

## Calculation of Loudspeaker Blocked Coil Impedance and Inductance vs. Position at 1kHz

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```
(* Base problem name and configuration *)  
  
myFile = "SSF-082_1kHz.fem";  
myCoilName = "Icoil";  
myCoilGroup = 1;  
  
(* Displacement range under consideration *)  
xmin = -15;  
xmax = 15;  
dx = 2;  
  
(* Frequency range under consideration in Hz *)  
  
w = 1000;  
  
<< c:\femm42\mathfemm\mathfemm.m  
MathFEMM loaded at Tue 3 Nov 2015 21:56:55  
  
OpenFEMM[]  
  
(* Open up base problem and save as the DC operating point with no coil current *)  
OpenDocument[NotebookDirectory[] <> myFile];  
MISetCurrent[myCoilName, 0];  
MISaveAs[NotebookDirectory[] <> "DCProblem.fem"];  
  
(* Open up base problem and save as the  
incremental AC problem with a coil current of 1A *)  
(* Incremental AC problem points back to the DC solution  
via the MISetPrevious["DCProblem.ans",1] call *)  
OpenDocument[NotebookDirectory[] <> myFile];  
MISetCurrent[myCoilName, 1];  
MIProbDef[w];  
MISetPrevious["DCProblem.ans", 1];  
MISaveAs[NotebookDirectory[] <> "ACProblem.fem"];  
  
(* Move the coil to the xmin position,  
assuming that the geometry is drawn so that the coil is nominally at x=0 *)  
  
DCSetFocus[] := MISetFocus["DCProblem.fem"];  
  
ACSetFocus[] := MISetFocus["ACProblem.fem"];
```

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DCSetFocus[];
MISelectGroup[myCoilGroup];
MIMoveTranslate[0, xmin];
ACSetFocus[];
MISelectGroup[myCoilGroup];
MIMoveTranslate[0, xmin];

(* Step through the full range of coil positions *)
Lx = {};
Vx = {};
Bl = {};
(* At each coil position,
evaluate Bl and coil inductance over a range of frequencies *)
For[x = xmin, x ≤ xmax, x += dx,
  DCSetFocus[];
  MIAnalyze[];
  ACSetFocus[];
  MIAnalyze[];
  MILoadSolution[];
  (* Get Bl *)
  MOGroupSelectBlock[1];
  f = Abs[MOBlockIntegral[29]];
  Bl = Append[Bl, {x, f}];
  (* Get Inductance and Voltage *)
  u = MOGetCircuitProperties[myCoilName];
  Lx = Append[Lx, {x, u[[3]]}];
  Vx = Append[Vx, {x, u[[2]]}];
  Print[{x, u[[3]]}];
  If[x < xmax,
    DCSetFocus[];
    MISelectGroup[myCoilGroup];
    MIMoveTranslate[0, dx];
    ACSetFocus[];
    MISelectGroup[myCoilGroup];
    MIMoveTranslate[0, dx];
  ];
]

```

```

{-15, 0.00482814- 0.00278792 i}
{-13, 0.00496937- 0.00270284 i}
{-11, 0.00511339- 0.00259933 i}
{-9, 0.00522405- 0.00246864 i}
{-7, 0.00526879- 0.0023075 i}
{-5, 0.00524326- 0.00212125 i}
{-3, 0.00516112- 0.00191732 i}
{-1, 0.00504053- 0.00170831 i}
{1, 0.00491105- 0.0015036 i}
{3, 0.00477723- 0.00130941 i}
{5, 0.00462044- 0.0011242 i}
{7, 0.0044263- 0.000951303 i}
{9, 0.00419797- 0.000786545 i}
{11, 0.00393325- 0.000634708 i}
{13, 0.00365867- 0.000499021 i}
{15, 0.00341709- 0.000384987 i}

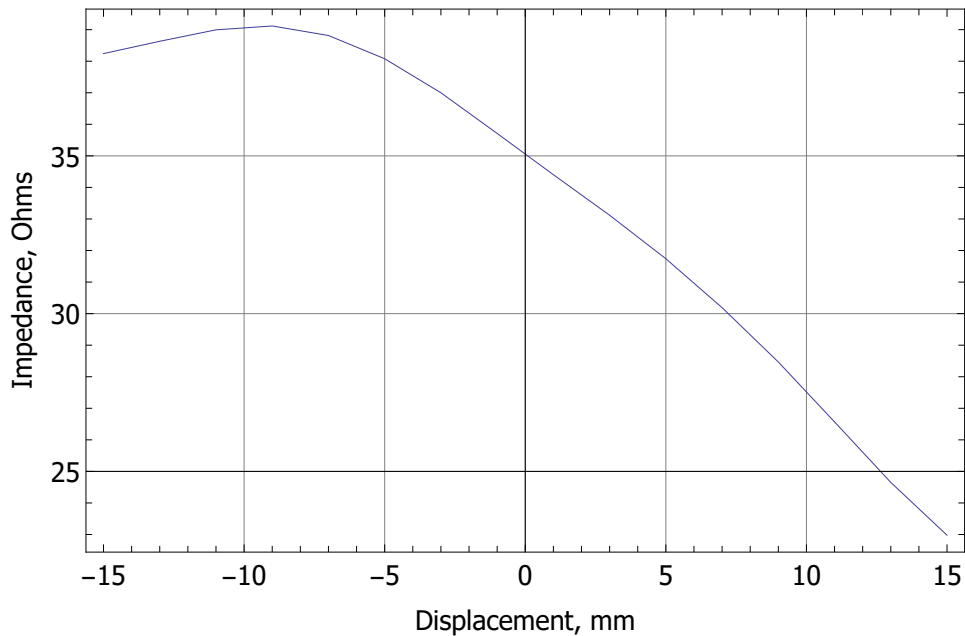
```

```
CloseFEMM[]
```

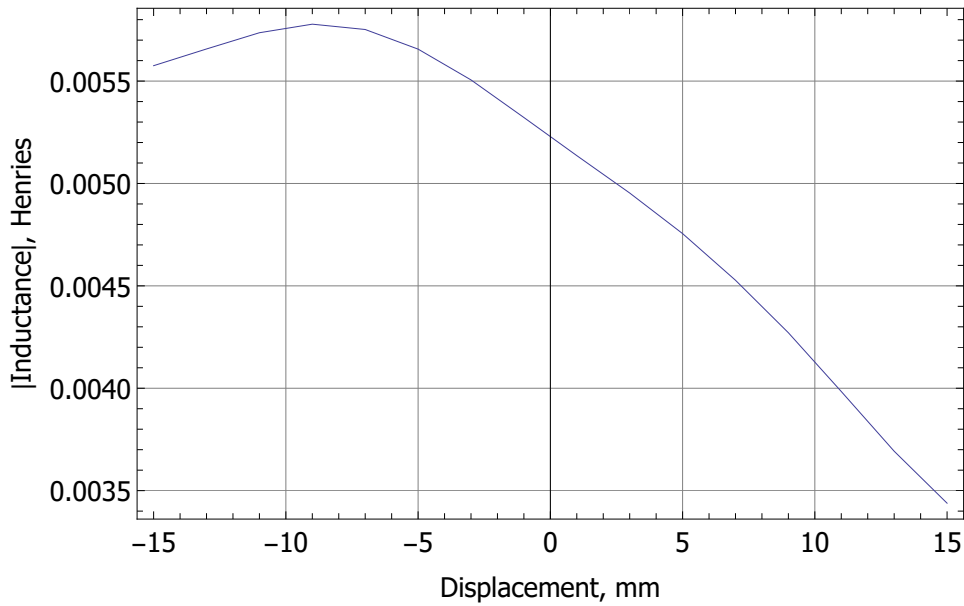
```

ListPlot[Transpose[{Vx.{1, 0}, Abs[Vx.{0, 1}]}], Joined → True, Frame → True,
  GridLines → Automatic, ImageSize → 500, BaseStyle → {FontFamily → "Tahoma", FontSize → 14},
  FrameLabel → {"Displacement, mm", "Impedance, Ohms"}]

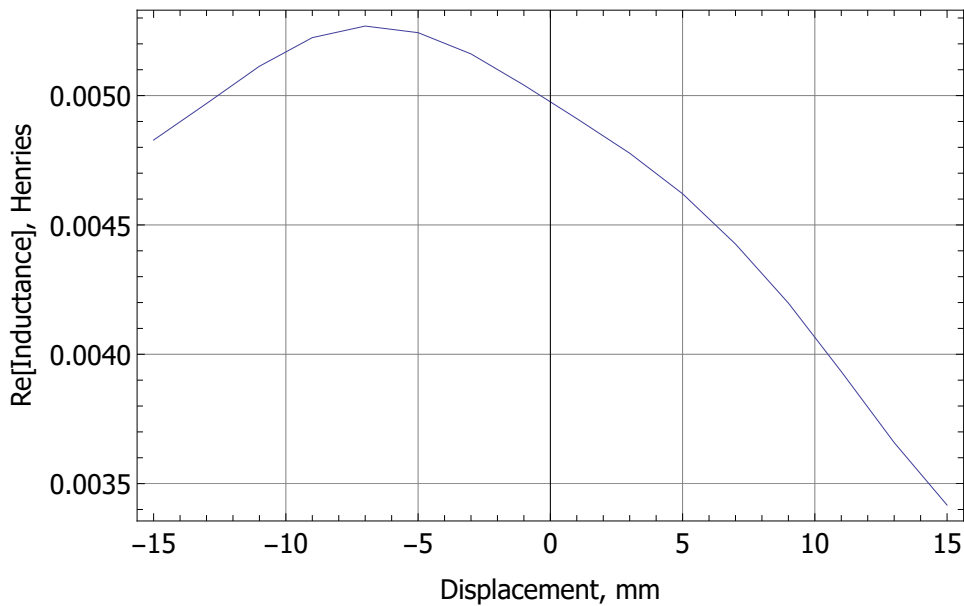
```



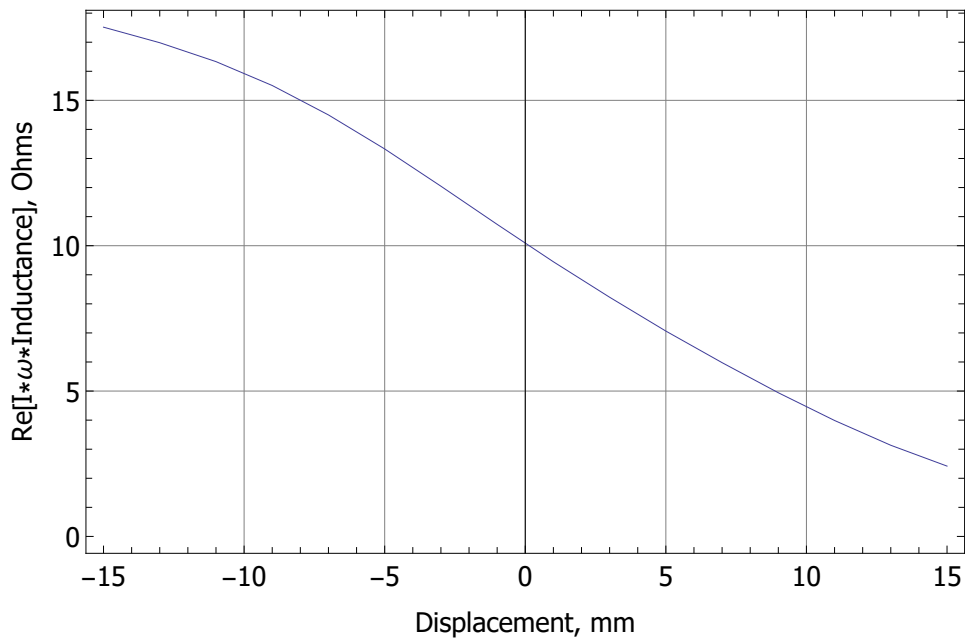
```
ListPlot[Transpose[{Lx.{1, 0}, Abs[Lx.{0, 1}]}], Joined → True, Frame → True,  
GridLines → Automatic, ImageSize → 500, BaseStyle → {FontFamily → "Tahoma", FontSize → 14},  
FrameLabel → {"Displacement, mm", "|Inductance|, Henries"}]
```



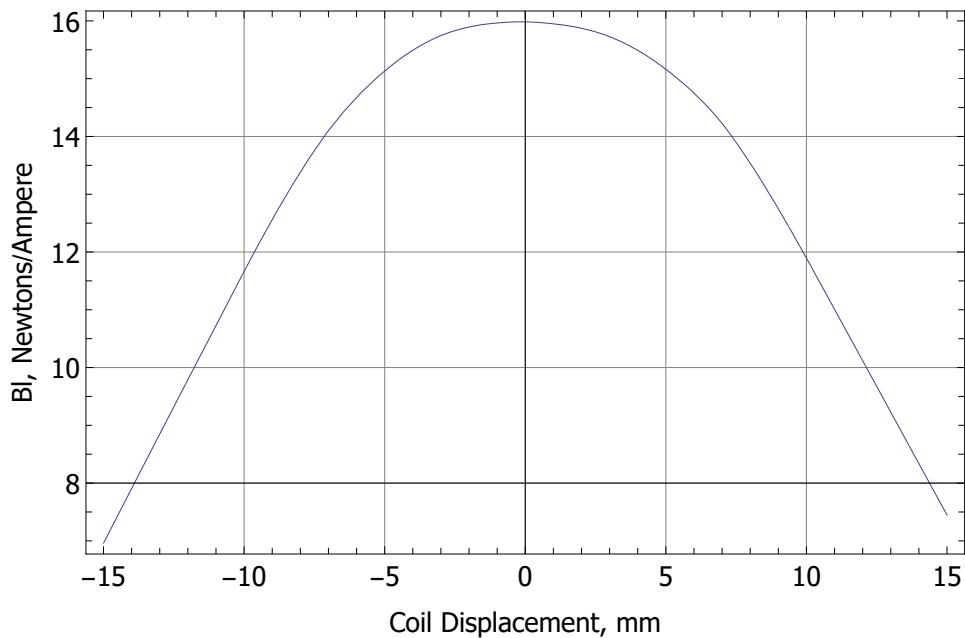
```
ListPlot[Re[Lx], Joined → True, Frame → True, GridLines → Automatic,  
ImageSize → 500, BaseStyle → {FontFamily → "Tahoma", FontSize → 14},  
FrameLabel → {"Displacement, mm", "Re[Inductance], Henries"}]
```



```
ListPlot[Re[Lx.{{1, 0}, {0, I * 2 * Pi * w}}], Joined → True, Frame → True,
GridLines → Automatic, ImageSize → 500, BaseStyle → {FontFamily → "Tahoma", FontSize → 14},
FrameLabel → {"Displacement, mm", "Re[I*ω*Inductance], Ohms"}]
```



```
Plot[Interpolation[B1][X], {X, Min[B1.{1, 0}], Max[B1.{1, 0}]}, Frame → True,
GridLines → Automatic, ImageSize → 500, BaseStyle → {FontFamily → "Tahoma", FontSize → 14},
FrameLabel → {"Coil Displacement, mm", "B1, Newtons/Ampere"}]
```



**Lx**

{-15, 0.00482814- 0.00278792 i}, {-13, 0.00496937- 0.00270284 i},  
 {-11, 0.00511339- 0.00259933 i}, {-9, 0.00522405- 0.00246864 i},  
 {-7, 0.00526879- 0.0023075 i}, {-5, 0.00524326- 0.00212125 i},  
 {-3, 0.00516112- 0.00191732 i}, {-1, 0.00504053- 0.00170831 i},  
 {1, 0.00491105- 0.0015036 i}, {3, 0.00477723- 0.00130941 i},  
 {5, 0.00462044- 0.0011242 i}, {7, 0.0044263- 0.000951303 i},  
 {9, 0.00419797- 0.000786545 i}, {11, 0.00393325- 0.000634708 i},  
 {13, 0.00365867- 0.000499021 i}, {15, 0.00341709- 0.000384987 i}}

**Vx**

{-15, 23.283+ 30.3361 i}, {-13, 22.7484+ 31.2235 i},  
 {-11, 22.098+ 32.1284 i}, {-9, 21.2769+ 32.8237 i},  
 {-7, 20.2644+ 33.1048 i}, {-5, 19.0942+ 32.9444 i}, {-3, 17.8129+ 32.4283 i},  
 {-1, 16.4996+ 31.6706 i}, {1, 15.2134+ 30.8571 i}, {3, 13.9932+ 30.0162 i},  
 {5, 12.8295+ 29.0311 i}, {7, 11.7432+ 27.8113 i}, {9, 10.708+ 26.3766 i},  
 {11, 9.75396+ 24.7134 i}, {13, 8.90142+ 22.9881 i}, {15, 8.18492+ 21.4702 i}}

**B1**

{-15, 6.96031}, {-13, 8.85003}, {-11, 10.7238}, {-9, 12.5628}, {-7, 14.1039},  
 {-5, 15.1344}, {-3, 15.7471}, {-1, 15.9635}, {1, 15.9487}, {3, 15.7279},  
 {5, 15.1637}, {7, 14.2276}, {9, 12.7492}, {11, 11.0048}, {13, 9.22781}, {15, 7.44816}}