APPENDIX C

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Python models used in the design process:

1 Basic CTLE

```
import numpy as np

Nfrq = 10e9
Av = -4.5
peakAv = -2
Cload = 0.1e-12

p2 = 1.5 * Nfrq
p1 = 0.35 * Nfrq

Rd = 1 / (2 * np.pi * p2 * Cload)
gm = (10**(peakAv / 20)) / Rd
Rs = (2 * Rd / (10**(Av / 20))) - (2 / gm)
Cs = (1 + gm * Rs / 2) / (2 * np.pi * Rs * p1)

z = 1 / (Rs * Cs)

print('****** CTLE normal ******')
print('Nfrq = {:.2e} Hz'.format(Nfrq))
print('DC gain = {:.2f} dB'.format(Av))
print('Peaking gain = {:.2f} dB'.format(peakAv))
```

```
print('Zero = {:.2e} Hz'.format(z))
print('Pole 1 = {:.2e} Hz'.format(p1))
print('Pole 2 = {:.2e} Hz'.format(p2))
print('**************************')
print('CL = {:.2e} F'.format(Cload))
print('Rd = {:.2e} Ohms'.format(Rd))
print('gm = {:.2e} S'.format(gm))
print('Rs = {:.2e} Ohms'.format(Rs))
print('Cs = {:.2e} F'.format(Cs))
```

2 CTLE with cherry-hooper active-inductor

```
Nfrq = 10e9
Av = -9
peakAv = -0.5
Cload = 0.1e-12

###############################################

pch = 2.9*Nfrq

###############################################

fop = Nfrq*0.75
p2 = 1.5 * fop
p1 = 0.3 * fop

gmch = (2 * np.pi * p2 * Cload)
Cg = gmch / (2 * np.pi * pch)
Rg = (2**(1/2))*(Cload)/(Cg*gmch)

gm = (10**( (peakAv - 2.5) / 20)) * gmch
Rs = (2 * (1/gmch) / (10**(Av / 20))) - (2 / gm)
Cs = (1 + gm * Rs / 2) / (2 * np.pi * Rs * p1)

z = 1 / (Rs * Cs)

print('****** CTLE whit Cherry-Hooper ******')
print('Nfrq = {:.2e} Hz'.format(Nfrq))
print('DC gain = {:.2f} dB'.format(Av))
print('Peaking gain = {:.2f} dB'.format(peakAv))
print('Zero = {:.2e} Hz'.format(z))
print('Pole 1 = {:.2e} Hz'.format(p1))
print('Pole 2 = {:.2e} Hz'.format(p2))
print('**********************************')
print('CL = {:.2e} F'.format(Cload))
print('gm = {:.2e} S'.format(gm))
print('Rs = {:.2e} Ohms'.format(Rs))
```

```
print('Cs = {:.2e} F'.format(Cs))
print('**********************************')
print('Rd = {:.2e} Ohms'.format(1/gmch))
print('gmch = {:.2e} Ohms'.format(gmch))
print('Rg = {:.2e} Ohms'.format(Rg))
print('Cg = {:.2e} Ohms'.format(Cg))
```

3 CTLE with cross-coupled pair

```
Nfrq = 10e9
Av = -9
peakAv = -0.5
Cload = 0.1e-12

################################################

pxcp = 2.9*Nfrq

################################################

fop = Nfrq * 0.75
p2 = 1.5 * fop
p1 = 0.3 * fop

Rd = 1 / (2 * np.pi * p2 * Cload)
zxcp = 1 / (2 * np.pi * (2**(1/2)) * Rd * Cload)
gmxcp = (1 / Rd) - (zxcp / (pxcp * Rd))
Cxcp = gmxcp / (2*2*np.pi*zxcp)

gm = (10**( (peakAv - 2.5) / 20)) / Rd
Rs = (2 * (Rd) / (10**(Av / 20))) - (2 / gm)
Cs = (1 + gm * Rs / 2) / (2 * np.pi * Rs * p1)

z = 1 / (Rs * Cs)

print('****** CTLE whit Cross-coupled pair ******')
print('Nfrq = {:.2e} Hz'.format(Nfrq))
print('DC gain = {:.2f} dB'.format(Av))
print('Peaking gain = {:.2f} dB'.format(peakAv))
print('Zero = {:.2e} Hz'.format(z))
print('Pole 1 = {:.2e} Hz'.format(p1))
print('Pole 2 = {:.2e} Hz'.format(p2))
print('**********************************')
print('CL = {:.2e} F'.format(Cload))
print('gm = {:.2e} S'.format(gm))
```

```
print('Rs = {:.2e} Ohms'.format(Rs))
print('Cs = {:.2e} F'.format(Cs))
print('Rd = {:.2e} Ohms'.format(Rd))
print('**********************************')
print('gmxcp = {:.2e} S'.format(gmxcp))
print('Cxcp = {:.2e} F'.format(Cxcp))
```

4 CTLE with cross-coupled pair and cherry-hooper active-inductor

```
Nfrq = 10e9
Av = -9
peakAv = -0.5
Cload = 0.1e-12

##############################################

pxcp = 1.5 * Nfrq
pch = 2 * Nfrq

##############################################

fop = Nfrq * 0.75
p2 = 1.2 * Nfrq
p1 = 0.35 * Nfrq

gmch = (2 * np.pi * p2 * Cload)
Cg = gmch / (2 * np.pi * pch)
Rg = (2**(1/2))*(Cload)/(Cg * gmch)

Rd = 1 / gmch
zxcp = 1 / (2 * np.pi * (2**(1/2)) * Rd * Cload)
gmxcp = (1 / Rd) - (zxcp / (pxcp * Rd))
Cxcp = gmxcp / (2*2*np.pi*zxcp)

gm = (10**( (peakAv - 6) / 20)) / Rd
Rs = (2 * (Rd) / (10**(Av / 20))) - (2 / gm)
Cs = (1 + gm * Rs / 2) / (2 * np.pi * Rs * p1)

z = 1 / (Rs * Cs)

print('****** CTLE complete ******')
print('Nfrq = {:.2e} Hz'.format(Nfrq))
print('DC gain = {:.2f} dB'.format(Av))
print('Peaking gain = {:.2f} dB'.format(peakAv))
```

```
print('Zero = {:.2e} Hz'.format(z))
print('Pole 1 = {:.2e} Hz'.format(p1))
print('Pole 2 = {:.2e} Hz'.format(p2))
print('CL = {:.2e} F'.format(Cload))
print('************************************')
print('Rd = {:.2e} Ohms'.format(Rd))
print('gm = {:.2e} S'.format(gm))
print('Rs = {:.2e} Ohms'.format(Rs))
print('Cs = {:.2e} F'.format(Cs))
print('********** Cherry-hooper parameters *************')
print('gmch = {:.2e} Ohms'.format(gmch))
print('Rg = {:.2e} Ohms'.format(Rg))
print('Cg = {:.2e} Ohms'.format(Cg))
print('********* Cross-coupled pair parameters **********')
print('gmxcp = {:.2e} S'.format(gmxcp))
print('Cxcp = {:.2e} F'.format(Cxcp))
```