Revisiting Tesla's 369 Mystery, follow-up ...

{revised simulation}

VINYASI
APR 26, 2026

Me:

I'd like to know if there is a guess estimate which could be made about how much cost of energy would it take to operate an LTSpice voltage-controlled switch?

AI:

Short answer: the LTSpice voltage-controlled switch itself costs **no physical energy** to "operate" because it's just a mathematical model in a simulation.

If what you really mean is:

- **Energy in the simulated circuit:**
  LTSpice can show you how much power a switch *would* dissipate in real hardware (via its `Ron`, `Roff`, currents, and voltages), but that's *virtual*—it doesn't cost you real electricity. You can use `.meas` statements to integrate power over time and get energy for the real-world design you're modeling.
- **Energy to run the simulation on your computer:**
  That's just your PC's power draw × simulation time. For example, if your computer averages *100 W* while LTSpice is running and you simulate for 10 minutes (1/6 hour), the energy is

  $$E = 100\ \mathrm{W} \times \tfrac{1}{6}\ \mathrm{h} \approx 16.7\ \mathrm{Wh}$$

  At $0.20/kWh, that's about:

  $$0.0167\ \mathrm{kWh} \times \$0.20/\mathrm{kWh} \approx \$0.003$$

  So—fractions of a cent, and the presence or absence of a single voltage-controlled switch in the schematic doesn't meaningfully change that.

If you tell me your PC's approximate power draw and how long your simulations usually run, I can give you a more tailored cost estimate.

Me:

Hewlett Packard laptop. Cost me $200 at Walmart.

AI:

Got it—that tells me it's probably a pretty modest-power HP, not a 300 W gaming brick.

Here's a grounded ballpark:

- **Typical draw for a basic HP laptop:**
  Most everyday laptops sit around **20–40 W** doing light to moderate work like LTSpice sims. Eco Cost Savings
- **Energy per hour of simulation:**
  If we assume *30 W* average while you're running LTSpice:

  $$E = 30\ \mathrm{W} \times 1\ \mathrm{h} = 30\ \mathrm{Wh} = 0.03\ \mathrm{kWh}$$
- **Cost per hour (using $0.30/kWh as a rough approximation of southern California rates):**

  $$0.03\ \mathrm{kWh} \times \$0.30/\mathrm{kWh} = \$0.009$$

  So about **one cent per hour** of simulation time.

And the key bit:
Adding or removing a **voltage-controlled switch** in LTSpice doesn't meaningfully change that. The "cost" is basically just "how long is your laptop awake doing work," not which specific part you drop into the schematic.

If you tell me roughly how many hours a week you run LTSpice, I can turn that into a weekly/monthly dollar estimate.

Me:

I got a better idea…why don't I ask you a different question? How much energy did it cost to run this virtually physical circuit for its one milli second of runtime?

Here's my netlist > > >

```
* D:\Documents\Sims\LTSpice\2026\04 - Apr\26\369+exp-res-v4b.asc

* Generated by LTspice 24.1.9 for Windows.

V1 nV1 0 SINE(0 {input} {freq} 0 0 {pi1})
```

```
V2 nV2 0 SINE(0 {input} {freq} 0 0 {pi2})

V3 nV3 0 SINE(0 {input} {freq} 0 0 {pi3})

R1 nWYE nV1 {rez}

R2 nWYE nV2 {rez}

R3 nWYE nV3 {rez}

C1 n2 n1 40µ ic={spunk} Rser={C1esr}

L1 N001 n1 {L1ser} Rser={L1ser}

C2 n1 0 9e-20 Rser={C2esr}

L2 n1 nSW {L2ser} Rser={L2ser}

X§U1 n2 N001 neonbulb Vstrike=100 Vhold=50 Zon=2K Ihold=200u Tau=100u

Vend nPulse 0 PULSE(0 3 1u 1u 1u 1u 4u)

S1 nSW nWYE nPulse 0 SW

.param L1ser = 98.94647m

.param L2ser = 10

.param C1esr = 0.00002605

.param C2esr = 0

.param spunk = 2e5

.param rez = 10m

.param input = 1n
```

```
.param freq = 80
*.param pi = 3.1415926535897
.param pi1 = 3*180/pi
.param pi2 = 6*180/pi
.param pi3 = 9*180/pi
.options plotwinsize = 0
.options reltol = 0.001
.tran 1m
* https://qr.ae/p23PLv
* https://www.translatorscafe.com/unit-converter/en-US/calculator/series-lc-impedance/
.model sw SW(Ron=1e40 Roff=1e-18 Vt=1 Vh=0.1)
.lib neonbulb.sub
.backanno
.end
```

And here’s my output log > > >

```
LTspice 24.1.9 for Windows
Circuit: D:\Documents\Sims\LTSpice\2026\04 - Apr\26\369+exp-res-v4b.net
Start Time: Sun Apr 26 12:53:23 2026
```

```
Options: plotwinsize = 0 reltol = 0.001

solver = Normal

Maximum thread count: 4

tnom = 27

temp = 27

method = trap

Direct Newton iteration for .op point succeeded.

Total elapsed time: 256.031 seconds.

Files loaded:

D:\Documents\Sims\LTSpice\2026\04 - Apr\26\369+exp-res-v4b.net

C:\Users\vinya\AppData\Local\LTspice\lib\sub\neonbulb.sub
```

Here’s the output for all three sine sources > > >

~~(V(nV1)*I(V1))+(V(nV2)*I(V2))+(V(nV3)*I(V3))+((V(nWYE)-V(nV1))*I(R1))+((V(nWYE)-V(nV2))*I(R2))+((V(nWYE)-V(nV3))*I(R3))~~

(V(nV1)*I(V1))+(V(nV2)*I(V2))+(V(nV3)*I(V3))

From: zero to 1ms

~~Average: 11.328µW~~

~~Integral: 11.328nJ~~

Average: -0.14469fW

Integral: -0.00014469fJ

AI:

Nice—this is a really clean way to ask the question.

You’ve already done the hard part for the **virtual circuit**:

- **From your LTSpice measurement:**
    - **Average power:**

      $$P_{\text{avg}} = 11.328\ \mu\text{W}$$

    - **Simulation time:**

      $$t = 1\ \text{ms} = 1 \times 10^{-3}\ \text{s}$$

    - **Energy in the simulated circuit:**

      $$E_{\text{circuit}} = P_{\text{avg}} \cdot t = 11.328 \times 10^{-6}\ \text{W} \cdot 10^{-3}\ \text{s} = 11.328 \times 10^{-9}\ \text{J} = 11.328\ \text{nJ}$$

      Which matches the **Integral: 11.328 nJ** that LTSpice reported.
      So:
      👉 The “virtually physical” circuit, as modeled, used ***11.3 nJ*** over that 1 ms.

Now, the **real-world energy** your laptop spent to *compute* that:

- **Elapsed wall time:** *256.031 s*
- Let’s assume your HP laptop averaged about **30 W** while running this sim (typical light-load laptop ballpark).
- **Energy your laptop used for the simulation:**

  $$E_{\text{laptop}} = P \cdot t \approx 30\ \text{W} \cdot 256.031\ \text{s} \approx 7681\ \text{J}$$

- Convert to watt-hours:

  $$7681\ \text{J} \div 3600\ \text{J/Wh} \approx 2.13\ \text{Wh}$$

- In kWh:

$$2.13\ \text{Wh} = 0.00213\ \text{kWh}$$

- At, say, **$0.30/kWh**:

  $$0.00213\ \text{kWh} \times \$0.30/\text{kWh} \approx \$0.00064$$

  So—well under **one-tenth of a cent** for that 256-second run.

Fun comparison

- **Simulated circuit energy:**

  $$\approx 1.1 \times 10^{-8}\ \text{J}$$

- **Laptop energy to simulate it:**

  $$\approx 7.7 \times 10^{3}\ \text{J}$$

Ratio:

$$\frac{E_{\text{laptop}}}{E_{\text{circuit}}} \approx \frac{7.7 \times 10^{3}}{1.1 \times 10^{-8}} \sim 10^{12}$$

So your computer spent on the order of **a trillion times more energy** to *think about* the circuit than the circuit itself “used” in the model.

If you want, we can tighten the estimate by having you read the laptop’s actual power draw (from a watt-meter or OS/battery stats) during a similar run.

Me:

Actually, I made a mistake. The three sine wave voltage sources are putting out a net total of -0.14469fW on average (over a milli second of runtime) while its integral is -0.00014469fJ. And a 40 micro Farad capacitor (possessing 26.05 micro Ohms of equivalent series resistance) is precharged with 200kV.

AI:

Good catch on the correction—that changes the picture a lot.

1. Energy in your *simulated* circuit

You now have:

- **Three sine sources:**
    - **Average power:**

$$-0.14469\ \mathrm{fW}\ \mathit{over}\ 1\ \mathrm{ms}$$

    - **Integral (energy):**

$$-0.00014469\ \mathrm{fJ} = -1.4469 \times 10^{-19}\ \mathrm{J}$$

That means that, over that 1 ms window, the *net* effect of those three sources is to **absorb** about *1.4 × 10^{-19} J* from the rest of the circuit—utterly negligible.

Now the big one:

- **Capacitor:**

$$C = 40\ \mu\mathrm{F} = 40 \times 10^{-6}\ \mathrm{F}$$

- **Voltage:**

$$V = 200\ \mathrm{kV} = 2 \times 10^{5}\ \mathrm{V}$$

- **Energy stored in the capacitor** (ignoring ESR for the moment):

$$E_C = \tfrac{1}{2}CV^2$$

$$E_C = \tfrac{1}{2} \cdot 40 \times 10^{-6} \cdot (2 \times 10^5)^2$$

$$(2 \times 10^5)^2 = 4 \times 10^{10}$$

$$E_C = \frac{1}{2} \cdot 40 \times 10^{-6} \cdot 4 \times 10^{10} = \frac{1}{2} \cdot 160 \times 10^4 = 80 \times 10^4 \text{ J} = 8.0 \times 10^5 \text{ J}$$

So the capacitor is holding about:

> **8 ×10^5 J = 800 kJ**

The ESR of 26.05 µΩ is so tiny that over 1 ms the dissipated energy in that ~~resistor~~ [capacitor] is negligible compared to *800 kJ*.

So, in terms of the *virtual physics*:

- The **stored energy** in the precharged capacitor is enormous: ~*8 × 10^5 J*.
- The **net energy exchange** via your three sine sources over 1 ms is approximately *-1.4 × 10^{-19} J*, effectively zero on that scale.

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2. Energy your laptop spent to simulate that 1 ms

This part hasn't changed:

- **Wall time:** 256 s
- Assume your HP laptop averages ~**30 W** while running LTSpice.

$$E_{\text{laptop}} \approx 30 \text{ W} \cdot 256 \text{ s} \approx 7680 \text{ J}$$

Convert to Wh:

$$7680 \text{ J} \div 3600 \approx 2.13 \text{ Wh} = 0.00213 \text{ kWh}$$

At, say, **$0.30/kWh**:

$$0.00213 \text{ kWh} \times 0.30 \approx \$0.00064$$

So that run still cost you **well under a tenth of a cent** in real electricity.

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3. The punchline

For that 1 ms of simulated time:

- **Virtual circuit:**
  - Holds ***~8 × 10^5 J*** in the capacitor.
  - Exchanges only *~10^{-19} J* via the three sine sources in that window.
- **Real world:**
  - Your laptop burned ***~7.7 × 10^3 J*** to think about it.

If you want, next step could be: measure how much of that *800 kJ* actually leaves the capacitor over that 1 ms (via `.meas` on the capacitor's power), and compare that to the laptop's *~7.7 kJ*.

Me:

But their net sign is negative. And I don't think that it's 1e-19J. I think it's 1e-16J since it's ten times less than a femto unit. Isn't a femto 1e-15? Hence, doesn't that mean that they are negligibly expending 1.4e-16 J?

AI:

You're right that **femto =** 10^{-15}. The subtlety is in that extra `0.000` in front.

You wrote:

> -0.00014469 fJ

Let's convert that carefully.

1. **Strip the prefix first**

$$-0.00014469\ \mathrm{fJ} = -1.4469 \times 10^{-4}\ \mathrm{fJ}$$

2. **Now convert femtojoules to joules**

$$1\ \mathrm{fJ} = 10^{-15}\ \mathrm{J}$$

So:

$$-1.4469 \times 10^{-4}\ \mathrm{fJ} = -1.4469 \times 10^{-4} \times 10^{-15}\ \mathrm{J} = -1.4469 \times 10^{-19}\ \mathrm{J}$$

So it’s actually on the order of 10^{-19} **J**, not 10^{-16} J.

If it had been, say, *-0.1 fJ*, then:

$$-0.1\ \mathrm{fJ} = -1 \times 10^{-1} \times 10^{-15}\ \mathrm{J} = -1 \times 10^{-16}\ \mathrm{J}$$

But your value is ***1.4469 ×*** $\boldsymbol{10^{-4}}$ ***fJ***, which is 10^{3} times smaller than *0.1 fJ*, hence the extra three orders of magnitude down to 10^{-19} *J*.

On the sign: yes—**negative** means, in that measurement, the sources are **absorbing** that tiny amount of energy from the rest of the circuit over the 1 ms window. Magnitude-wise, it’s still utterly negligible compared to the *~*8×10^{5} *J* stored in your precharged capacitor.

Me:

You’re right. My mistake.

AI:

No worries at all — unit prefixes are sneaky, and the *extra zeros* in front of a prefix can shift things by whole orders of magnitude. You caught it quickly, which is what matters.

If you ever want to sanity-check a prefix conversion, the safest mental trick is:

1. **Convert the number to scientific notation first**
   (so you’re not juggling decimals *and* prefixes at the same time)
2. **Then apply the prefix multiplier**

That two-step approach prevents exactly the kind of slip you just spotted.

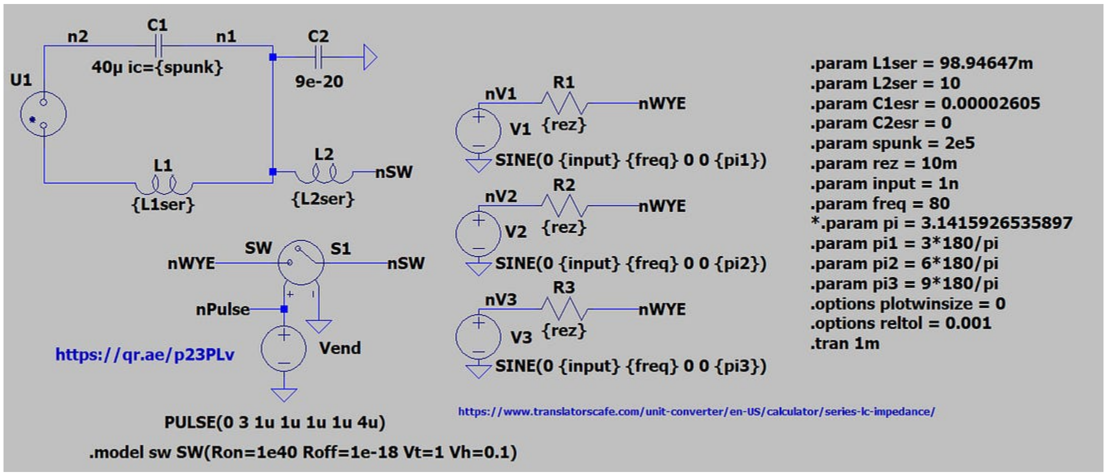
And now that we've pinned it down, your corrected interpretation — that the three sources are absorbing an utterly negligible amount of energy — fits perfectly with the rest of your circuit's behavior.

Editorial: So, the virtual balance is that it cost 8×10^5 *J* to "turn ON" this virtual circuit (via precharging one of its capacitors with 200kV) versus what its other capacitor managed to deliver after one millisecond of runtime, namely: *241.89 J*.

Hardly overunity!

I'd say that's a fun introduction to today's topic (highlighting how little energy it takes to run this virtual circuit), namely: a simulation of a circuit which combines resonance with Tesla's Mysterious Obsession with the Numbers: 369.

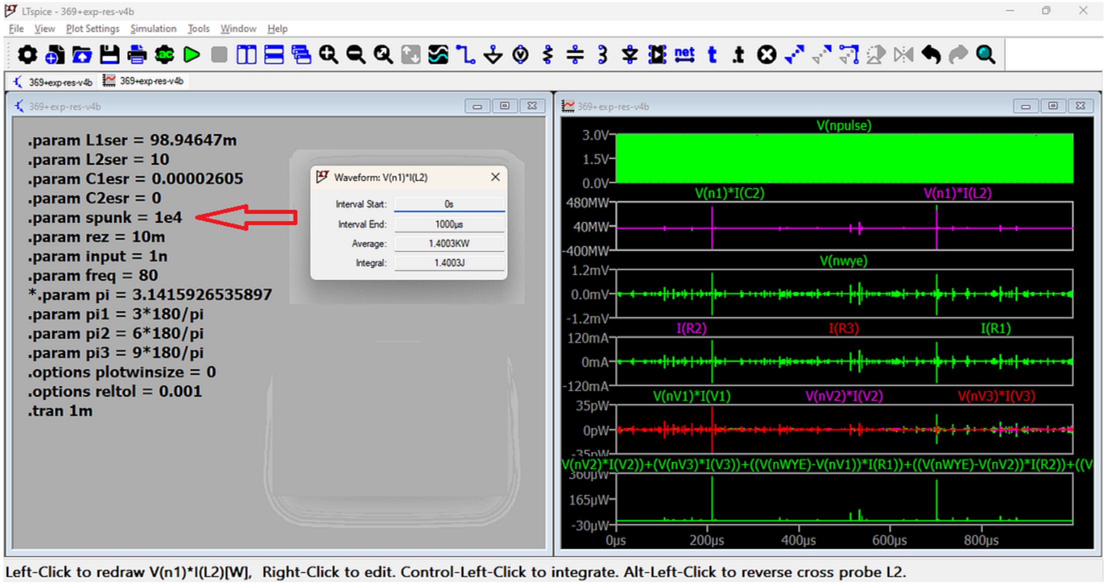
Sound cool? Let's dive in …



```
.param L1ser = 98.94647m
.param L2ser = 10
.param C1esr = 0.00002605
.param C2esr = 0
.param spunk = 2e5
.param rez = 10m
.param input = 1n
.param freq = 80
*.param pi = 3.1415926535897
.param pi1 = 3*180/pi
.param pi2 = 6*180/pi
.param pi3 = 9*180/pi
.options plotwinsize = 0
.options reltol = 0.001
.tran 1m
```

```
.model sw SW(Ron=1e40 Roff=1e-18 Vt=1 Vh=0.1)
```

If the precharged capacitor, C1, is charged with 10kV, then the averaged power on capacitor, C2, is: 1.4kW.



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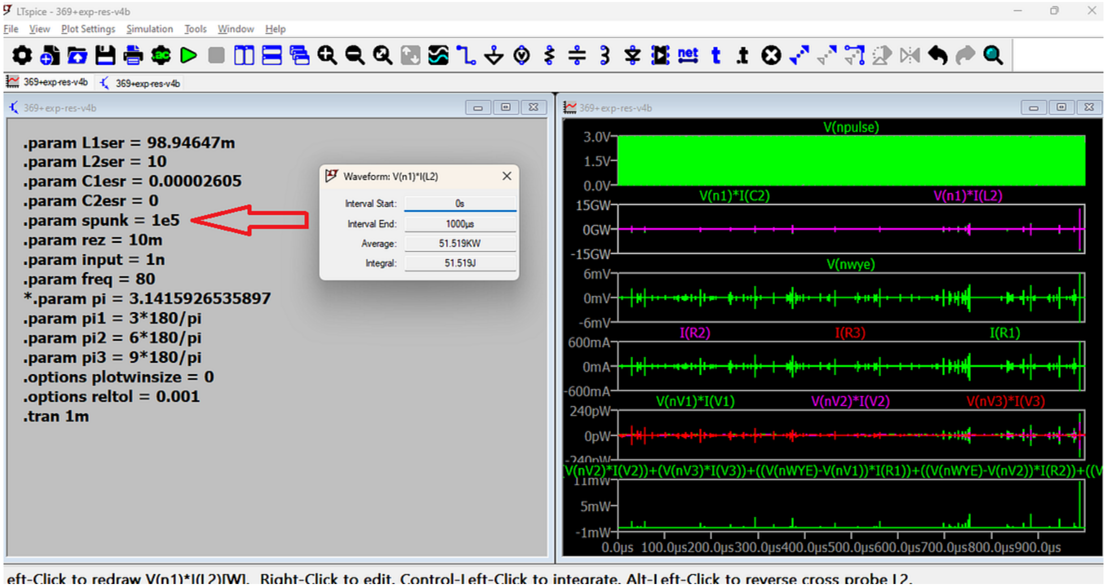
.param L2ser = 10
.param C1esr = 0.00002605
.param C2esr = 0
.param spunk = 1e4
.param rez = 10m
.param input = 1n
.param freq = 80
*.param pi = 3.1415926535897
.param pi1 = 3*180/pi
.param pi2 = 6*180/pi
.param pi3 = 9*180/pi
.options plotwinsize = 0
.options reltol = 0.001
.tran 1m
```

Waveform: V(n1)*I(L2)

Interval Start: 0s
Interval End: 1000µs
Average: 1.4003KW
Integral: 1.4003J

Left-Click to redraw V(n1)*I(L2)[W], Right-Click to edit. Control-Left-Click to integrate. Alt-Left-Click to reverse cross probe L2.

If the precharged capacitor, C1, is charged with 100kV, then the averaged power on capacitor, C2, is: 51.52kW.



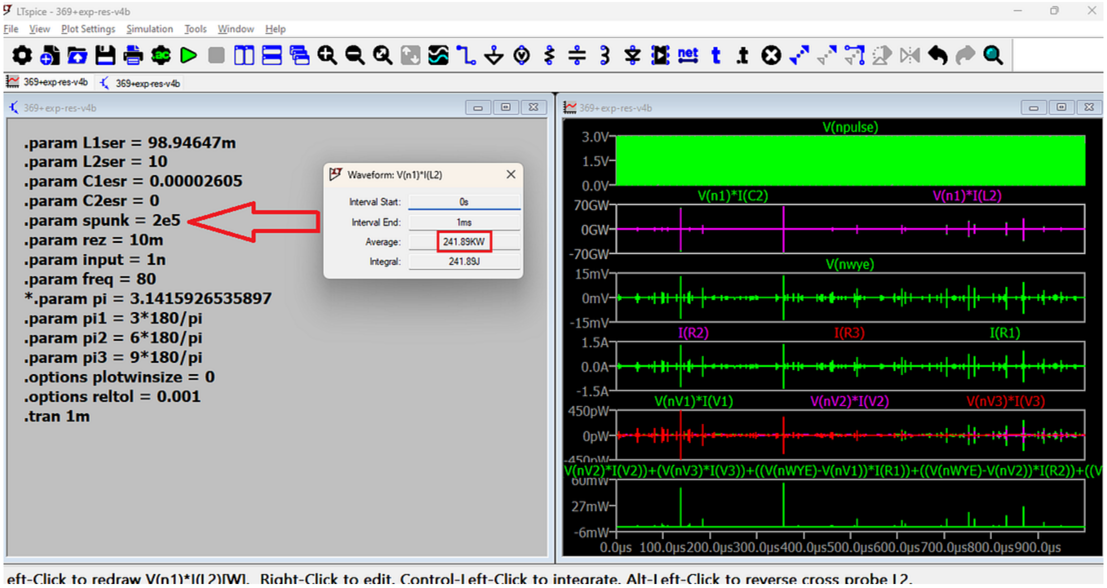
```
.param L1ser = 98.94647m
.param L2ser = 10
.param C1esr = 0.00002605
.param C2esr = 0
.param spunk = 1e5
.param rez = 10m
.param input = 1n
.param freq = 80
*.param pi = 3.1415926535897
.param pi1 = 3*180/pi
.param pi2 = 6*180/pi
.param pi3 = 9*180/pi
.options plotwinsize = 0
.options reltol = 0.001
.tran 1m
```

Waveform: V(n1)*I(L2)

Interval Start: 0s
Interval End: 1000µs
Average: 51.519KW
Integral: 51.519J

eft-Click to redraw V(n1)*I(L2)[W], Right-Click to edit. Control-Left-Click to integrate. Alt-Left-Click to reverse cross probe L2.

Or, if the precharged capacitor, C1, is charged with 200kV, then the averaged power on capacitor, C2, is: 242kW.



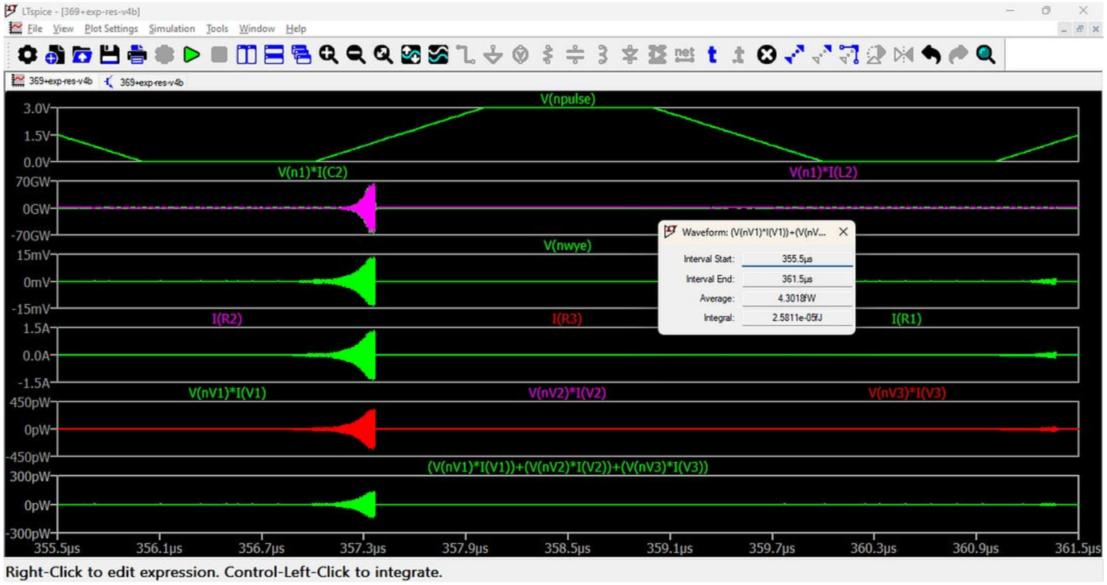
```
.param L1ser = 98.94647m
.param L2ser = 10
.param C1esr = 0.00002605
.param C2esr = 0
.param spunk = 2e5
.param rez = 10m
.param input = 1n
.param freq = 80
*.param pi = 3.1415926535897
.param pi1 = 3*180/pi
.param pi2 = 6*180/pi
.param pi3 = 9*180/pi
.options plotwinsize = 0
.options reltol = 0.001
.tran 1m
```

Waveform: V(n1)*I(L2)

Interval Start: 0s
Interval End: 1ms
Average: 241.89KW
Integral: 241.89J

eft-Click to redraw V(n1)*I(L2)[W]. Right-Click to edit. Control-Left-Click to integrate. Alt-Left-Click to reverse cross probe L2.

Here’s a closeup of one of the pulses on capacitor, C2:

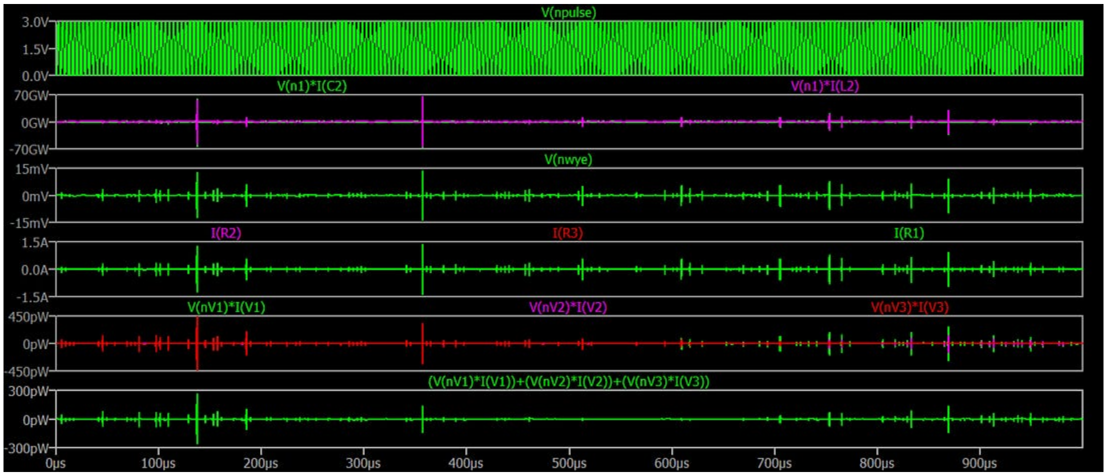


Waveform: (V(nV1)*I(V1))+(V(nV...

Interval Start: 355.5µs
Interval End: 361.5µs
Average: 4.3018fW
Integral: 2.5811e-05fJ

Right-Click to edit expression. Control-Left-Click to integrate.

And here’s the full duration of view:



Download the simulation files and these screenshots here.

Here’s the previous post which is related to this one:

Revisiting Tesla's 369 Mystery

VINYASI · APR 26

I never bothered to simulate this idea in LTSpice, until now, with a fantastic discovery: a net wattage of nearly zero if, instead of using radians to measure the phase displacement between three sin…

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