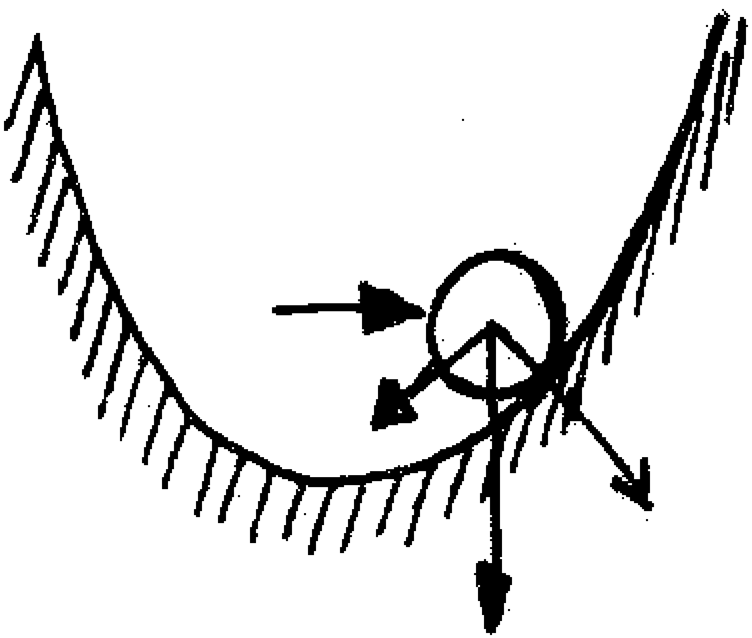
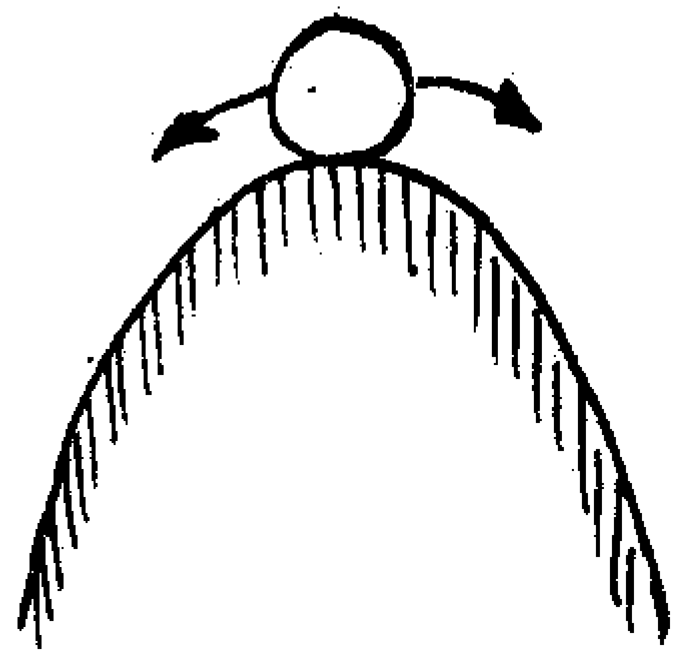
(Negativna) povratna sprega

Negativna i pozitivna povratna sprega

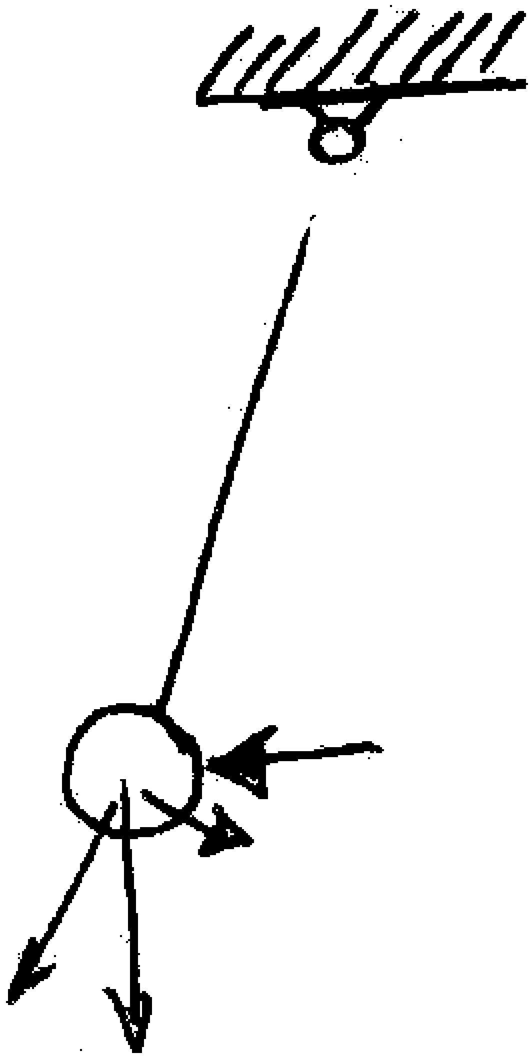
NPS-ravnoteža, stabilnost

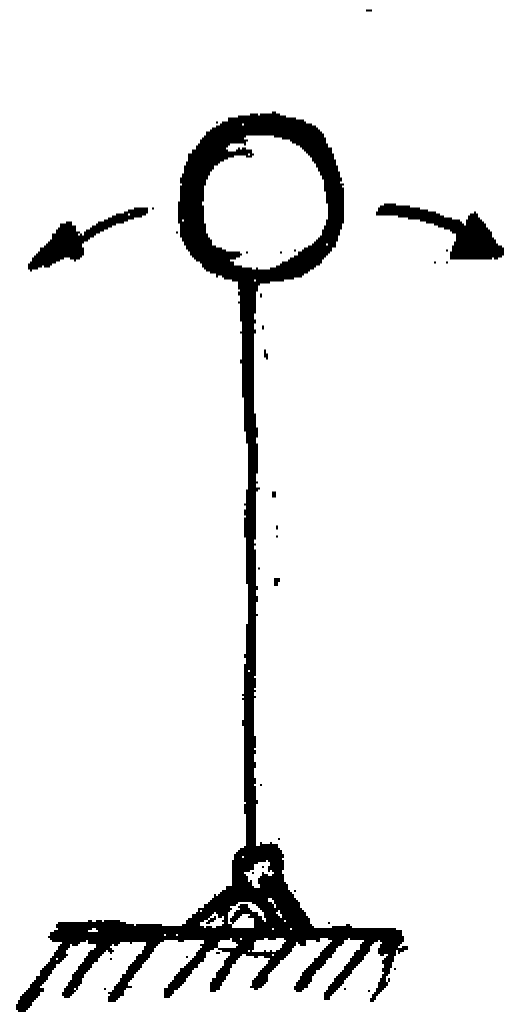
PPS-divergencija, nestabilnost



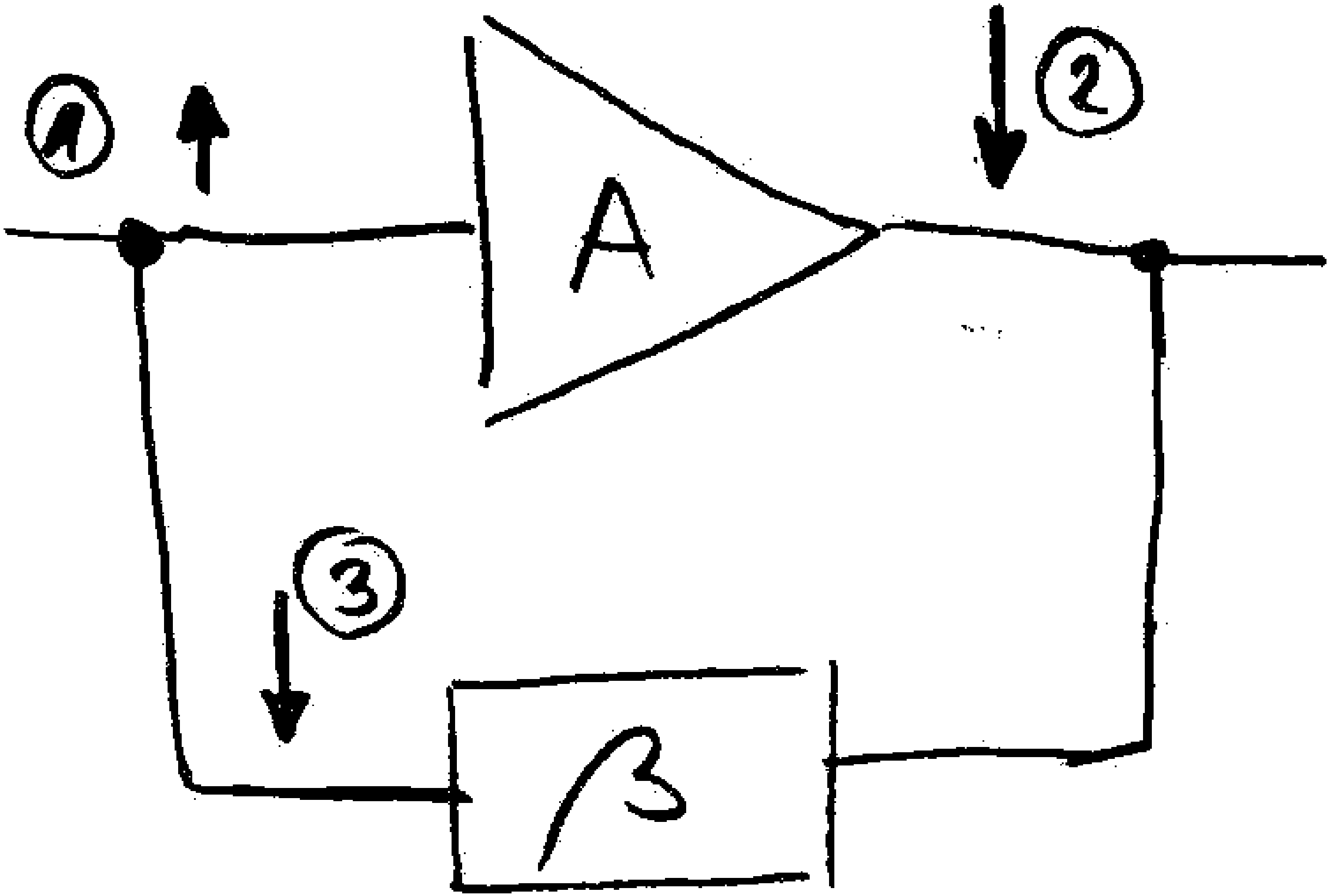


NPS i PPS

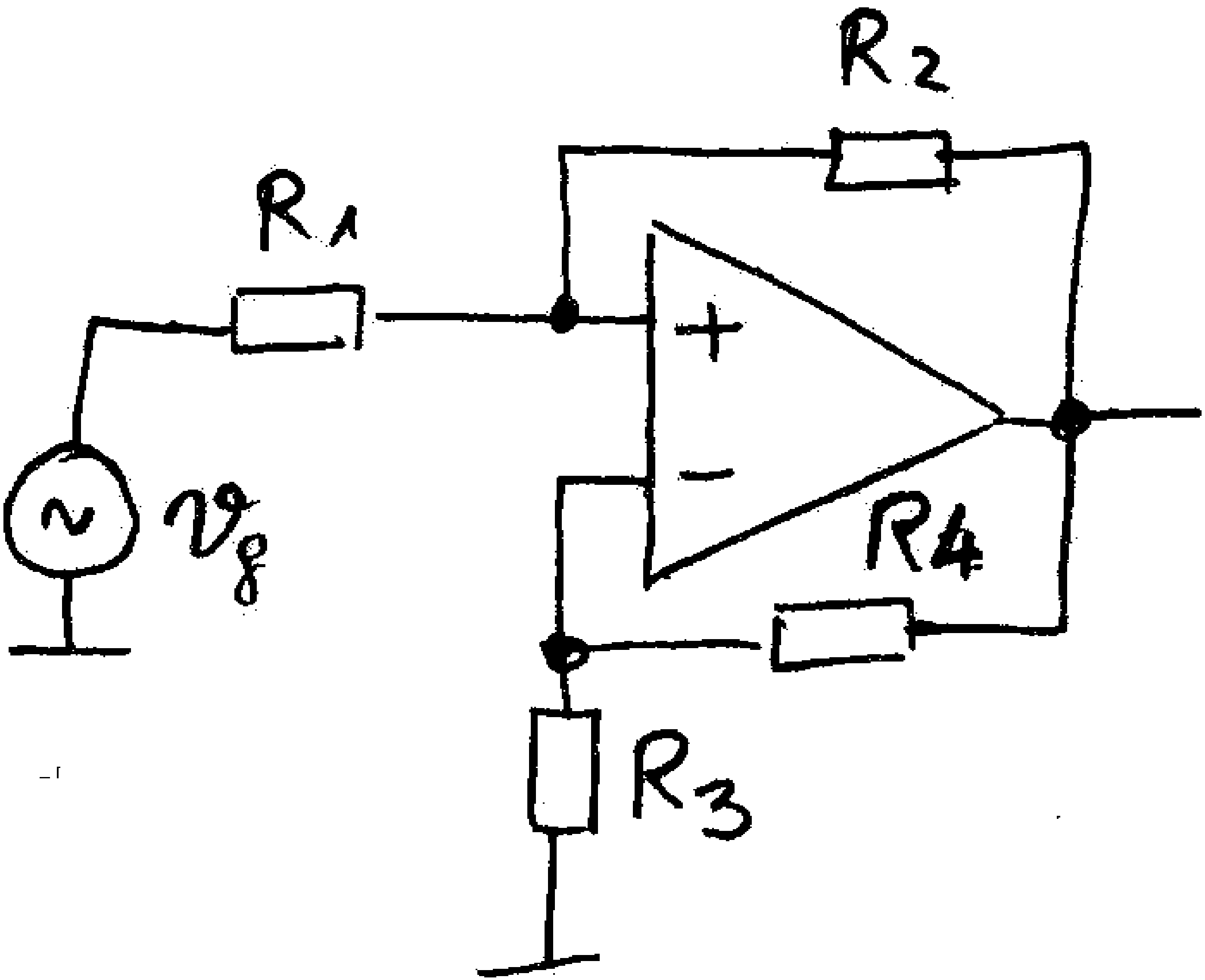




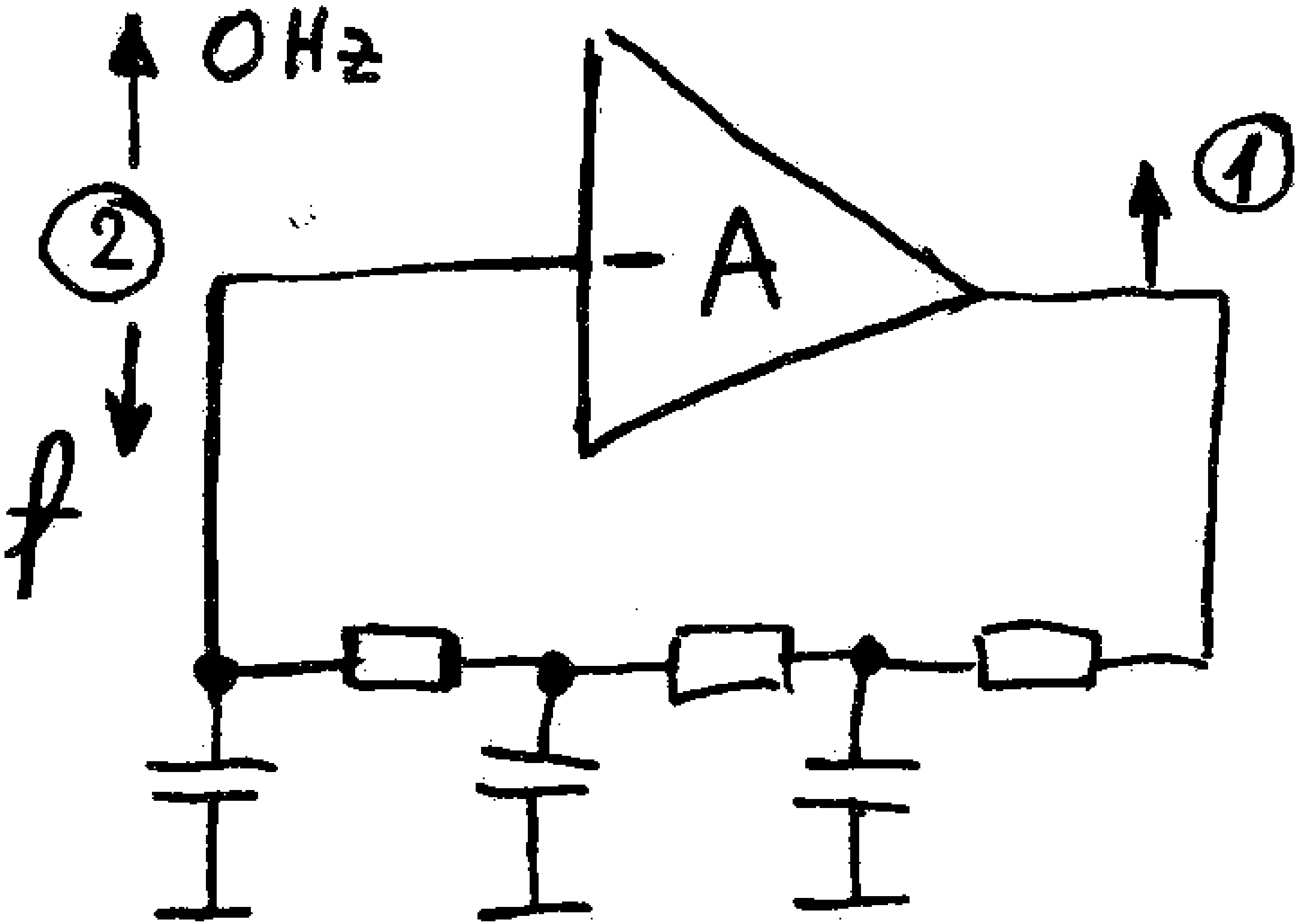
Kod NPS odziv konture je nasuprot početne pobude



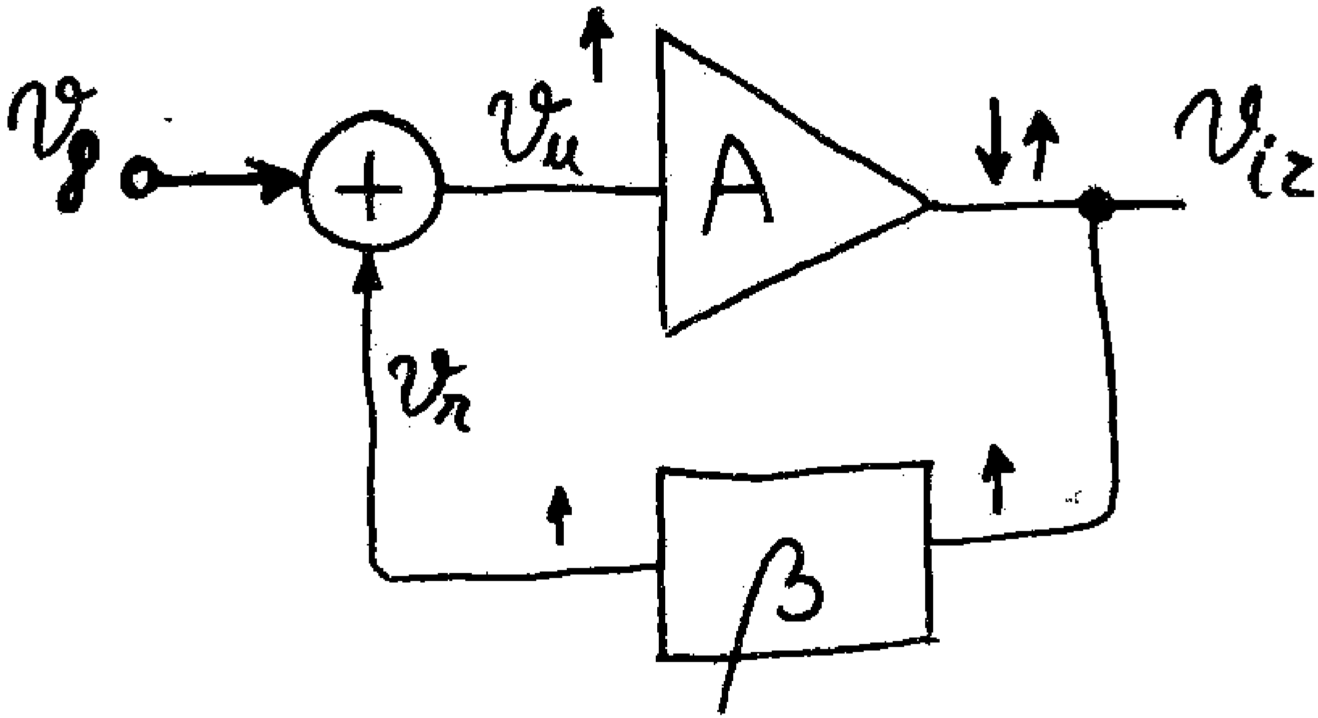
Kolo može imati i NPS i PPS



NPS na niskim, a PPS na visokim frek.



NPS … A je negativno



$$\left.\begin{aligned} v_u &= v_g + v_r \\ v_r &= \beta \cdot v_{iz} \\ v_{iz} &= A \cdot v_u \end{aligned}\right\} \Rightarrow \frac{v_{iz}}{v_g} = \frac{A}{1 - A\beta} = A_r$$

Osnovni pojmovi

A_β = кружно појачање

$1 - A_\beta$ = функција реакције

A_n = појачање са реакцијом

A = појачање у отвореној контури

v_n = напон (сигнал) реакције

v_u = улазни напон

v_g = побудни напон

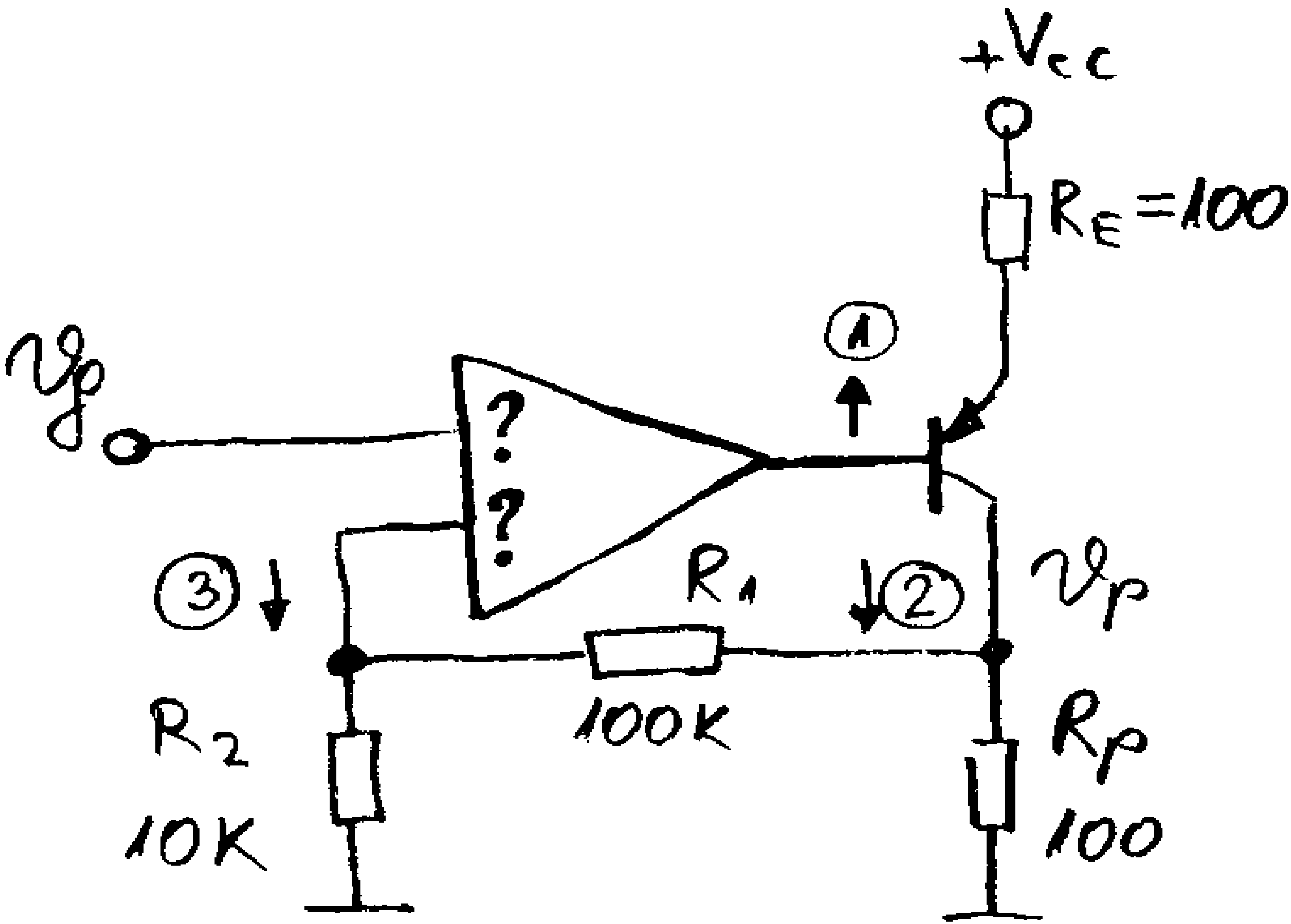
Uticaj NPS na konstantnost pojačanja

$$A = A(T, t, V_{cc}, R_p, N, \ldots)$$

$\frac{dA}{A}$, $\frac{\Delta A}{A}$ релативна промјена A

$$\frac{dA_n}{A_n} = \frac{d\left(\frac{A}{1-A\beta}\right)}{\frac{A}{1-A\beta}} = \frac{\frac{dA}{A}}{1-A\beta}$$

Odrediti + i - ulaze na OP



BASIC INSTRUMENTS

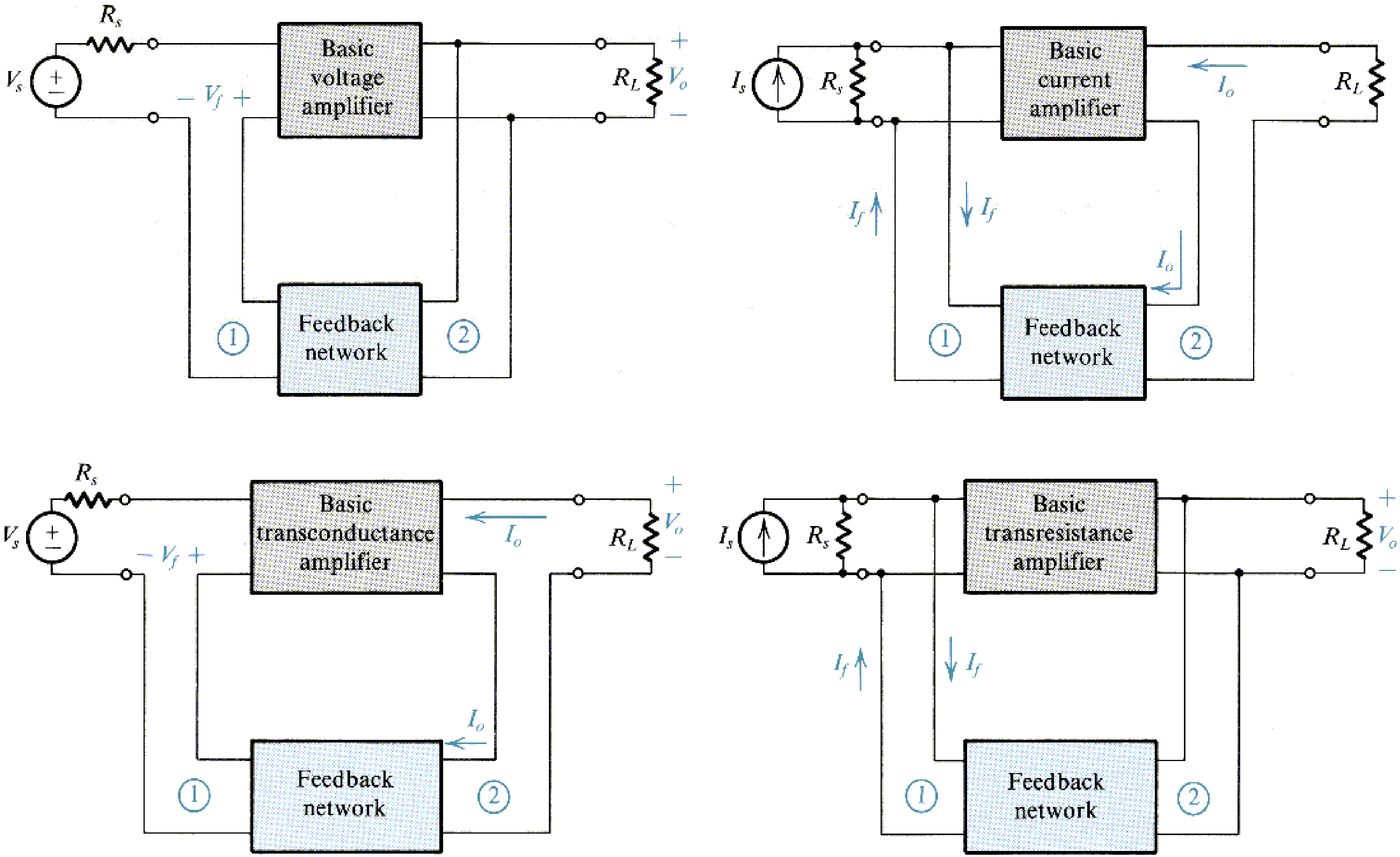


Fig. 8.4 The four basic feedback topologies: (a) voltage-sampling series-mixing (series-shunt) topology; (b) current-sampling shunt-mixing (shunt-series) topology; (c) current-sampling series-mixing (series-series) topology; (d) voltage-sampling shunt-mixing (shunt-shunt) topology.

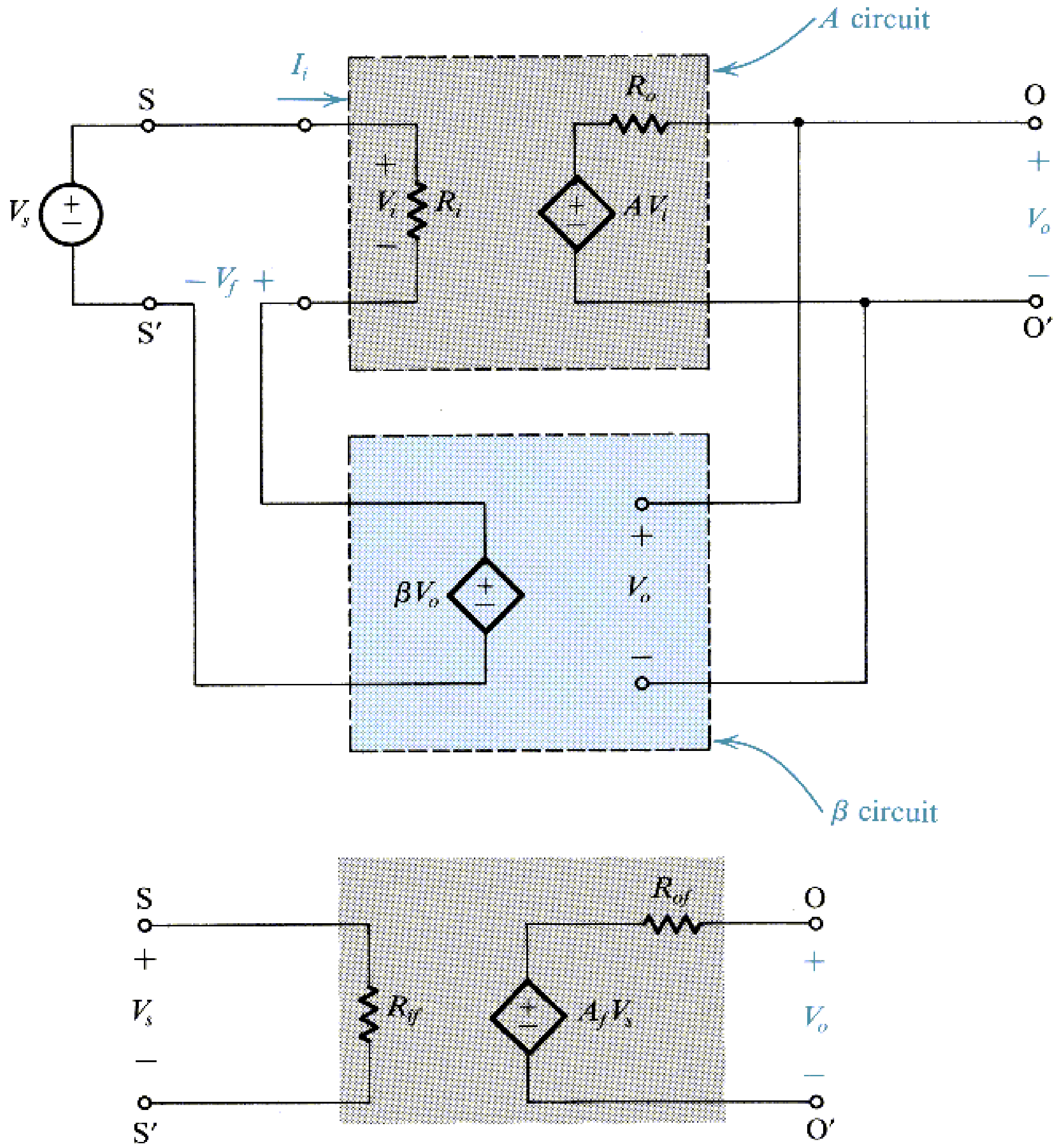


Fig. 8.8 The series-shunt feedback amplifier: (a) ideal structure; (b) equivalent circuit.

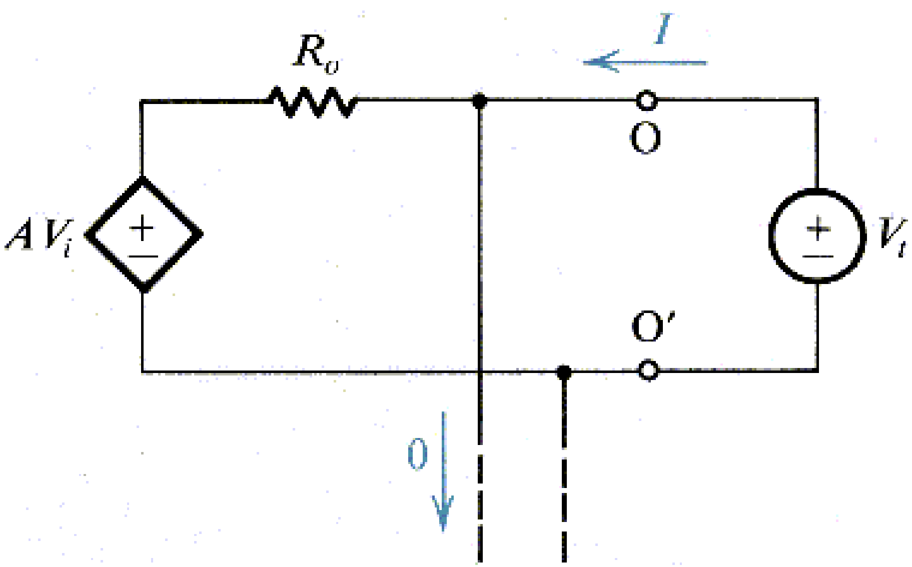


Fig. 8.9 Measuring the output resistance of the feedback amplifier of Fig. 8.8 (a): R_{of} V_t/I.

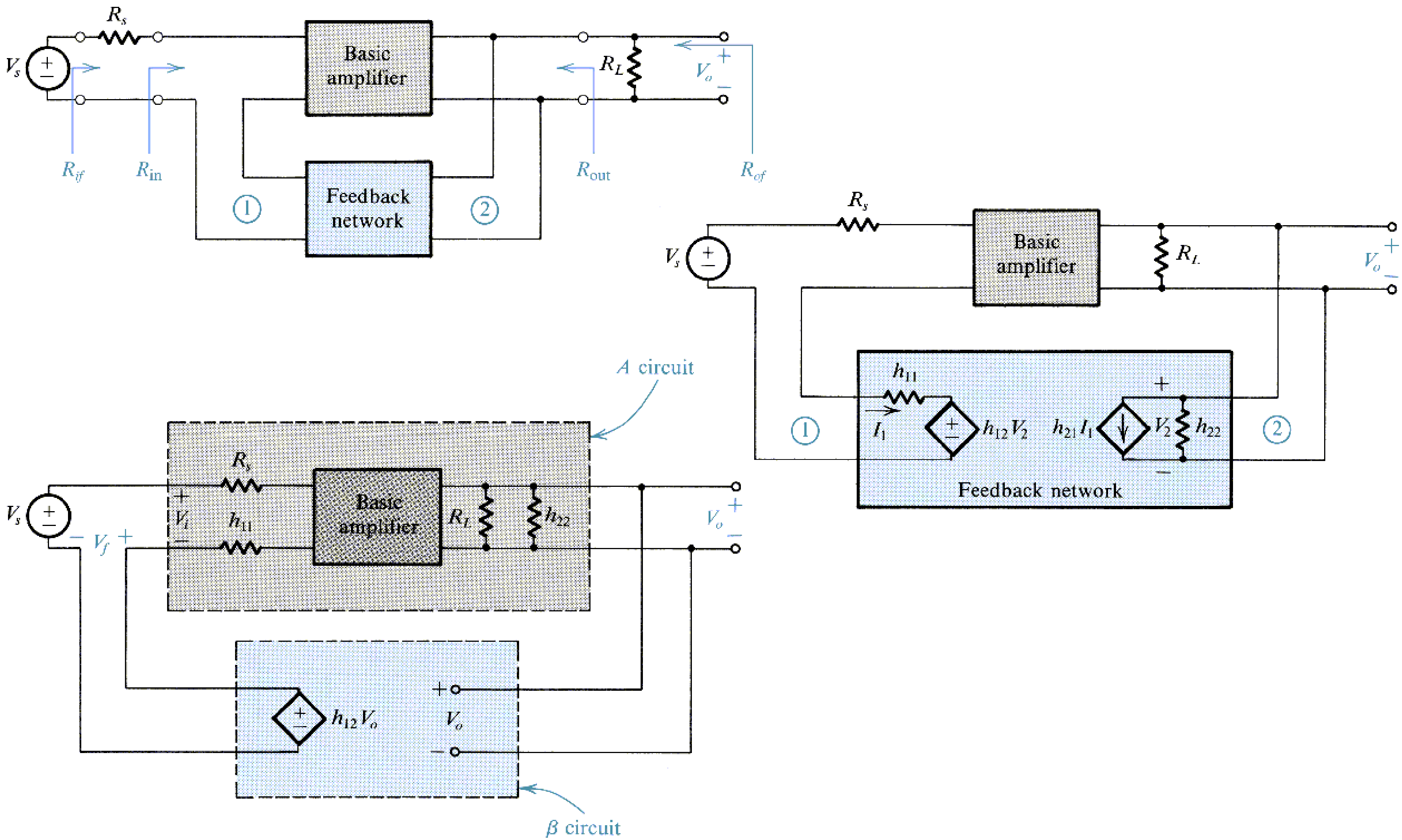


Fig. 8.10 Derivation of the *A* circuit and circuit for the series-shunt feedback amplifier. (a) Block diagram of a practical series-shunt feedback amplifier. (b) The circuit in (a) with the feedback network represented by its *h* parameters. (c) The circuit in (b) after neglecting h_{21}.

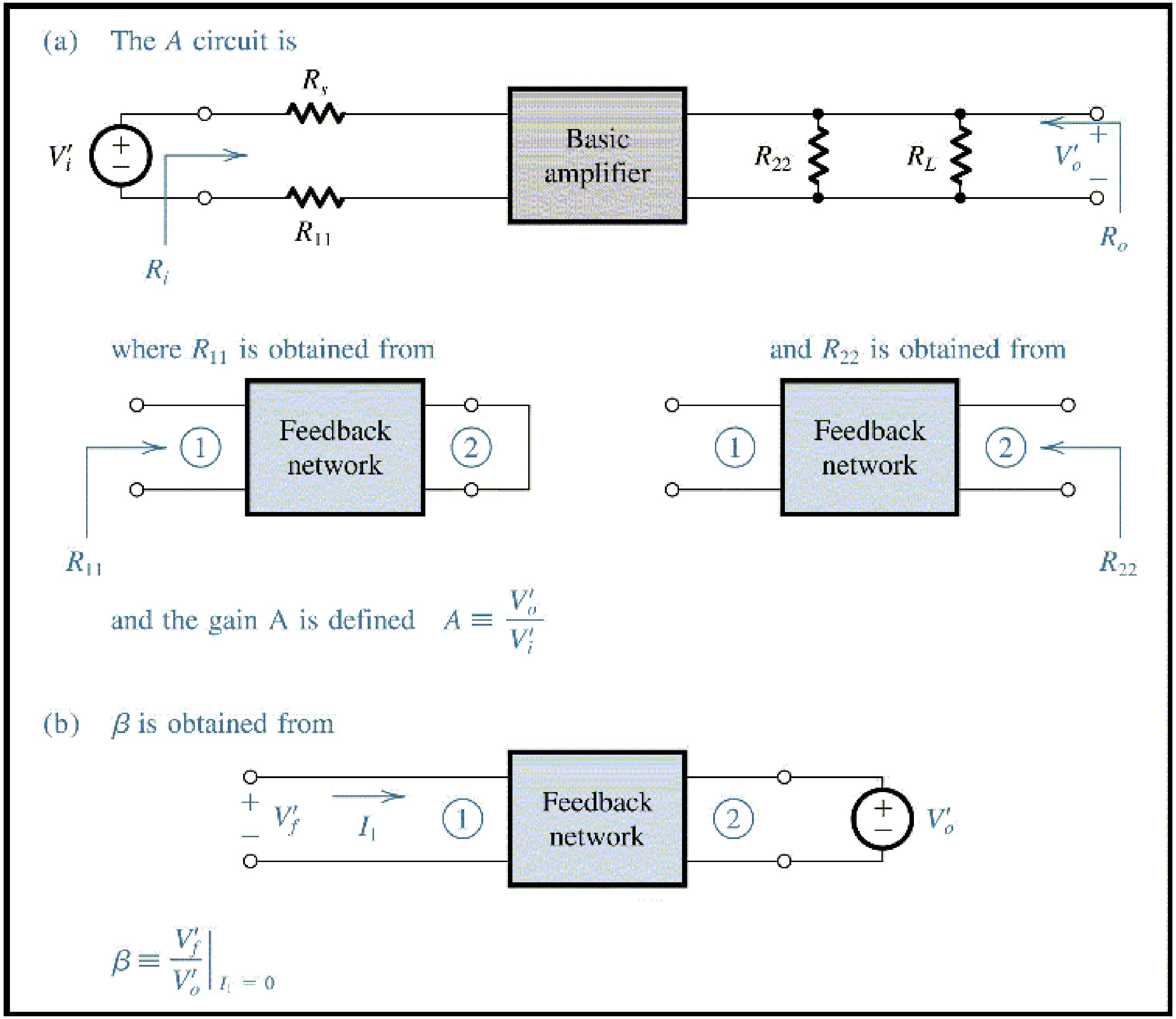


Fig. 8.11 Summary of the rules for finding the *A* circuit and for the voltage-sampling series-mixing case of Fig. 8.10(a).

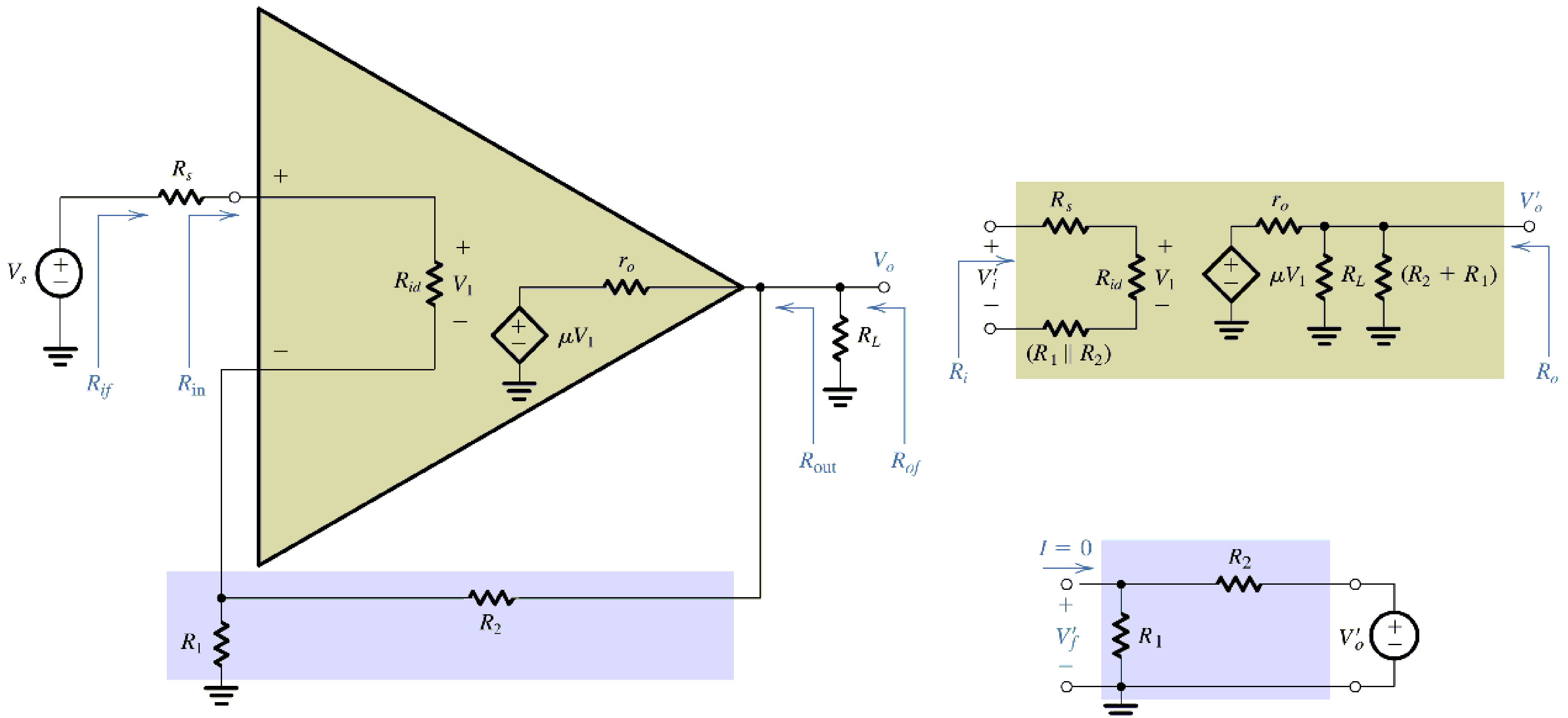
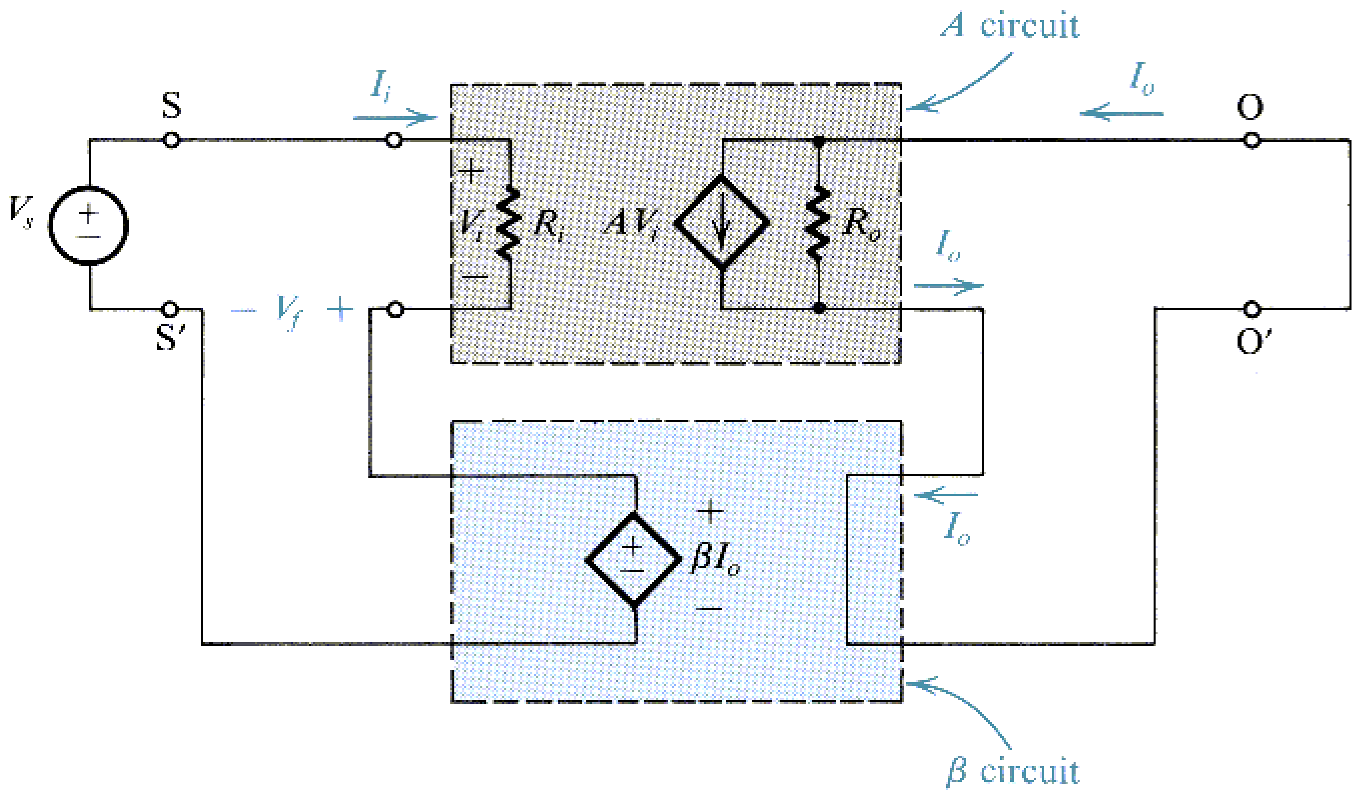


Fig. 8.12 Circuits for Example 8.1.



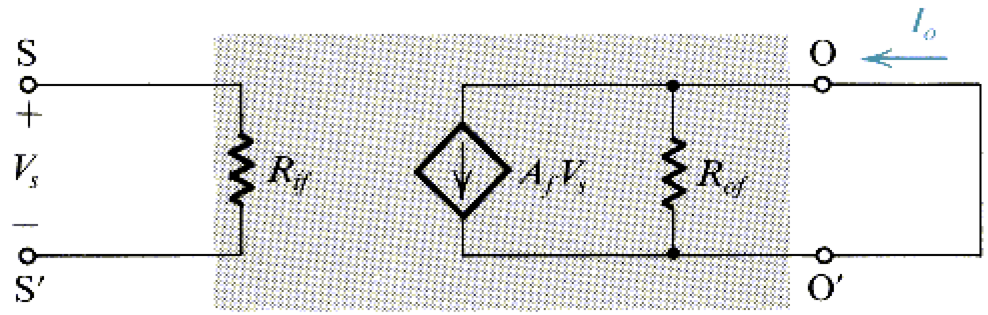


Fig. 8.13 The series-series feedback amplifier: (a) ideal structure; (b) equivalent circuit.

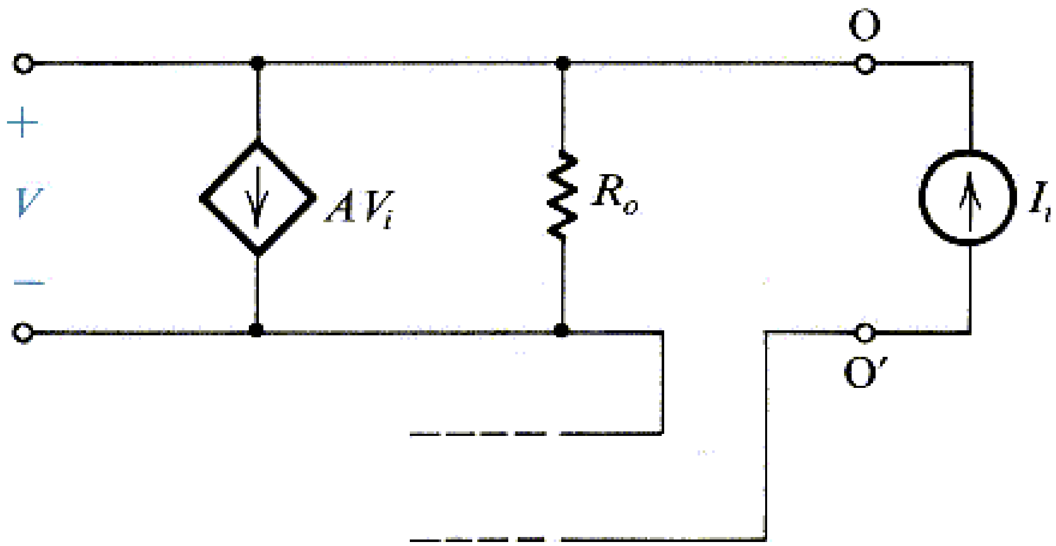


Fig. 8.14 Measuring the output resistance R_{of} of the series-series feedback amplifier.

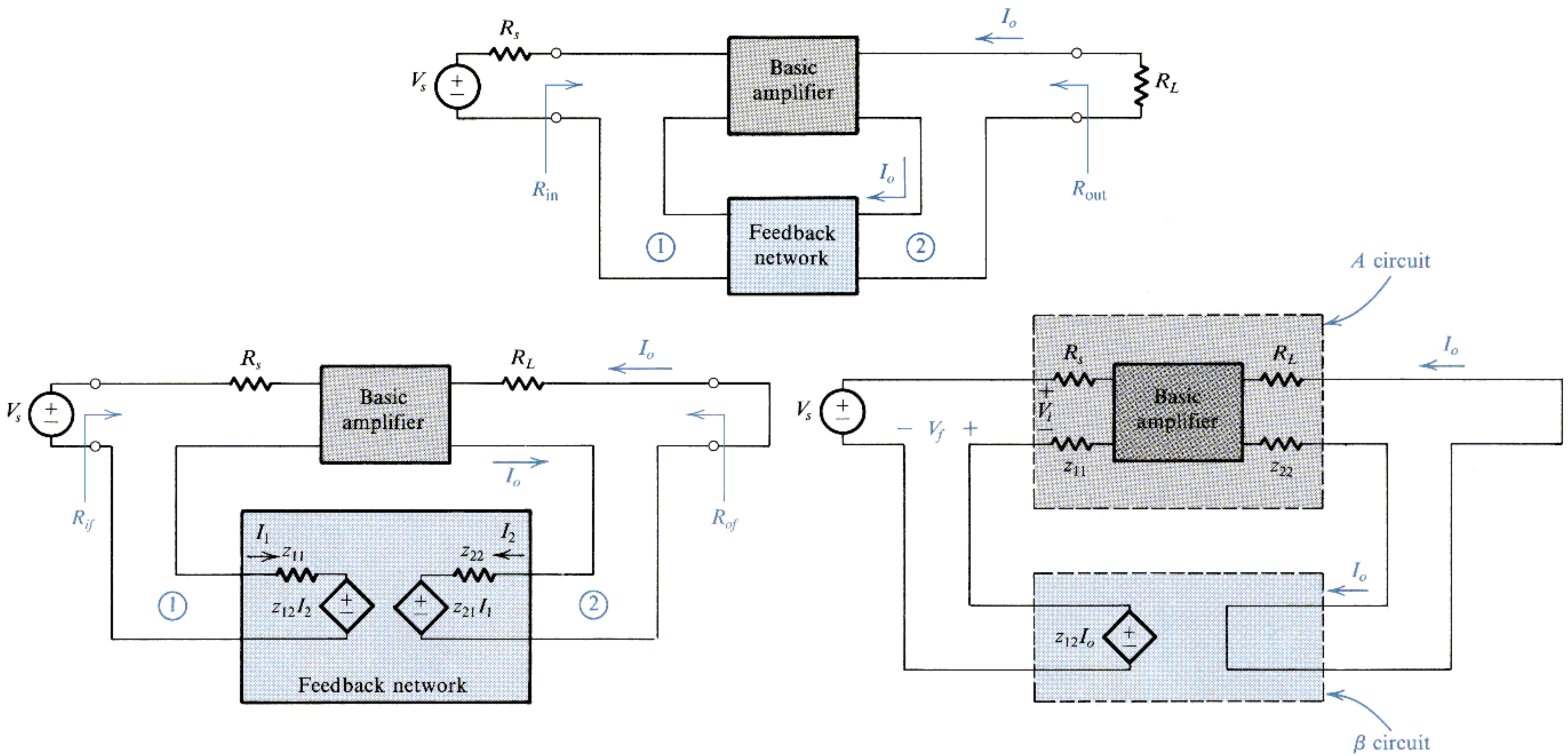


Fig. 8.15 Derivation of the *A* circuit and circuit for the series-series feedback amplifiers. (a) A series-series feedback amplifier. (b) The circuit of (a) with the feedback network represented by its *z* parameters. (c) A redrawing of the circuit in (b) after neglecting z_{21}.

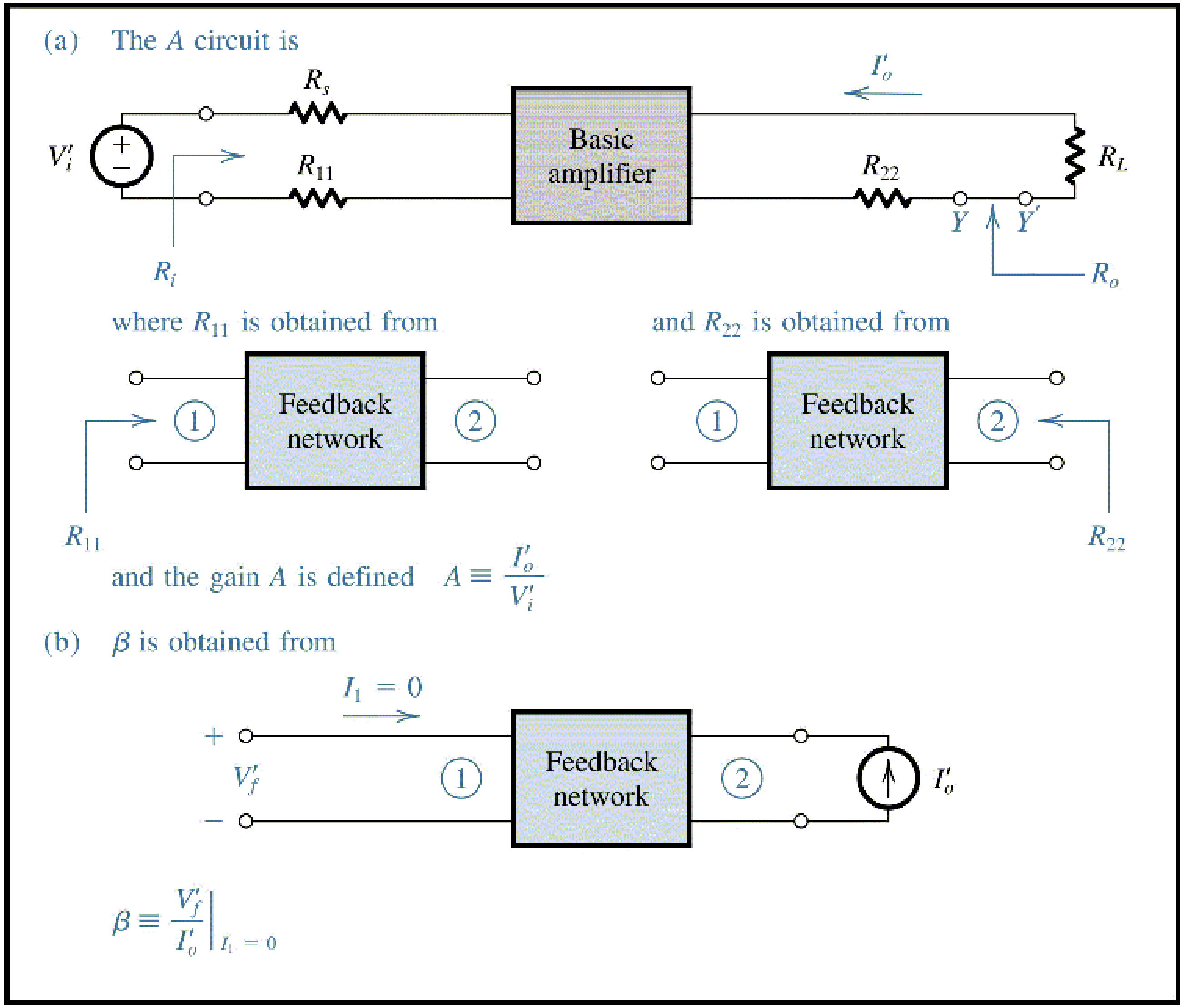


Fig. 8.16 Finding the *A* circuit and for the current-sampling series-mixing (series-series) case.

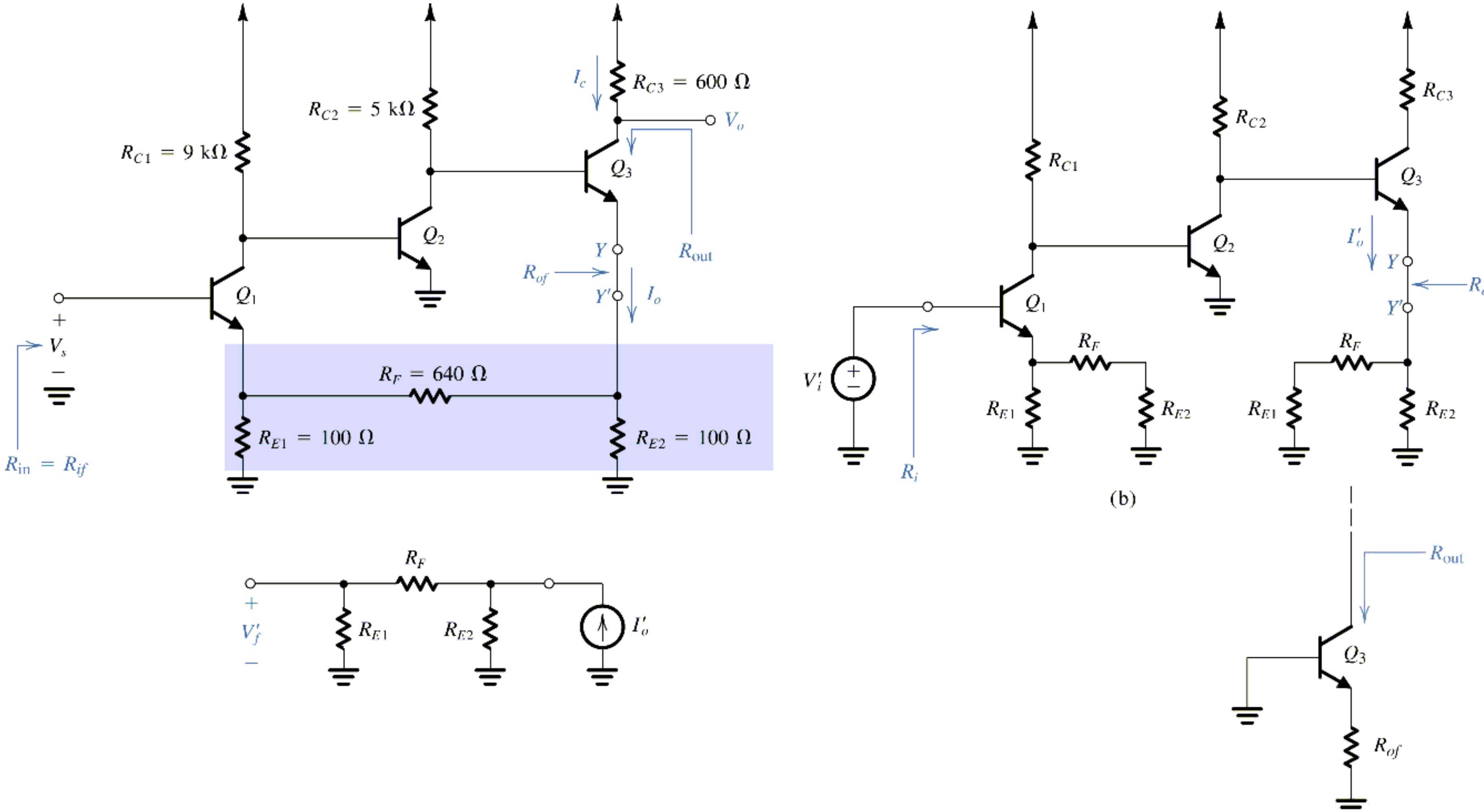


Fig. 8.17 Circuits for Example 8.2.

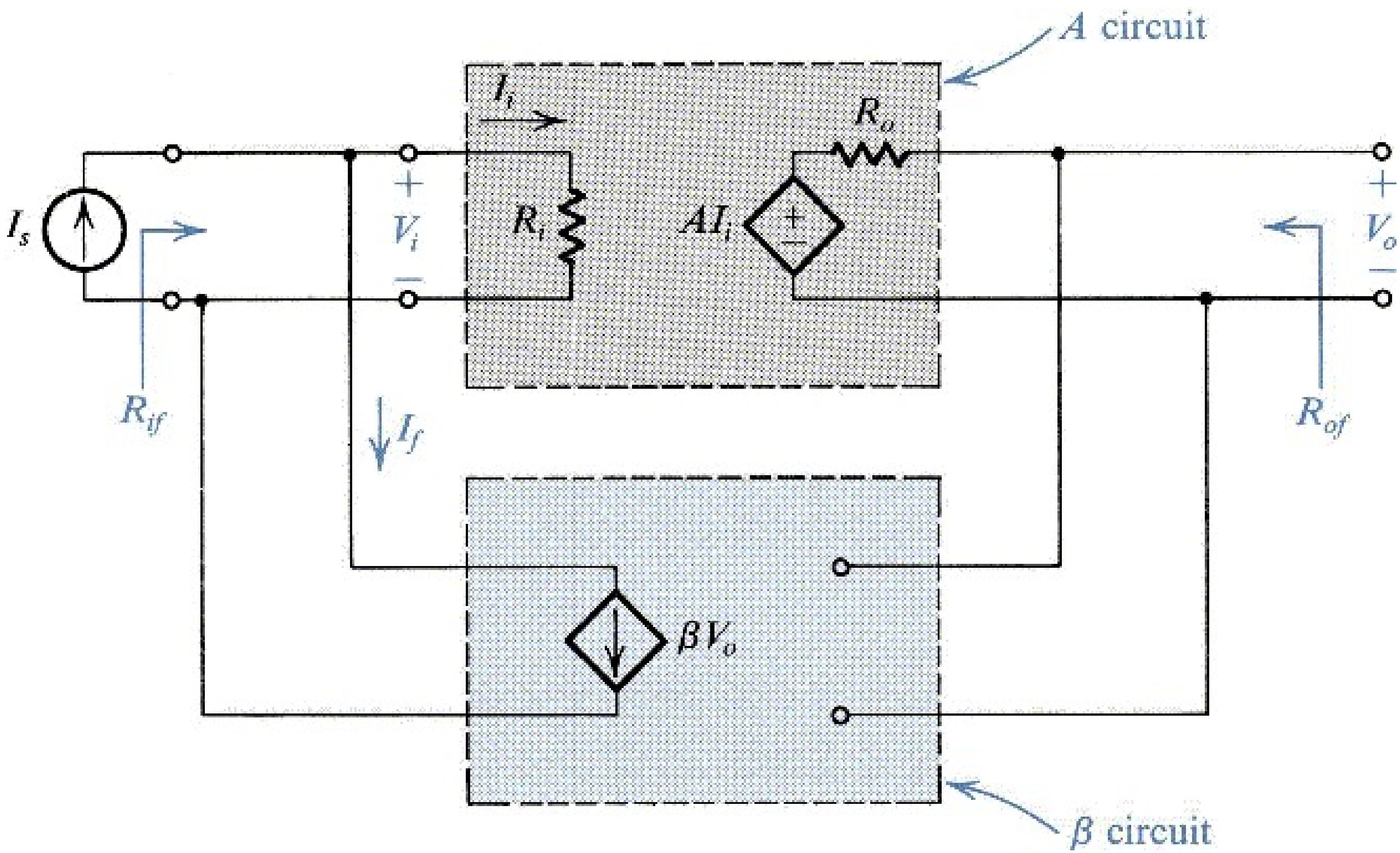


Fig. 8.18 Ideal structure for the shunt-shunt feedback amplifier.

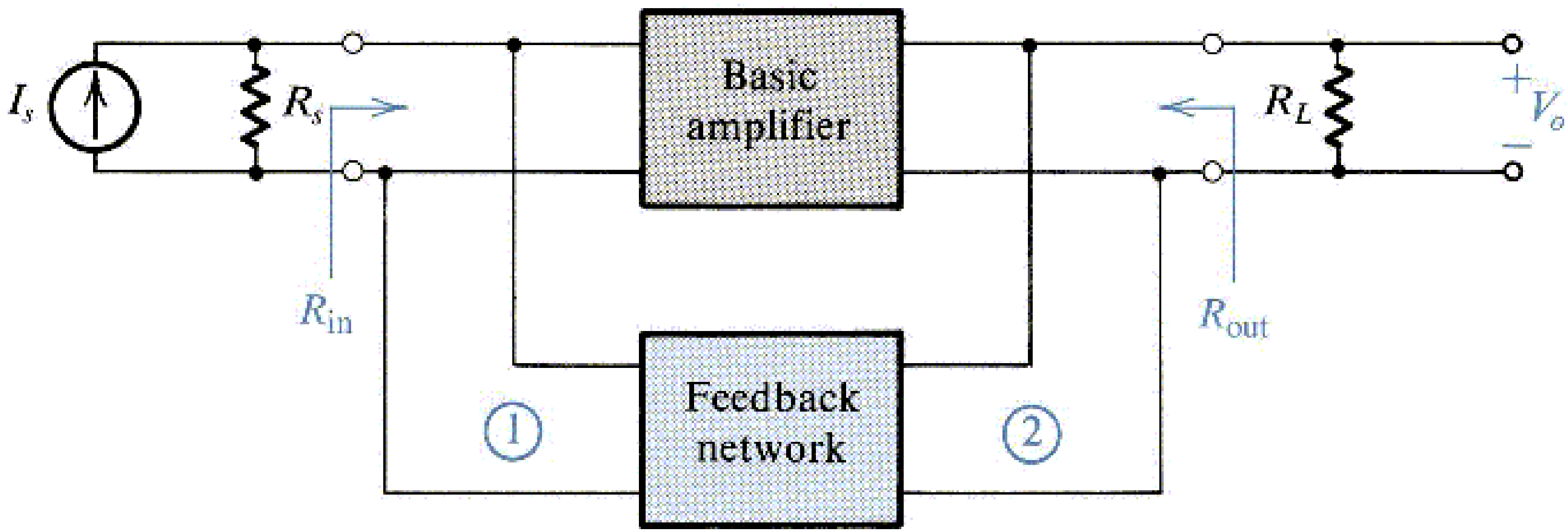


Fig. 8.19 Block diagram for a practical shunt-shunt feedback amplifier.

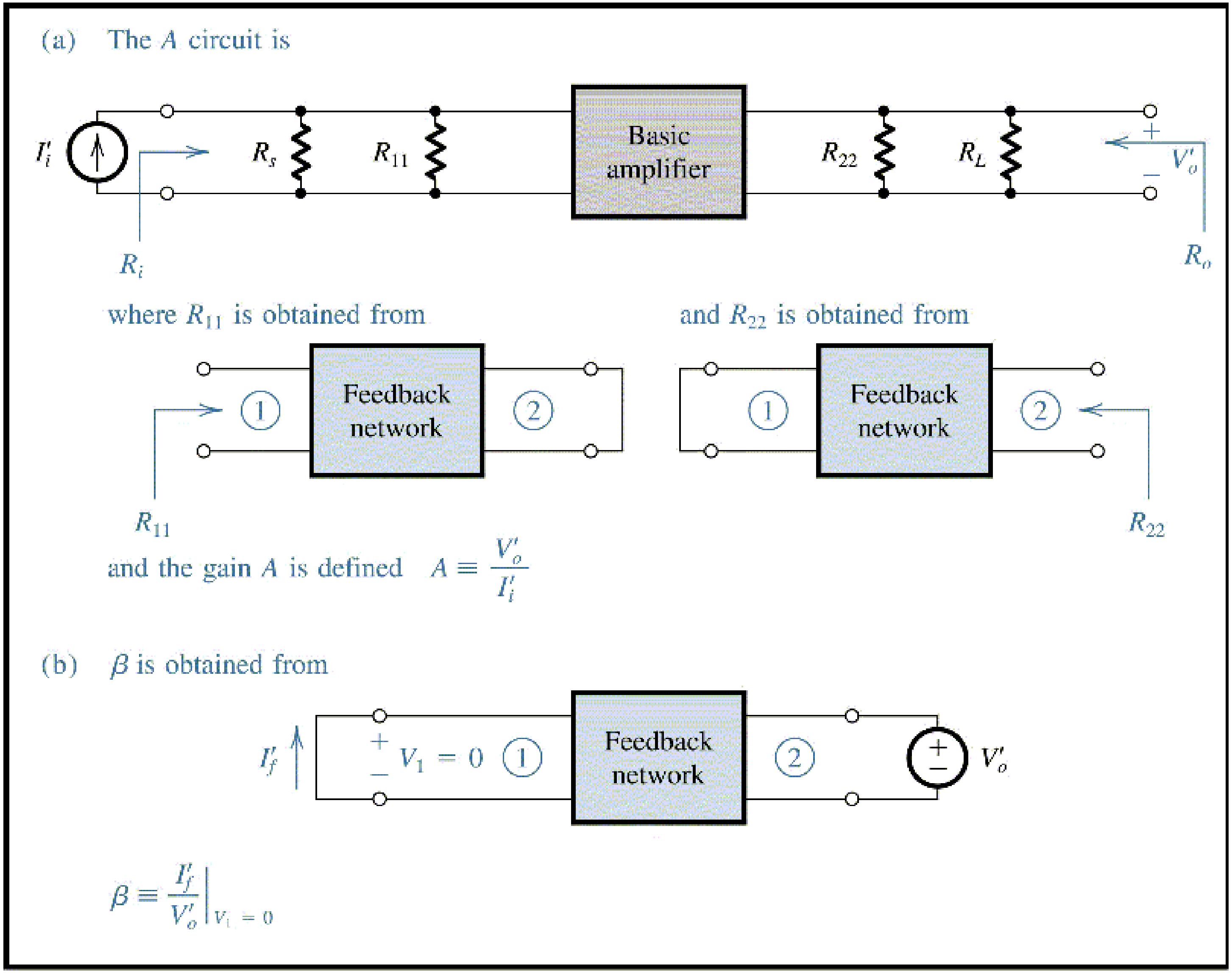


Fig. 8.20 Finding the *A* circuit and for the voltage-sampling shunt-mixing (shunt-shunt) case.

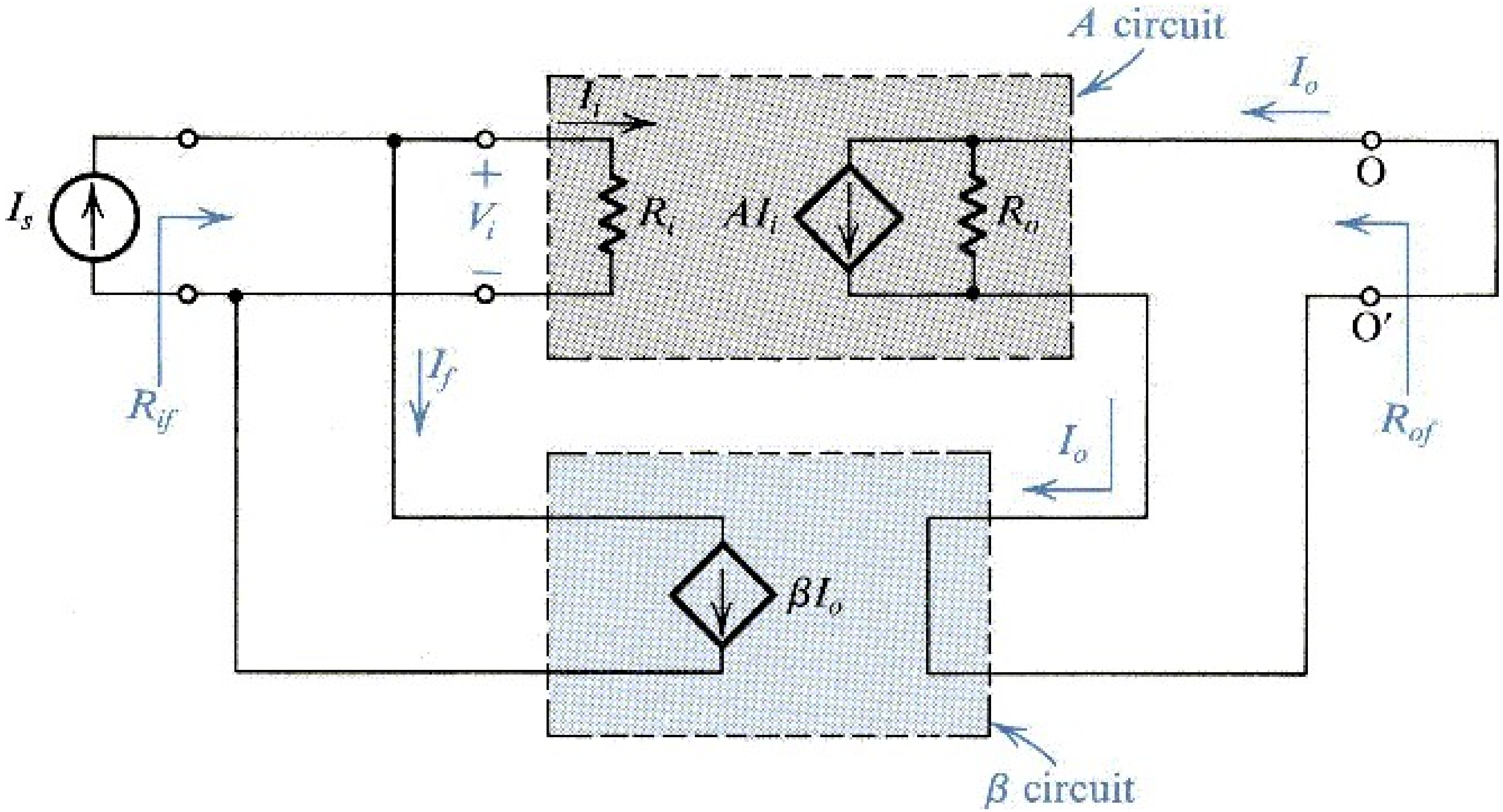


Fig. 8.22 Ideal structure for the shunt-series feedback amplifier.

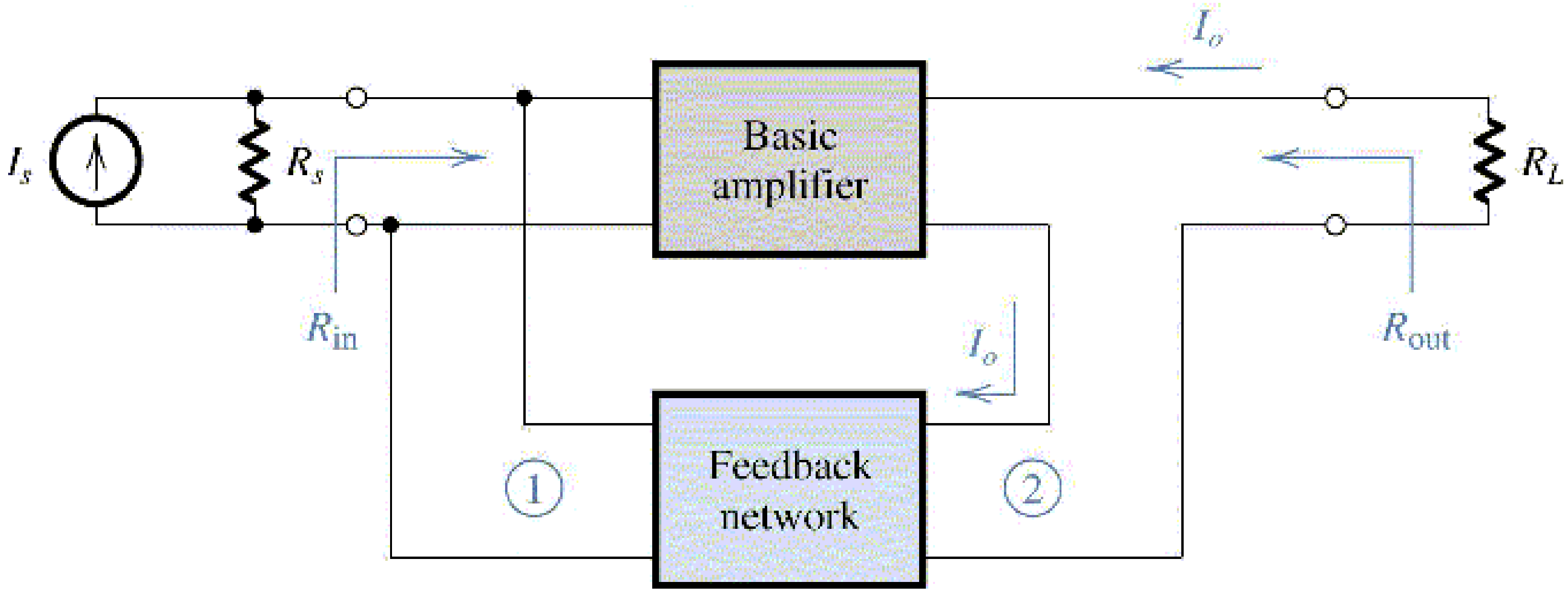


Fig. 8.23 Block diagram for practical shunt-series feedback amplifier

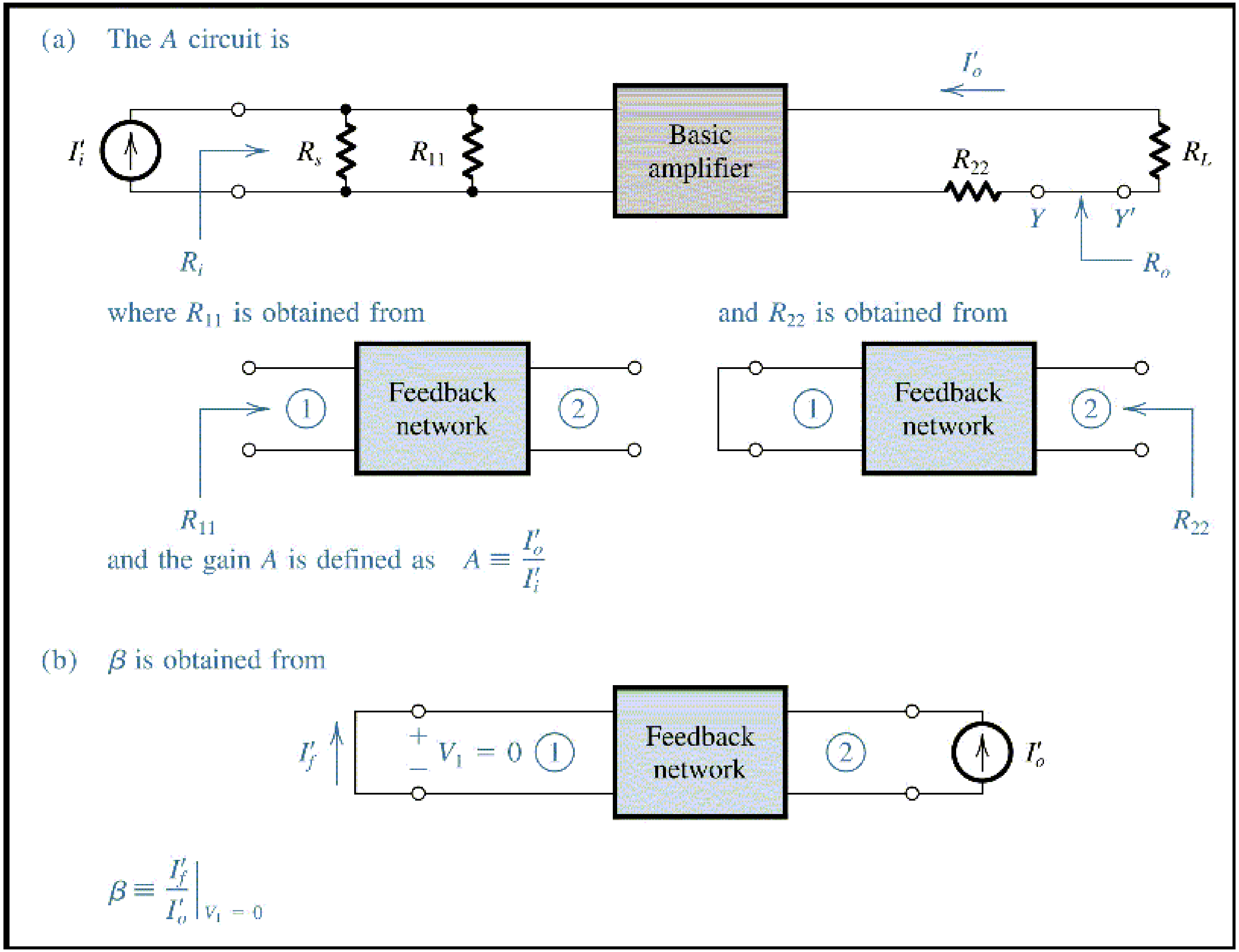


Fig. 8.24 Finding the *A* circuit and   for the current-sampling shunt-mixing (shunt-series) case.

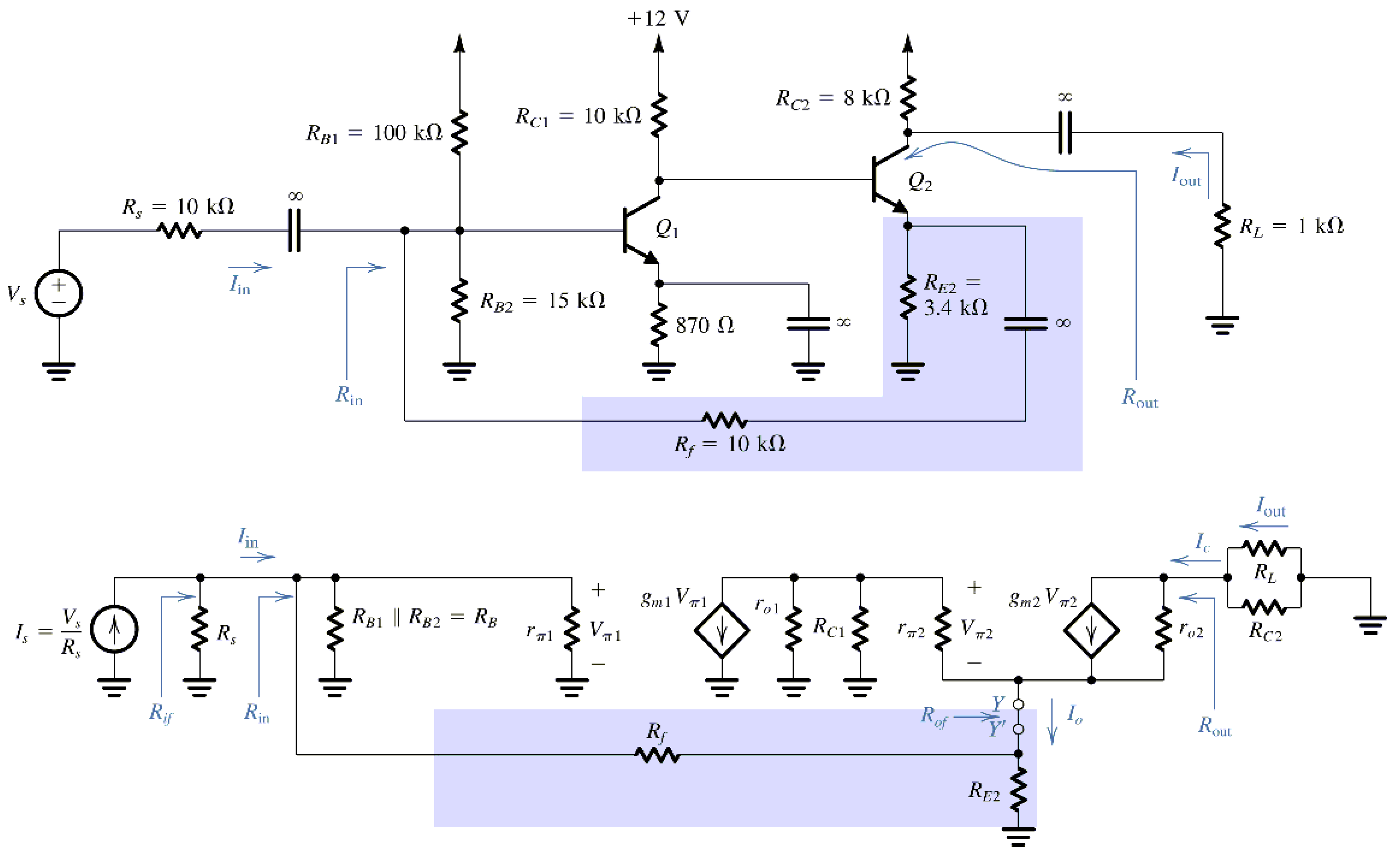


Fig. 8.25-1 Circuits for Example 8.4.

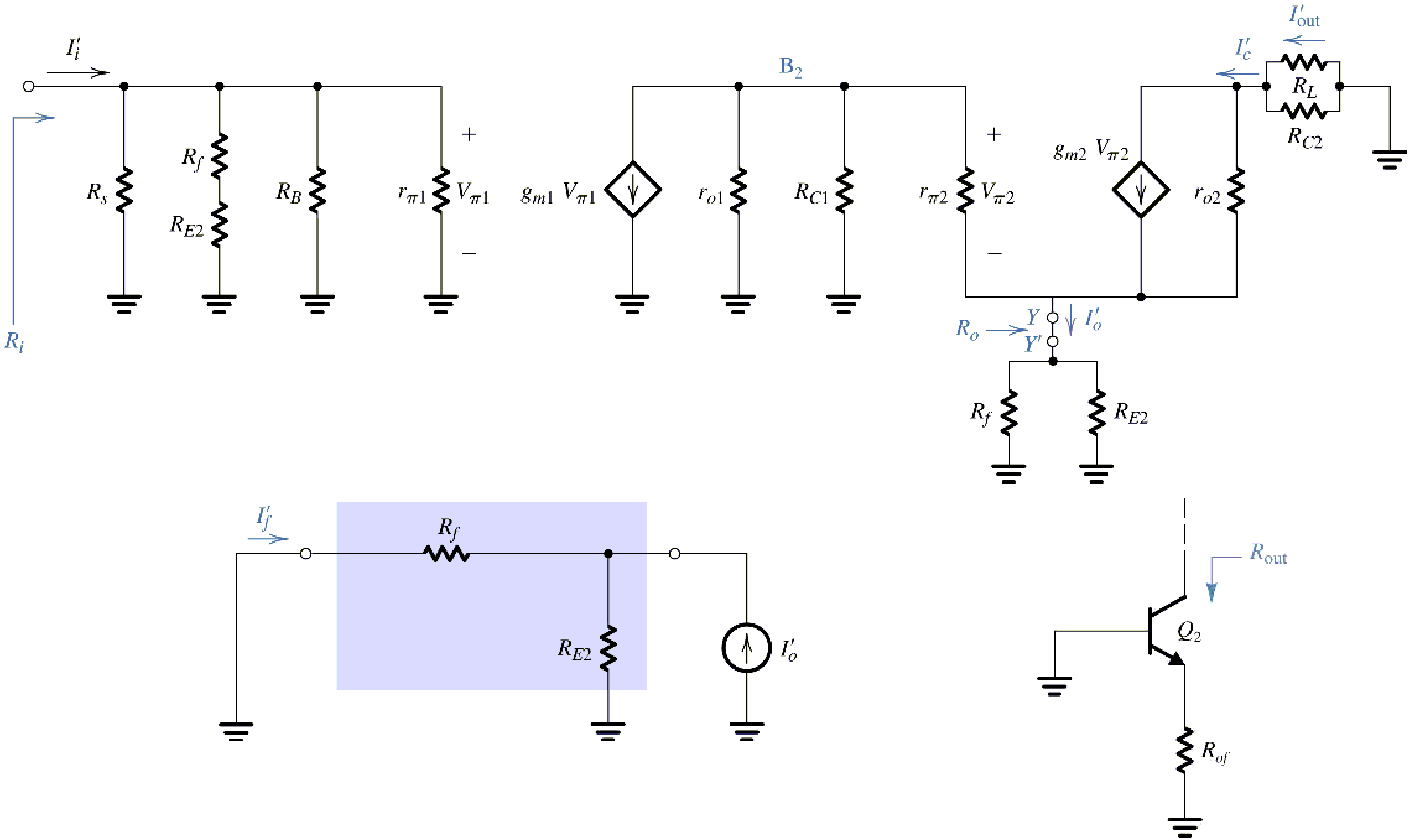
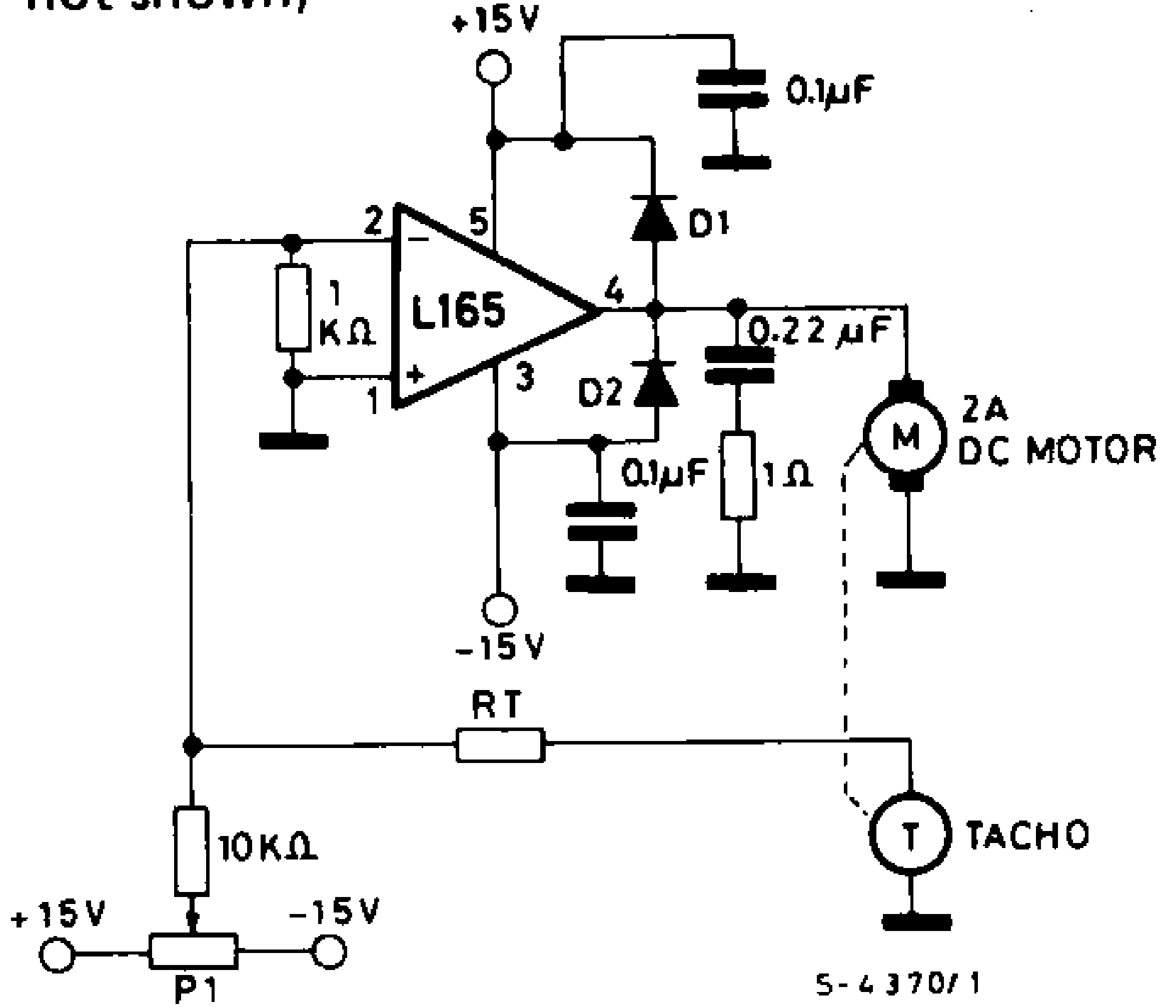


Fig. 8.25-2 Circuits for Example 8.4.


BOARD TESTER

Mehanicka povratna sprega

Fig. 12 - Bidirectional speed control of DC motor (Compensation networks not shown)



Transformatorska sprega sa modulatorom i demodulatorom

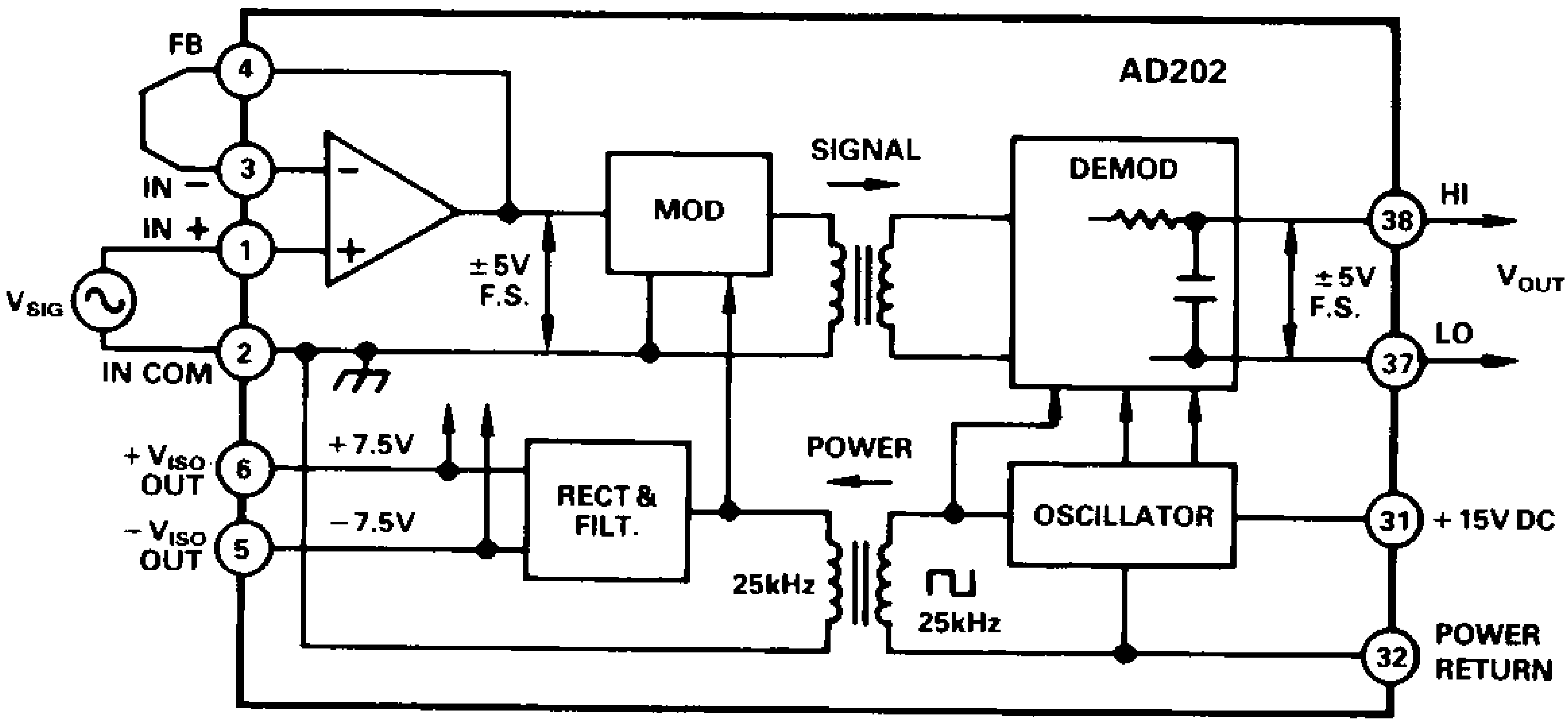


Figure 1a. AD202 Functional Block Diagram

Opticka sprega
(pomocu laserskog zraka)

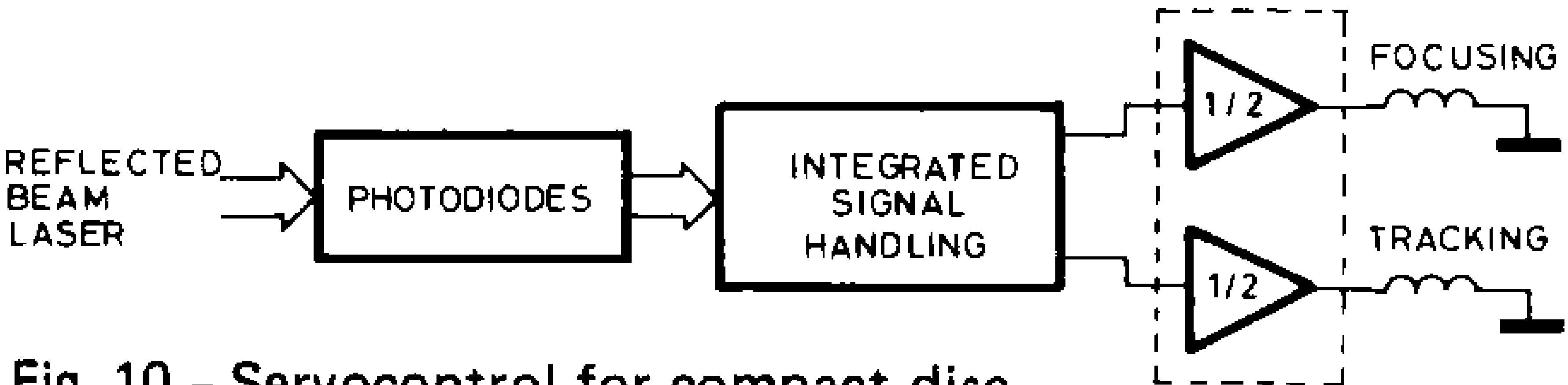


Fig. 10 – Servocontrol for compact-disc

Sprega pomocu Holove sonde

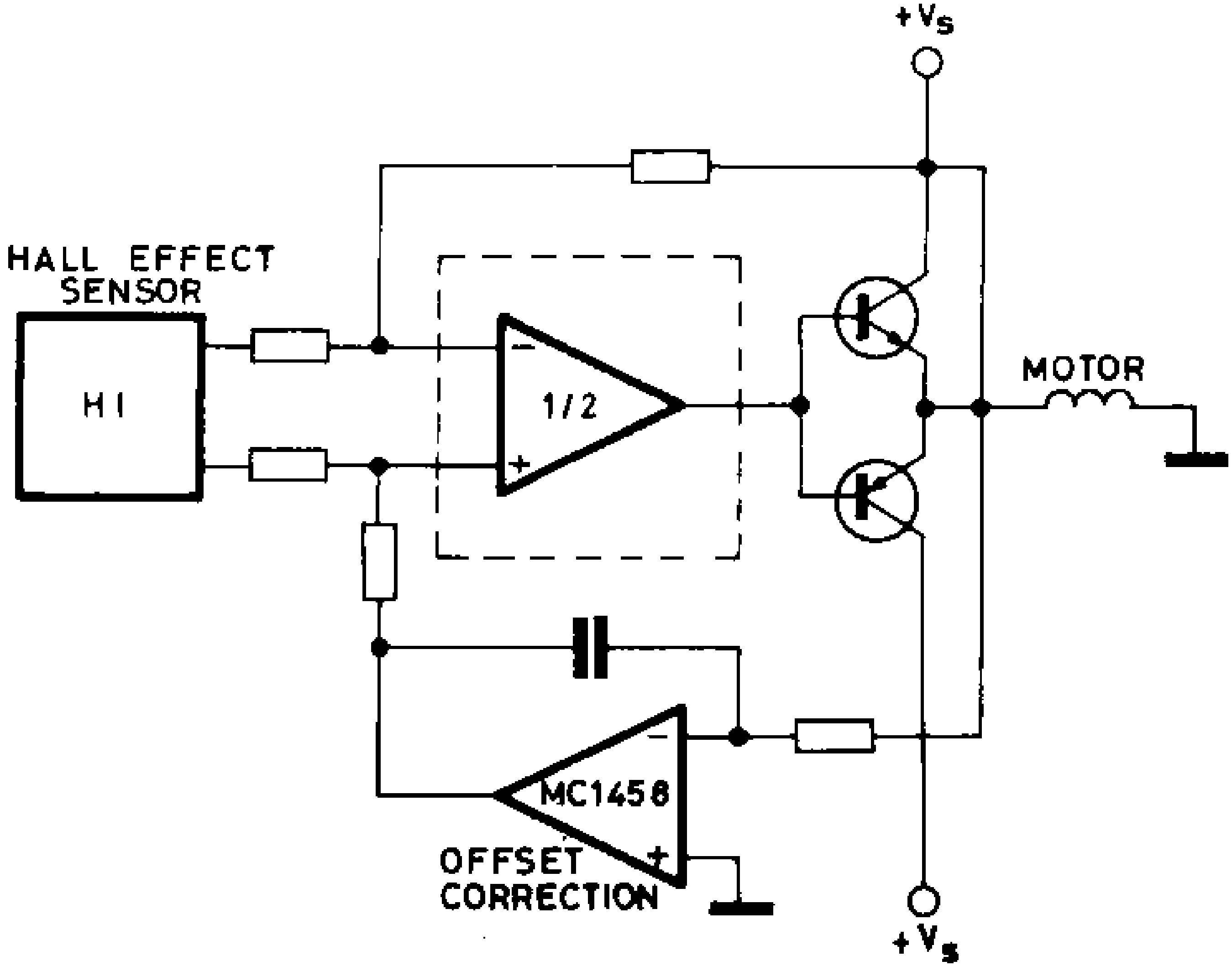
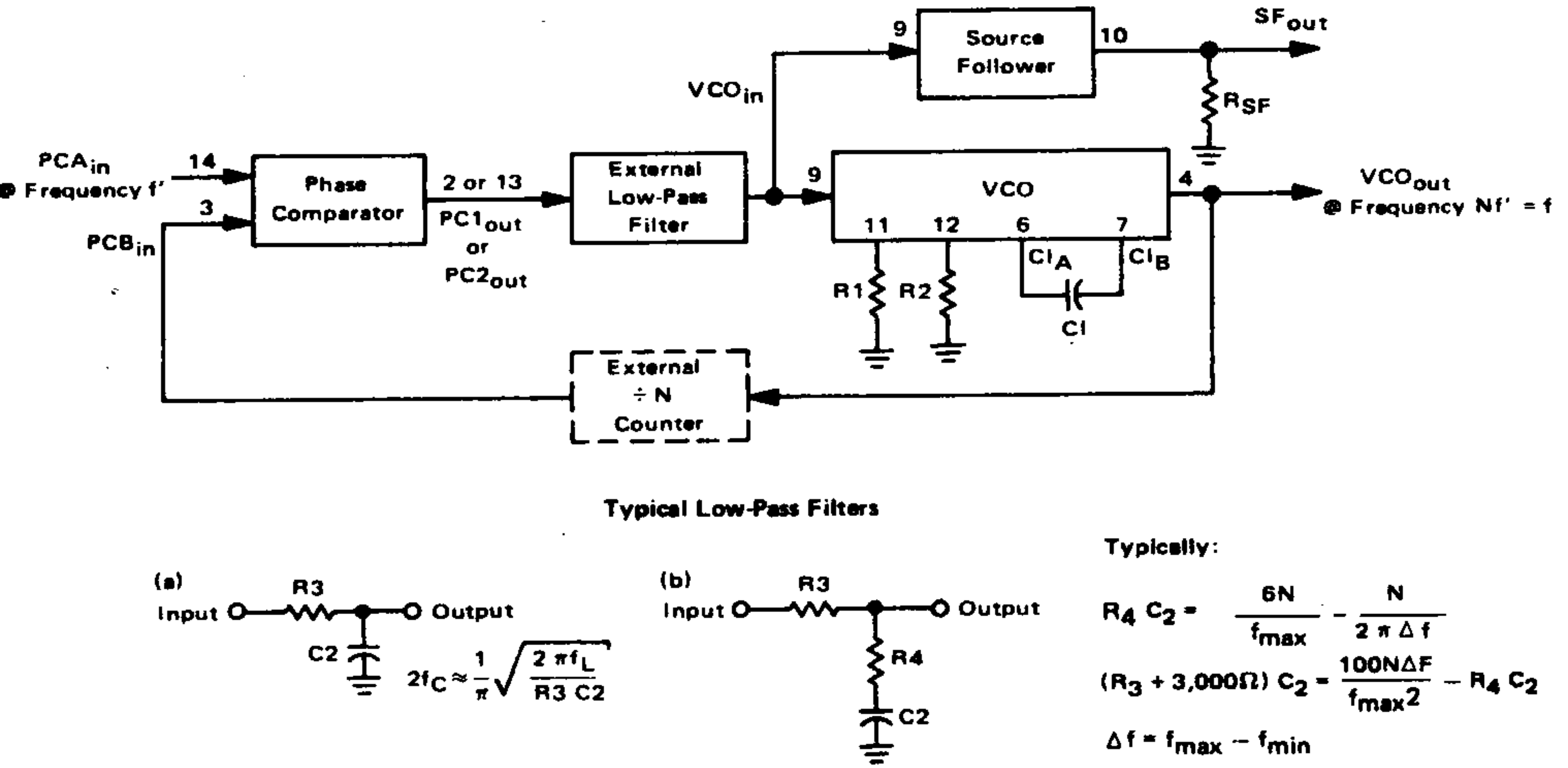


Fig. 11 – Compact-disc motor driver (1/2 section)

PLL = Fazno zatvorena petlja

FIGURE 3 – GENERAL PHASE-LOCKED LOOP CONNECTIONS AND WAVEFORMS

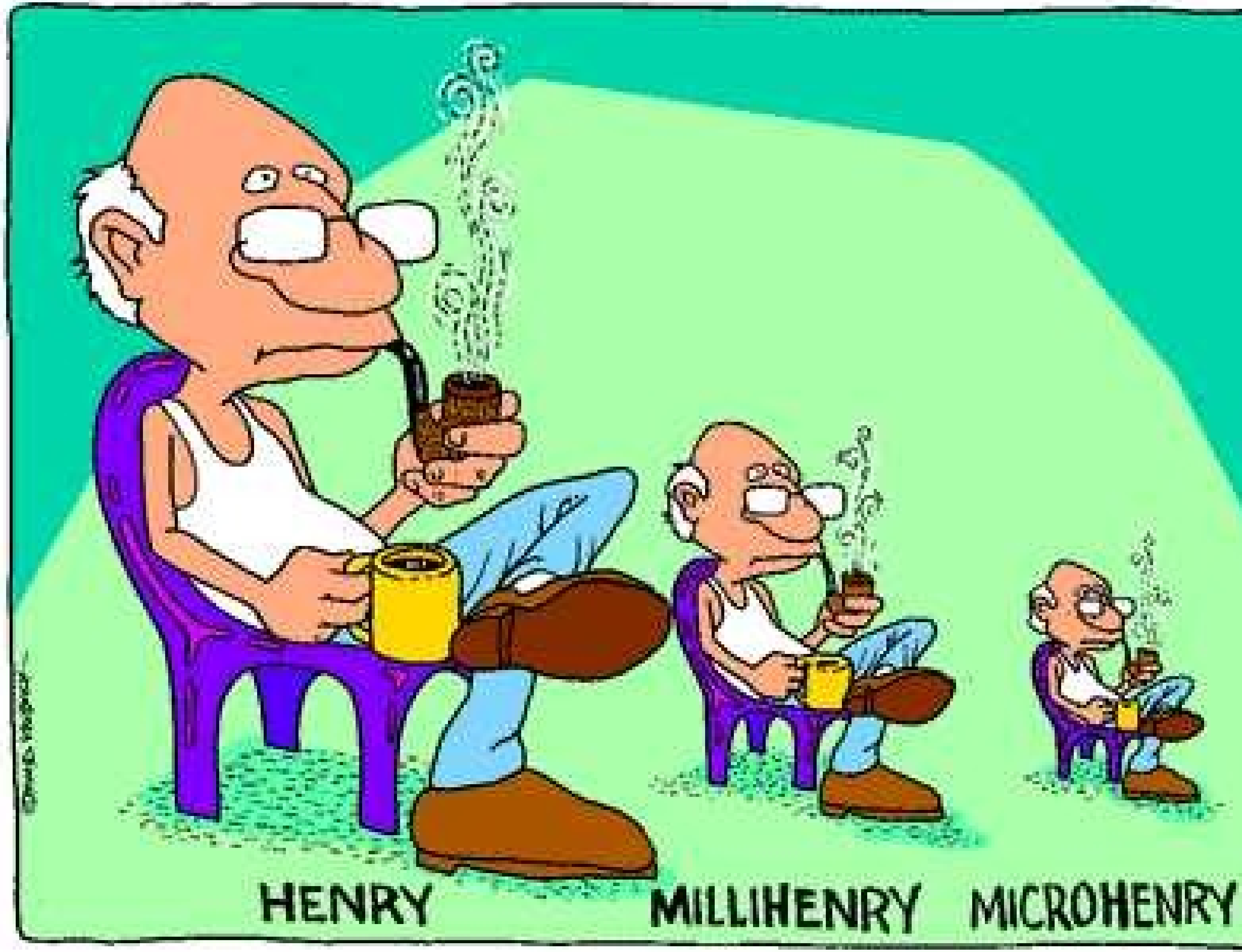


Razne vrste signala i povratnih sprega

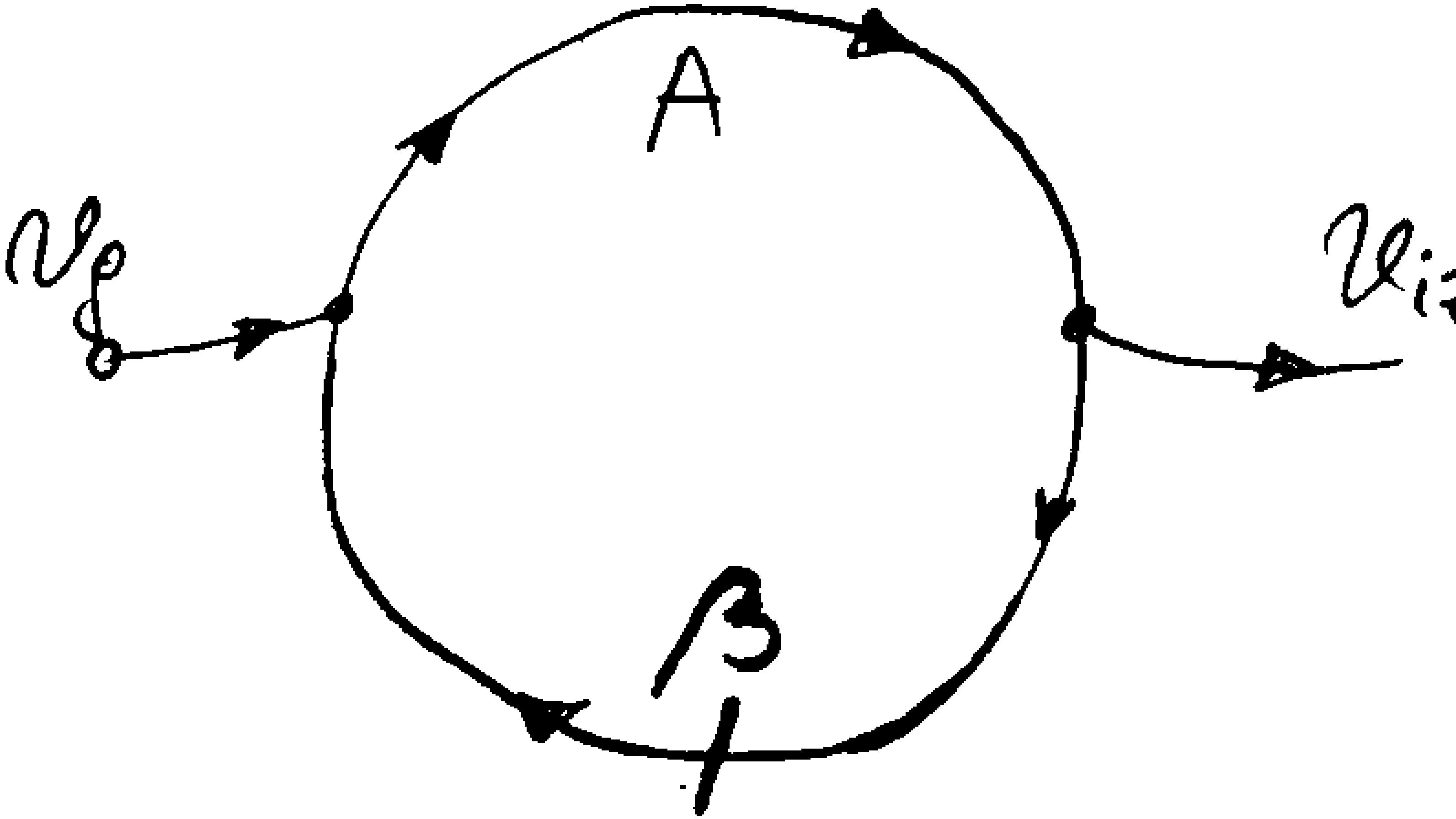
- Termicka - kod termoregulatora
- Force balance - kod vaga
- vlaga - kod regulatora vlage
- osvjetljaj - kod regulatora rasvjete
- kiselost - kod pH regulatora
- brzina fluida - kod regulatora protoka
- tezina ili duzina - kod regulatora nivoa
- ……………….

Različit pristup (ima i pogrešnih)

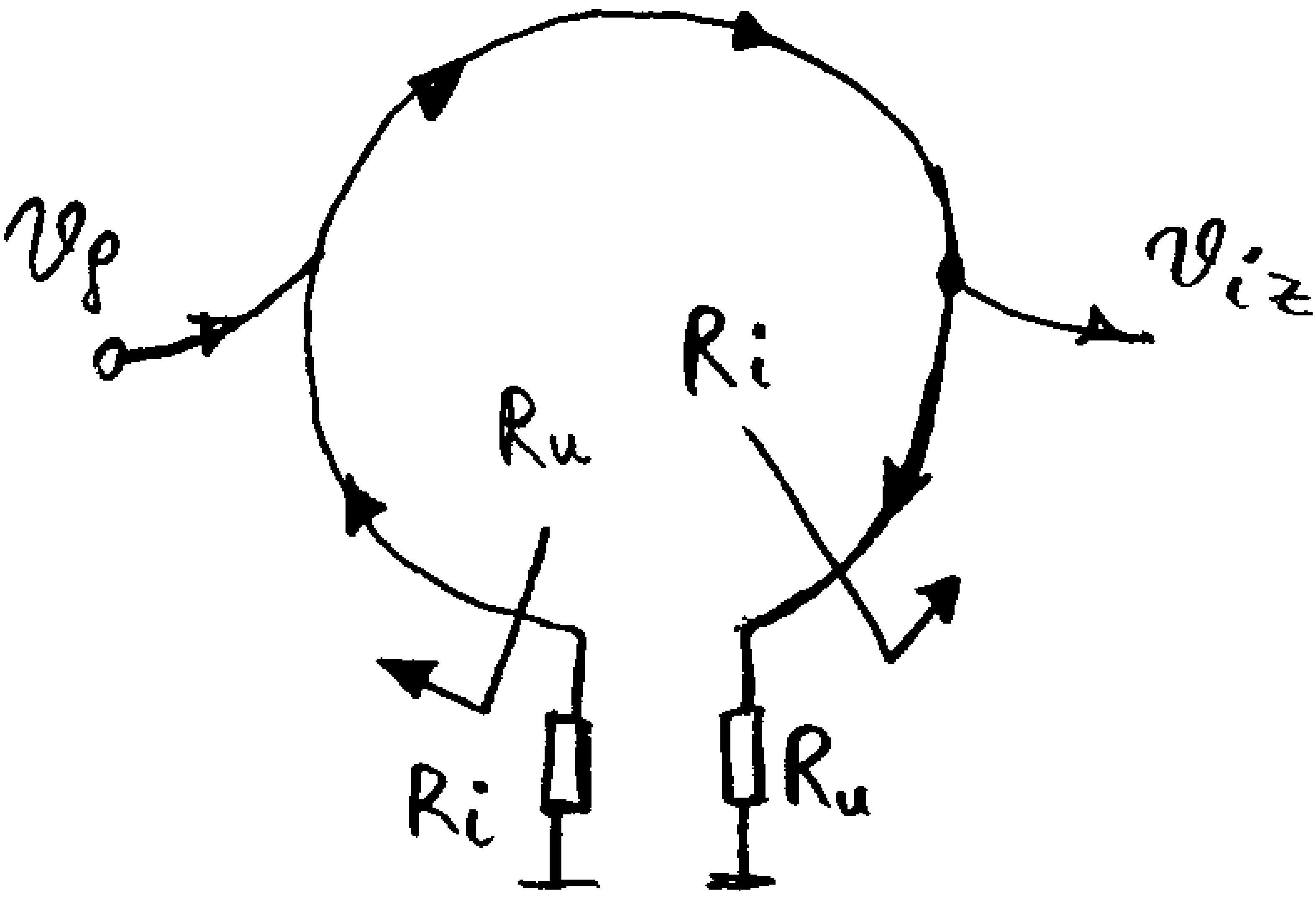
- https://en.wikipedia.org/wiki/Negative-feedback_amplifier
- https://www.electronics-tutorials.ws/systems/negative-feedback.html
- https://learnabout-electronics.org/Amplifiers/amplifiers30.php
- https://www.electrical4u.com/what-is-an-oscillator/


HENRY
MILLIHENRY
MICROHENRY

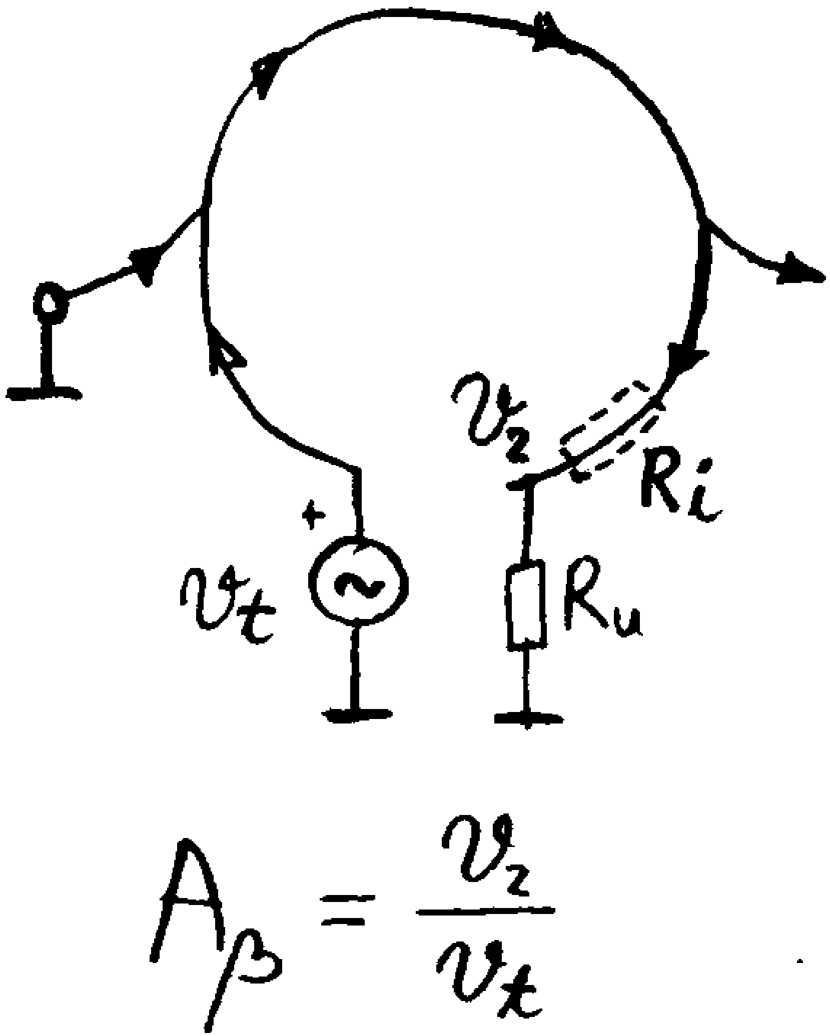
Nalazenje A i Ab presjecanjem kruzne konture

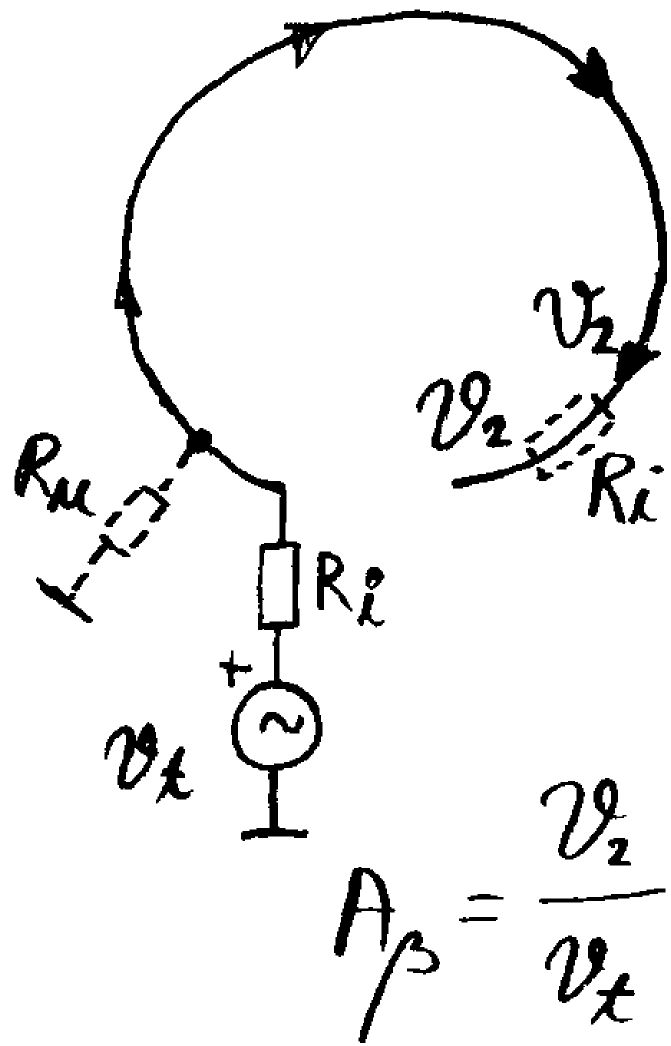


Modifikacija kola nakon presjecanja

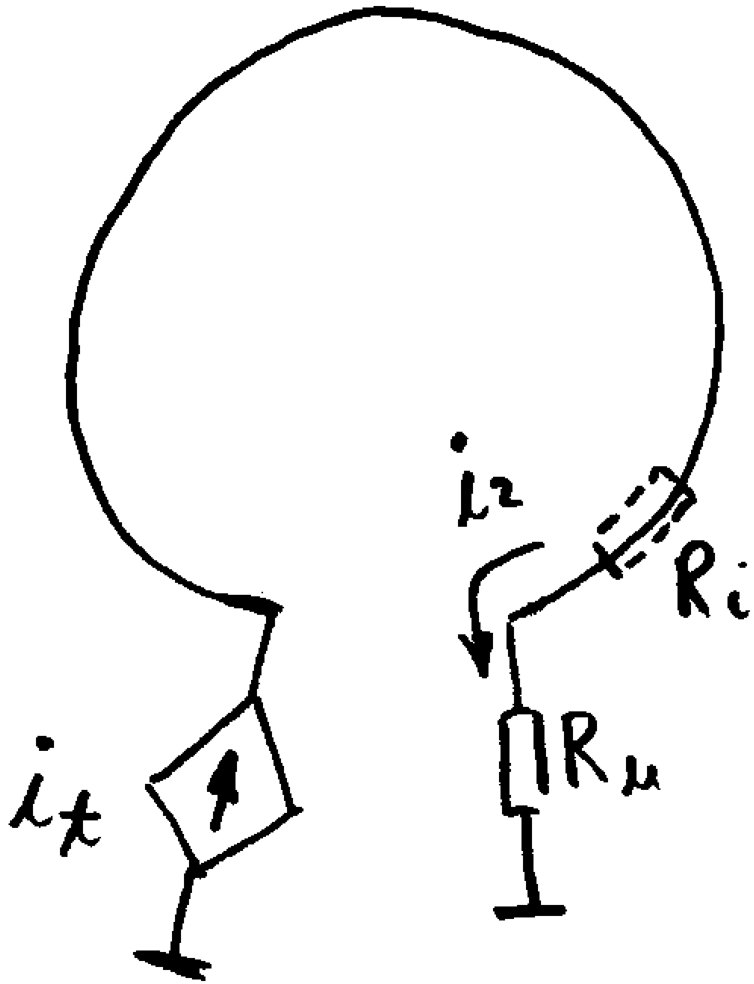


Nalazenje Ab pomocu naponskog testnog generatora (Vt)



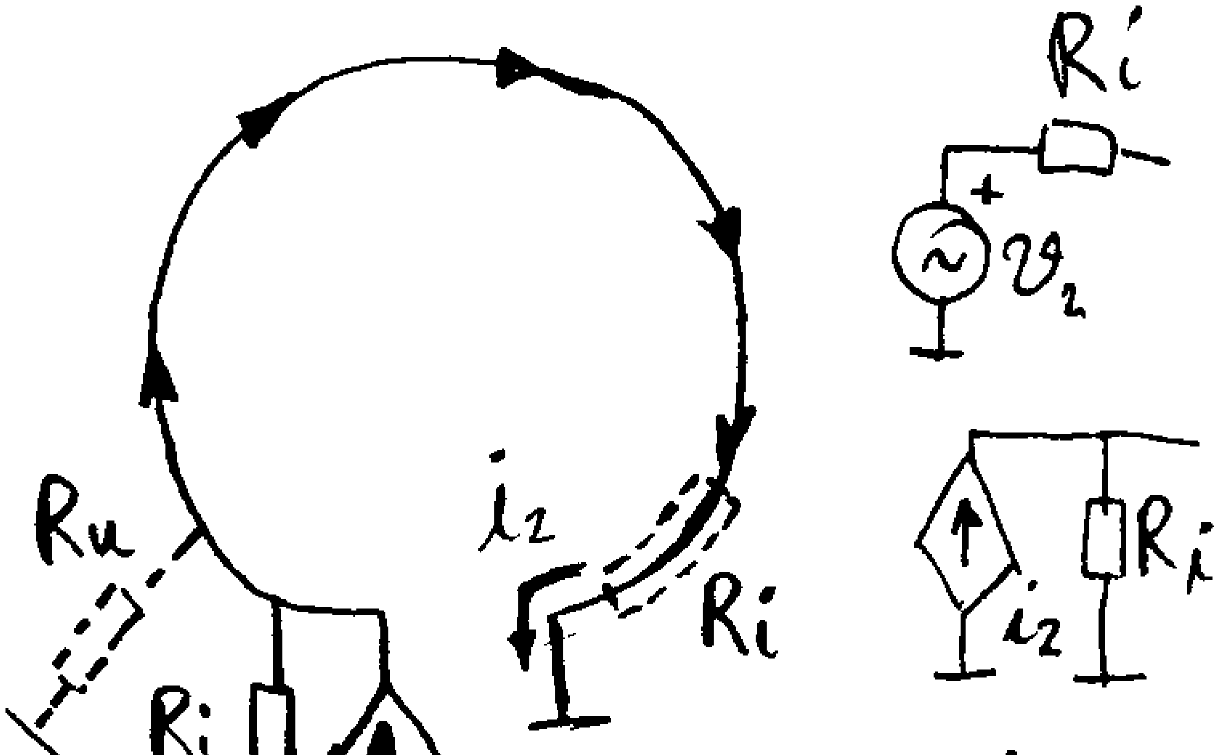


Nalazenje Ab pomocu strujnog testnog generatora (It)



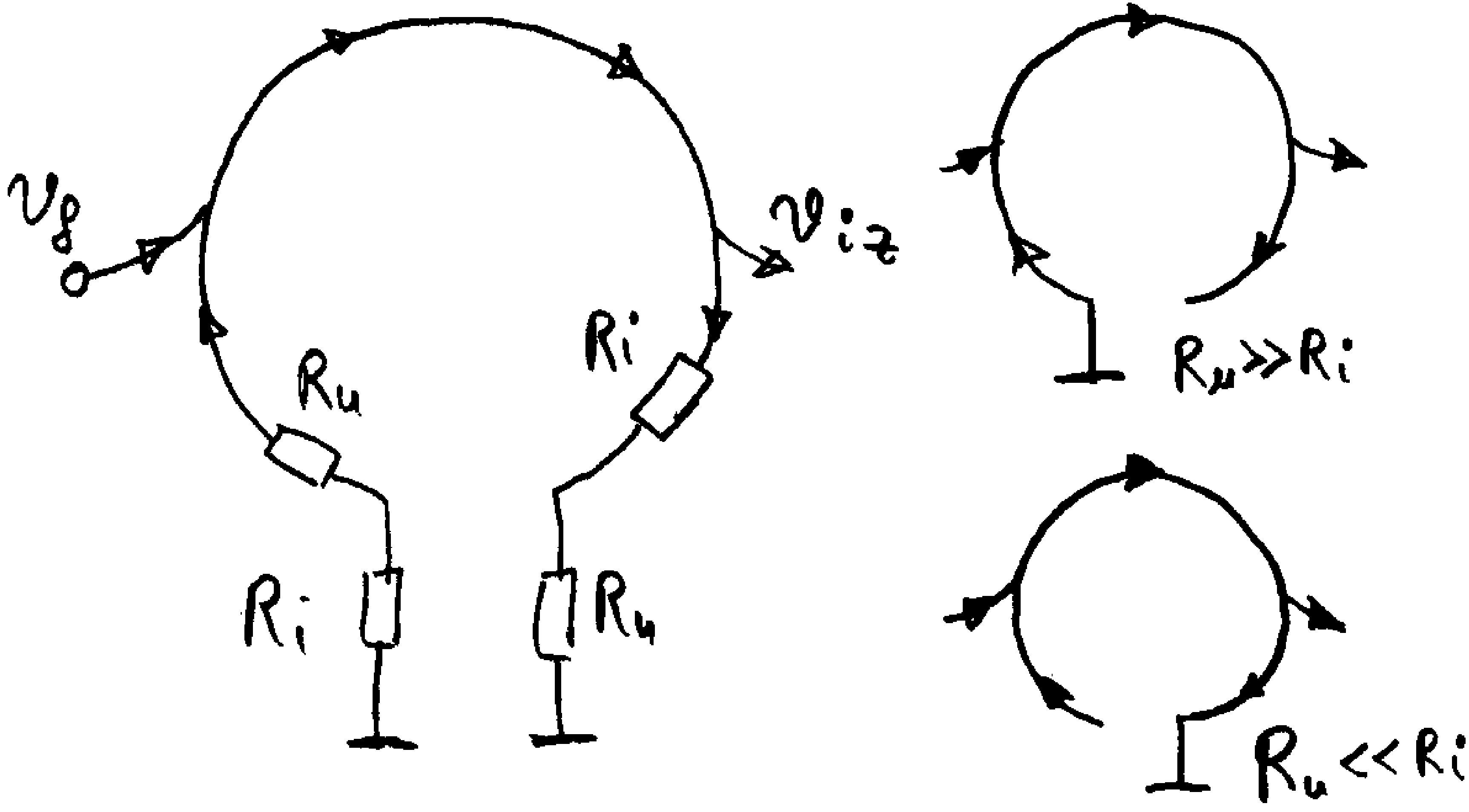
$$A_\beta = \frac{i_2}{i_t}$$

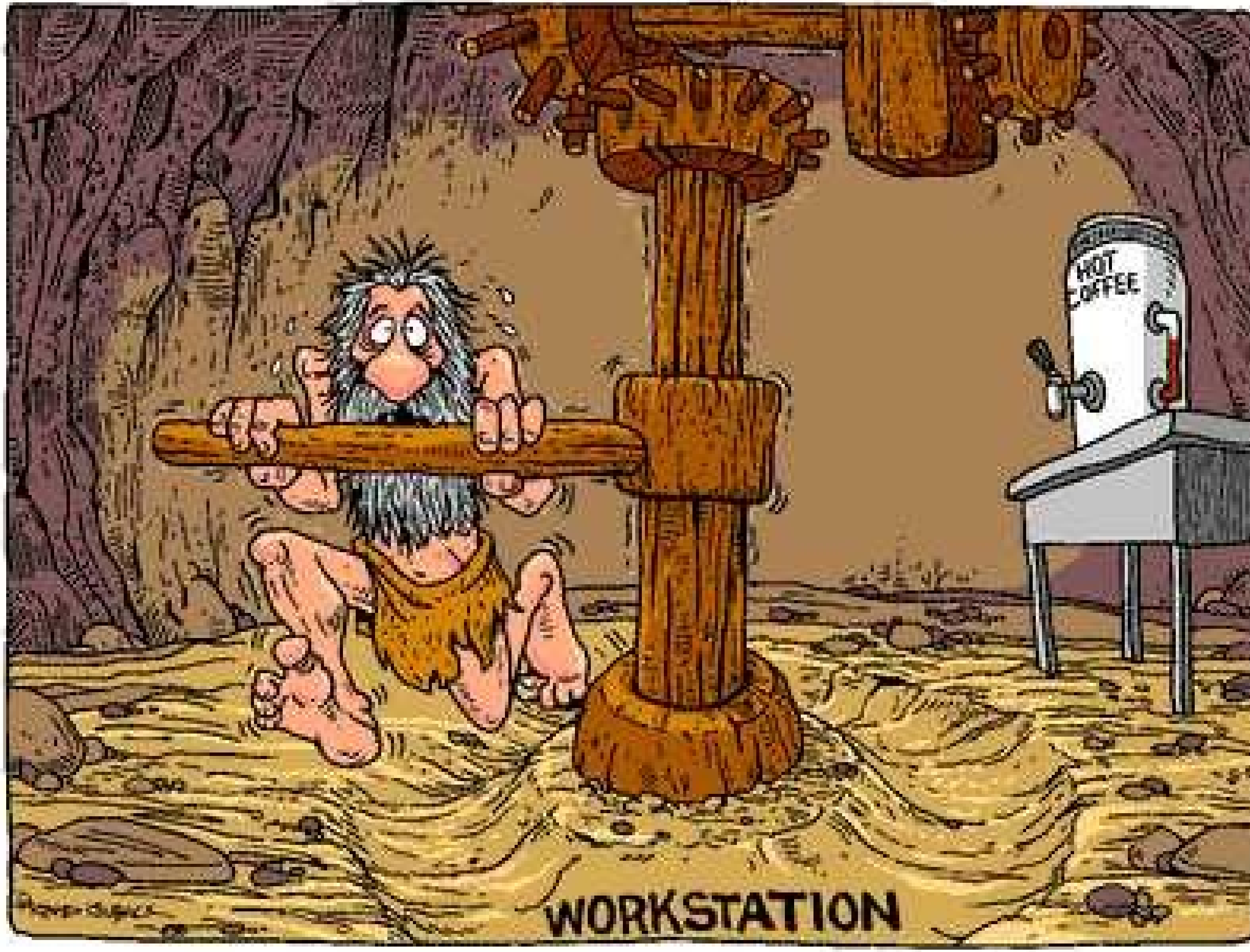
Nalazenje Ab pomocu It na drugi nacin (kratkospojen izlaz)



$$A_\beta = \frac{i_2}{i_t}$$

Ako se kontura presjece na pogodnom mjestu, modifikacija kola moze biti veoma jednostavna




HOT COFFEE
WORKSTATION

NPS smanjuje uticaj nelinearnosti direktne grane

Sve neprecizne, nelinearne, nestabilne elemente stavljamo u direktnu granu, a precizne i stabilne u povratnu granu

$$I_C = I_S e^{V_{BE}/V_T}$$

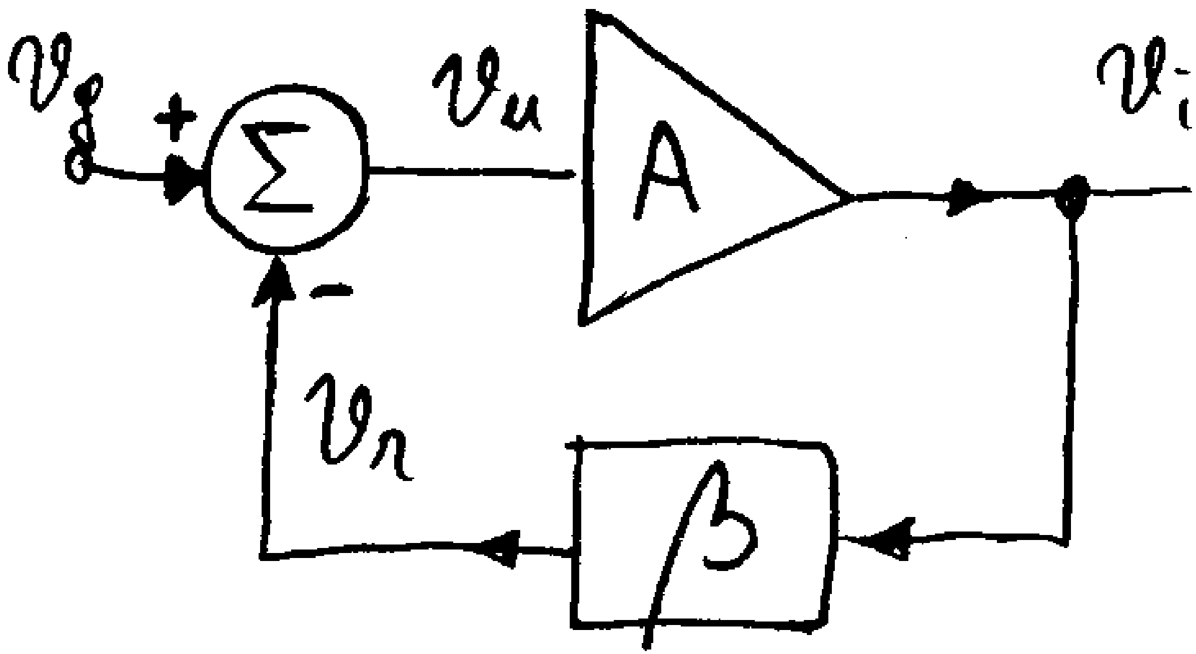
$$I_D = B\left(V_{GS} - V_{GST}\right)^2$$

$$I_D = I_0\left(e^{V_D/V_T} - 1\right)$$

$$A_r = \frac{A}{1 - A\beta}$$

$$|A\beta| \gg 1 \Rightarrow A_r = \frac{1}{-\beta}$$

Dobijanje inverznih funkcija pomocu NPS



$$A \to \infty$$

$$\Rightarrow v_u \to 0$$

$$\Rightarrow v_r = v_g$$

$$v_r = \beta(v_{iz})$$

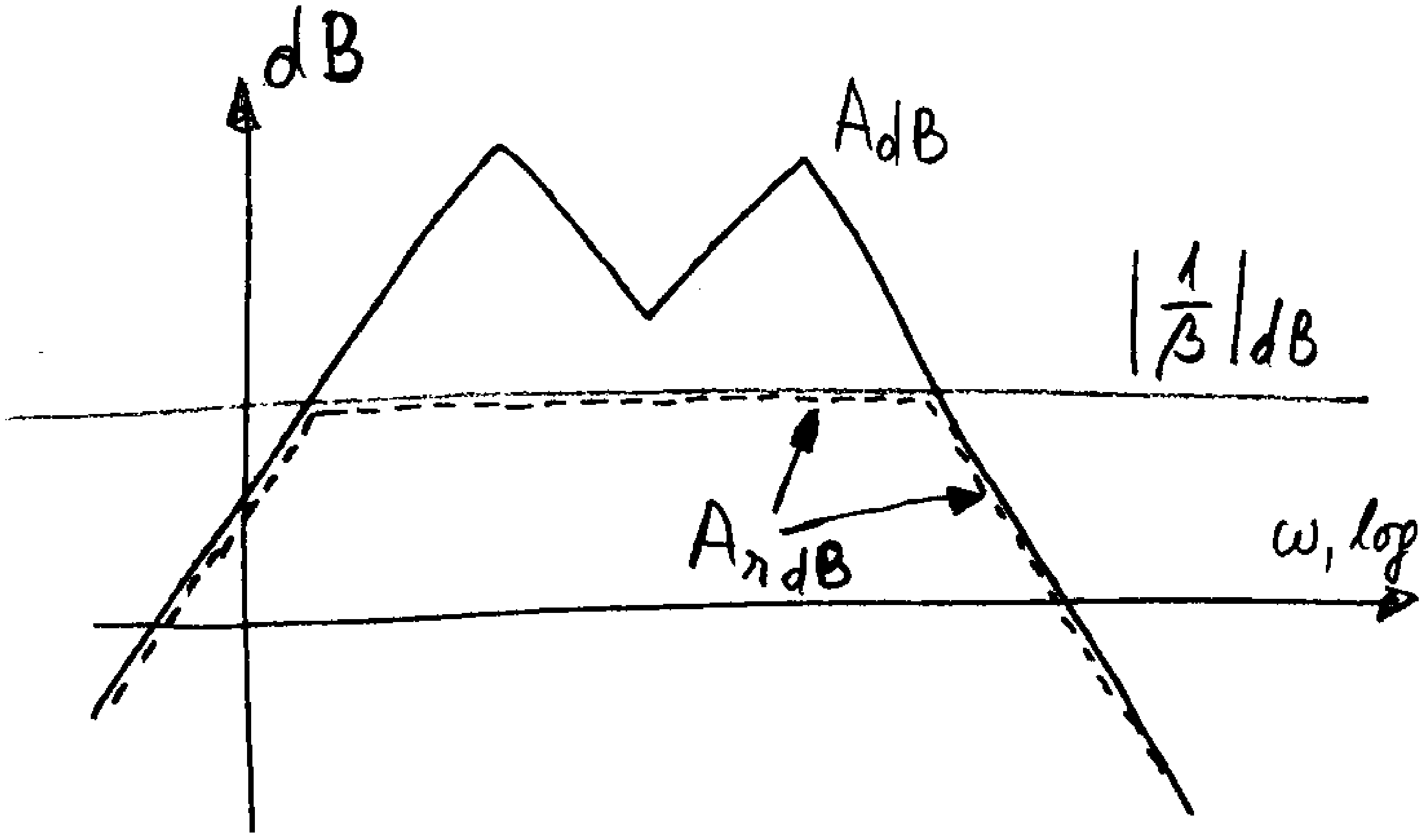
$$v_g = \beta(v_{iz})$$

$$\Rightarrow v_{iz} = \beta^{-1}(v_g)$$

Uticaj NPS na AFK i FFK

$$A_n = \frac{A}{1 - A\beta} = \begin{cases} A & ; \ |A\beta| \ll 1 \\ & \ \ |A| \ll \left|\frac{1}{\beta}\right| \\ -\frac{1}{\beta} & ; \ |A\beta| \gg 1 \\ & \ \ |A| \gg \left|\frac{1}{\beta}\right| \end{cases}$$

AFK od Ar se dobija kada se uzima manja AFK od: A i 1/β



Ne moramo da znamo koliko je β, niti šta je sve uključeno u β.

Postupak je sledeći:

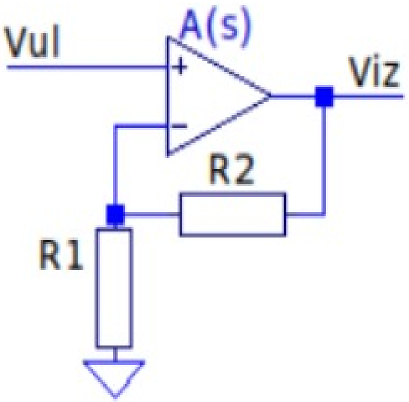
1) Uočimo direktnu i povratnu grane kola.

2) Računamo asimptotu prenosne funkcije za slučaj da je $A\beta \gg 1$. Zatvorimo petlju i računamo kao da je A beskonačno ($A \to \infty$). Drugim riječima, računamo kao da imamo idealne OP.

3) Računamo asimptotu prenosne funkcije za slučaj da je $A\beta \ll 1$. Prekinemo povratnu granu ($\beta = 0$) i nađemo pojačanje direktne grane. Ono se još zove pojačanje u otvorenoj petlji A_{OL} (open loop gain).

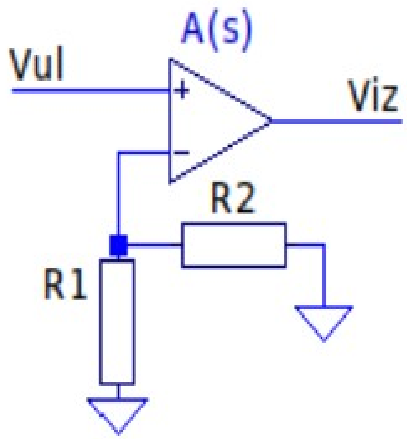
4) Na kraju uzimamo od obje asimptote onaj dio koji je manji.

Primjer 1 – neinvertujući pojačavač sa OP (fg=40Hz i ft=1MHz)



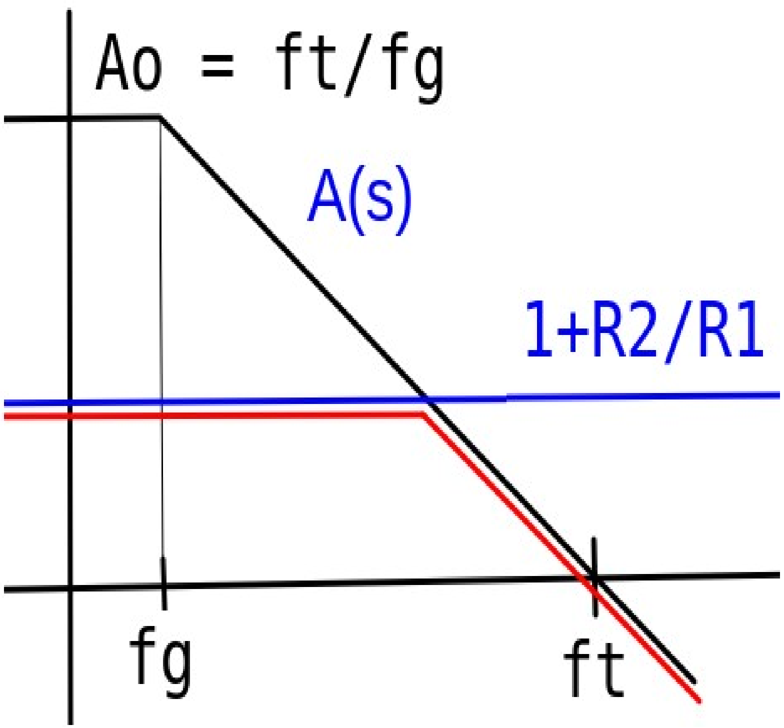
$A\beta >> 1; \quad A -> \infty$

Viz/Vul = 1+R2/R1

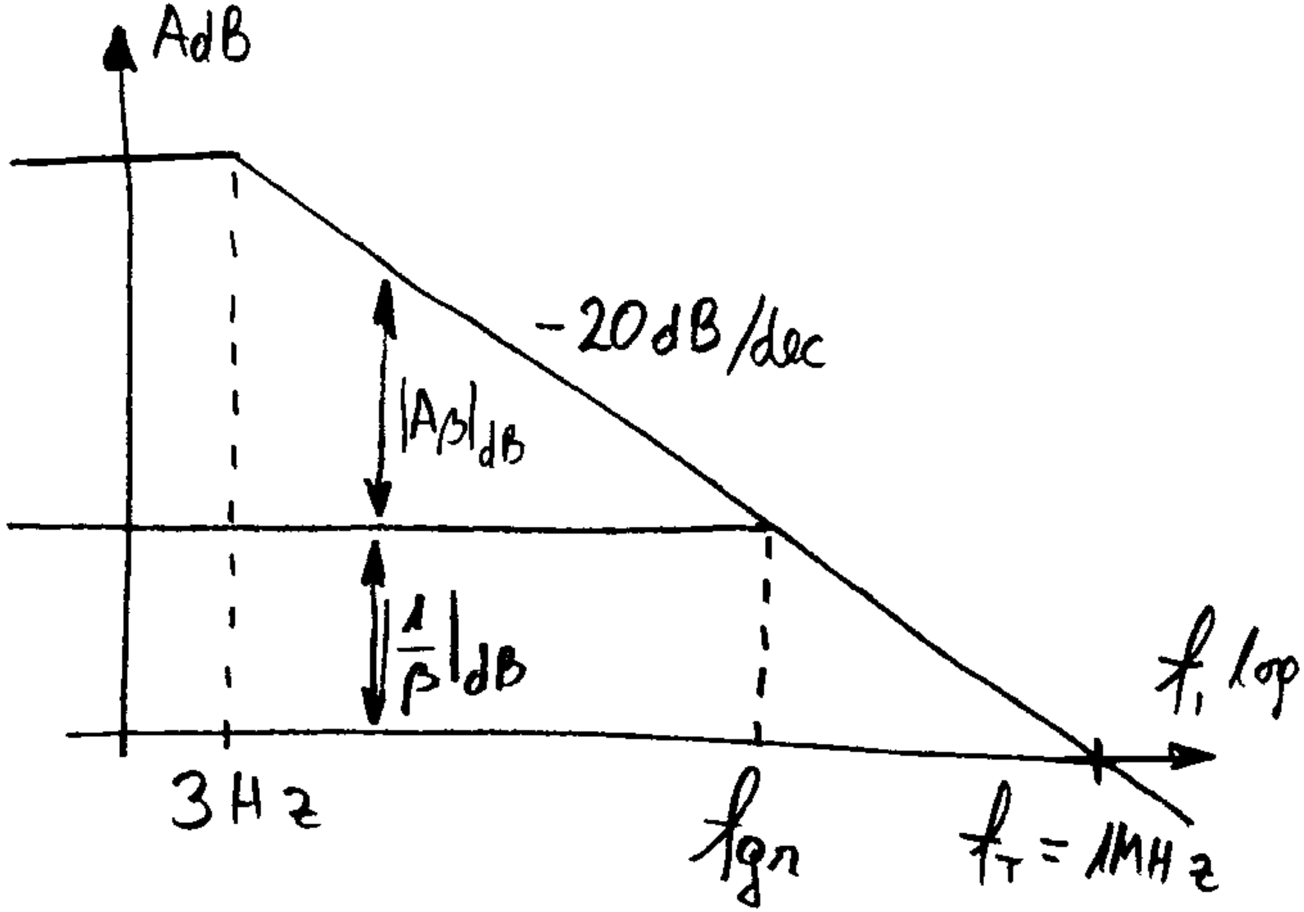


$A\beta << 1; \quad \beta = 0$

Viz/Vul = A(s)

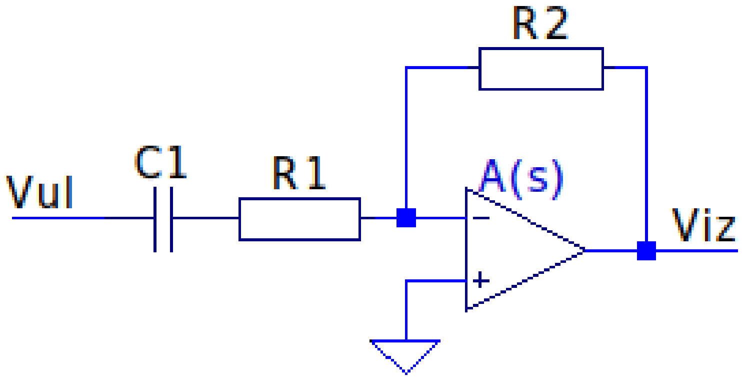


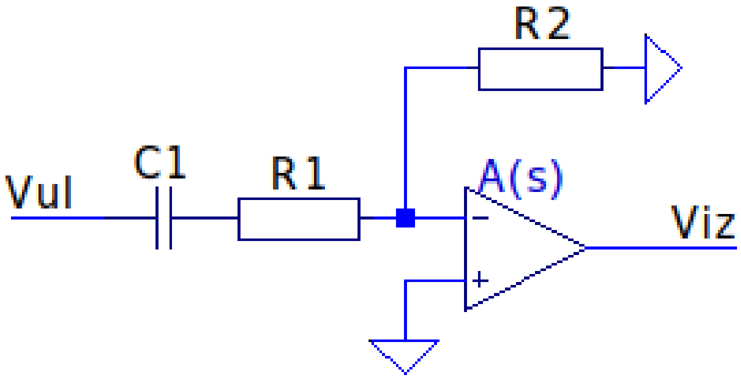
Primjer uticaja NPS na AFK kod LM741



$$A_r \cdot f_{gr} = GBWP = f_T$$

Primjer 2





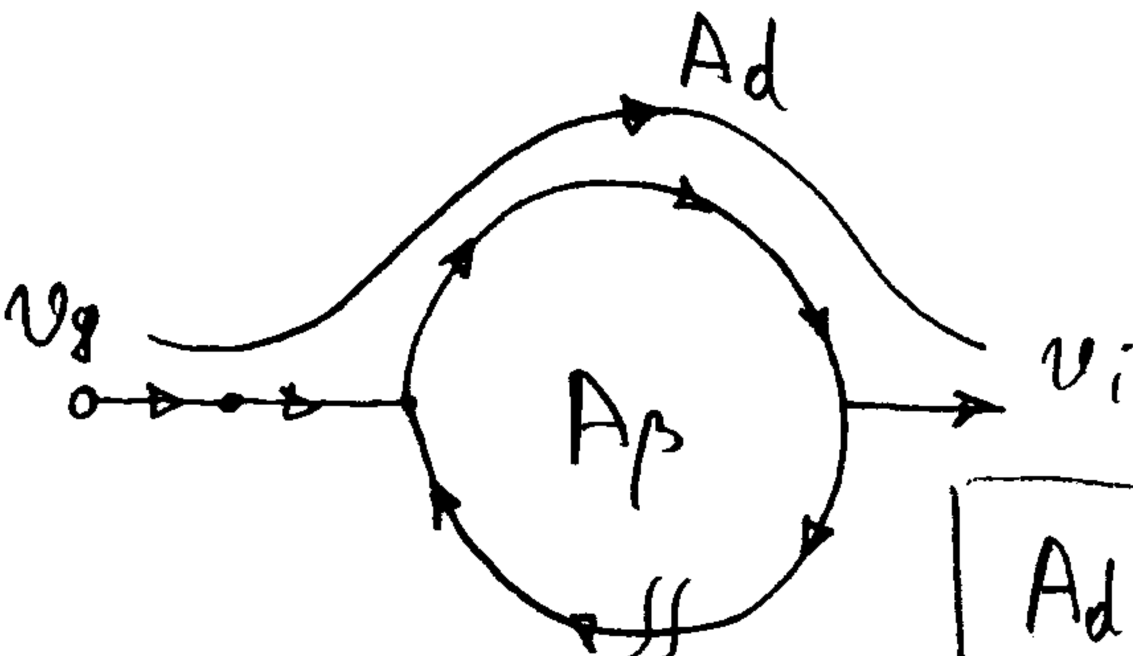
$$A\beta >> 1;\ A \to \infty$$

Viz/Vul =
 -R2/(R1+1/sC1)

$$A\beta << 1;\quad \beta = 0$$

Viz/Vul =
R2/(R1+R2+1/sC1)*
(-A(s))

Nalazenje Ar kod kola sa NPS i direktnim granama van NPS



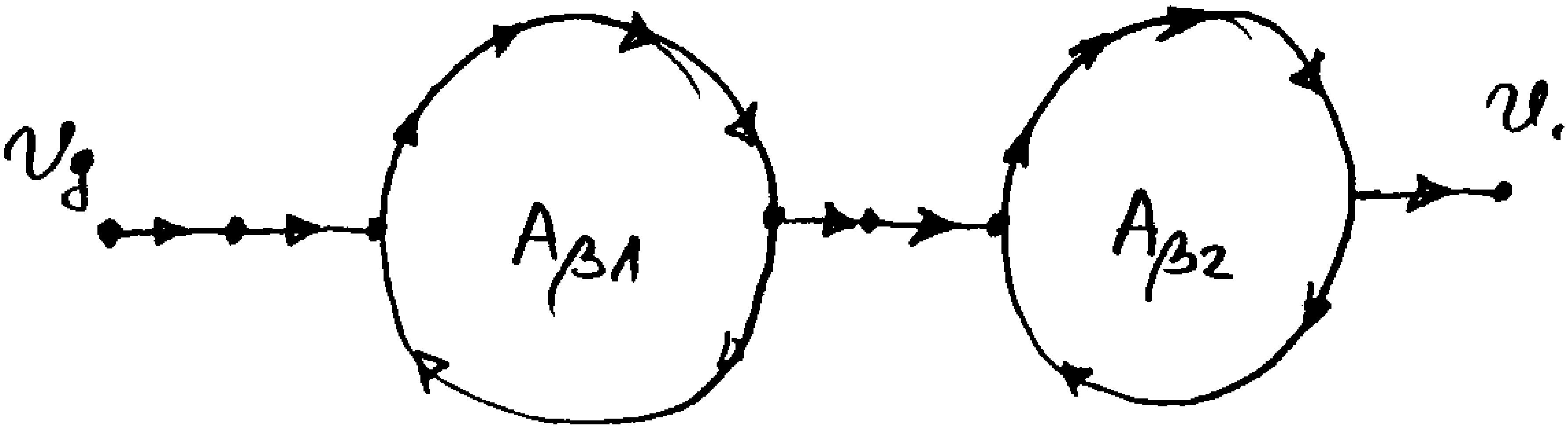
$$A_r = \frac{v_i}{v_g} = \frac{A_d}{1 - A_\beta}$$

$$A_d = \frac{v_i}{v_g}$$

уз отворену контуру

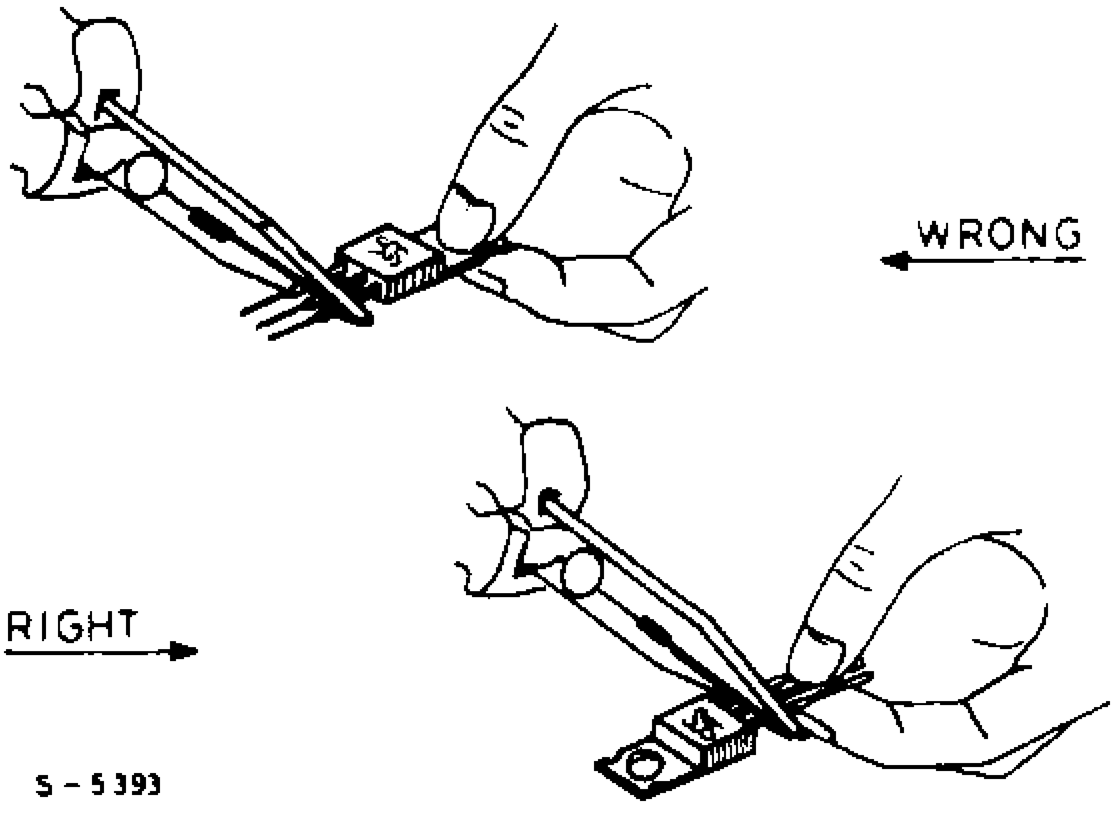
A_β = кружно појачање

Kolo sa dvije lokalne NPS

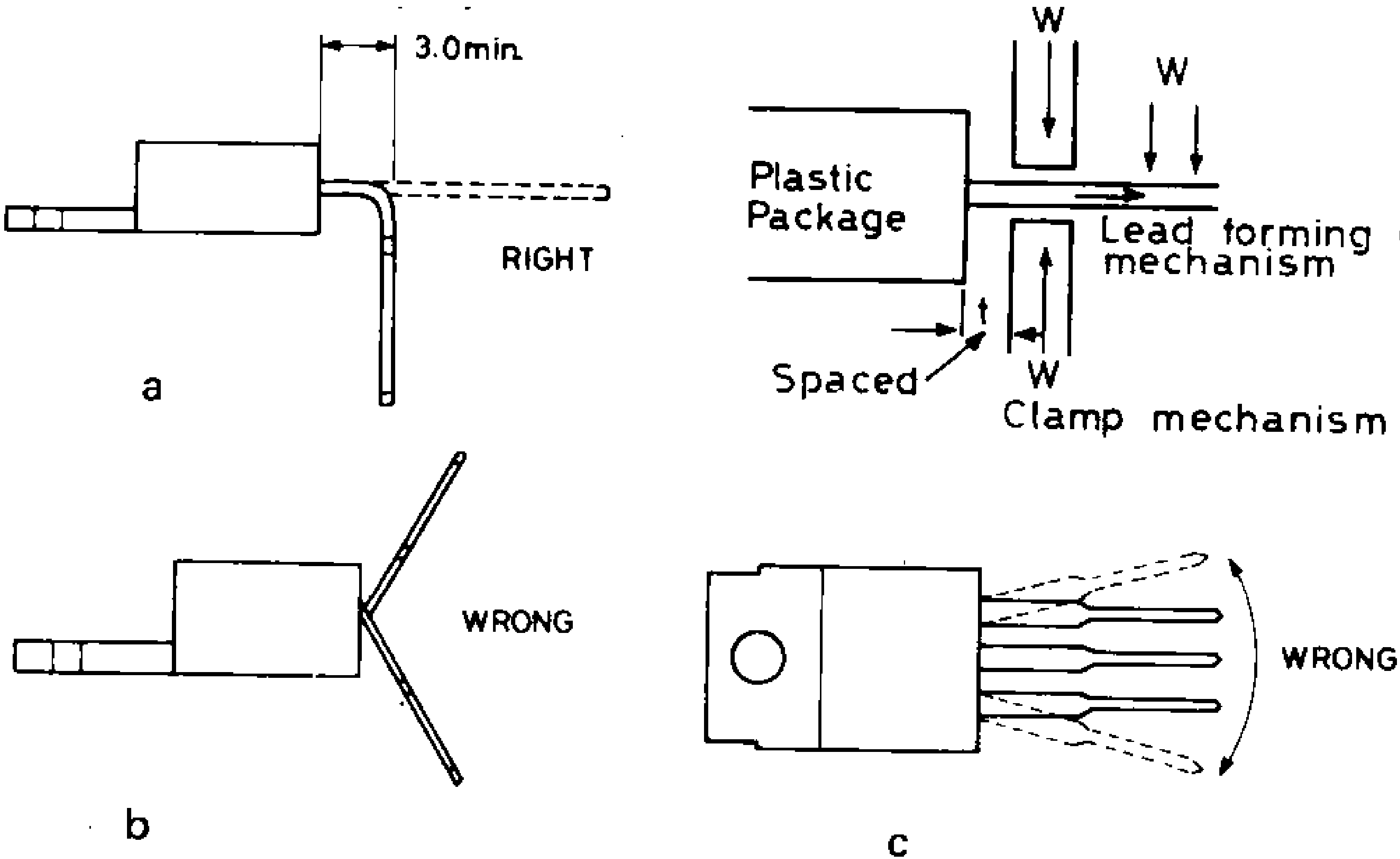


$$A_r = \frac{v_i}{v_g} = \frac{A_d}{(1-A_{\beta 1})(1-A_{\beta 2})}$$

Kako savijati nozice tranzistora

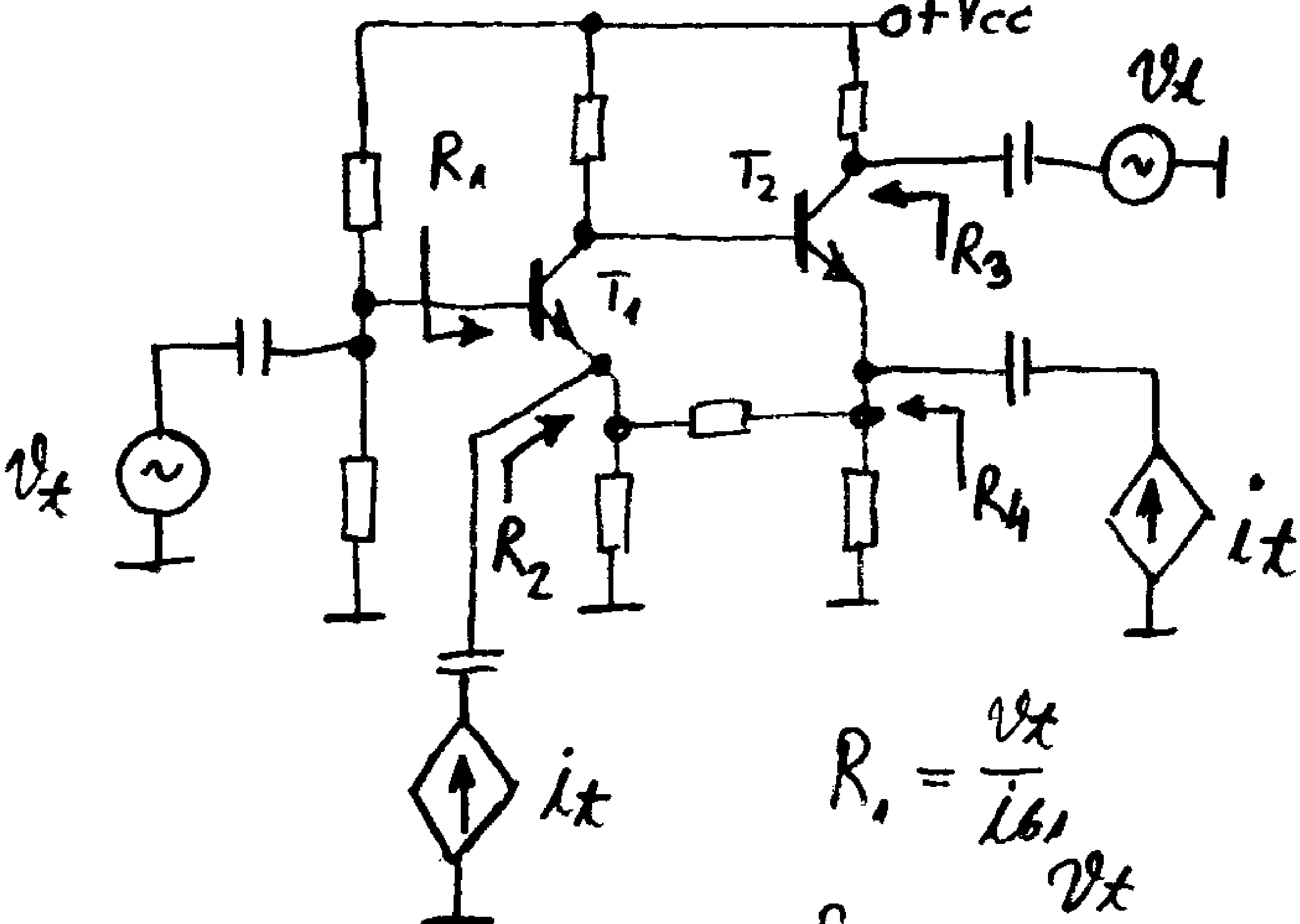


Savijajte bar 3mm dalje od kucista



Teme u nastavku price o NPS:

- Uticaj NPS na ulazne, izlazne i ostale impedanse u kolu
- Uticaj NPS na izoblicenja i mrtve zone
- Primjer audio pojacavaca sa NPS
- Razna kola sa OP



$$R_1 = \frac{v_t}{i_{b1}}$$

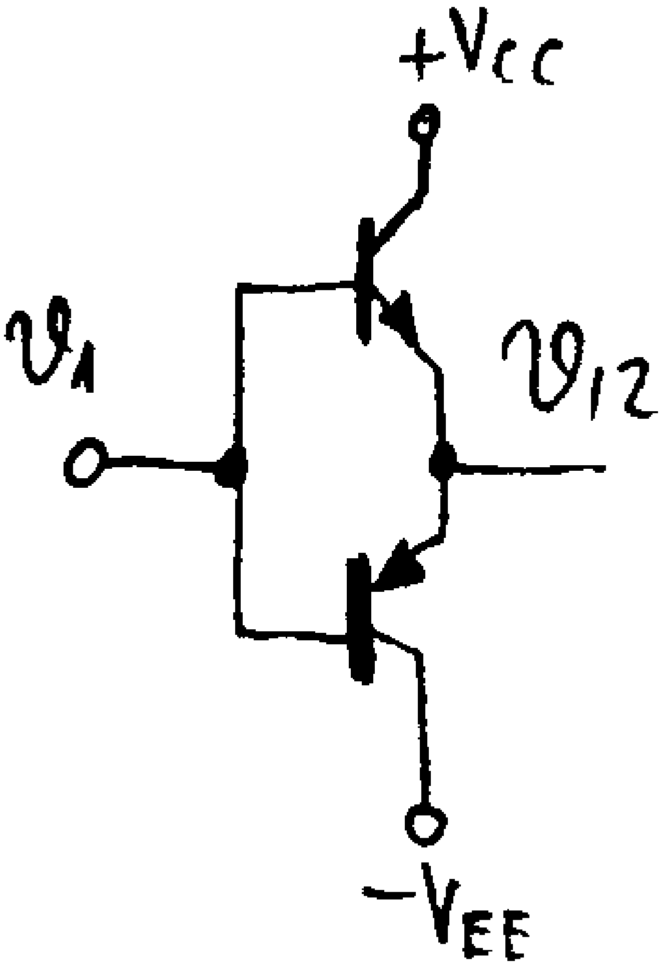
$$R_{in} = \frac{v_t}{i_{bin}}$$

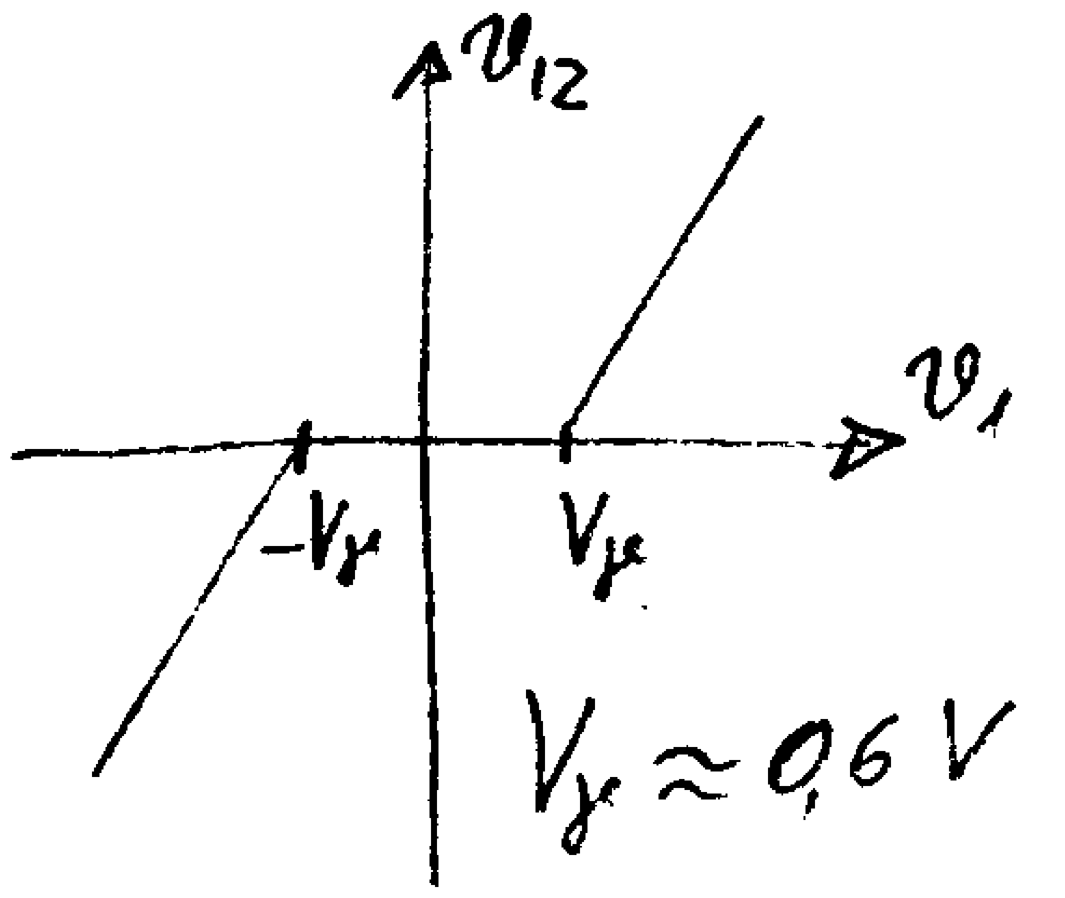
NPS smanjuje impedanse na konturi, a povecava impedanse van konture.

$$R_{1n} = R_1 (1 - A\beta); \quad R_{2n} = \frac{R_2}{1 - A\beta}$$

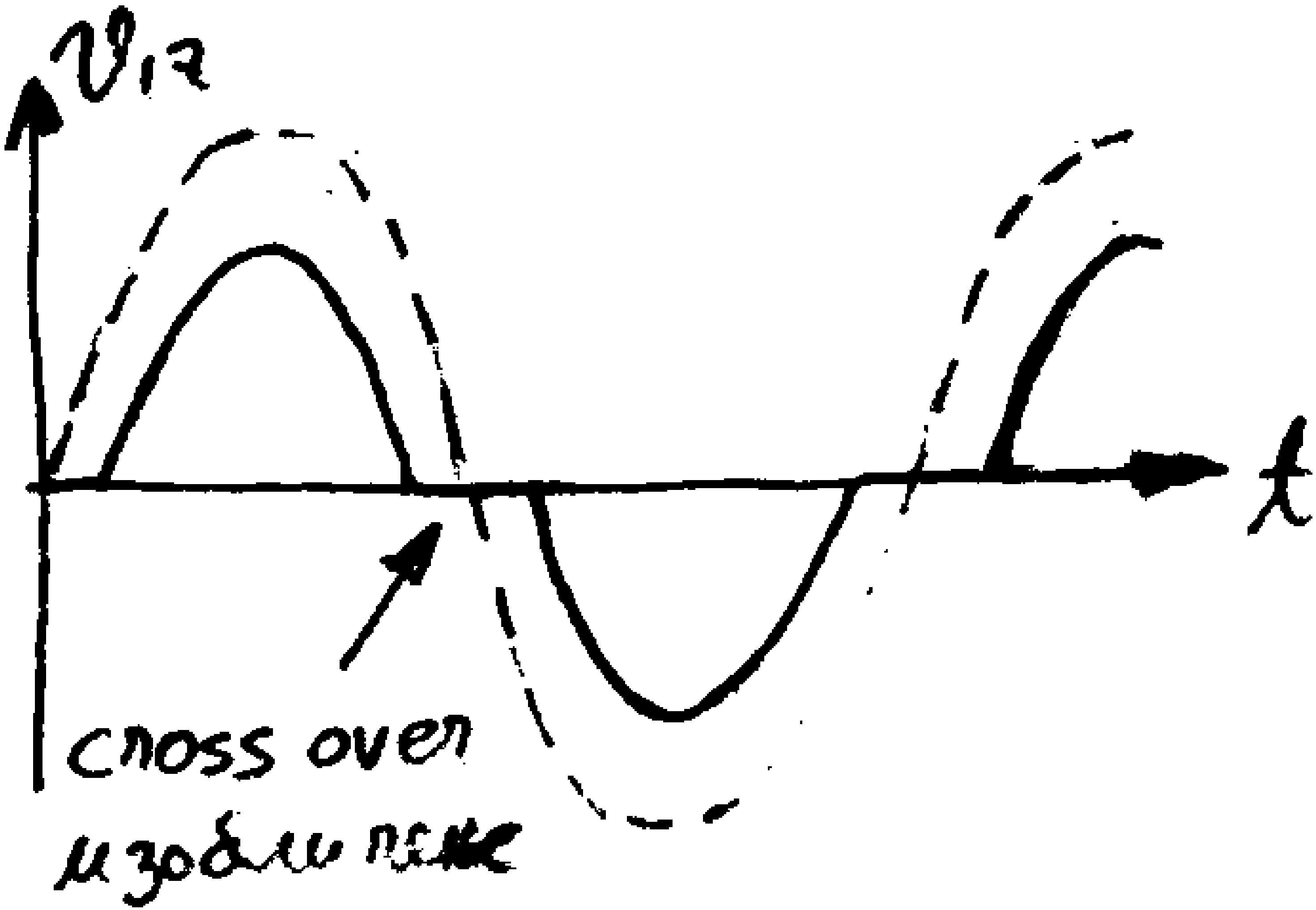
$$R_{3n} = R_3 (1 - A\beta); \quad R_{4n} = \frac{R_4}{1 - A\beta}$$

Izoblicenje mrtve zone kod pojacavaca u B klasi

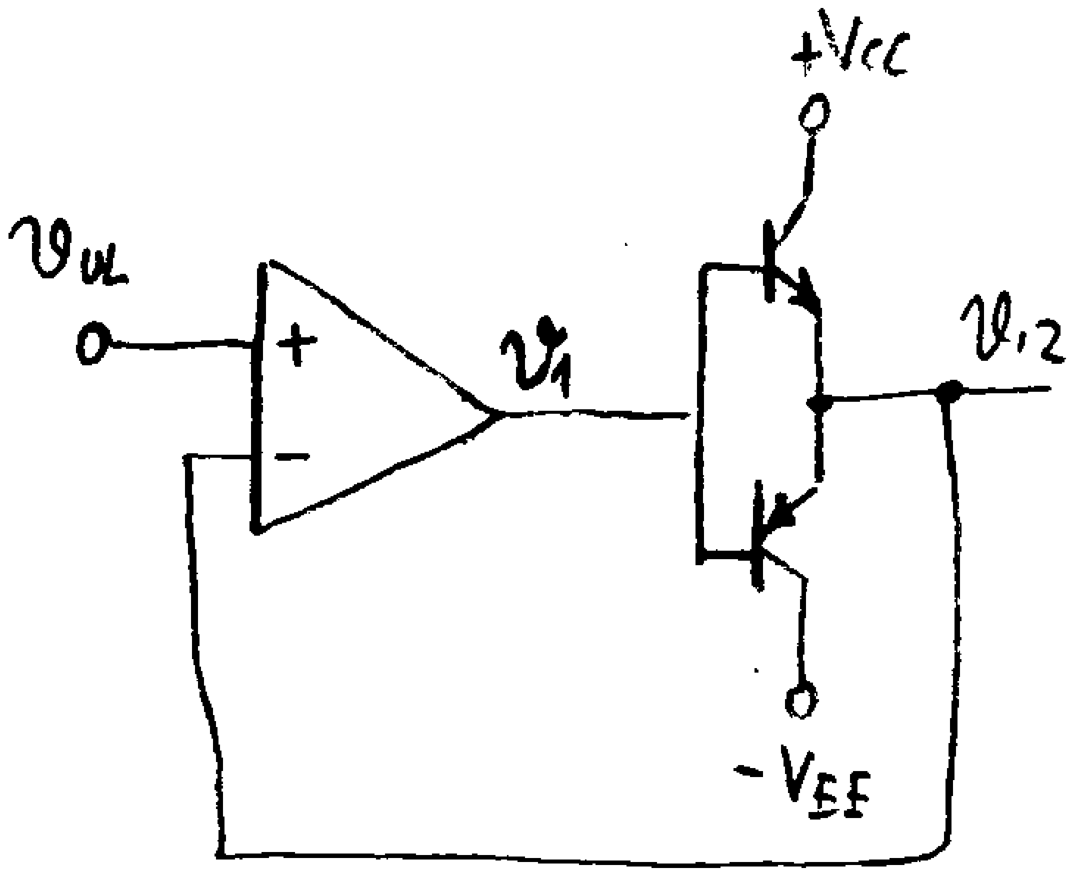


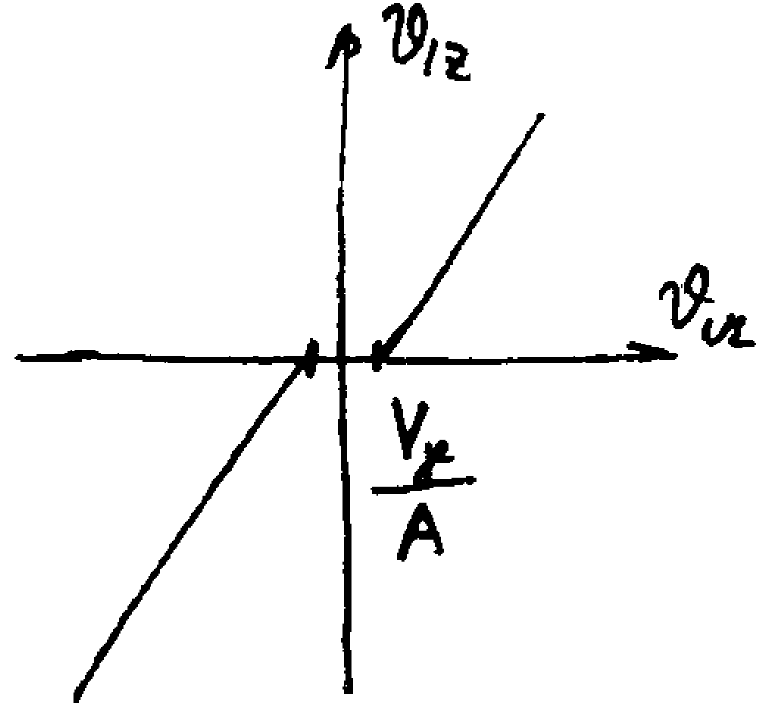


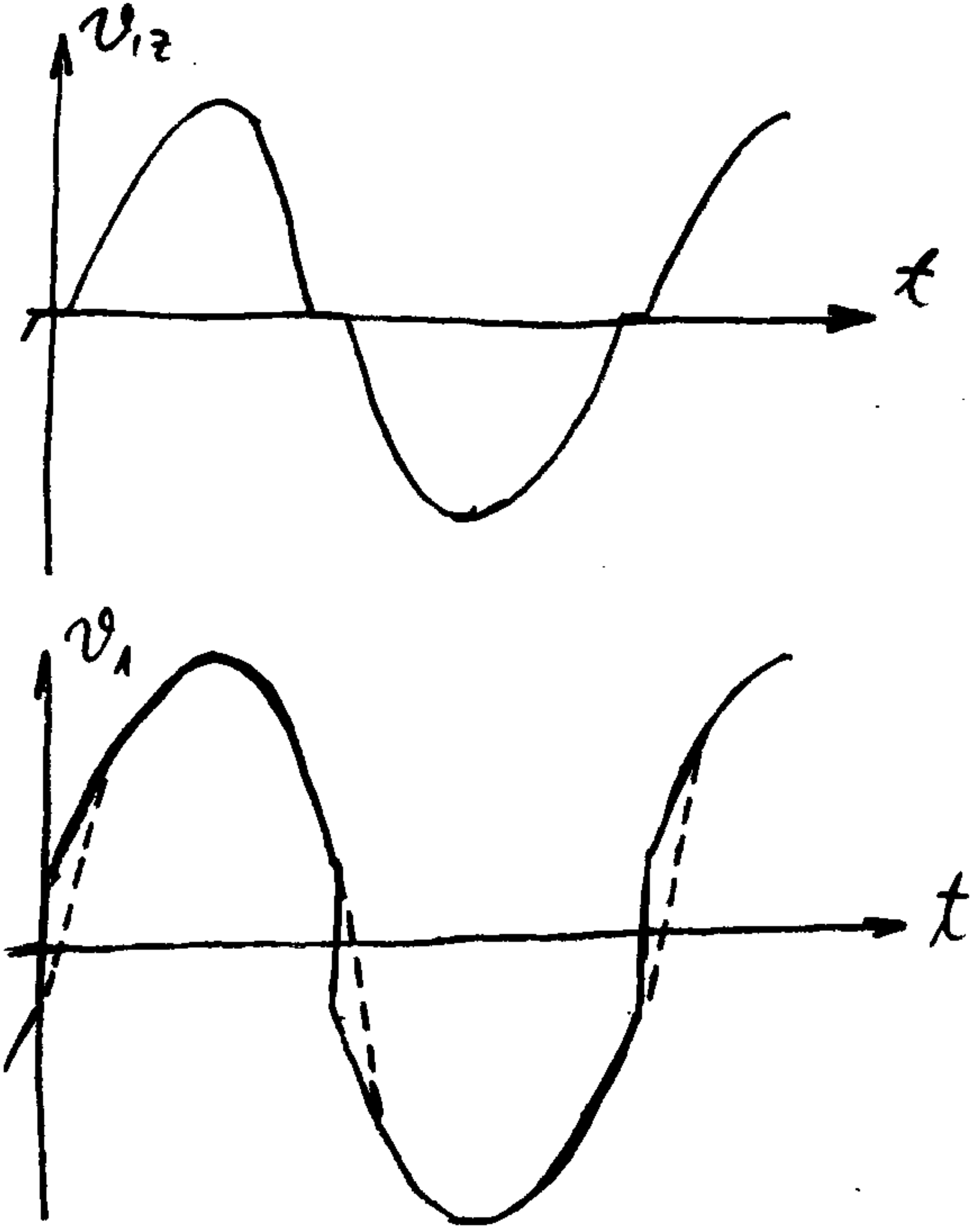
Izoblicenje zbog mrtve zone



NPS smanjuje mrtvu zonu A puta



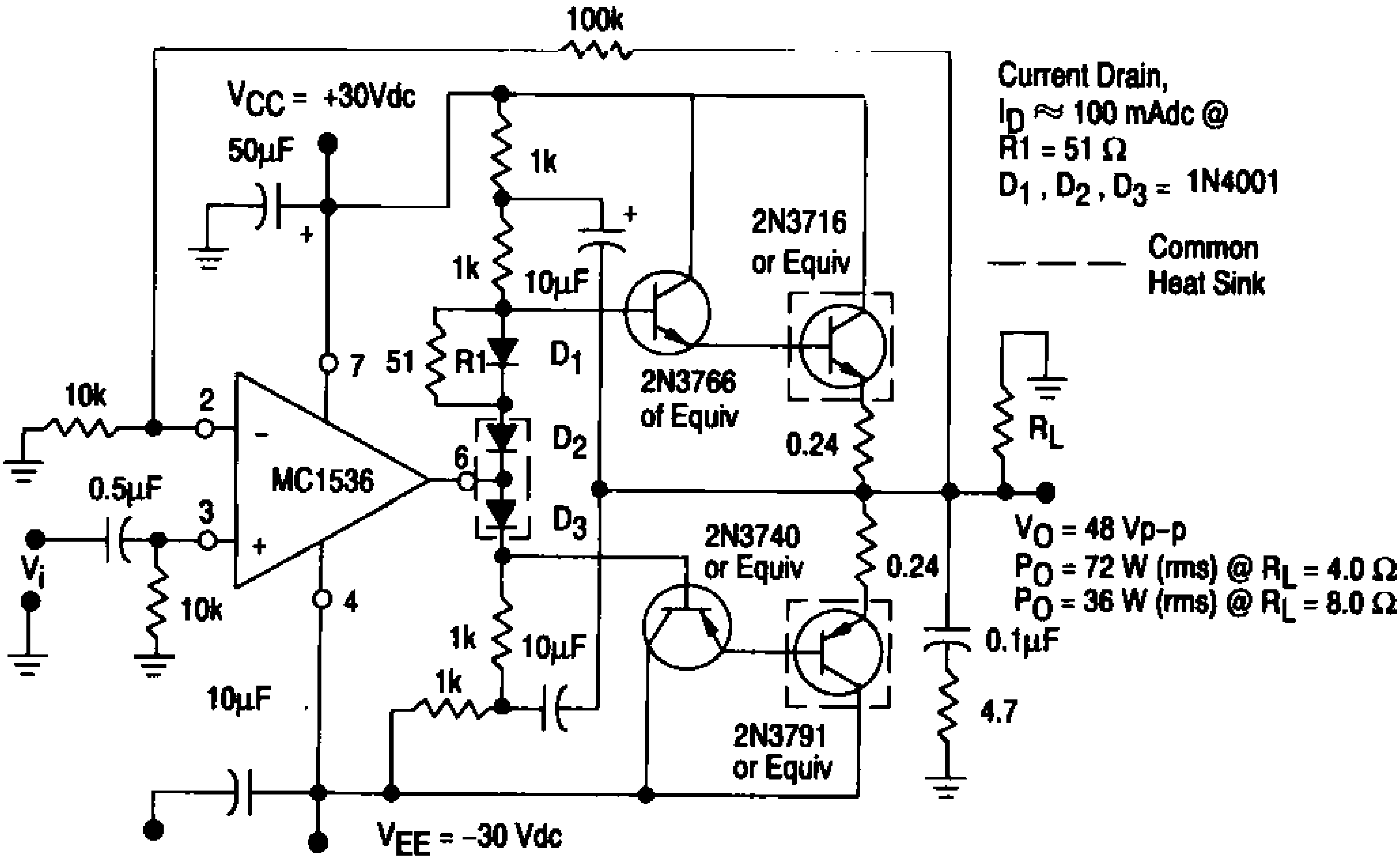




Zbog ogranicene brzine pojacavaca (slew rate), izoblicenja ce ipak postojati bez obzira na NPS.

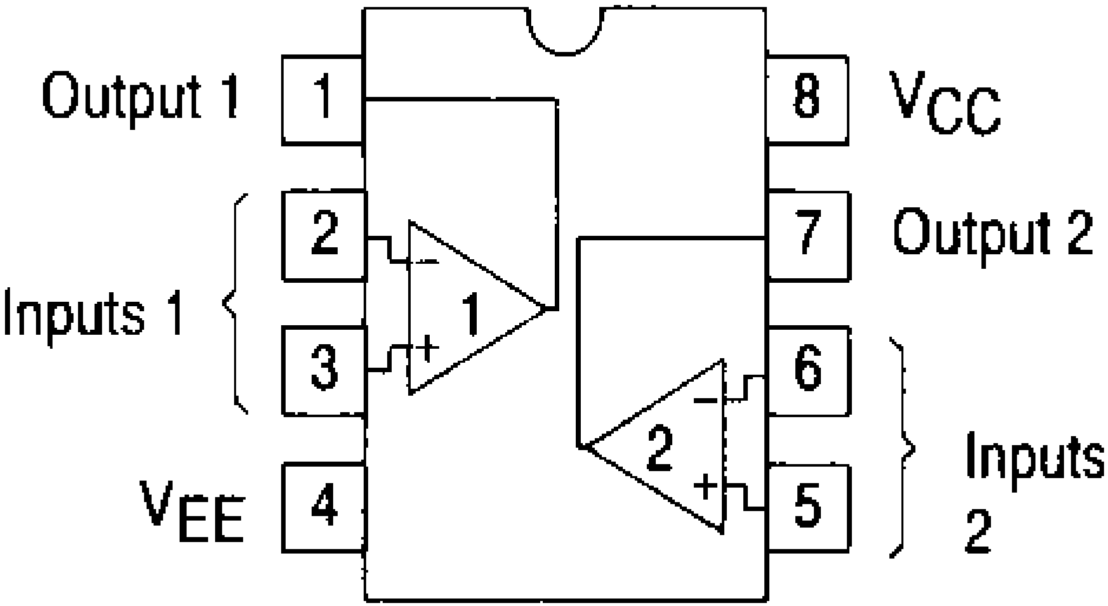
Koliko je Av ovog pojacavaca?

Figure 11. Audio Amplifier

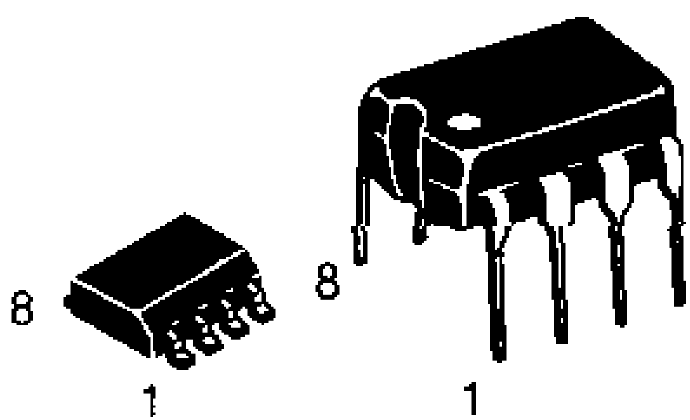


DIGITAL VOLTMETER

PIN CONNECTIONS



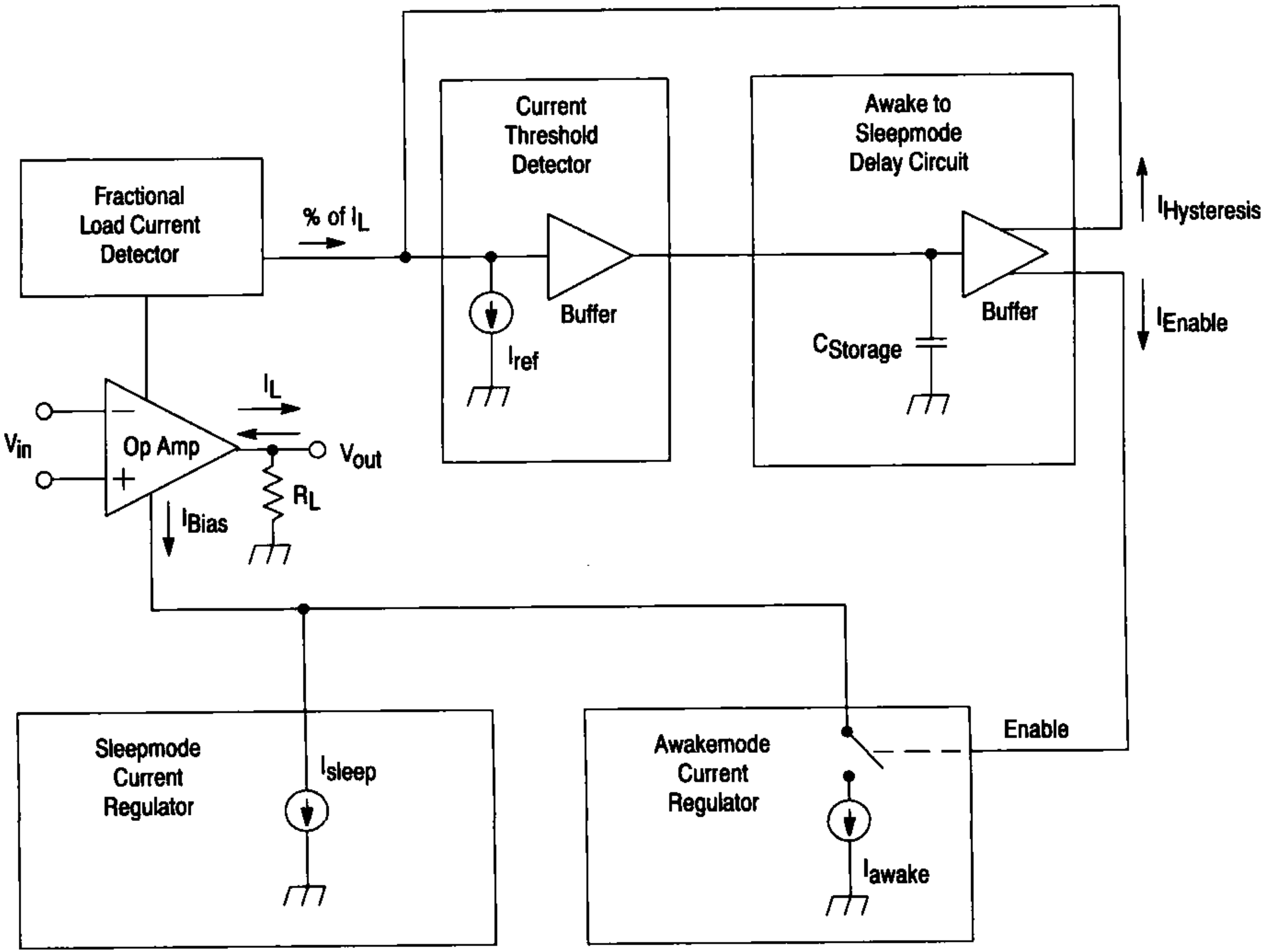
(Dual Package,
Top View)



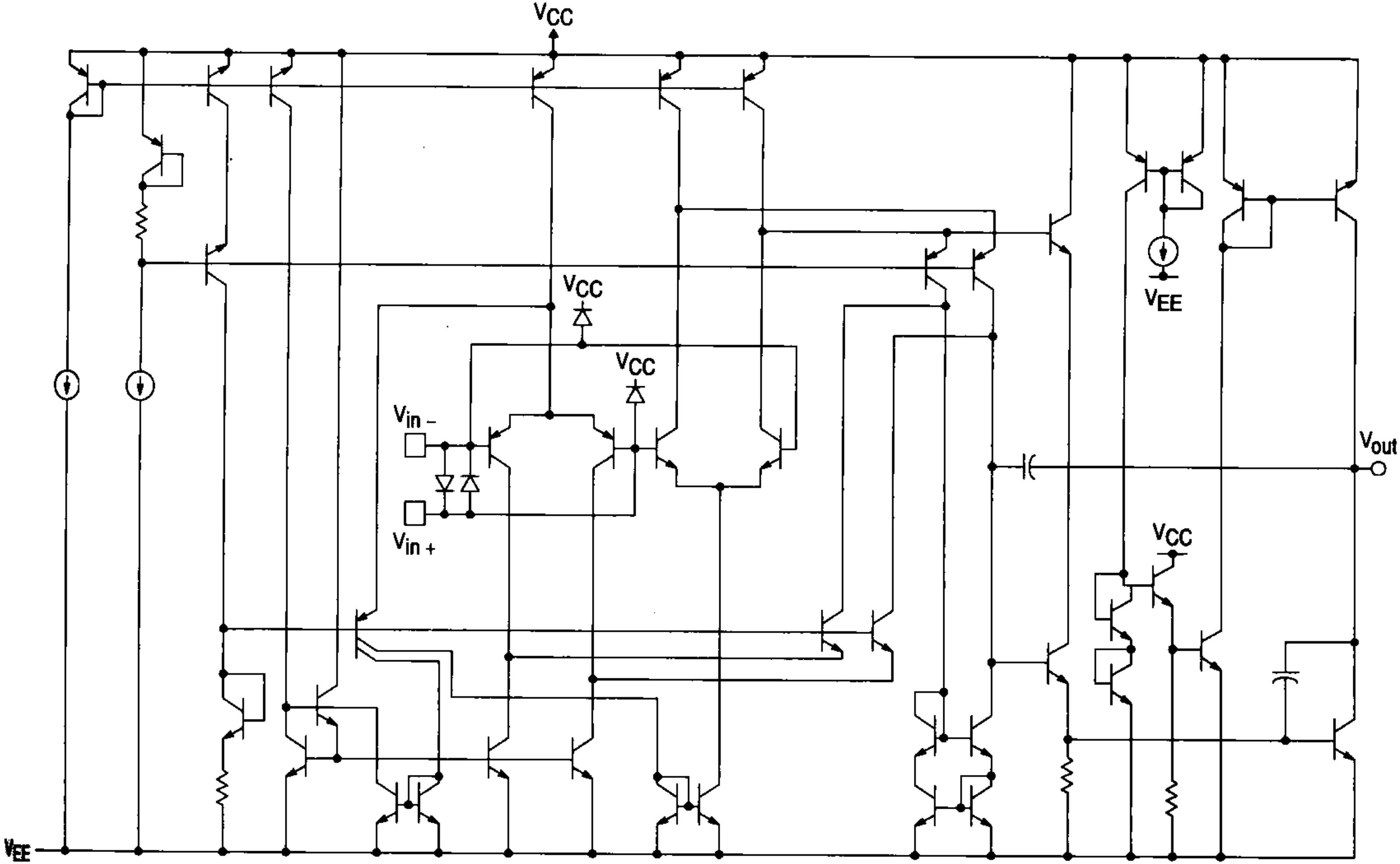
Sleep Op.Amp.

Operacioni pojacavac koji spava

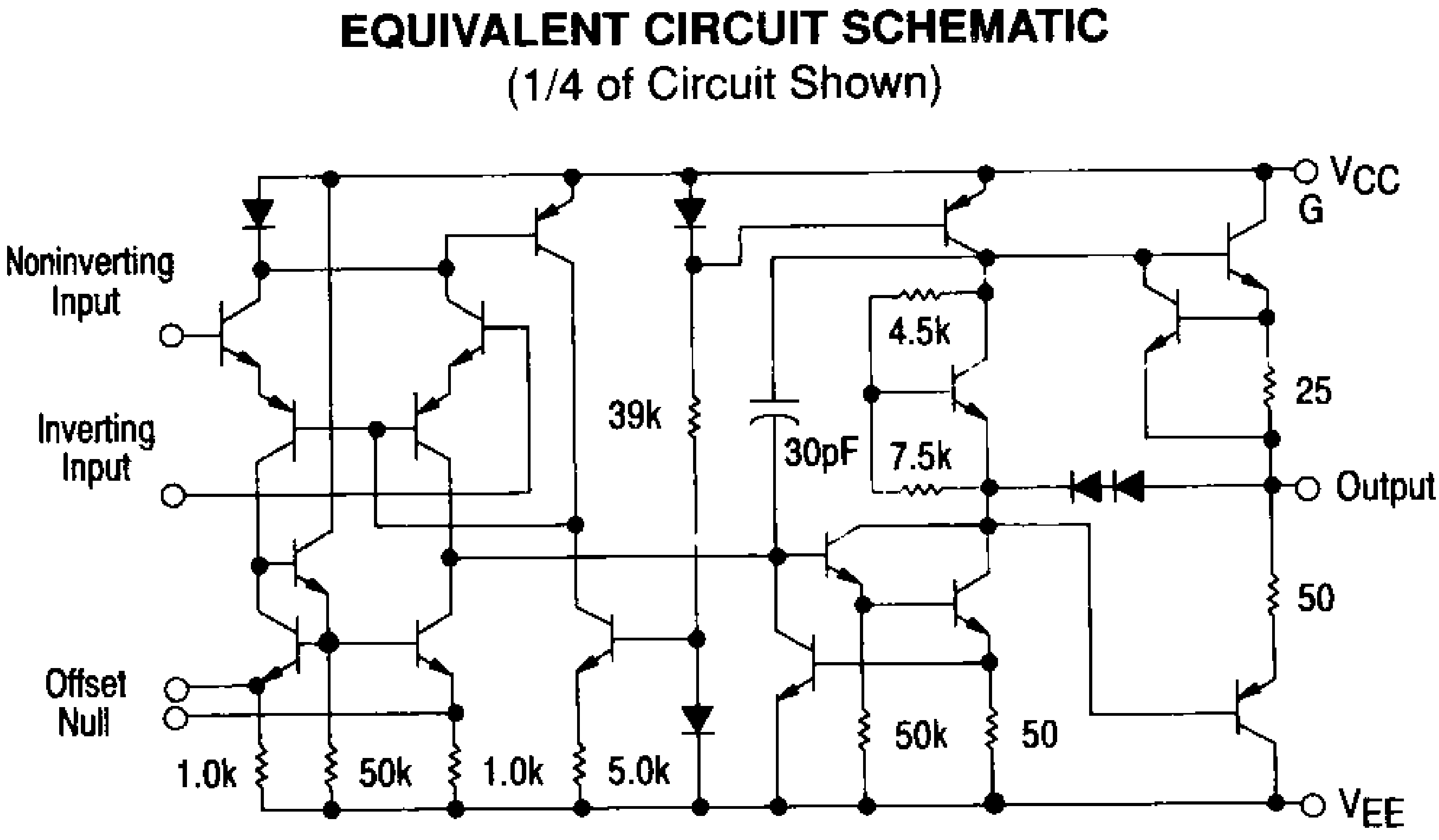
Simplified Block Diagram



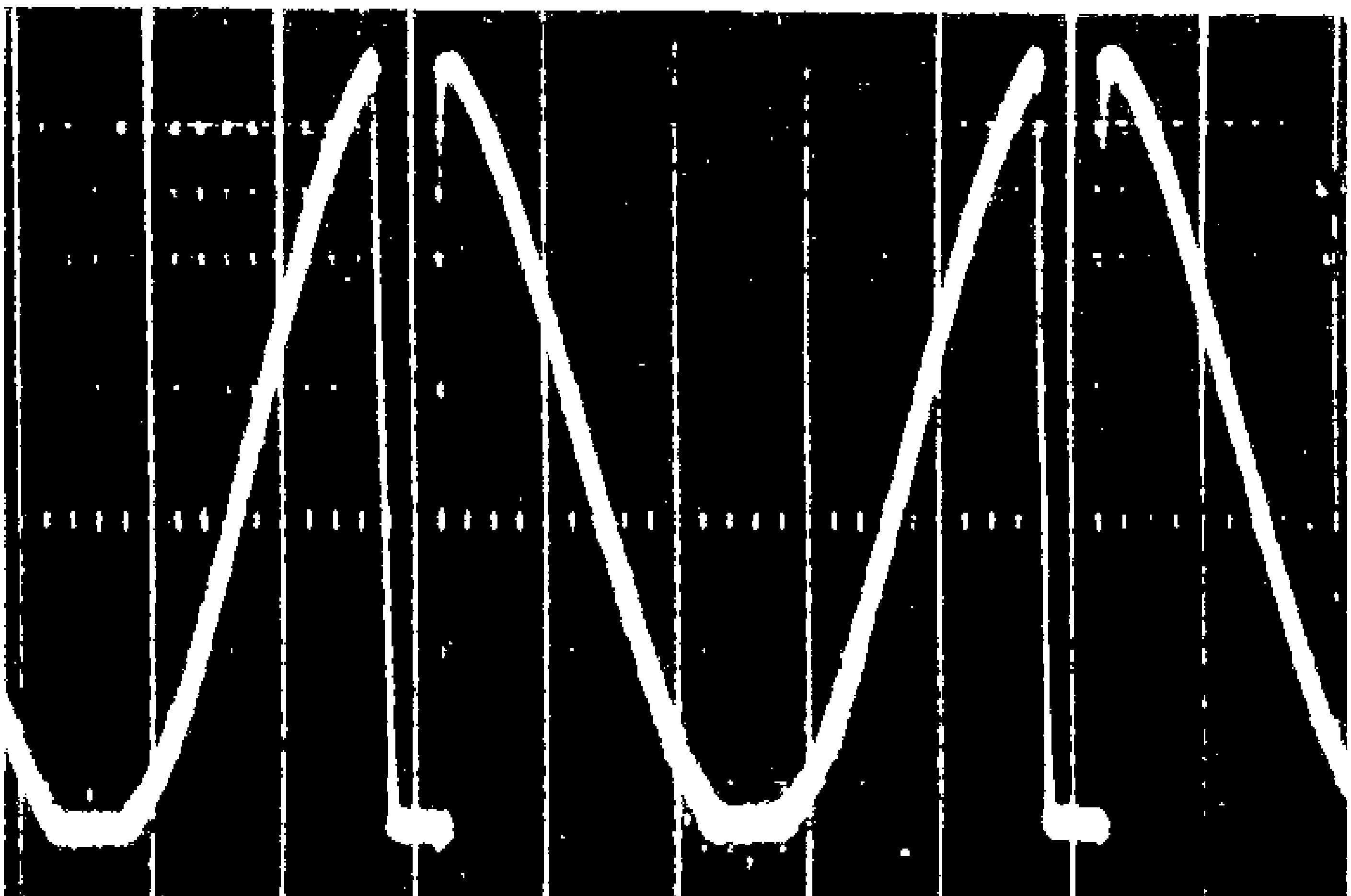
OP od sine do sine (Rail to rail)



LM741- OP opste namjene



Kod prekoracenja max. zajednickog napona na ulazu OP dolazi do obrtanja faze (Phase reversal)



PHASE REVERSAL

The OP-467 is immune to phase reversal; its inputs can exceed the supply rails by a diode drop without any phase reversal.

*Teflon is a registered trademark of E.I. du Pont Co.

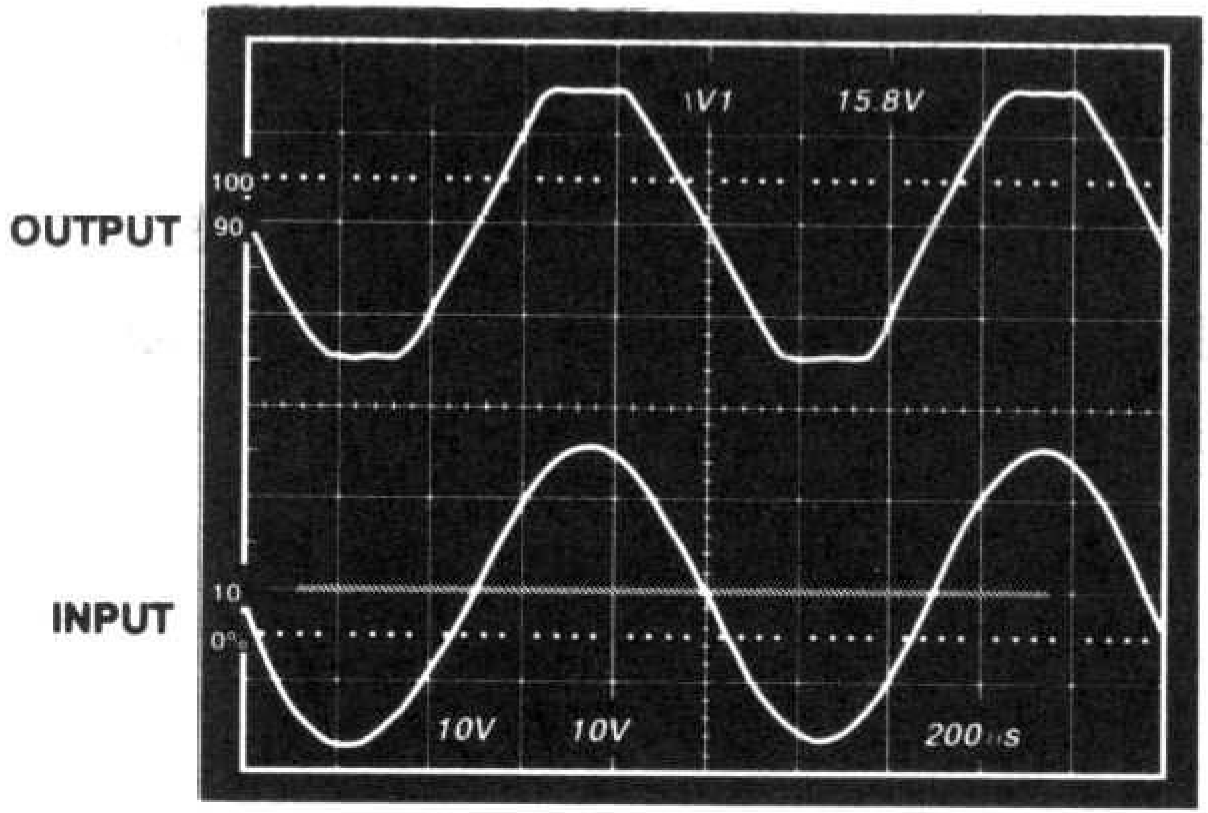


Figure 36. No Phase Reversal ($A_V = +1$)


BASIC LANGUAGE

Generator stepenica
- diodna pumpa i integrator -

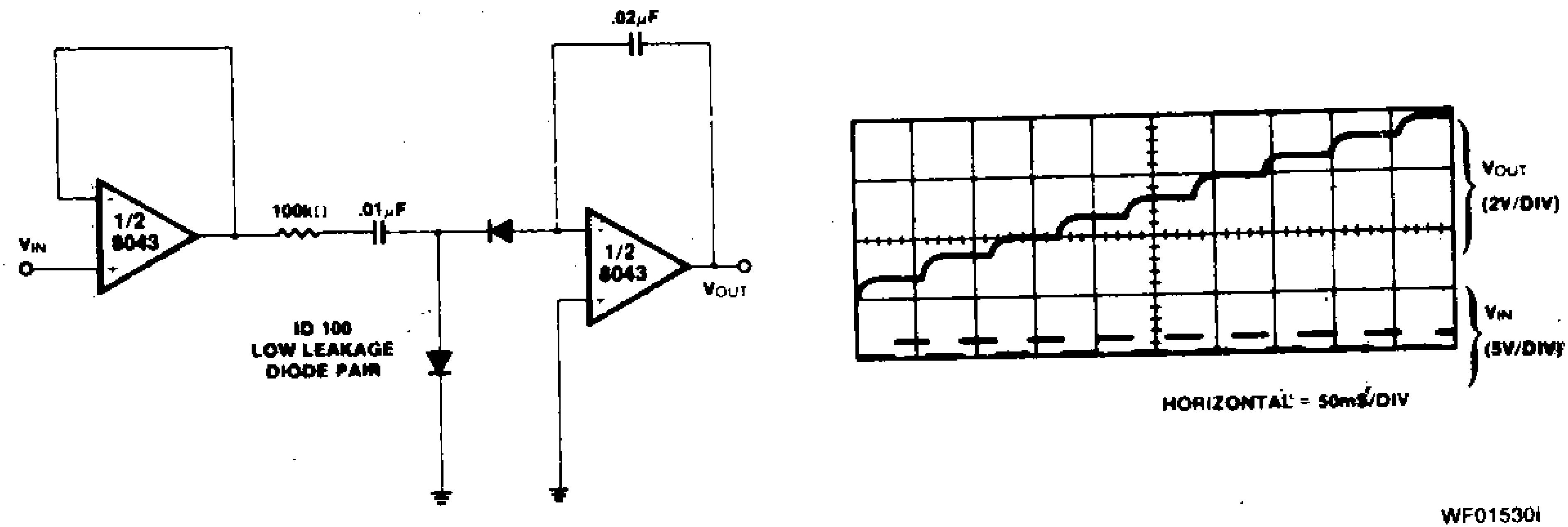


Figure 7: Staircase Generator Circuit

Analogni brojac (i generator spepenastih testera)

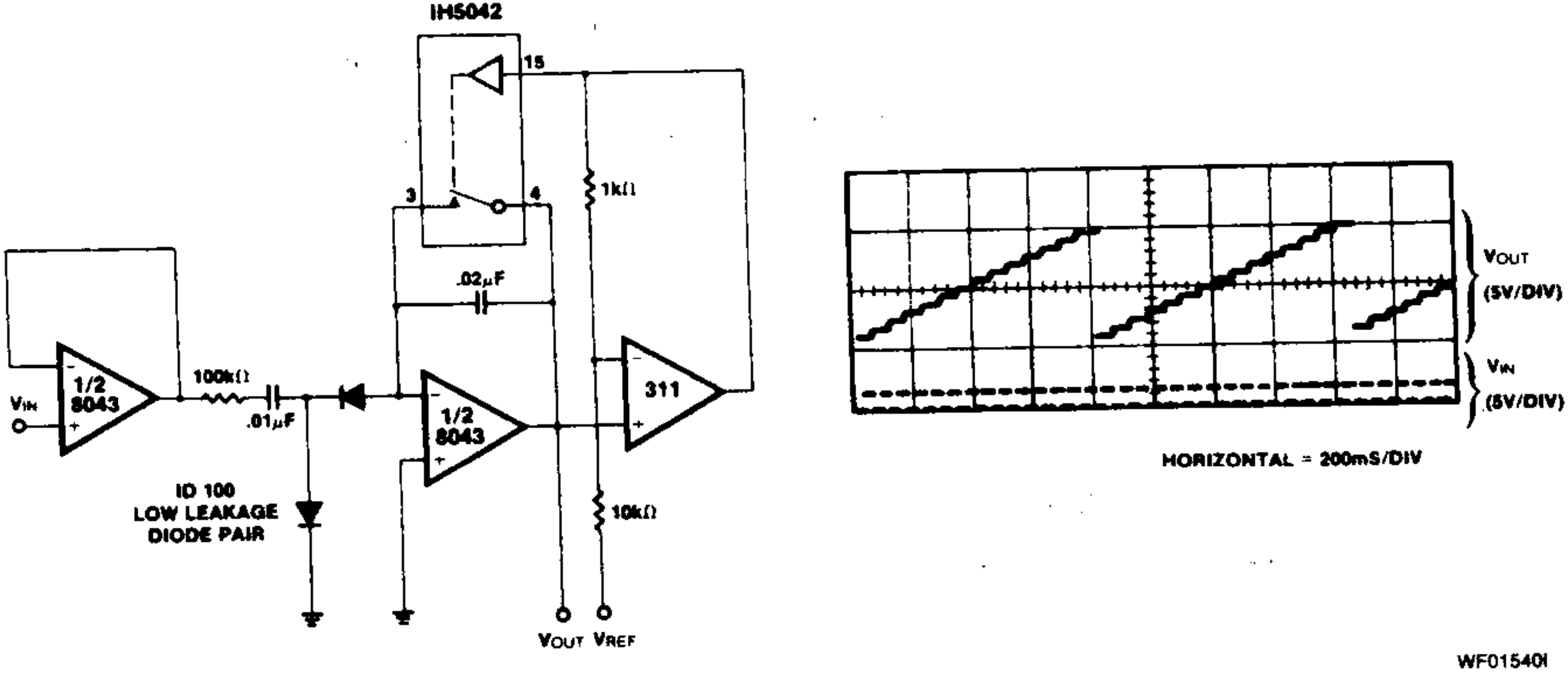


Figure 8: Analog Counter Circuit

Blokiranje napona napajanja

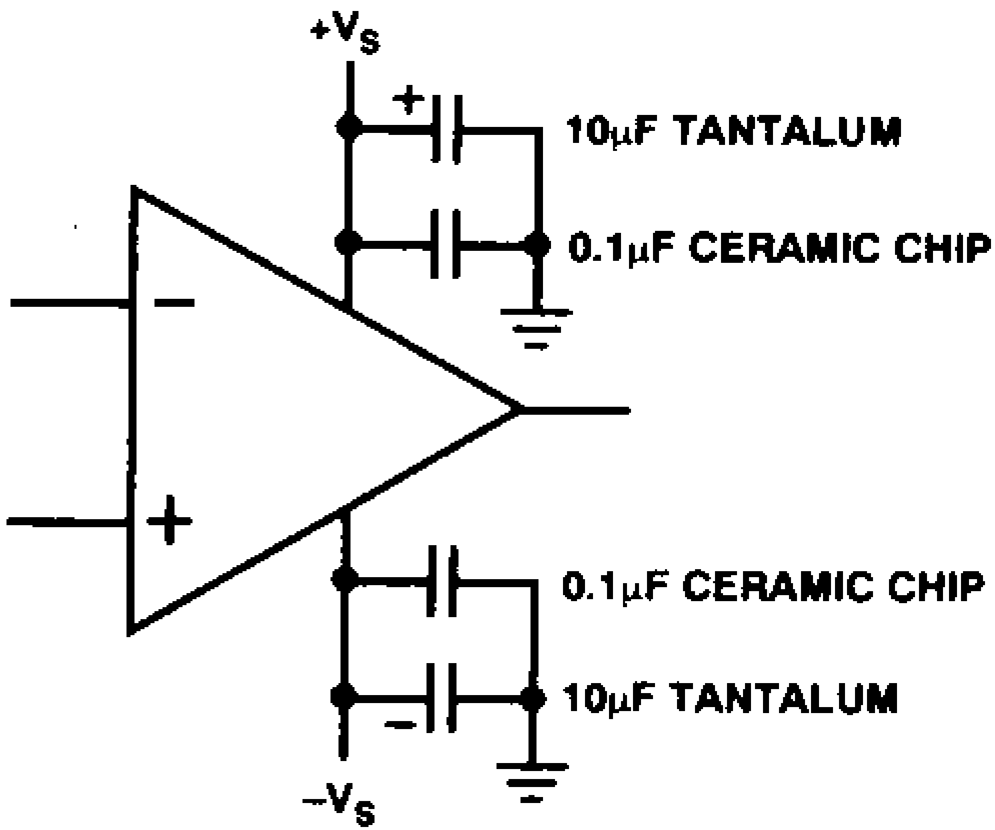
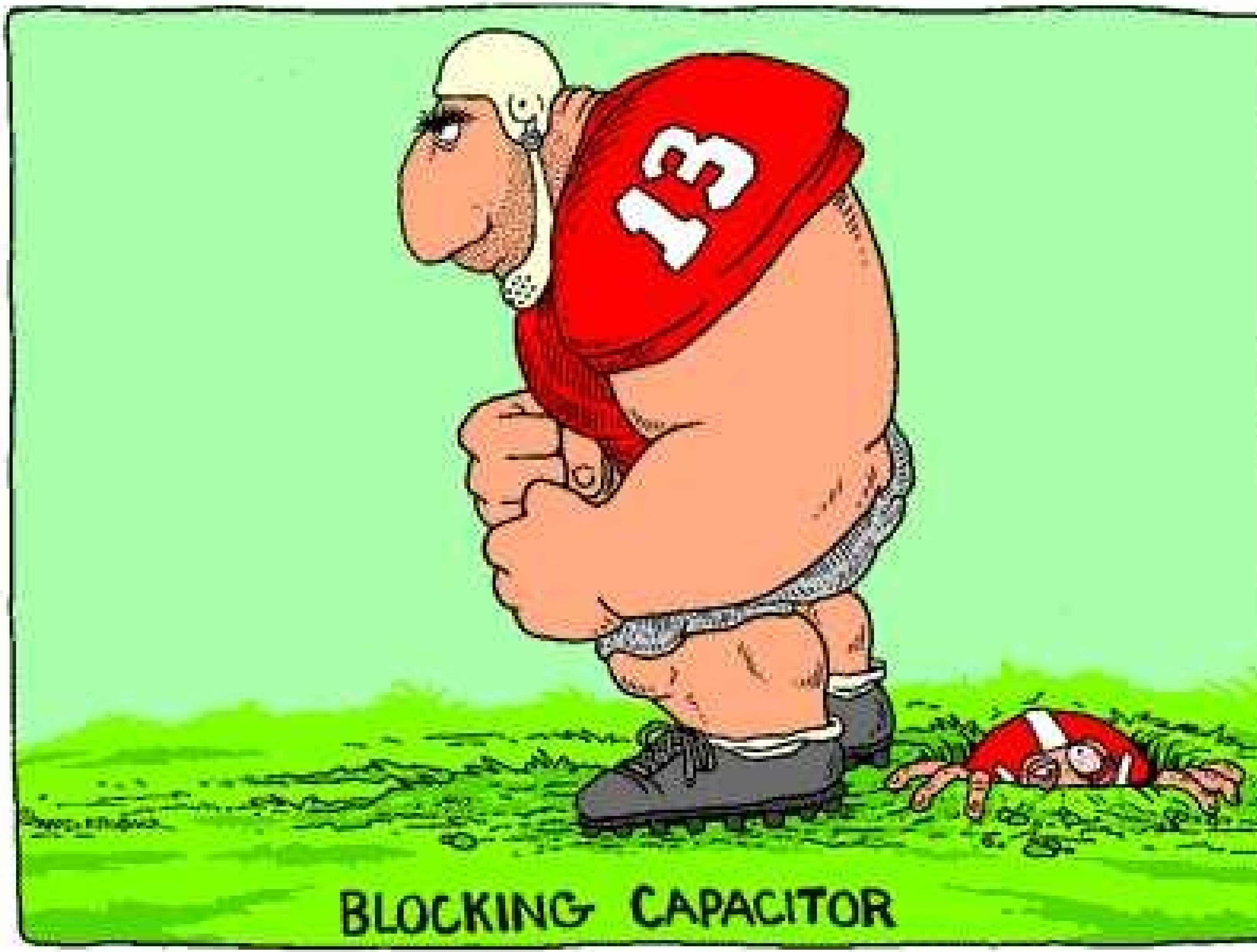
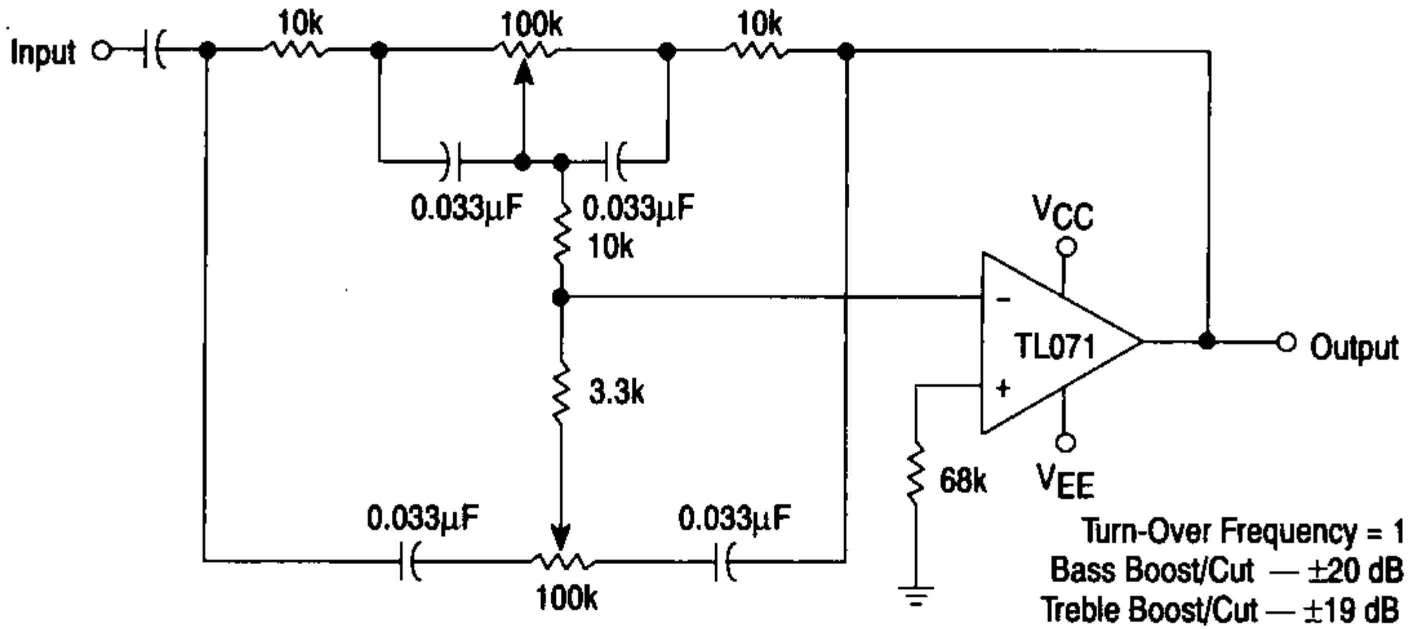


Figure 35. Recommended Power Supply Bypass



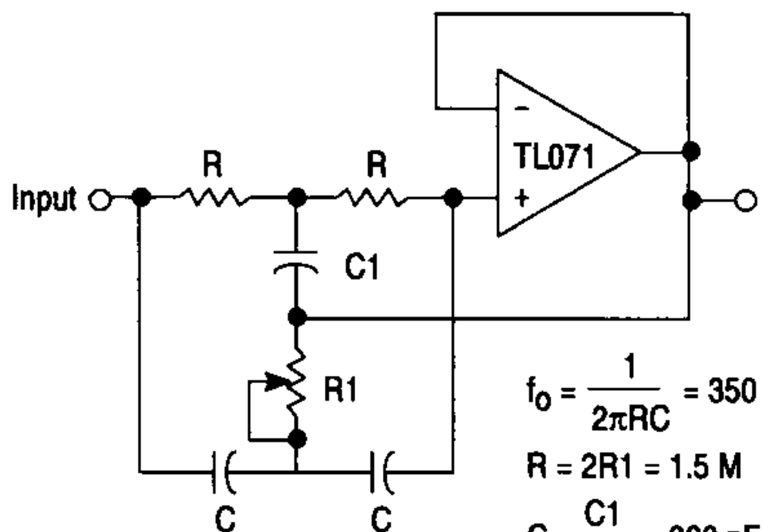
BLOCKING CAPACITOR

Figure 14. Audio Tone Control Amplifier



Turn-Over Frequency = 1.0 kHz
Bass Boost/Cut — ±20 dB at 20 Hz
Treble Boost/Cut — ±19 dB at 20 kHz

Figure 15. High Q Notch Filter



$$f_o = \frac{1}{2\pi RC} = 350\text{ Hz}$$

$$R = 2R1 = 1.5\text{ M}$$

$$C = \frac{C1}{2} = 300\text{ pF}$$

Obostrani pogon motora

Figure 9. Bidirectional Speed Control of DC Motors

For circuit stability, ensure that $R_X > \frac{2R3 \cdot R1}{R_M}$ where, R_M = internal resistance of motor.

The voltage available at the terminals of the motor is: $V_M = 2\ (V_1 - \frac{V_S}{2}) + |R_o| \cdot I_M$

where, $|R_o| = \frac{2R3 \cdot R1}{R_X}$ and I_M is the motor current.