FET IQ Demodulator

In[408]:=

```
Needs["Controls`LinearControl`"]
$TextStyle = {FontFamily → "Helvetica", FontSize → 13};
plotopt = PlotStyle → {{Thickness [0.007], RGBColor [1, 0, 0]},
              {Thickness [0.007], RGBColor [0, 0, 1]},
              {Thickness [0.007], RGBColor [0.1, 0.7, 0.2]},
              {Thickness [0.007], RGBColor [0.5, 0.5, 0.2]}};
textoptsmall = {TextStyle → {FontFamily → "Helvetica", FontSize → 11}};
```

In[412]:=

```
par[r1_, r2_] := 1/(1/r1 + 1/r2)
```

Parameters

In[413]:=

```
prm = {C6 → 1*^-9, C3 → 47*^-9, R11 → 182,
  R6 → 10, L1 → 2.2*^-6, R2 → 1000, C1 → 1*^-9, s → 2 π i f}
```

Out[413]=

$$\{C6 \to \frac{1}{1000000000},\ C3 \to \frac{47}{1000000000},\ R11 \to 182,\ R6 \to 10,\ L1 \to 2.2 \times 10^{-6},\ R2 \to 1000,\ C1 \to \frac{1}{1000000000},\ s \to 2\, i\, f\, \pi\}$$

Formulae

v1: Voltage at the IF point
i1: current into virtual ground
v2: voltage at OpAmp output

In[414]:=

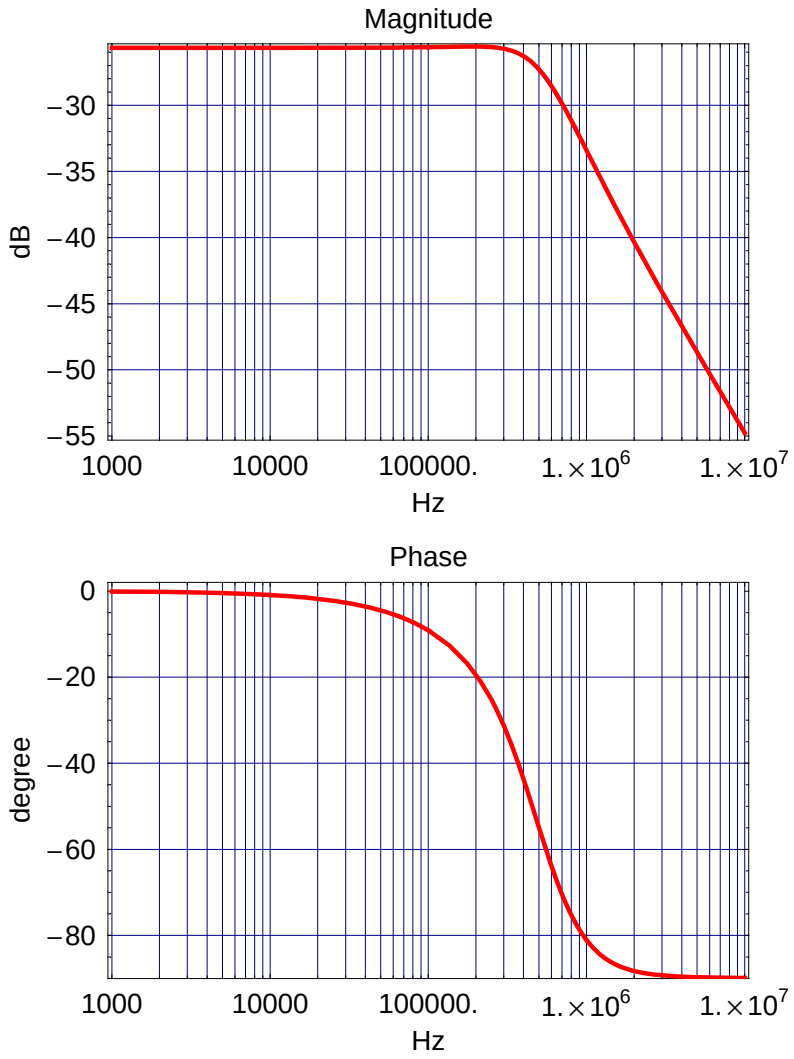
```
z2 = s L1 + R6;
z1 = par[1/(s C6), par[1/(s C3), z2]] // Together
v1 = z1/(R11 + z1) /. prm;
i1 = v1 / z2;
v2 = i1 par[R2, 1/(s C1)] /. prm;
```

Out[415]=

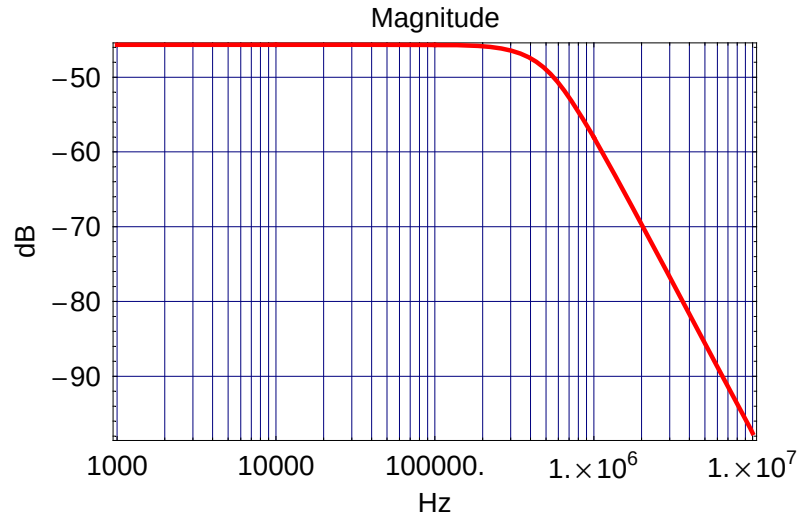
$$\frac{R6 + L1\, s}{1 + C3\, R6\, s + C6\, R6\, s + C3\, L1\, s^2 + C6\, L1\, s^2}$$

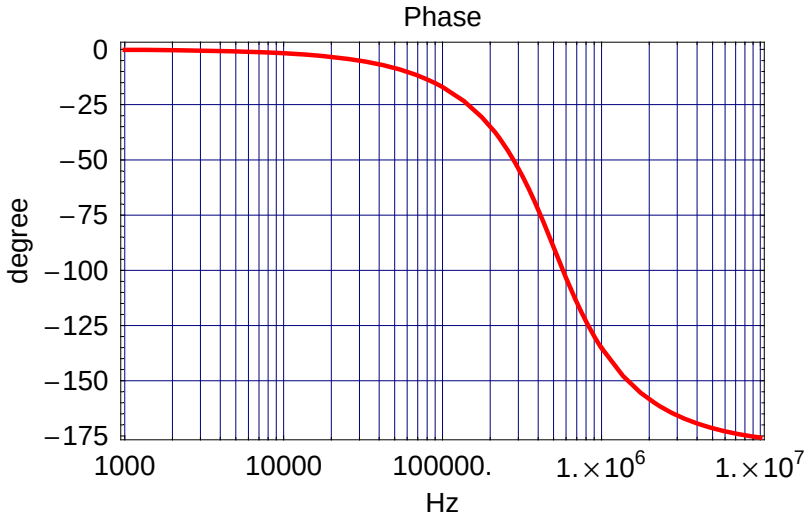
Plots

In[419]:=
```
BodePlot[v1, {f, 1*^3, 1*^7}, plotopt];
```



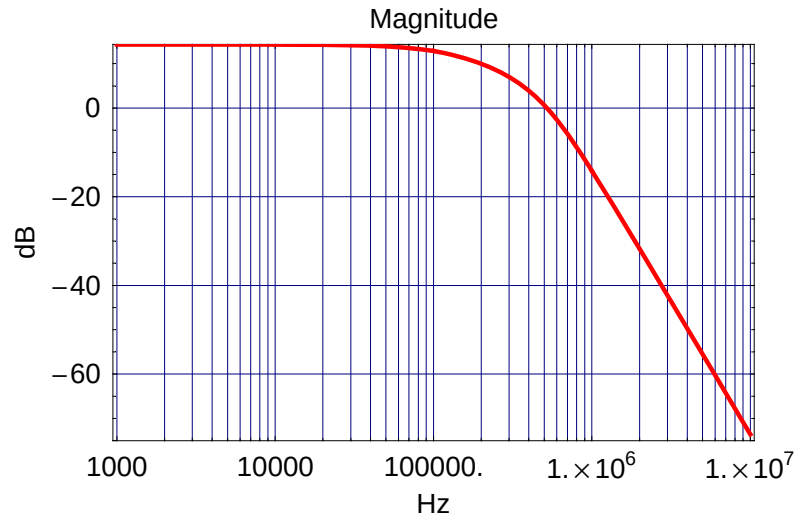
In[420]:=
```
BodePlot[i1 /. prm, {f, 1*^3, 1*^7}, plotopt];
```

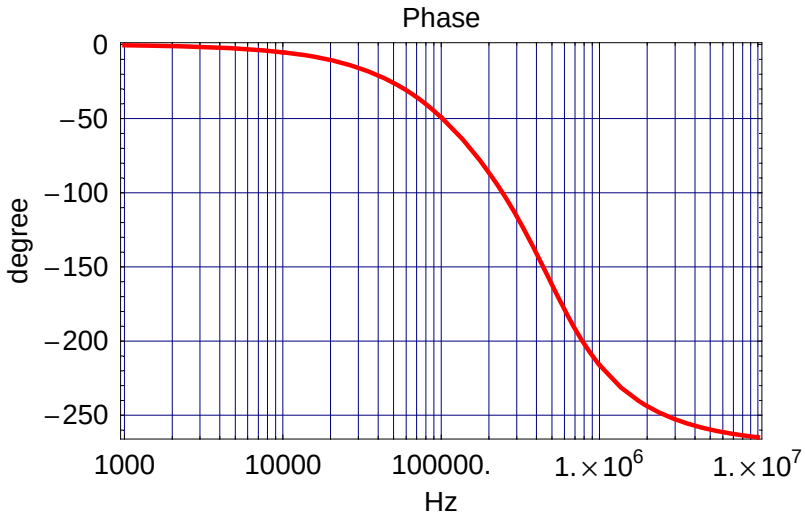




In[421]:=

```
BodePlot[v2, {f, 1*^3, 1*^7}, plotopt];
```





Values

■ DC gain

In[422]:=

```
dcgain = Abs[v2] /. {f → 0.}
```

Out[422]=

```
5.20833
```

■ Bandwidth

In[423]:=

```
f /. FindRoot[Abs[v2] == dcgain/√2, {f, 0.5*^5, 5*^5}]
```

Out[423]=

```
155137.
```

■ Phase at 10 kHz

In[424]:=

```
Arg[v2]/Degree /. {f → 10*^3}
```

Out[424]=

```
-5.27471
```

■ Phase at 100 kHz

In[425]:=

```
Arg[v2]/Degree /. {f → 100*^3}
```

Out[425]=

```
-49.1111
```

■ LC circuit resonant frequency and Q

In[426]:=

```
LCpoles = Solve[z2 / z1 == 0, s];
LComega = √(Times @@ (s /. LCpoles)) // Simplify;
LCQ = LComega / (Plus @@ (-s /. LCpoles)) // Simplify;
√(LCQ^2) // Simplify // PowerExpand;

LComega/(2 π) /. prm
LCQ /. prm
```

Out[430]=

```
489765.
```

Out[431]=

```
0.677003
```