LINE LOSS PRO

Technical Analysis

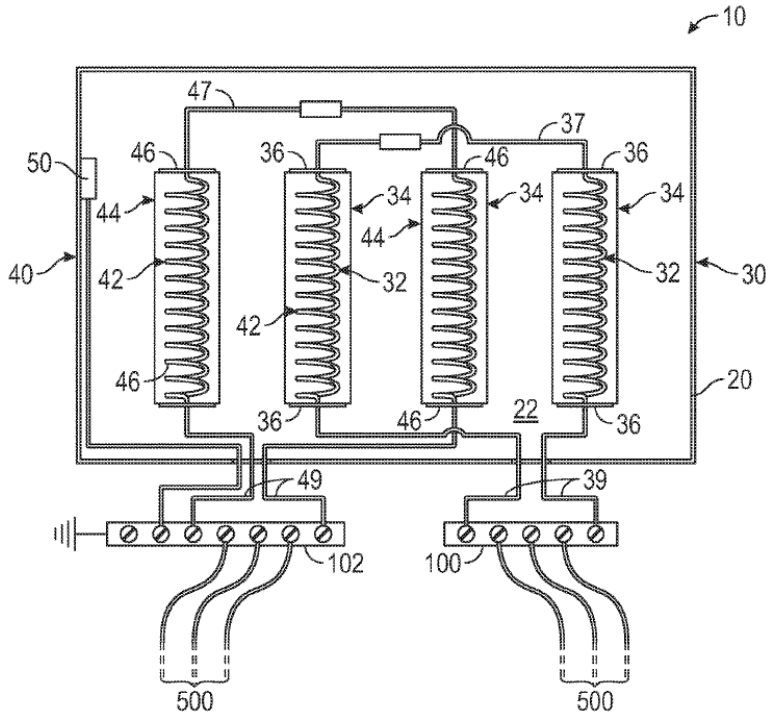
OCTOBER 19th, 2020

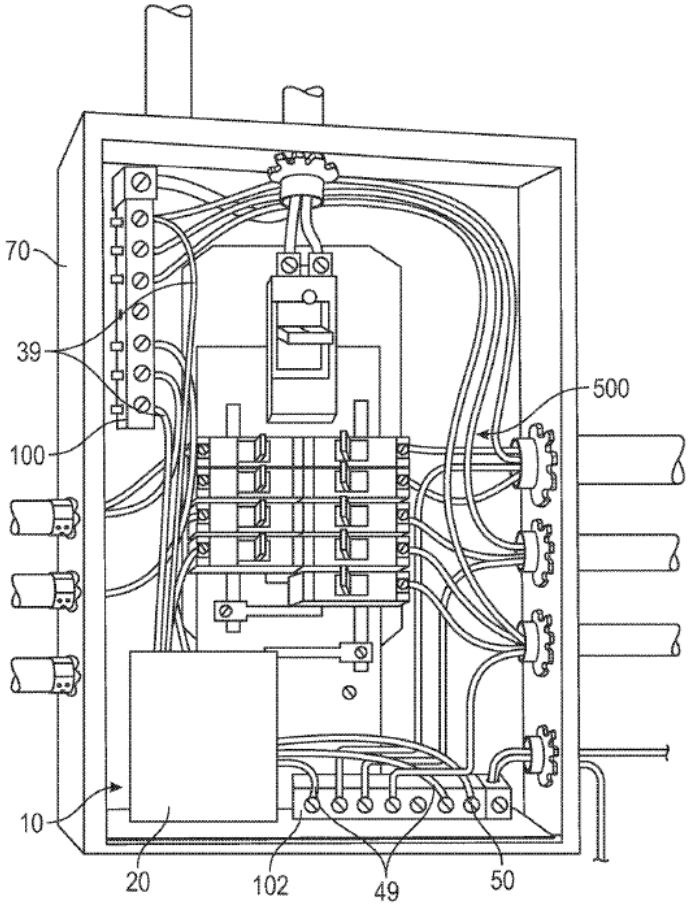
www.LineLossPro.com

Purpose

To validate the claim the LLP's passive inductive harmonic filter(electro-magnetic rectification unit) can effectively reduce AC harmonics seen on the neutral bus bar.

- Parallel Inductors
- Mutual Capacitance
- Neutral Bus Bar
- Earth Ground Bus Bar
- Redactors 1 & 2

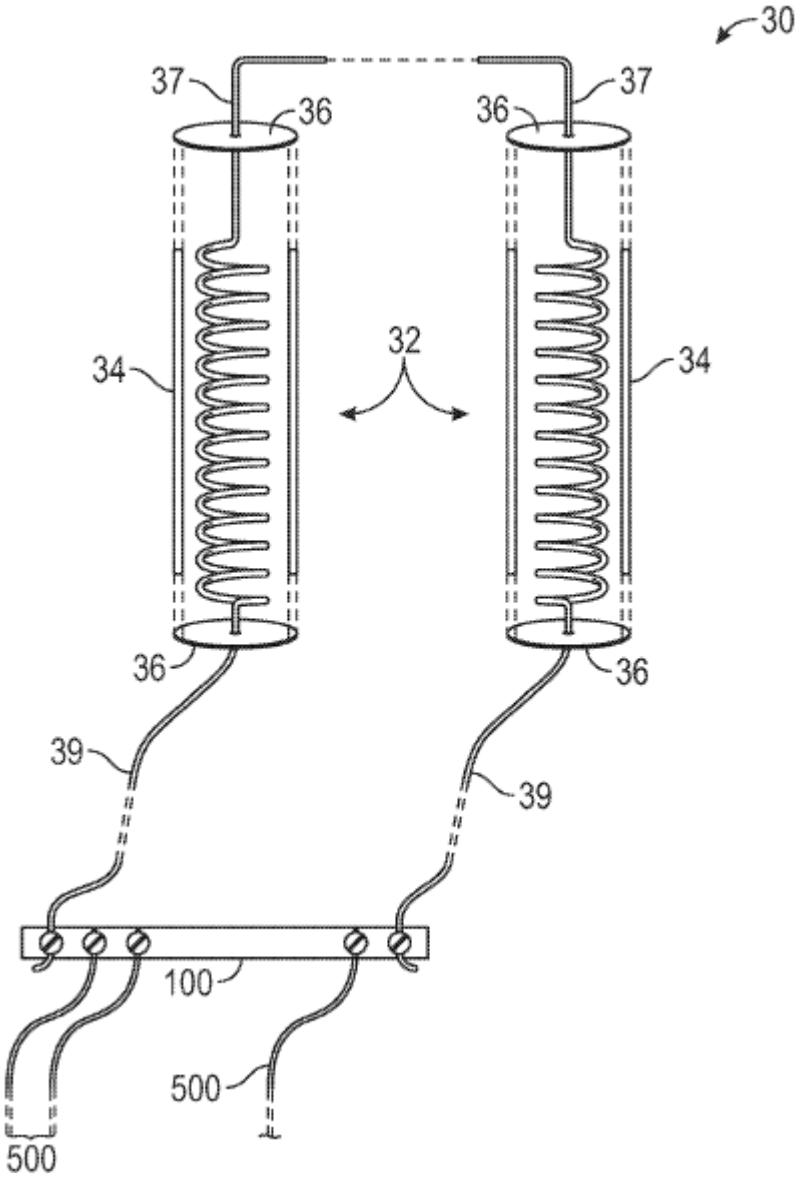




Scope

Line Loss Pro Harmonics Redactor

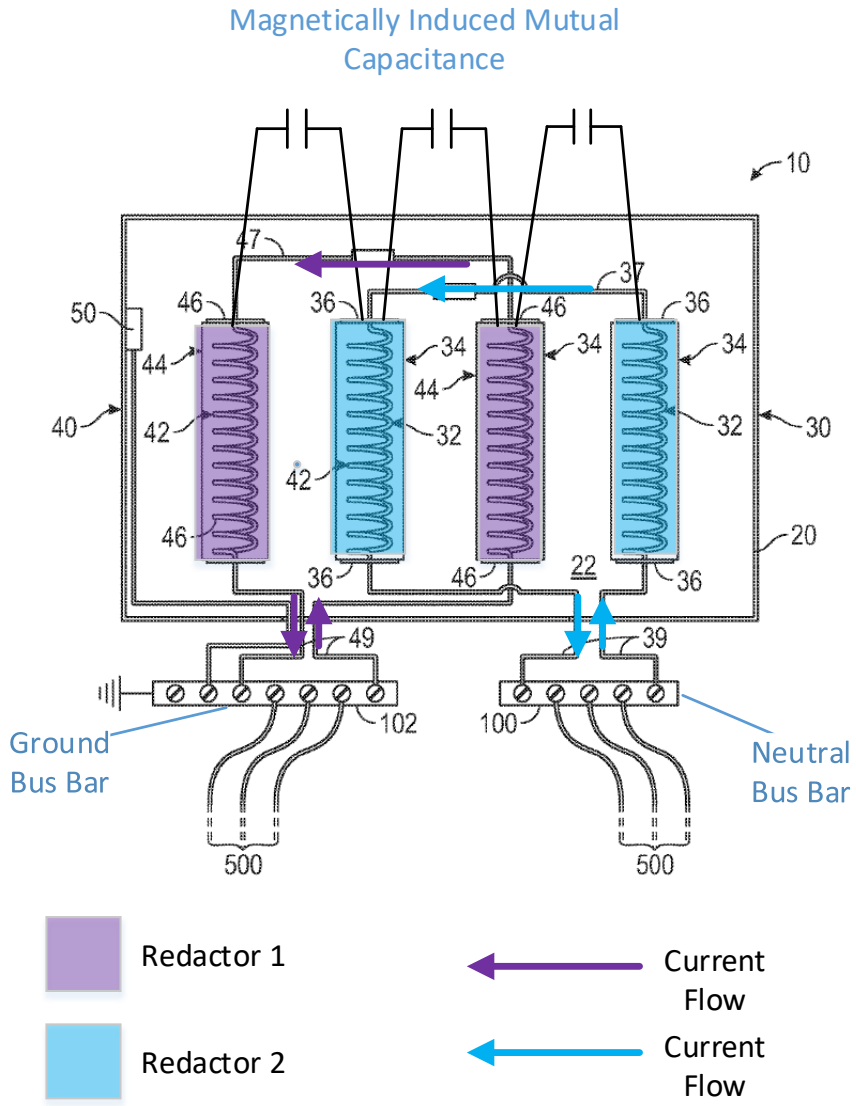
- Physical Components
  - Parallel Inductance
  - Redactor 1 – Ground Bus
  - Redactor 2 – Neutral Bus
- Electrical Properties
  - Mutual Capacitance
  - Power Factor
  - Total Harmonic Distortion
- Control Knobs
  - Increasing/Decreasing Parallel Inductance
    - Affect on PF and THD
  - Increasing/Decreasing Mutual Capacitance
    - Affect on PF and THD



High Level Summary

Operation

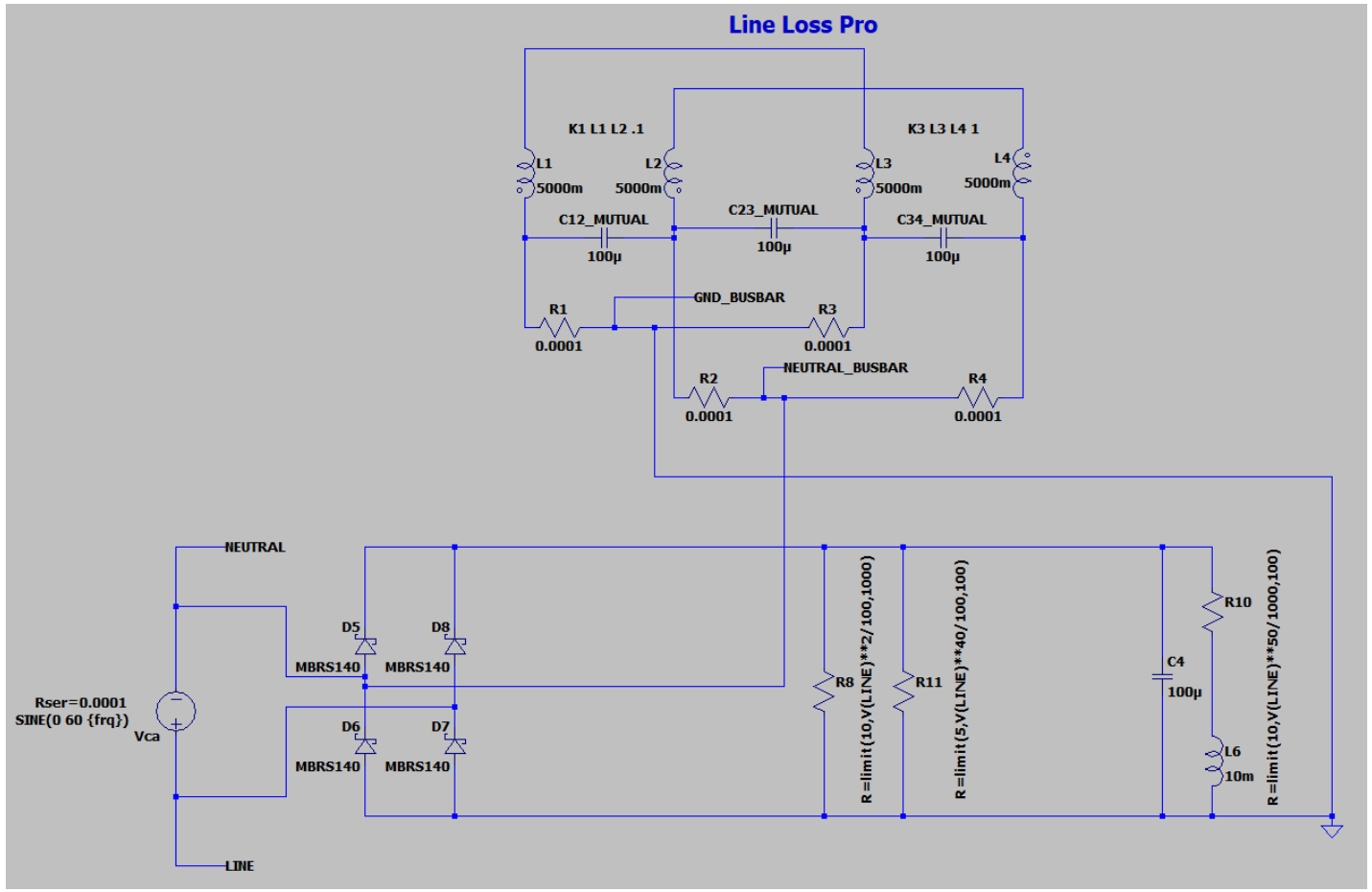
- The LLP works by using two redactors to cancel out spurious harmonics on the ground/neutral bus bar
- The Redactors resist the change in current flow and therefor cause a phase shift in harmonics when current is flowing through the redactors
- The Redactors also generate a Mutual Capacitance through magnetically generated fields when current flows through the LLP. This allows the LLP to also store/replace power
- The destructive harmonics are therefor redacted through AC phase shifting of the Inductors and energy storage generated by the magnetically generated mutual capacitance



LT Spice Simulation Overview

- LT Spice was used to simulate the Line Loss Pro Module
- L1 and L3 Form Redactor 1
- L2 and L4 Form Redactor 2
- C12, C23, and C34 is the modeled mutual capacitance that is formed during current flow thru the LLP

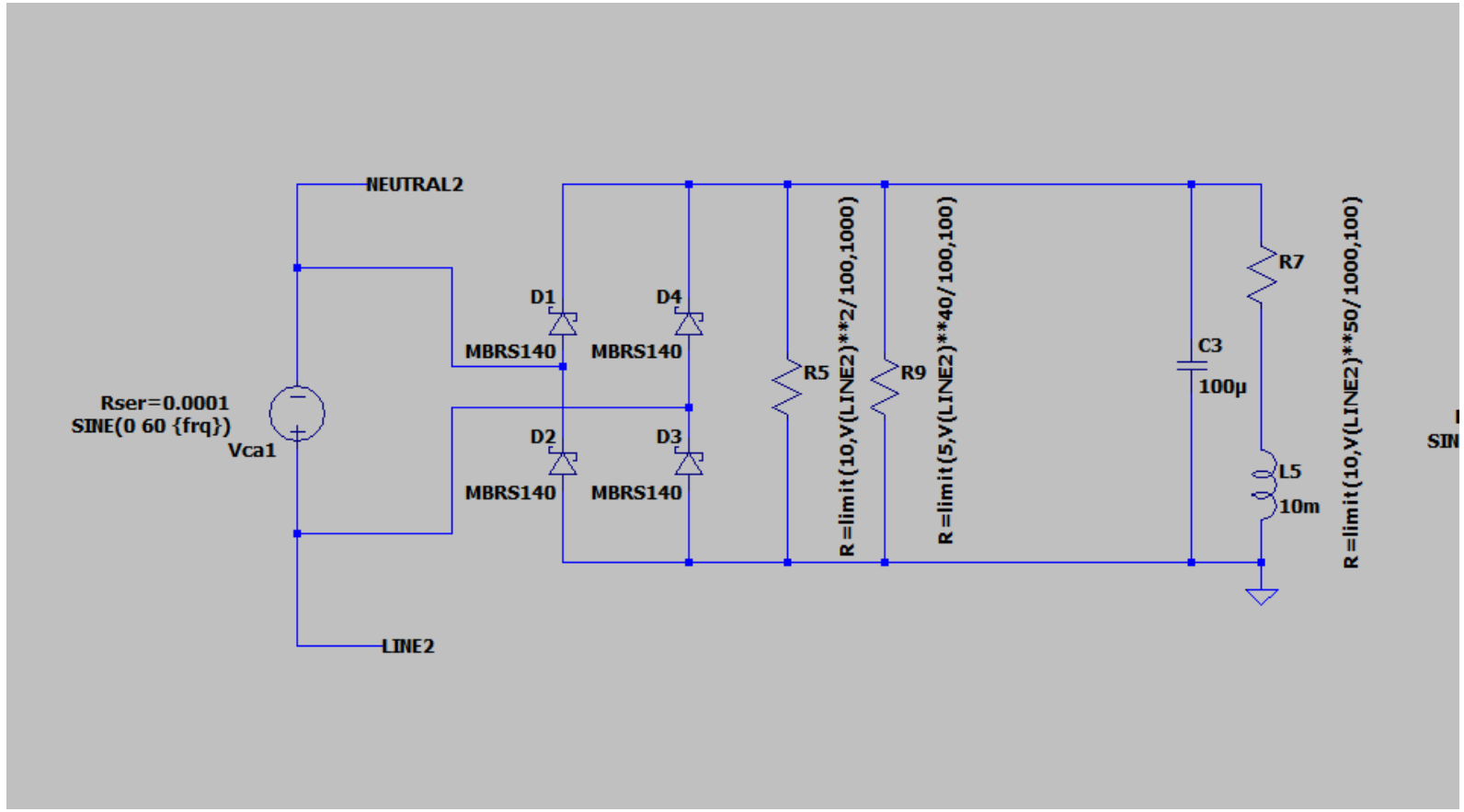
- R8, R11, and R10/L6 are dynamic loads to used to add harmonics to the power bus



*Note – For purposes of simplifying the analysis and single AC phase was used

LT Spice Simulation Overview

- For Comparison, the same load circuit was used but without the LineLossPro in place



*Note – For purposes of simplifying the analysis and single AC phase was used

LLP LT Spice Analysis – Power Factor & Total Harmonic Distortion

Comparison

- Without LLP
  - THD = 49.35%
  - PF = 0.38
- With LLP
  - THD = 48.32
  - PF = .51
- Summary
  - The Line Loss Pro slightly improves THD but greatly improves PF by 34%
  - The THD is improved by 2%

Power Factor and Total Harmonic Distortion of the Loaded Circuit w/o LLP

Fourier components of I(vca1)
DC component:1.37724

Harmonic Number	Frequency [Hz]	Fourier Component	Normalized Component	Phase [degree]	Normalized Phase [deg]
1	5.000e+01	6.375e+00	1.000e+00	-64.74°	0.00°
2	1.000e+02	2.444e+00	3.834e-01	114.58°	179.32°
3	1.500e+02	1.286e+00	2.018e-01	160.55°	225.29°
4	2.000e+02	1.237e+00	1.941e-01	-43.41°	21.33°
5	2.500e+02	2.900e-01	4.550e-02	152.29°	217.03°
6	3.000e+02	6.489e-01	1.018e-01	179.53°	244.27°
7	3.500e+02	3.088e-01	4.844e-02	6.36°	71.10°
8	4.000e+02	1.028e-01	1.612e-02	-142.66°	-77.92°
9	4.500e+02	3.561e-01	5.586e-02	-149.52°	-84.78°

Total Harmonic Distortion: 49.348444%(50.165212%) PF=-0.382702(-0.381457)

Power Factor and Total Harmonic Distortion of the Loaded Circuit with LLP

Fourier components of I(vca)
DC component:1.66671

Harmonic Number	Frequency [Hz]	Fourier Component	Normalized Component	Phase [degree]	Normalized Phase [deg]
1	5.000e+01	7.055e+00	1.000e+00	-55.32°	0.00°
2	1.000e+02	2.716e+00	3.849e-01	145.81°	201.13°
3	1.500e+02	1.269e+00	1.799e-01	138.57°	193.89°
4	2.000e+02	1.268e+00	1.798e-01	-17.65°	37.66°
5	2.500e+02	7.338e-01	1.040e-01	-135.56°	-80.25°
6	3.000e+02	3.527e-01	4.999e-02	175.06°	230.38°
7	3.500e+02	4.652e-01	6.594e-02	112.38°	167.69°
8	4.000e+02	3.375e-01	4.784e-02	-54.12°	1.19°
9	4.500e+02	1.798e-01	2.548e-02	-103.73°	-48.41°

Total Harmonic Distortion: 48.317587%(49.893290%) PF=-0.512376(-0.509192)

LLP LT Spice Analysis – FFT Spectral Analysis

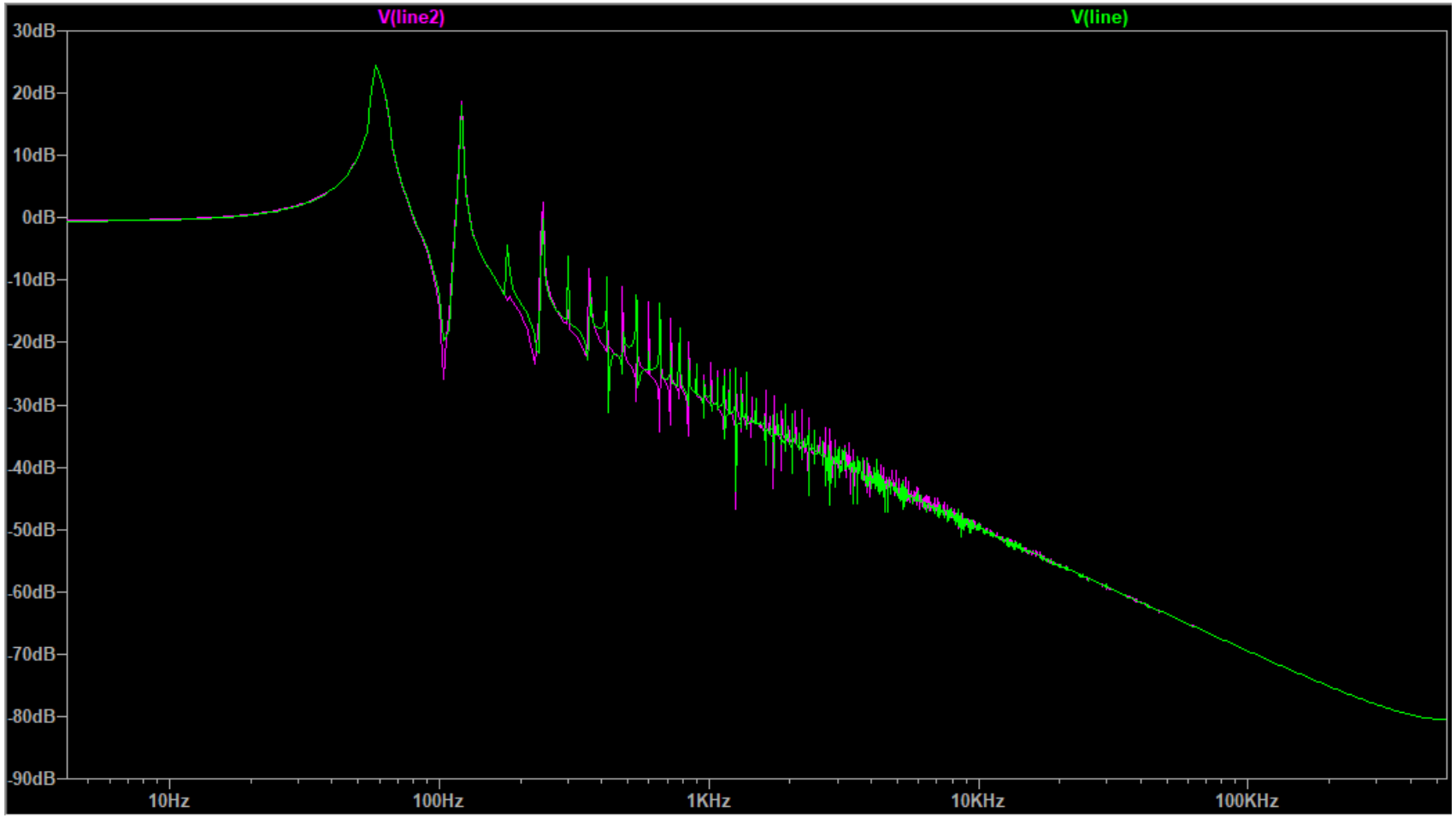
Graphs

- Line (in Green) is the FFT with LLP module in place
- Line2 (in Purple) is the FFG without the LLP module

Comparison

- It can be seen that the LLP (green trace) has much reduced spectral content than the FFT with out the LLP in place (purple trace)
- This shows a reduction in harmonics between to the two identically loaded AC circuits
- This is what contributes to a lower THD and higher PF rating of the LLP

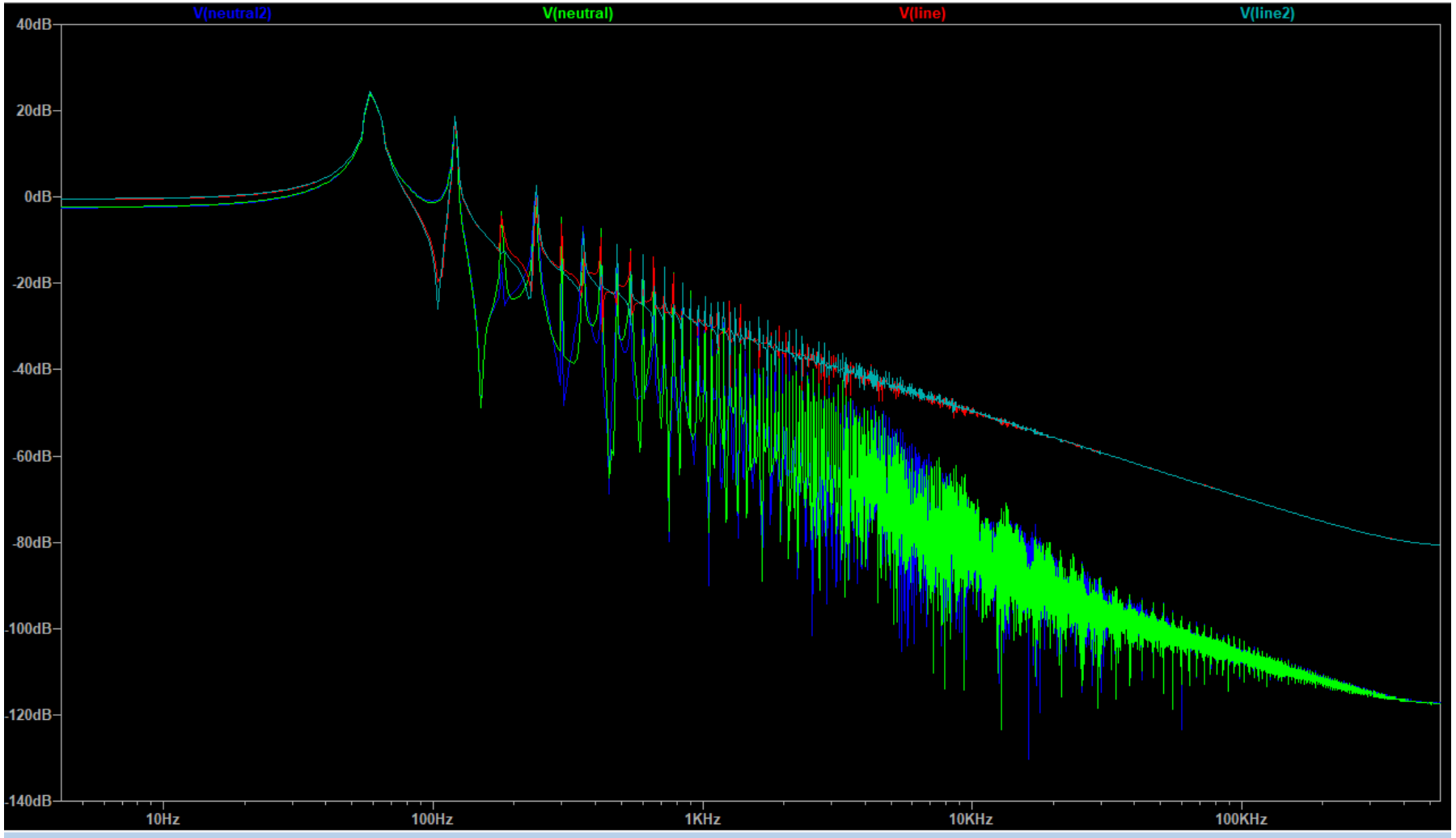
FFT Waveform Comparison of AC Line – LLP vs non-LLP



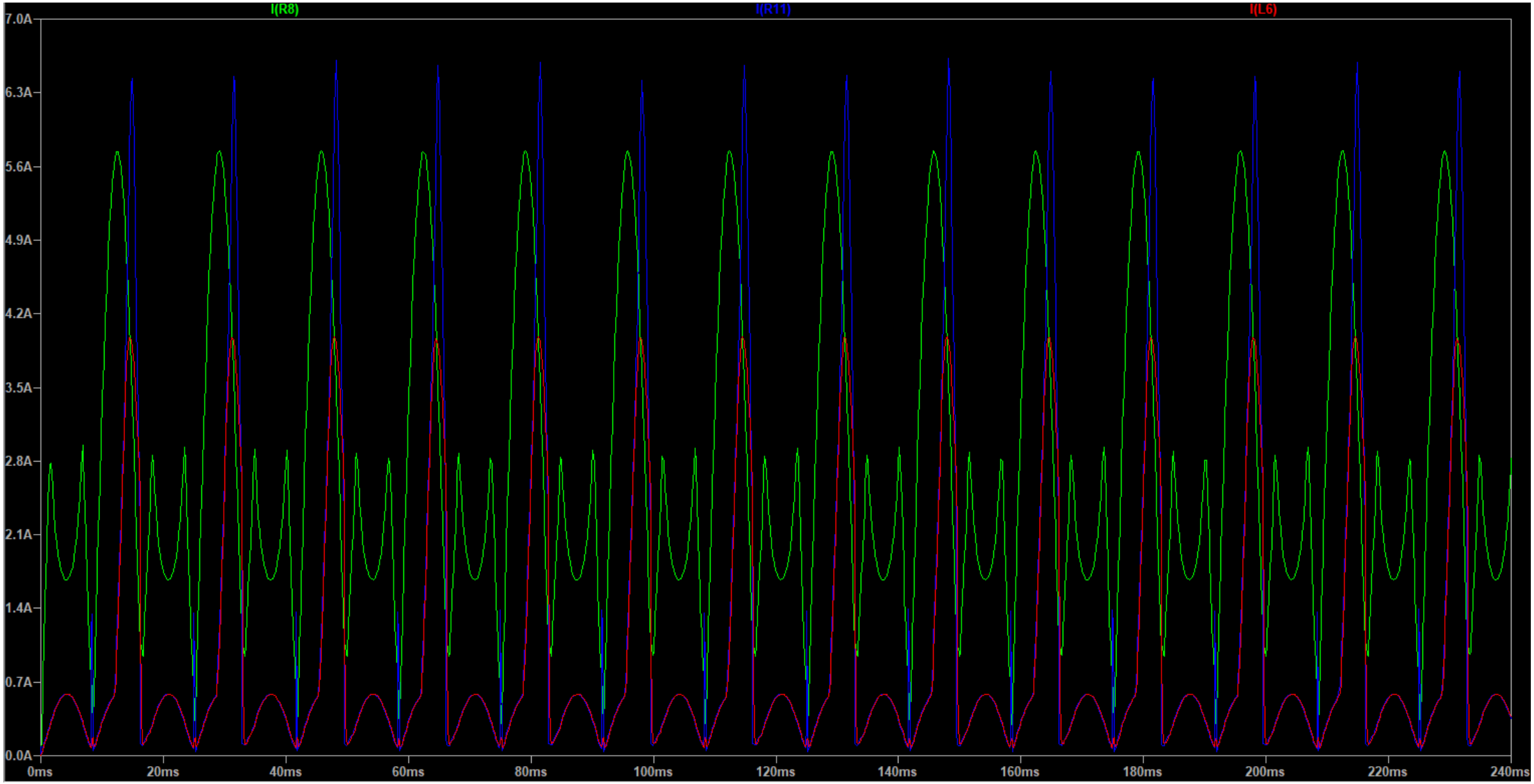
FFT of Neutral Bus Bars and AC Lines

Graphs

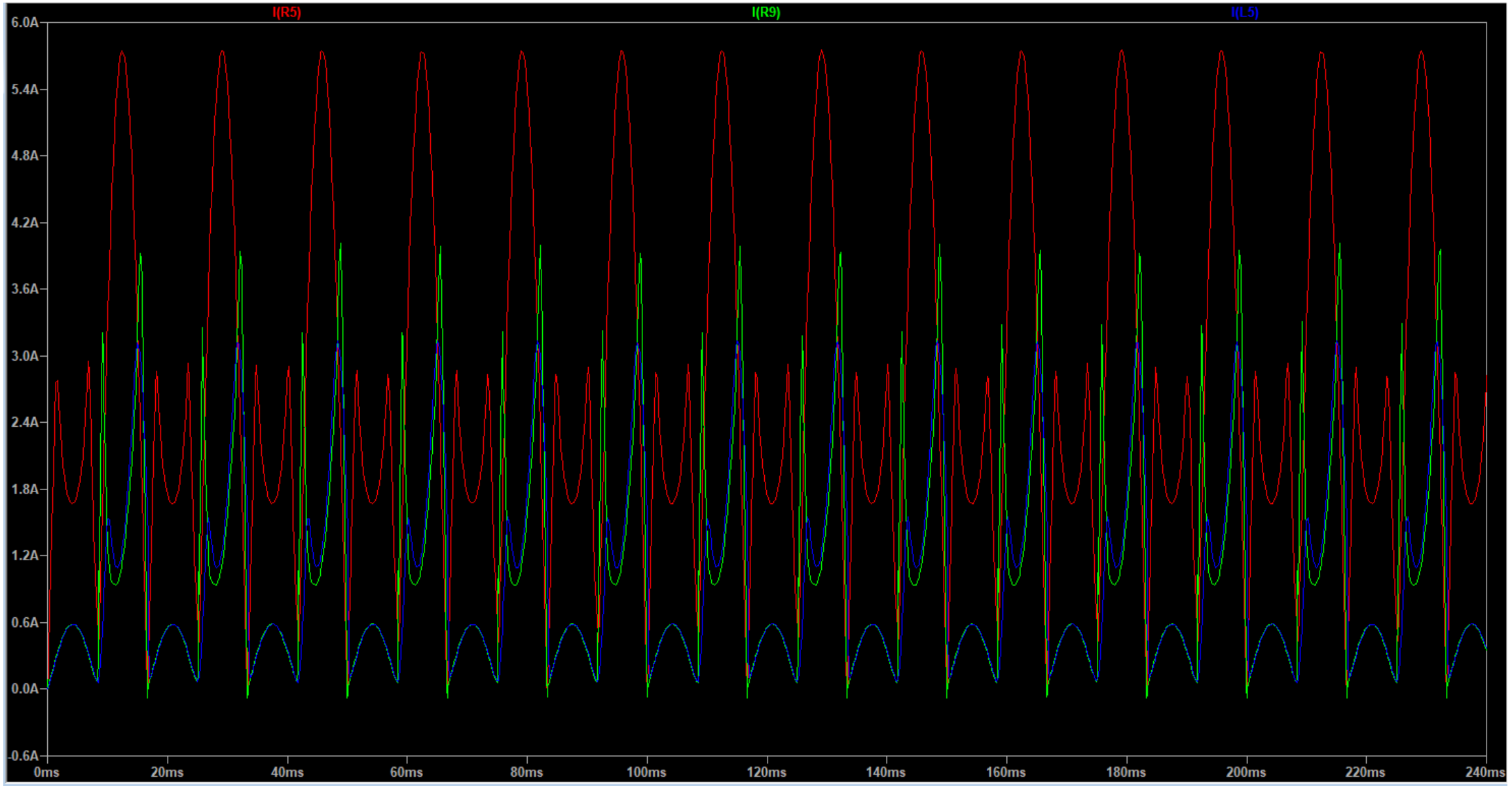
- Neutral and Line are graphs with the LLP module operating
- Neutral2 and Line are graphs without the LLP module



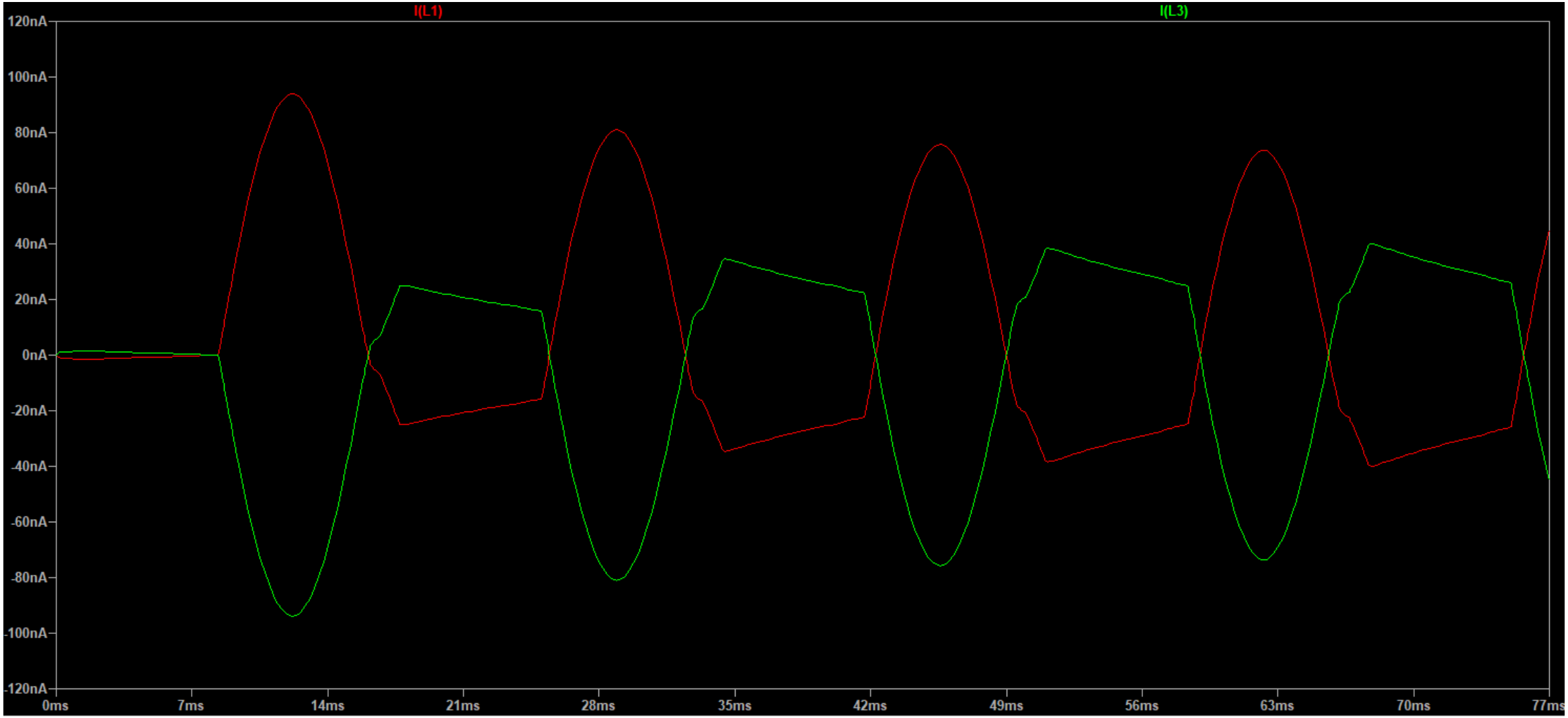
AC Load – With LLP



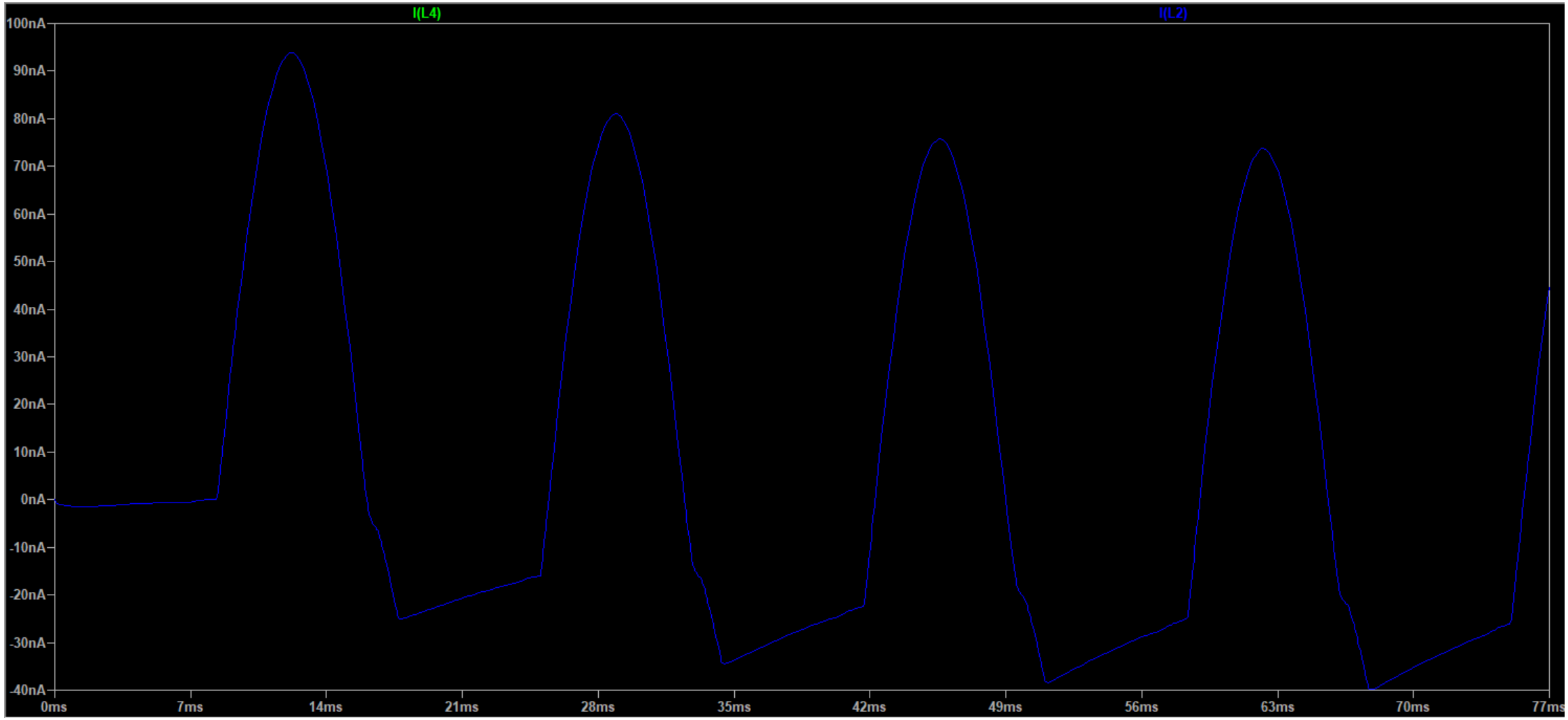
AC Load – Without LLP



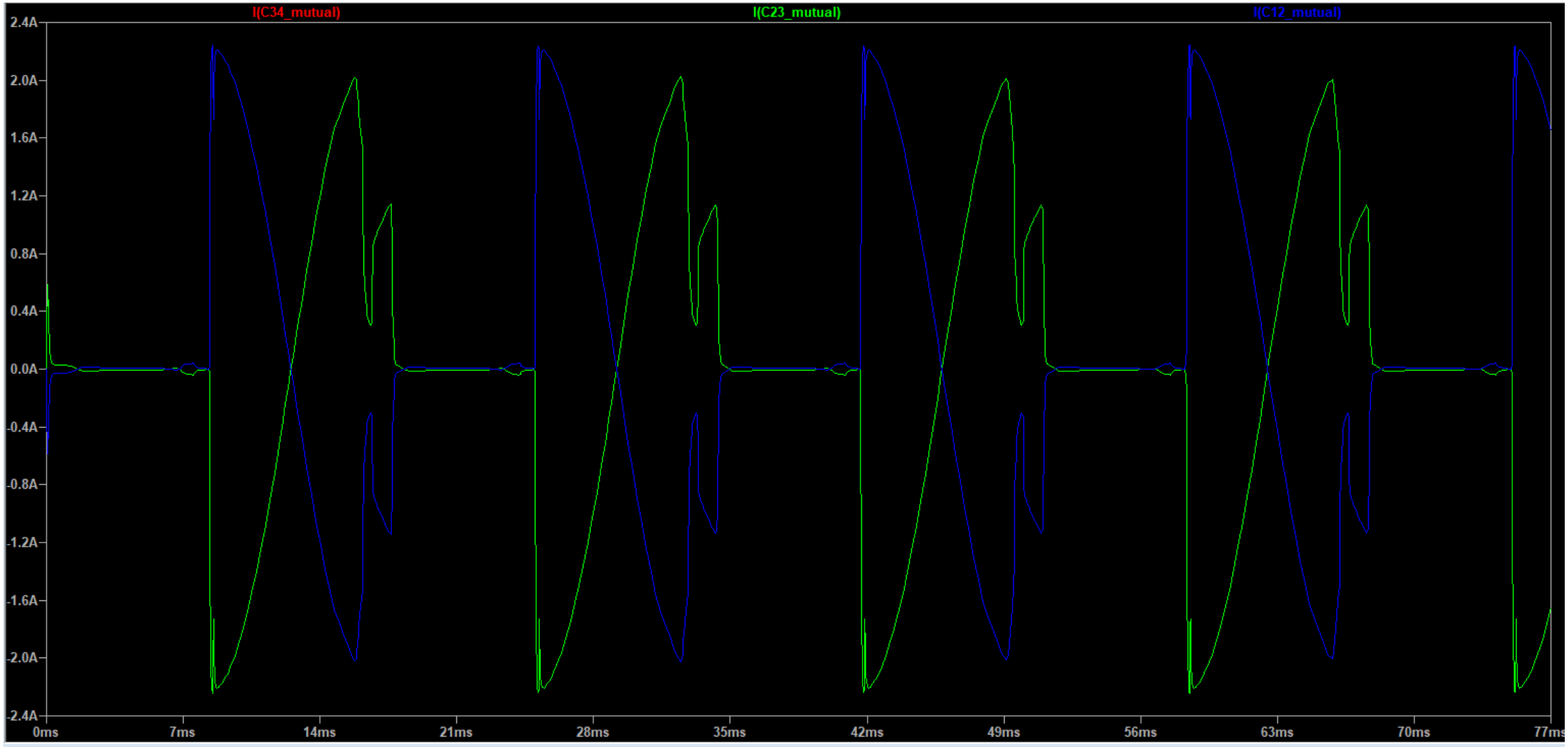
Current Through Redactor 1 – Ground Bus Bar



Current Through Redactor 2 – Ground Bus Bar



Current Stored/Supplied Through Mutual Capacitance



Voltage Differential Between Line(w/ LLP) and Line2(w/o LLP)