm)     mm       Geometry SPL Impedance Displacement Surface PressurePlot     Server Plot  | aker Adaptor Geometry<br>ker Adaptor Geometry<br>ker Adaptor Vieth<br>50 mm<br>ker Adaptor Height<br>220 mm<br>ometry SPL Impedance Displacement Surface PressurePlot<br>Q. Q. 19. E. $\forall v \neq v \not v \neq v \neq$  | CouplingSlotLocation2 | 400                  | mm       |                | Sd             | 0.0079           | mm2    |          | BIW Integratio          | n Repo  | ort          |
| jepaker/AdaptorLength 20 mm<br>jepaker/AdaptorVikith 50 mm<br>jepaker/AdaptorVikith 50 mm<br>Geometry SPL Impedance Displacement   Surface PressurePlot<br>Q Q 10 FH Jz V Irz Izz III III III IIII IIIIIIIIIII  | kerAdaptor/width       50       mm         kerAdaptor/width       50       mm         kerAdaptor/Height       220       mm         ometry       SPL       Impedance       Displacement         Sufface       PressurePlot       Impedance       Impedance         Q       Q       IR       Impedance       Impedance   | Speaker Adaptor Geo   | ometry               |          |                |                |                  |        |          | -                       |         |              |
| ispeakerAdaptorWidth 50 mm<br>ispeakerAdaptorHeight 220 mm<br>Geometry SPL Impedance Displacement Surface PressurePlot<br>Q Q r0 r6 r4 J₂ ▼ 1×y 1/z 1zz m r5 m r6 m   | kerAdaptor/Width       50       mm       Report         kerAdaptor/Height       220       mm       Report         ometry       SPL       Impedance       Displacement       Surface PressurePlot         Q       <   | SpeakerAdaptorLength  | 200                  | mm       |                |                |                  |        |          |                         |         |              |
| ipeakerAdaptorHeight 220 mm Report<br>Geometry SPL Impedance Displacement Surface PressurePlot<br>Q Q r0 r6 r4 J₂ ▼ 1×y 1/z 1zz m R2 R0 m R0 m  | kerAdaptorHeight 220 mm Report<br>ometry SPL Impedance Displacement Surface PressurePlot<br>Q Q R R II ↓ • Ex Ex III III III III III IIII IIII I   | SpeakerAdaptorWidth   | 50                   | mm       |                |                |                  |        |          |                         |         |              |
| Geometry SPL Impedance Displacement Surface PressurePlot  | ometry SPL Impedance Displacement Surface PressurePlot<br>Q. Q. 19. ⊞ ↓ • Ex   | peakerAdaptorHeight   | 220                  | mm       |                |                |                  |        |          | Report                  |         |              |
|   |  | Geometry SPL Imp      | pedance Displacement | nt Surfa | ace PressurePl | lot            |                  |        |          |                         |         |              |
|   |  |                       | t two two two        | [777]    |                |                |                  |        |          |                         |         |              |
|   |  | ध्य छर 🖽              |                      |          |                |                |                  |        |          |                         |         |              |
|   |  |                       |                      |          |                |                |                  |        | /        | $\sim$                  |         |              |
|   |  |                       |                      |          |                |                | /                |        |          |                         |         |              |
|   |  |                       |                      |          |                | _              |                  |        |          |                         |         |              |
|   |  |                       |                      |          |                |                |                  |        |          |                         |         |              |
|   |  |                       |                      |          |                |                |                  | $\sim$ |          |                         |         |              |
|   |  |                       |                      |          | /              | / /            | 10               | 22     |          |                         |         |              |

#### 1.1. VERSIONS

BIW Study App Version 1.0

Comsol MultiPhysics Version : 5.3a

#### 1.2. USER

User: Nambati

#### 1.3. COMMENT

Multiple beam BIW enclosure integrated Speaker at Center and Coupling Slots at 1/4th of Beam

#### 1.4. SOLVER\_SETTINGS

| Name                         | Value | Unit |
|------------------------------|-------|------|
| Lower Frequency limit        | 20    | (Hz) |
| <b>Upper Frequency limit</b> | 200   | (H2) |
| Frequency step               | 5     | (Hz) |

#### **1.5. GEOMETRY CONFIGURATION PARAMETERS**

| Name                                      | Value                                  | Unit     |
|---|--|----------|
| Speaker Position w.r.t 82W Beam           | 0.00                                   | (m)      |
| B2W Beam Type                             | Multi Beam Type                        |          |
| Total Length of Beam                      | 2.0                                    | (m)      |
| Beam Coupling type                        | VOL1 + VOL2 + VOL3 as Resonance volume |          |
| Volume of each Beam (VOL1/VOL2/VOL1/VOL4) | 80.00                                  | (liters) |
| Coupling Location 1                       | 0.00                                   | [m]      |
| Coupling Location 2                       | 0.50                                   |          |

#### **1.6. SPEAKER PARAMETERS**

| Name               | Value | Unit  |
|--------------------|-------|-------|
| Voltage            | 2.7   | EV1   |
| Re - Dc Resistance | 7.4   | [Ohm] |

\* Total solution time(including simulation report generation)

= 2-3 mins

### **RESULTS** SPL AND DISPLACEMENT PLOTS



### SPL and Displacement plots for Multi Beam enclosure





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### **RESULTS** IMPEDANCE & SURFACE PRESSURE PLOTS

### Impedance plots for Multi Beam enclosure





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# SUMMARY

- 1. The BIW Comsol App predicted the acoustic behavior of loudspeaker for all configurations as expected.
- 2. This App is used to perform the preliminary study on the placement of speaker.
- 3. More detailed Pressure acoustic simulation would be performed for final optimum configuration which would be derived from the BIW Comsol App.

THANK YOU

#### FEA Disclaimer

Do not accept or reject a design based solely on the data presented in this report. Every effort is undertaken to ensure the analysis represents the real life scenario as much as possible. Certain factors cannot be accounted for such as temperature, casting / moulding anomalies, polymer fibre orientation and metal drawing inconsistencies. Evaluate designs by considering this information in conjunction with experimental test data and the practical experience of the Design Engineers. A quality approach to engineering design usually mandates final testing as the means of validating the structural integrity of any product

