

# PARALLEL NEGATIVE FEEDBACK CIRCUIT BUILDER

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*In the classic electronics courses, the electronic circuits are presented in their complete, final and perfect form. Only, in order to really understand circuits, we need to know the relation between passive and active versions and how passive circuits have been converted into active ones.*

*The novel interactive multimedia tutorial described in this paper reveals one of the most powerful ideas of analog electronics – parallel negative feedback principle. First, using a lot of analogies, the general idea behind this class of circuits is generalized. Then, the passive circuits are converted into active ones, using one and the same 4-step procedure.*

## 1. INTRODUCTION.

In traditional electronic courses, analog circuits are unnaturally divided into passive and active ones using one and the same “scenario”.

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C. However, nobody shows us what we really need in order to comprehend active circuit operation: **circuit evolution**, i.e. how the passive and active versions relate, and how passive circuits have been converted into active ones.

Well, let's look for an answer.

over 40 famous circuits in the field of analog elec

**Fig. 1** First, we are persuaded how imperfect passive circuits are. Then we are given finished and perfect active versions, analogous to passive ones, and it is proved formally they are almost ideal. However, nobody shows us what we really need in order to comprehend active circuit operation.

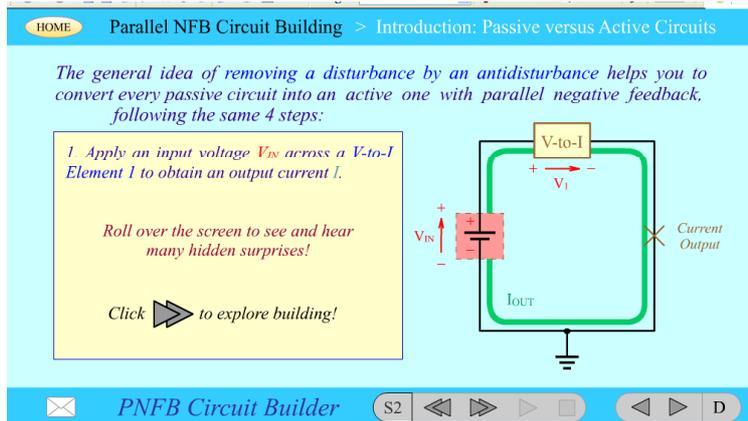
**2. PROBLEM.** In order to really understand circuits, we need to know the relation between passive and active versions and how passive circuits have been converted into active ones [1]. We can reveal this circuit evolution building rather than analyzing circuits. For this purpose, we can use the common procedure as follows.

First, we derive the most elementary passive building blocks from basic electric circuits. Then, we use these "bricks" to build more and still more complicated passive circuits. Further, adding active elements in accordance with suitable basic ideas, we build a lot of transistor circuits. Finally, applying the negative feedback principle in

all its variety, we transform these circuits into ideal op-amp ones. Doing that, students will be able to convert any imperfect passive circuit into an ideal one.

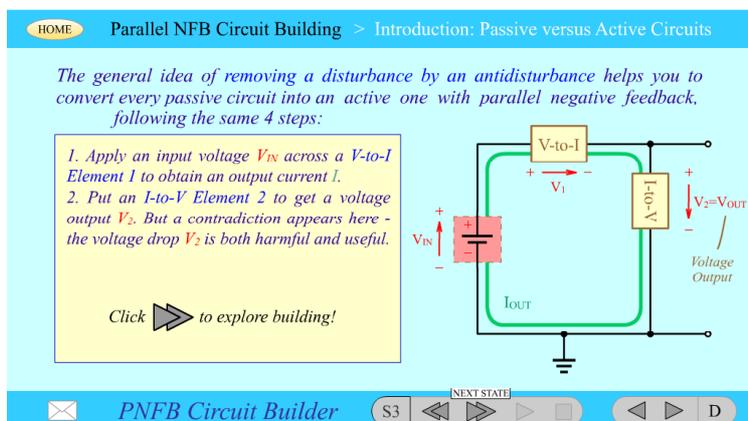
## 2. BUILDING PROCEDURE.

The novel interactive multimedia tutorial described in this paper reveals one of the most powerful ideas of analog electronics – *parallel negative feedback principle*. First, using a lot of analogies, the general idea behind this class of circuits is generalized. Then, the passive circuits are converted into active ones, using one and the same 4-step procedure.



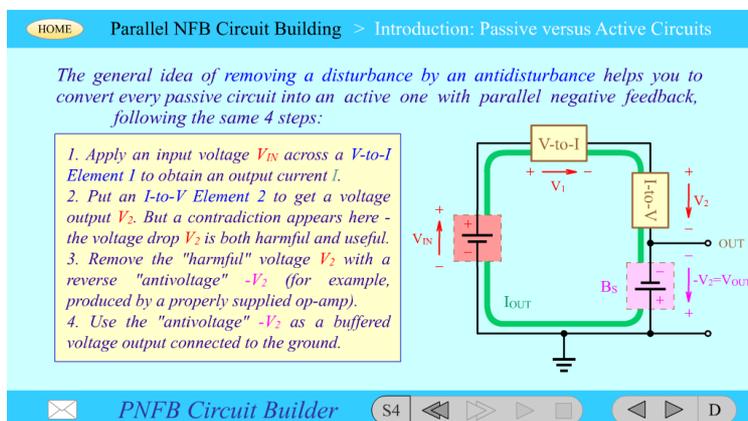
Step 1. We apply an input voltage across a passive element (resistor, capacitor, diode etc.) in order to obtain an output current. In this way, a passive voltage-to-current converter is built.

Fig. 2



Step 2. We connect another passive element (resistor, capacitor, diode etc.) in series with the former in order to obtain an output voltage -- a voltage-to-voltage compound converter is built. Only, a “harmful” voltage drop appears on the current-to-voltage element.

Fig. 3



Step 3. In order to compensate the “harmful” voltage drop across the current-to-voltage passive element, we include an additional “aiding” voltage source (properly supplied op-amp) in the circuit loop.

Fig. 4

**Step 4.** We use the compensating “antivoltage” as a buffered voltage output connected to the ground -- an active voltage-to-voltage converter is “invented”.

Applying this 4-step “scenario”, over 40 popular analog electronic circuits are built. Furthermore, the tutorial reveals the secret of how to convert any imperfect passive circuit, even completely unknown, into an active one with parallel negative feedback.

### 3. IMPLEMENTATION.

The tutorial is implemented as a Macromedia Flash movie. It consists of element library and a stage where the current circuit is built. Interactive action script controlled animations, hyperlinks, hidden explanation buttons and sounds are associated to the circuits operation. Also, a lot of innovative interactive tools (potential bars and diagrams, current loops, superimposed I-V curves etc.) are used to visualize and sound the invisible electrical attributes of the circuits. For example, a passive diode logarithmator is shown on the fig. 4.

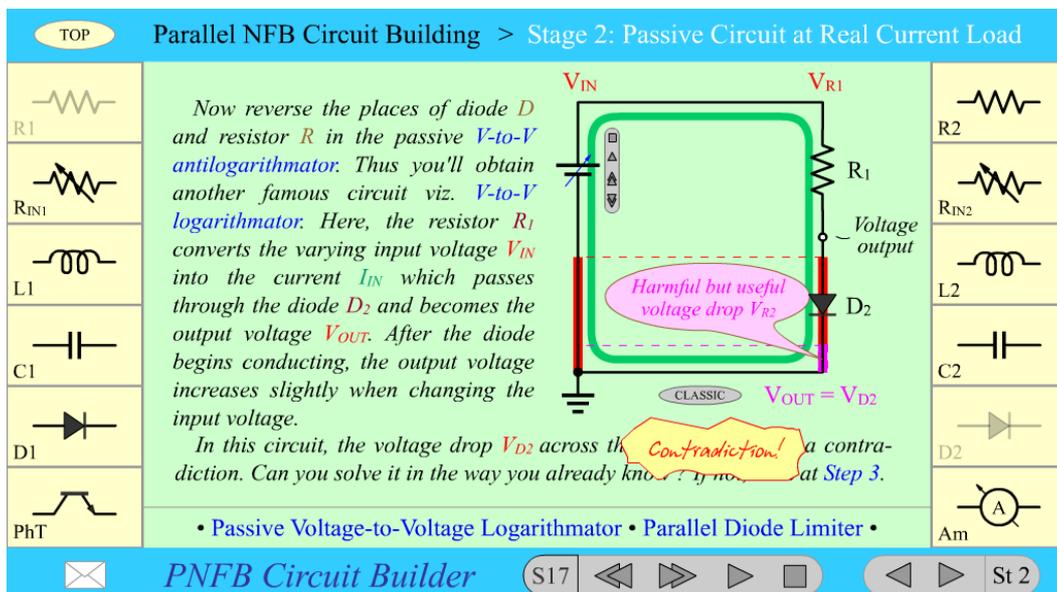


Fig. 5

### 4. CONCLUSION.

A novel circuit building procedure is proposed in this paper. Using the 4-step “scenario” described students may convert any imperfect passive circuit, even completely unknown, into an active one with parallel negative feedback.

### 5. REFERENCES.

[1] Mechkov C., *Heuristic methods for converting passive analogue devices into negative feedback active circuits*, Proceedings of The Sixth Int. Conference ELECTRONICS'97, 1997.