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# Can the Thevenin equivalent circuit have no solutions?

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***Abstract*—This paper presents an analysis of a circuit containing resistors, dependent and independent sources. The circuit was posted on Electronics Stack Exchange where a question was asked about maximum power through one of the resistors and the Thevenin equivalent circuit of the network which was sought as part of the solution. The analysis presented in this paper will use Modified Nodal Analysis to generate the network equations. It is shown that the maximum power through the resistor in question occurs when $R \to \infty$ and that the formulation of the Thevenin equivalent circuit for the network is incorrect.**

***Index Terms*—Linear Circuit Analysis, Modified Nodal Analysis**

## I. Introduction

The circuit in this paper comes from a question posted on Electronics Stack Exchange, *Can the Thevenin equivalent circuit have no solutions?*, where [1] asks a question about the circuit in Fig. 1. The schematic has been re-drawn using LTSpice with the addition of $V_2$ so the the current through $R_6$'s branch can be measured. Additionally, the nodes have been numbered in a particular order so that when branches are eliminated when calculating the Thevenin equivalent circuit, the node numbering remains consistent and ordered without skipping numbers. The reference node was arbitrarily chosen. The schematic shown in the question did not have reference designators listed for the components, so these were assigned as shown in the schematic.

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### A. Problem Statement

The author of the question asked:

"Can the Thevenin equivalent circuit have no solutions? I need to find R so that the power on it is maximum. So I find R=R Thevenin. But when I use the test current source 1A (replacing R), there is no solution. I have turned off the independent sources and changed 50i3=50V (because i3=1A now). I don't know what my mistake is."

The resistor, $R$, being asked about is $R_6$ in Fig. 1. As described in the question, the task is to find the value of $R_6$ such that the power dissipated in $R_6$ is maximum. The questioner stated that he attempted to find the Thevenin equivalent circuit, but he could not find a solution.

People answering his question also attempted to find the Thevenin equivalent circuit. After reading his question and answers supplied by the community, it seems that there are two questions being asked:

1) What value of $R_6$ will yield the maximum power dissipated in $R_6$?
2) What is the Thevenin equivalent resistance when $R_6$ is considered the load?

Based on the comments and answers offered by the community:

- $R_6$ is considered the load in the context of the Thevenin equivalent.
- The current through the $R_6$ controls the dependent source, $H_1$, which is kind of unusual when considering $R_6$ as the load.

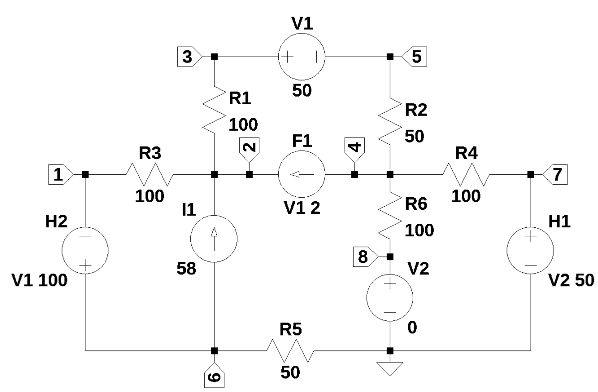


Fig. 1. Schematic for the problem.

### B. Circuit Description

The schematic shown in Fig. 1 has 12 branches, 8 nodes, 1 independent current source, $I_1$, two independent voltage sources, $V_1$ and $V_2$. $V_2$ was added to the schematic to serve as a reference to measure the current through the branch consisting of $R_6$, as stated above. There are three dependent sources, $H_1$, $H_2$ and $F_1$ and the network has six resistors. The author of the question did not indicate where this circuit originated from.

### C. Q&A on Electronics Stack Exchange

I've read through the Q&A and there is a bit of back and forth concerning the analysis. My schematic, Fig. 1, agrees with the schematic drawn by *periblepsis* in his analysis.

The discussion contains several highly detailed, but conflicting results.

**Analysis 1:** *Amit M* was the first to respond to the question. He stated:

"To find the thevenin resistance as seen by R, short circuit all voltage sources and open circuit all current sources except dependent voltage sources and dependent current sources. Replace R,connect a 1A current sources in place of R.

Connect the bottom node of that branch to ground. Measure the voltage across the upper terminal. This would give the thevenin resistance as seen by R. R should be equal to that thevenin resistance for maximum power transfer."

*Amit M* and *periblepsis* had several exchanges and concluded that the question's solution based on finding the Thevenin equivalent was "specified" incorrectly. Some solutions were proposed, but the answers don't agree with my analysis.

**Analysis 2:** *periblepsis* presented a loop analysis of the circuit with some Python code to solve the network equations. He also provided an LTSpice simulation to verify his results. He concluded that the current through $R_{\text{LOAD}}$ is independent of the value of $R_{\text{LOAD}}$. *periblepsis* and *Frederik Justesen* exchanged several comments.

*periblepsis* got a current of −115 flowing in $R_{\text{LOAD}}$, independent of the value of $R_{\text{LOAD}}$, which agrees with my analysis.

**Analysis 3:** *Tahmid Hassan* made the following statement:

"The idea of a Thevenin equivalent does not apply here. If you divide the load resistor as a separate system from the rest of the circuit, you see that one of the variables (I3) is a variable that exists outside the system. However, the Thevenin equivalent asks that we avoid splitting the dependent variable from the rest of the circuit - an inevitable situation here."

I agree, treating $R_6$ as the load, when $H_2$ depends on current flowing in $R_6$ means that the Thevenin equivalent probably should consider both $R_6$, $R_4$ and $H_2$ separate from the circuit.

**Analysis 4:** *Franc. M.* provided a detailed analysis contained in a rather long png image. He concluded that both $V_{\text{th}} = \infty$ and $R_{\text{th}} = \infty$. My analysis shows that $V_{\text{th}} = \infty$.

**Analysis 5:** *Jan Eerland* provided a node analysis which he solved using some Mathematica code. He concluded the following:

$$\begin{aligned} V_{\text{th}} &= -5750 \\ I_{\text{th}} &= -\frac{115}{2} = -57.5 \\ R_{\text{th}} &= 100\Omega \end{aligned} \tag{1}$$

My analysis and conclusion are in the analysis below. In general I agree with analysis 1 and 3. The Thevenin equivalent does not apply to this specific circuit if $R_6$ is considered the load. This is because the controlling variable for the dependent source, $H_1$, is a current that flows in $R_6$, making it impossible to cleanly separate the load from the rest of the circuit. It's interesting that the answers were different and varied.

## II. Analysis Method

Modified Nodal Analysis (MNA) was used to obtain the network equations. The MNA procedure provides an algorithmic method for generating a system of independent equations for linear circuit analysis and was first described by [2]. Once the schematic is drawn and the net list is exported, the network equations and solutions for the node voltages are easily obtained as shown in this paper. A JupyterLab notebook was written to perform the analysis and write the content of this paper (add reference in bib for JupyterLab notebook). The code in the JupyterLab notebook can be used as a template to analyze almost any linear circuit.

The schematic for the circuit, Fig. 1, was drawn using LTSpice and the netlist was exported for the analysis. Drawing a circuit with a schematic capture program and exporting the netlist reduced the possibilities for errors as the analysis proceeds. The analysis begins with generating the network equations from the circuit's netlist by calling:

```
report, network_df, df2, A, X, Z =
SymMNA.smna(filter_net_list)
```

The function `SymMNA.smna()` is described in [3]. The SymPy `solve` is capable of working through the algebra to solve the system of equations and can even find the roots of the numerator and denominator polynomials in some cases. Analytic expressions are easily generated for the circuit's node voltages.

There are two questions being asked in the Electronic Stack Exchange question. The first question asks what value of $R_6$ will produce the maximum power dissipation. This can be addressed by using MNA. The second question is about the Thevenin circuit viewed from $R_6$. Considering $R_6$ as the load is problematic as discussed below. Regardless, finding the Thevenin equivalent circuit is not needed to solve the first question.

## III. Analysis Results

Symbolic analysis presented in this paper employs the MNA technique to generate network equations from the circuit's netlist where the element values are represented by symbols. SymPy is used to solve the system of equations in symbolic form to obtain analytic expressions for the circuit's node voltages. The symbolic expressions can in some cases provide a deeper understanding of how each component contributes to the circuit's operation that can complement numerical simulations.

The netlist generated by LTSpice from the schematic is shown below. The nodes were labeled in the schematic, otherwise LTSpice will use default labels such as N001, N002 etc. and the `.smna` function wants integer values for the node numbers and these need to be consecutively ordered with no gaps in the numbering.

Generation of the netlist from a schematic capture program is convenient and less error prone than generating the netlist by hand. A visual inspection of the schematic ensures that the circuit to be analyzed is correct and it follows that the netlist is also correct. This is especially true for larger, more complicated schematics.

The netlist for the circuit in Fig. 1 is:

```
R3 2 1 100
R1 3 2 100
R2 5 4 50
R6 4 8 100
R5 0 6 50
R4 7 4 100
I1 6 2 58
V1 3 5 50
H2 6 1 V1 100
```

```
H1 7 0 V2 50
F1 4 2 V1 2
V2 8 0 0
```

By calling the function below, the network equations can be generated from the netlist. This function is documented in already referenced [3].

```
report, network_df, i_unk_df, A, X, Z =
SymMNA.smna(net_list)
```

The following equations were generated by the Python code using MNA.

$$
\begin{aligned}
0 &= -I_{H_2} + \frac{v_1}{R_3} - \frac{v_2}{R_3} \\
I_1 &= -I_{F_1} + v_2\left(\frac{1}{R_3} + \frac{1}{R_1}\right) - \frac{v_1}{R_3} - \frac{v_3}{R_1} \\
0 &= I_{V_1} - \frac{v_2}{R_1} + \frac{v_3}{R_1} \\
0 &= I_{F_1} + v_4\left(\frac{1}{R_6} + \frac{1}{R_4} + \frac{1}{R_2}\right) - \frac{v_8}{R_6} - \frac{v_7}{R_4} - \frac{v_5}{R_2} \\
0 &= -I_{V_1} - \frac{v_4}{R_2} + \frac{v_5}{R_2} \\
-I_1 &= I_{H_2} + \frac{v_6}{R_5} \\
0 &= I_{H_1} - \frac{v_4}{R_4} + \frac{v_7}{R_4} \\
0 &= I_{V_2} - \frac{v_4}{R_6} + \frac{v_8}{R_6} \\
V_1 &= v_3 - v_5 \\
V_2 &= v_8 \\
0 &= -I_{V_1} h_2 - v_1 + v_6 \\
0 &= -I_{V_2} h_1 + v_7 \\
0 &= I_{F_1} - I_{V_1} f_1
\end{aligned} \tag{2}
$$

After substituting in component values in the symbolic equations above, the following numeric equations were obtained and displayed below.

$$
\begin{aligned}
0 &= -I_{H_2} + 0.01v_1 - 0.01v_2 \\
58.0 &= -I_{F_1} - 0.01v_1 + 0.02v_2 - 0.01v_3 \\
0 &= I_{V_1} - 0.01v_2 + 0.01v_3 \\
0 &= I_{F_1} + 0.04v_4 - 0.02v_5 - 0.01v_7 - 0.01v_8 \\
0 &= -I_{V_1} - 0.02v_4 + 0.02v_5 \\
-58.0 &= I_{H_2} + 0.02v_6 \\
0 &= I_{H_1} - 0.01v_4 + 0.01v_7 \\
0 &= I_{V_2} - 0.01v_4 + 0.01v_8 \\
50.0 &= v_3 - v_5 \\
0 &= v_8 \\
0 &= -100.0I_{V_1} - v_1 + v_6 \\
0 &= -50.0I_{V_2} + v_7 \\
0 &= I_{F_1} - 2.0I_{V_1}
\end{aligned} \tag{3}
$$

After substituting in component values in the symbolic equations above, the solution for the node voltages were obtained and are tabulated in Table I.

TABLE I
DC OPERATING POINT

| Unknowns | Values | Units |
|---|---|---|
| $v_1$ | −8,625.0 | voltage |
| $v_2$ | 14,425.0 | voltage |
| $v_3$ | −2,825.0 | voltage |
| $v_4$ | −11,500.0 | voltage |
| $v_5$ | −2,875.0 | voltage |
| $v_6$ | 8,625.0 | voltage |
| $v_7$ | −5,750.0 | voltage |
| $v_8$ | 0.0 | voltage |
| $I_{\mathrm{V1}}$ | 172.5 | device current |
| $I_{\mathrm{V2}}$ | −115.0 | device current |
| $I_{\mathrm{H2}}$ | −230.5 | device current |
| $I_{\mathrm{H1}}$ | −57.5 | device current |
| $I_{\mathrm{F1}}$ | 345.0 | device current |

From above, the current through $R_6$ is the same as the current in $V_2$ which is: $I_{V_2}$

$$
I_{V_2} = \frac{\begin{gathered}-I_1R_3R_4f_1 + I_1R_3R_4 - R_1V_2 - R_2V_2 + \\ R_3V_2f_1 - R_3V_2 + R_4V_1f_1 - R_4V_1 + \\ R_4V_2f_1 - R_4V_2 + R_5V_2f_1 - R_5V_2 - V_2h_2\end{gathered}}{\begin{gathered}R_1R_4 + R_1R_6 - R_1h_1 + R_2R_4 + R_2R_6 - \\ R_2h_1 - R_3R_4f_1 + R_3R_4 - R_3R_6f_1 + \\ R_3R_6 + R_3f_1h_1 - R_3h_1 - R_4R_5f_1 + \\ R_4R_5 - R_4R_6f_1 + R_4R_6 + R_4h_2 - \\ R_5R_6f_1 + R_5R_6 + R_5f_1h_1 - R_5h_1 + \\ R_6h_2 - h_1h_2\end{gathered}} \tag{4}
$$

Assigning the component values, we get: current through $V_2 = -115.0$ A

The above indicates that the current through $R_6$ is independent of the value of $R_6$, when the component values assigned in the Fig. 1 are used.

The power dissipated by $R_6$ is $P = \left(I_{V_2}\right)^2 R_6$

$$
P = 13225.0R_6 \tag{5}
$$

As $R_6 \to 0$, $P \to 0$, so the answer would seem to be $R_6 \approx \infty$ would produce the maximum power.

Thinking about what $H_1$ is doing, which is to supply an increasing voltage as the current through $R_6$ increases, which would happen as $R_6 \longrightarrow$ short circuit.

### A. Thevenin equivalent circuit

A Thevenin equivalent circuit is a simplified model of any complex linear electrical circuit that contains multiple voltage sources, current sources, and resistors. It's based on Thevenin's theorem.

The Thevenin equivalent circuit replaces the complex original network (when viewed from two specific terminals) with a circuit that consists of:

- A single voltage source ($V_{\mathrm{Th}}$), called the Thevenin voltage.
- A single resistor ($R_{\mathrm{Th}}$), called the Thevenin resistance, connected in series with the voltage source.

a) *Thevenin Voltage, $V_{\mathrm{Th}}$:* Find the Thevenin Voltage ($V_{\mathrm{Th}}$): This is the open-circuit voltage measured across nodes 4 and 8 when the load resistor is removed. Assume that $R_6$ is the load resistance. Since $V_2 = 0$, this makes the voltage at node 8, $v_8 = 0$.

Comment out $R_6$, $V_2$, $H_1$ and ground one end of $R_4$ in the netlist. The new netlist is:

```
R3 2 1 100
R1 3 2 100
R2 5 4 50
*R6 4 8 100
R5 0 6 50
*R4 7 4 100
R4 0 4 100
I1 6 2 58
V1 3 5 50
H2 6 1 V1 100
*H1 7 0 V2 50
F1 4 2 V1 2
*V2 8 0 0
```

Using the `SymMNA.smna` function, the network equations for the circuit are generated using MNA. The following network equations were generated:

$$\begin{aligned}
0 &= -I_{H_2} + 0.01v_1 - 0.01v_2\\
58.0 &= -I_{F_1} - 0.01v_1 + 0.02v_2 - 0.01v_3\\
0 &= I_{V_1} - 0.01v_2 + 0.01v_3\\
0 &= I_{F_1} + 0.04v_4 - 0.02v_5 - 0.01v_7 - 0.01v_8\\
0 &= -I_{V_1} - 0.02v_4 + 0.02v_5\\
-58.0 &= I_{H_2} + 0.02v_6\\
0 &= I_{H_1} - 0.01v_4 + 0.01v_7\\
0 &= I_{V_2} - 0.01v_4 + 0.01v_8\\
50.0 &= v_3 - v_5\\
0 &= v_8\\
0 &= -100.0I_{V_1} - v_1 + v_6\\
0 &= -50.0I_{V_2} + v_7\\
0 &= I_{F_1} - 2.0I_{V_1}
\end{aligned} \tag{6}$$

Use `solve` to generate a symbolic solution. The solution for the voltage at node 5 is:

$$v_5 = \frac{\begin{array}{c}-I_1R_2R_3 + I_1R_3R_4f_1 - I_1R_3R_4 +\\ R_2V_1 - R_4V_1f_1 + R_4V_1\end{array}}{\begin{array}{c}-R_1 - R_2 + R_3f_1 - R_3 + R_4f_1 - R_4 +\\ R_5f_1 - R_5 - h_2\end{array}} \tag{7}$$

After substituting values into the denominator, the denominator resolves to zero. Therefore, there is no solution for the Thevenin equivalent circuit, when $R_6$ is considered the load.

## IV. Conclusion

The problem and the circuit are kind of interesting. The other commentators also said they found this to be an interesting circuit. The original poster did not indicate where this circuit came from. When $R_6$ is considered the load, there is no Thevenin equivalent circuit. This was also expressed by a few of the commenters. Finding the Thevenin equivalent circuit is not required to answer the question about power dissipation in $R_6$.

## References

[1] Kiên Nguyễn Đặng Trung, “Can the Thevenin equivalent circuit have no solutions?.” Accessed: Nov. 01, 2025. [Online]. Available: https://electronics.stackexchange.com/questions/755922/can-the-thevenin-equivalent-circuit-have-no-solutions

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[3] Tiburonboy, “Symbolic Modified Nodal Analysis using Python.” Accessed: Aug. 13, 2025. [Online]. Available: https://tiburonboy.github.io/Symbolic-Modified-Nodal-Analysis-using-Python/