Project 2:-

Simulate a full wave rectifier.
Infer its behaviour and explain its rectification efficiency and its ripple factor in comparison to half wave rectifier.

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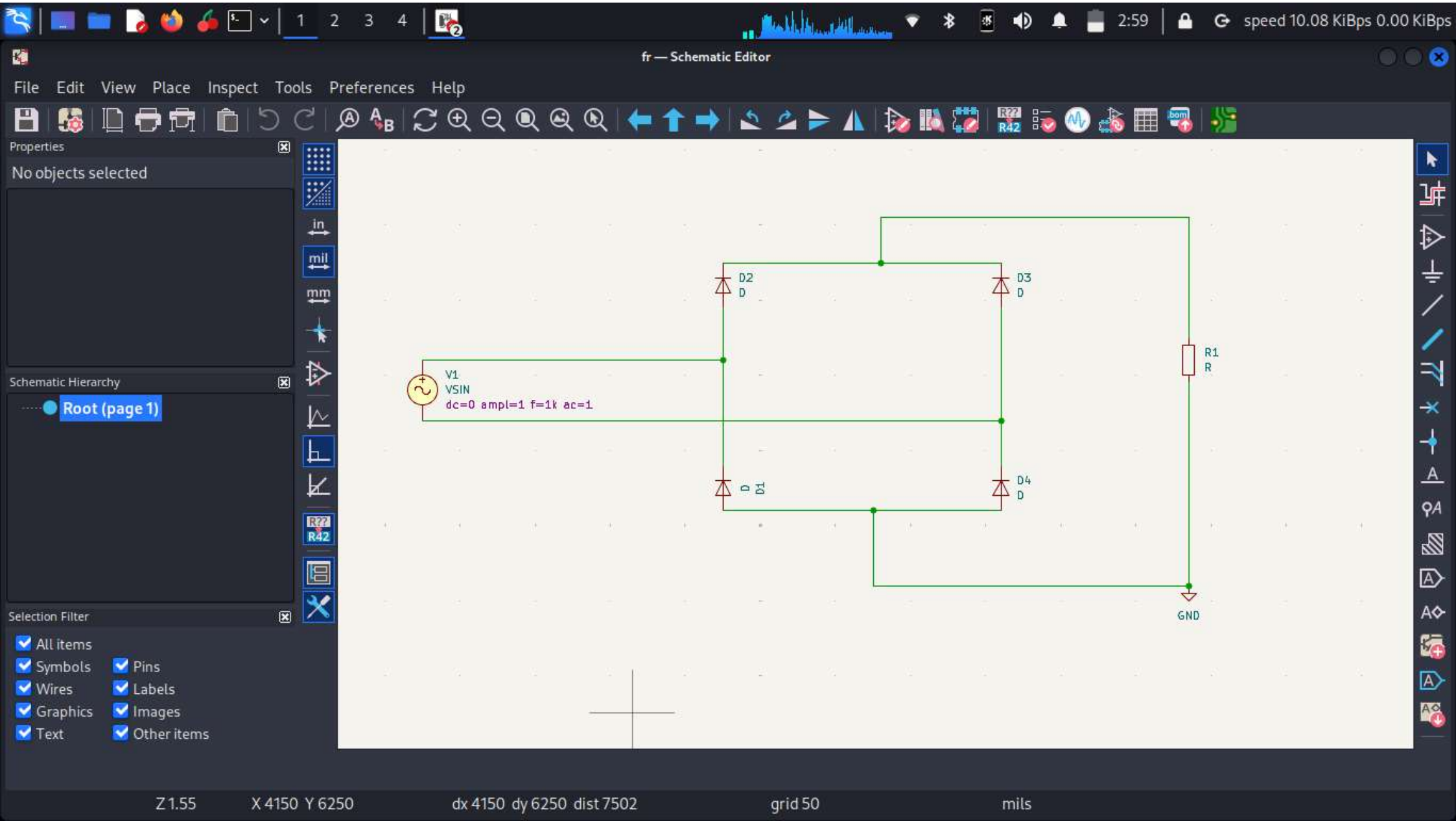
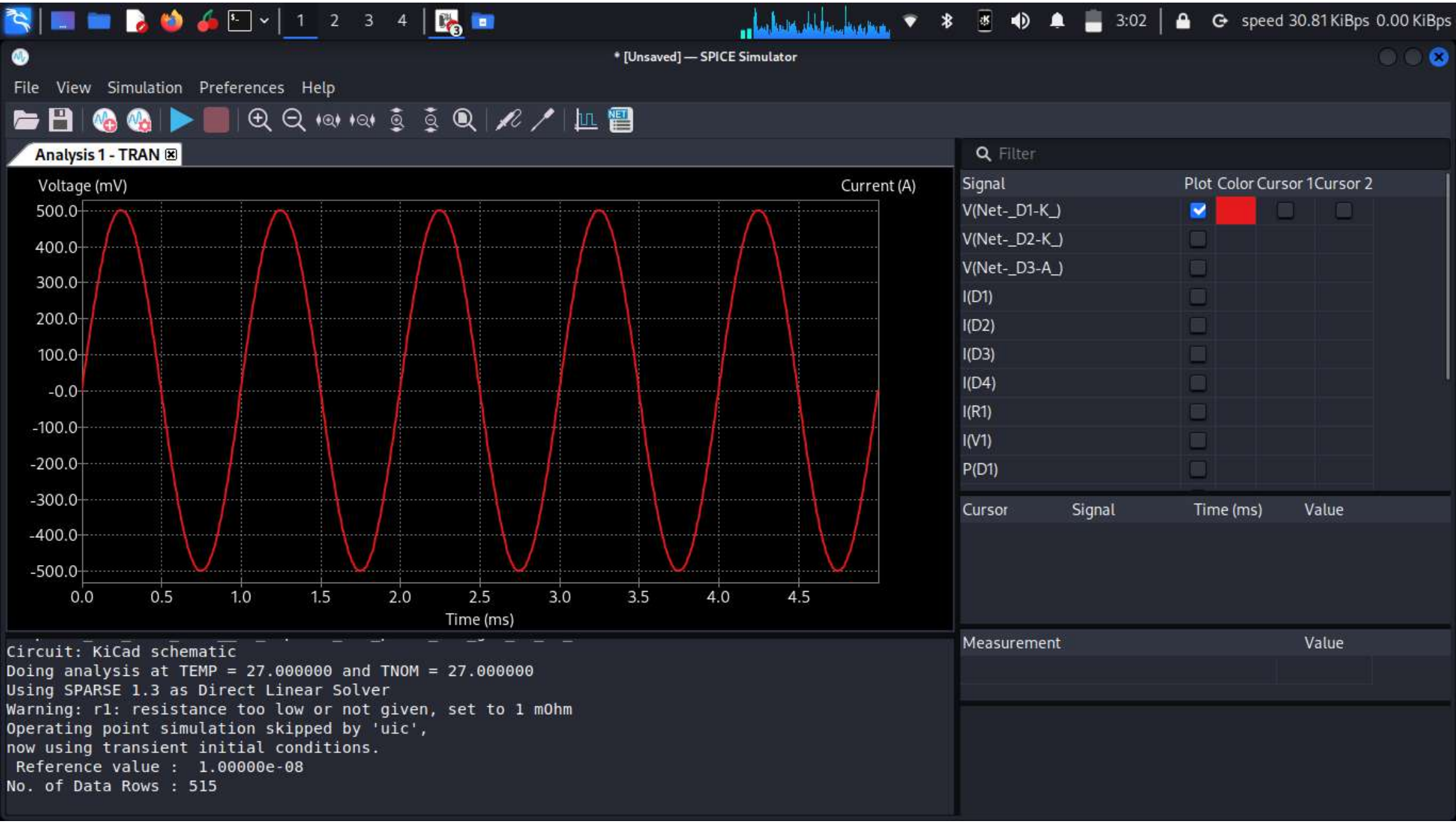
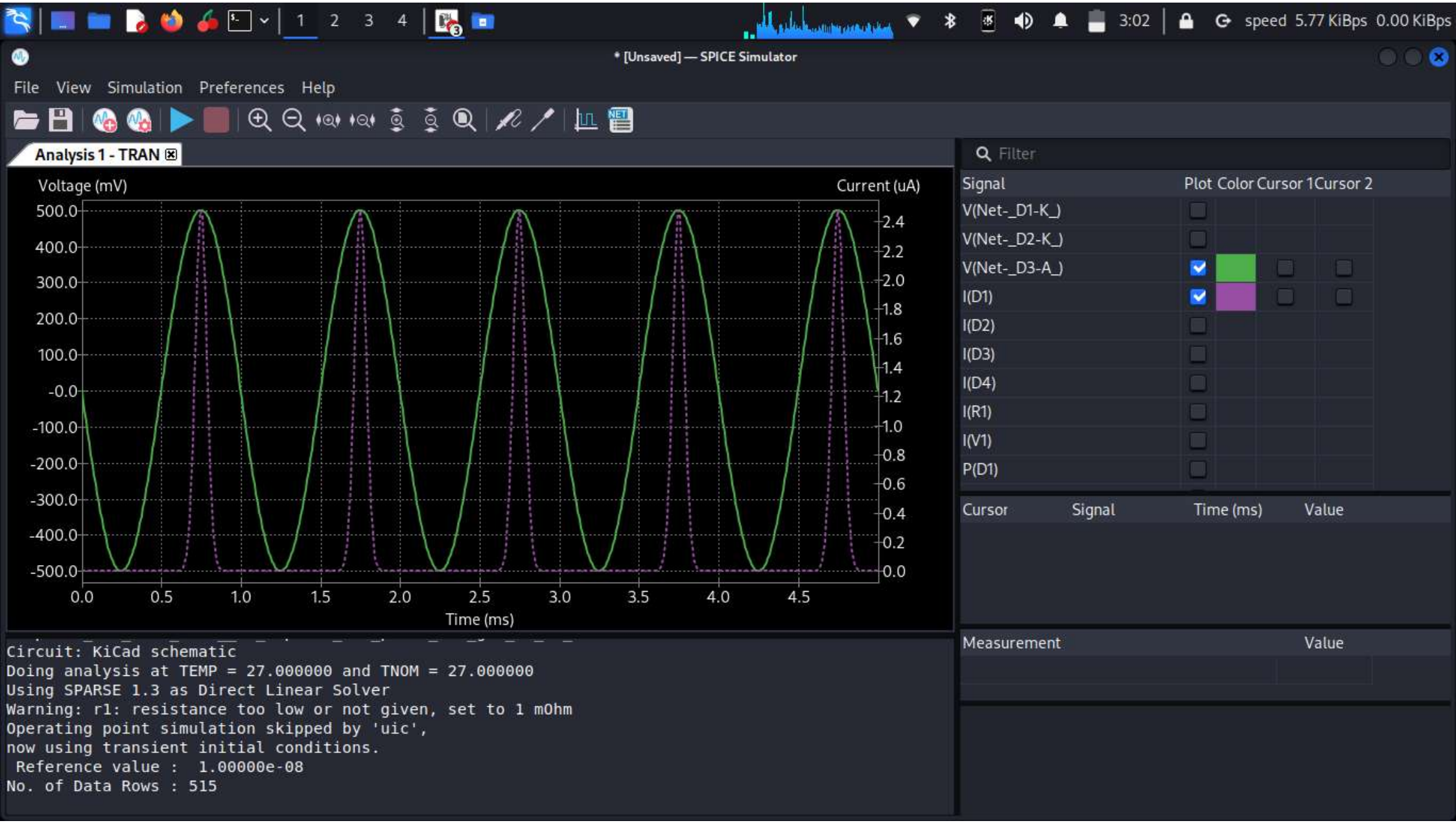
Prabal Singh

Shivam Giri

Rishav Raj


fr — Schematic Editor
File Edit View Place Inspect Tools Preferences Help
Properties
No objects selected
Schematic Hierarchy
Root (page 1)
Selection Filter
All items
Symbols
Pins
Wires
Labels
Graphics
Images
Text
Other items
D2
D
D3
D
R1
R
V1
VSIN
dc=0 ampl=1 f=1k ac=1
D1
D
D4
D
GND
Z 1.55
X 4150 Y 6250
dx 4150 dy 6250 dist 7502
grid 50
mils


1 2 3 4
3:02
speed 30.81 KiBps 0.00 KiBps
* [Unsaved] — SPICE Simulator
File View Simulation Preferences Help
Analysis 1 - TRAN
Voltage (mV)
Current (A)
500.0
400.0
300.0
200.0
100.0
-0.0
-100.0
-200.0
-300.0
-400.0
-500.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
Time (ms)
Filter
Signal Plot Color Cursor 1 Cursor 2
V(Net-_D1-K_)
V(Net-_D2-K_)
V(Net-_D3-A_)
I(D1)
I(D2)
I(D3)
I(D4)
I(R1)
I(V1)
P(D1)
Cursor Signal Time (ms) Value
Measurement Value
Circuit: KiCad schematic
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000
Using SPARSE 1.3 as Direct Linear Solver
Warning: r1: resistance too low or not given, set to 1 mOhm
Operating point simulation skipped by 'uic',
now using transient initial conditions.
Reference value : 1.00000e-08
No. of Data Rows : 515


1 2 3 4
3:02
speed 5.77 KiBps 0.00 KiBps
* [Unsaved] — SPICE Simulator
File View Simulation Preferences Help
Analysis 1 - TRAN
Voltage (mV)
Current (uA)
500.0
400.0
300.0
200.0
100.0
-0.0
-100.0
-200.0
-300.0
-400.0
-500.0
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
Time (ms)
Filter
Signal Plot Color Cursor 1 Cursor 2
V(Net-_D1-K_)
V(Net-_D2-K_)
V(Net-_D3-A_)
I(D1)
I(D2)
I(D3)
I(D4)
I(R1)
I(V1)
P(D1)
Cursor Signal Time (ms) Value
Measurement Value
Circuit: KiCad schematic
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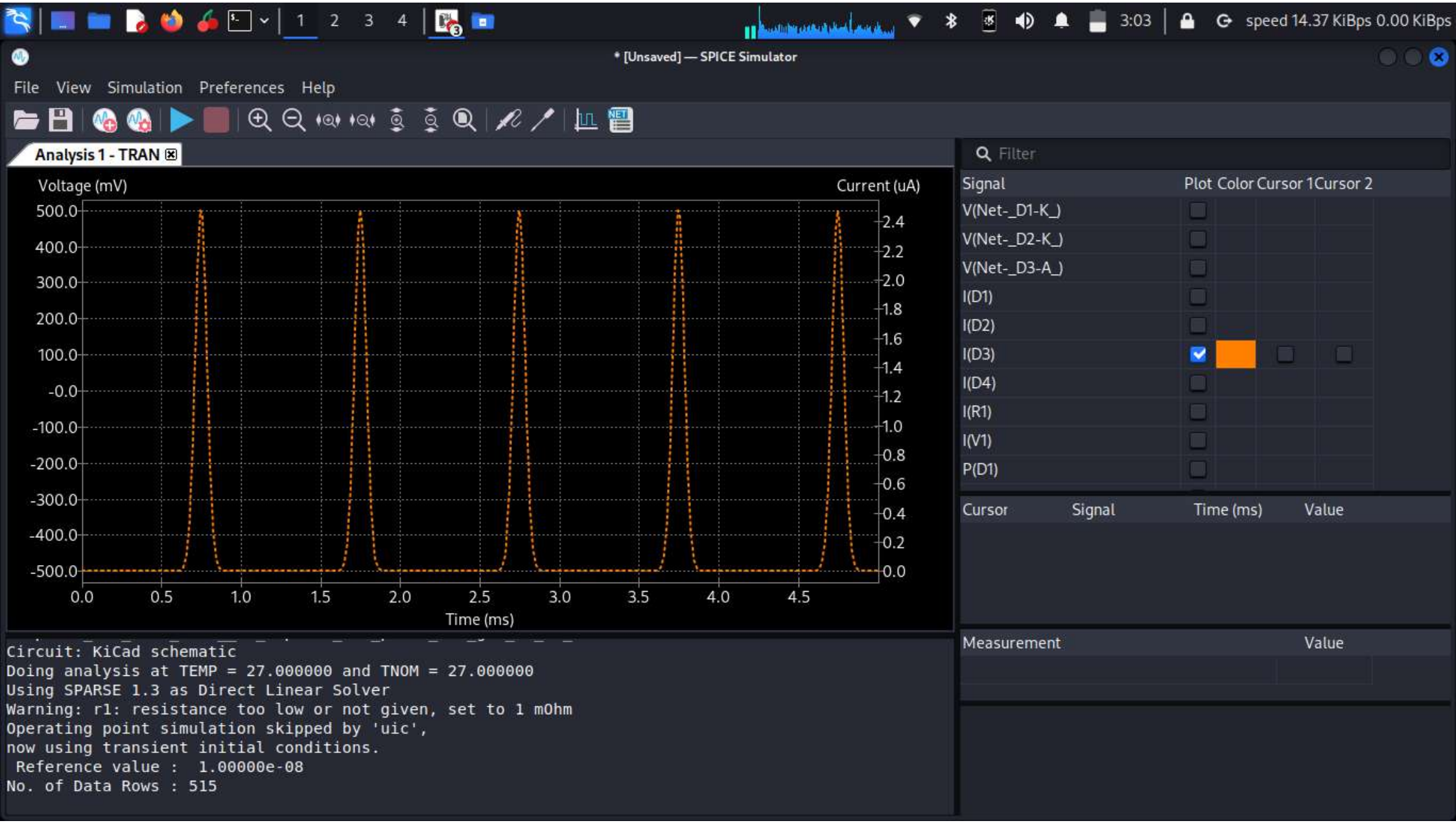
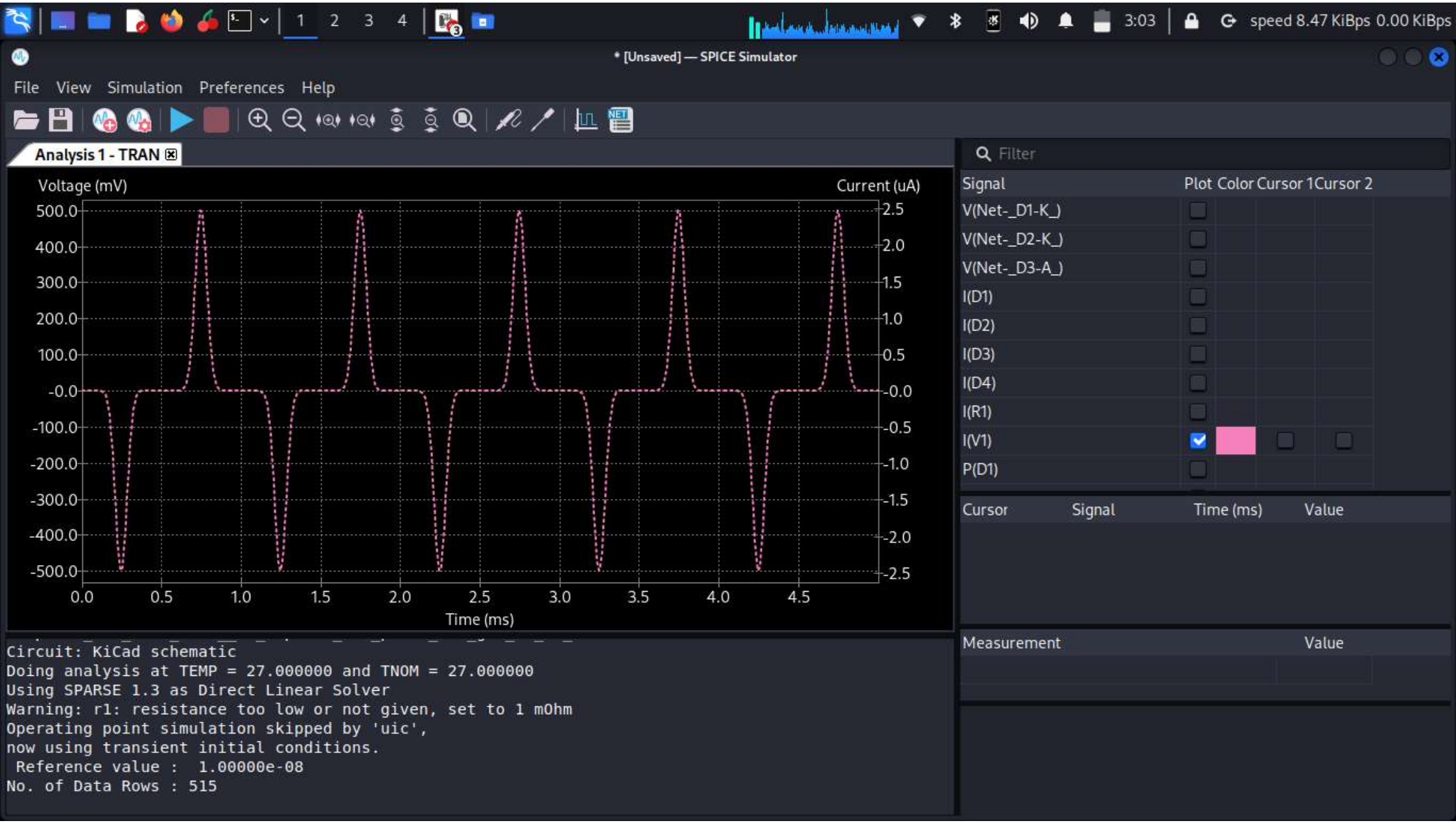
Operating point simulation skipped by 'uic',
now using transient initial conditions.
Reference value : 1.00000e-08
No. of Data Rows : 515

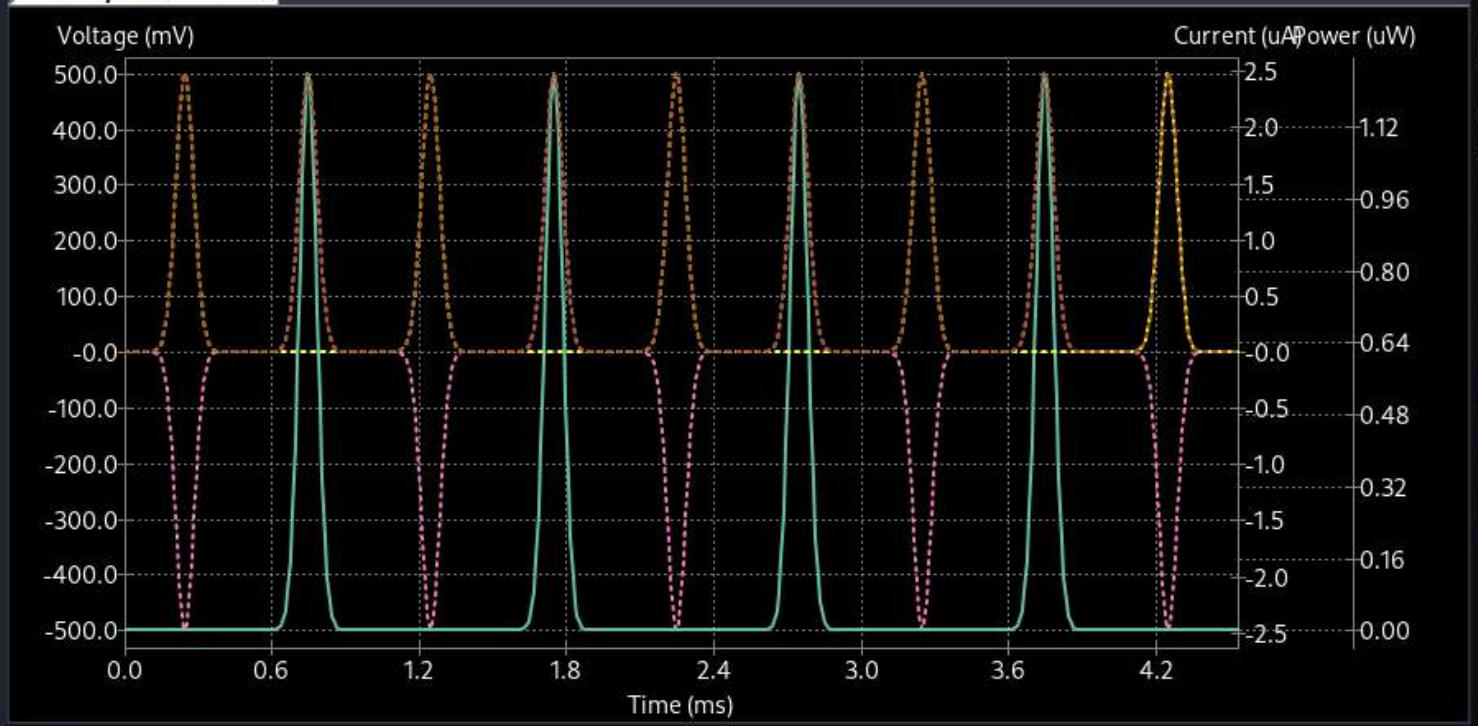

1 2 3 4
3:03
speed 14.37 KiBps 0.00 KiBps
* [Unsaved] — SPICE Simulator
File View Simulation Preferences Help
Analysis 1 - TRAN
Voltage (mV)
Current (uA)
500.0
400.0
300.0
200.0
100.0
-0.0
-100.0
-200.0
-300.0
-400.0
-500.0
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
Time (ms)
Filter
Signal Plot Color Cursor 1 Cursor 2
V(Net-_D1-K_)
V(Net-_D2-K_)
V(Net-_D3-A_)
I(D1)
I(D2)
I(D3)
I(D4)
I(R1)
I(V1)
P(D1)
Cursor Signal Time (ms) Value
Measurement Value
Circuit: KiCad schematic
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000
Using SPARSE 1.3 as Direct Linear Solver
Warning: r1: resistance too low or not given, set to 1 mOhm
Operating point simulation skipped by 'uic',
now using transient initial conditions.
Reference value : 1.00000e-08
No. of Data Rows : 515


* [Unsaved] — SPICE Simulator
File View Simulation Preferences Help
Analysis 1 - TRAN
Voltage (mV)
Current (uA)
500.0
400.0
300.0
200.0
100.0
-0.0
-100.0
-200.0
-300.0
-400.0
-500.0
2.5
2.0
1.5
1.0
0.5
-0.0
-0.5
-1.0
-1.5
-2.0
-2.5
0.0 0.5 1.0 1.5 2.0 2.5 3.0 3.5 4.0 4.5
Time (ms)
Filter
Signal Plot Color Cursor 1 Cursor 2
V(Net-_D1-K_)
V(Net-_D2-K_)
V(Net-_D3-A_)
I(D1)
I(D2)
I(D3)
I(D4)
I(R1)
I(V1)
P(D1)
Cursor Signal Time (ms) Value
Measurement Value
Circuit: KiCad schematic
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000
Using SPARSE 1.3 as Direct Linear Solver
Warning: r1: resistance too low or not given, set to 1 mOhm
Operating point simulation skipped by 'uic',
now using transient initial conditions.
Reference value : 1.00000e-08
No. of Data Rows : 515

* [Unsaved] — SPICE Simulator

File View Simulation Preferences Help

Analysis 1 - TRAN



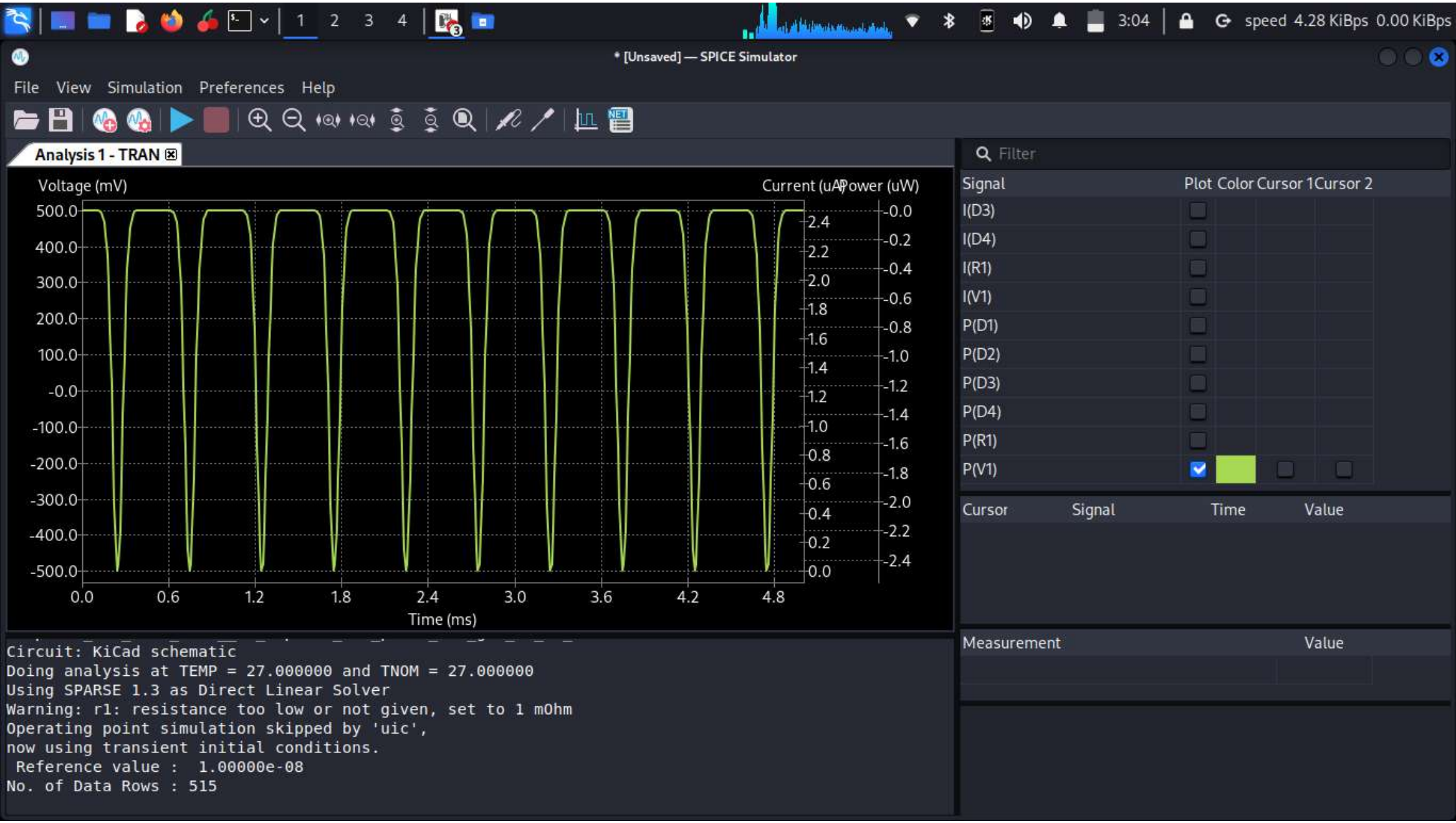

```
Circuit: KiCad schematic
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000
Using SPARSE 1.3 as Direct Linear Solver
Warning: r1: resistance too low or not given, set to 1 mOhm
Operating point simulation skipped by 'uic',
now using transient initial conditions.
 Reference value :  1.00000e-08
No. of Data Rows : 515
```

Filter

Signal	Plot	Color	Cursor 1	Cursor 2
V(Net-_D1-K_)	☐			
V(Net-_D2-K_)	☐			
V(Net-_D3-A_)	☐			
I(D1)	☐			
I(D2)	☐			
I(D3)	☐			
I(D4)	☑		☐	☐
I(R1)	☑		☐	☐
I(V1)	☑		☐	☐
P(D1)	☑		☐	☐

Cursor	Signal	Time (ms)	Value

Measurement	Value


1 2 3 4
3:04
speed 4.28 KiBps 0.00 KiBps
* [Unsaved] — SPICE Simulator
File View Simulation Preferences Help
Analysis 1 - TRAN
Voltage (mV)
Current (uA)
Power (uW)
500.0
400.0
300.0
200.0
100.0
-0.0
-100.0
-200.0
-300.0
-400.0
-500.0
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.0
-0.2
-0.4
-0.6
-0.8
-1.0
-1.2
-1.4
-1.6
-1.8
-2.0
-2.2
-2.4
0.0 0.6 1.2 1.8 2.4 3.0 3.6 4.2 4.8
Time (ms)
Filter
Signal Plot Color Cursor 1 Cursor 2
I(D3)
I(D4)
I(R1)
I(V1)
P(D1)
P(D2)
P(D3)
P(D4)
P(R1)
P(V1)
Cursor Signal Time Value
Measurement Value
Circuit: KiCad schematic
Doing analysis at TEMP = 27.000000 and TNOM = 27.000000
Using SPARSE 1.3 as Direct Linear Solver
Warning: r1: resistance too low or not given, set to 1 mOhm
Operating point simulation skipped by 'uic',
now using transient initial conditions.
Reference value : 1.00000e-08
No. of Data Rows : 515

1. Behavior of Full-Wave Rectifier (Bridge Configuration)

During the positive half-cycle of the AC input:

Diodes D2 and D4 conduct.

Current flows through the load resistor R1 in one direction.

During the negative half-cycle:

Diodes D1 and D3 conduct.

Current still flows in the same direction through R1.

Result: Output across the resistor is unidirectional (pulsating DC) with double the frequency of the input AC. If input is 1 kHz, the output ripple is at 2 kHz.

2. Rectification Efficiency (η)

Rectification efficiency is the ratio of DC power delivered to the load to the AC power supplied.

Full-Wave Rectifier Efficiency:

$\eta = 81.2\%$

Half-Wave Rectifier Efficiency:

$\eta = 40.6\%$

Conclusion:

A full-wave rectifier is twice as efficient as a half-wave rectifier because it utilizes both halves of the AC cycle.

3. Ripple Factor (γ)

Ripple factor measures the amount of AC content in the output DC. Lower is better.

Ripple Factor for Full-Wave Rectifier:

γ = 0.482

Ripple Factor for Half-Wave Rectifier:

γ = 1.21

Conclusion:

The full-wave rectifier produces smoother DC output compared to a half-wave rectifier. You can reduce ripple further by adding a filter capacitor in parallel with the load.