LAYOUT GUIDELINES

1. Circuit Schematic
   gEDA,
2. Physical dimensions to components
3. LAYOUT //
4. Routing
5. Gerber files

1. Dimensions of PWB
2. Card guide space
3. Mounting
4. Connectors.
5. Components (criticality, sensitivity, shorted interconnection length)

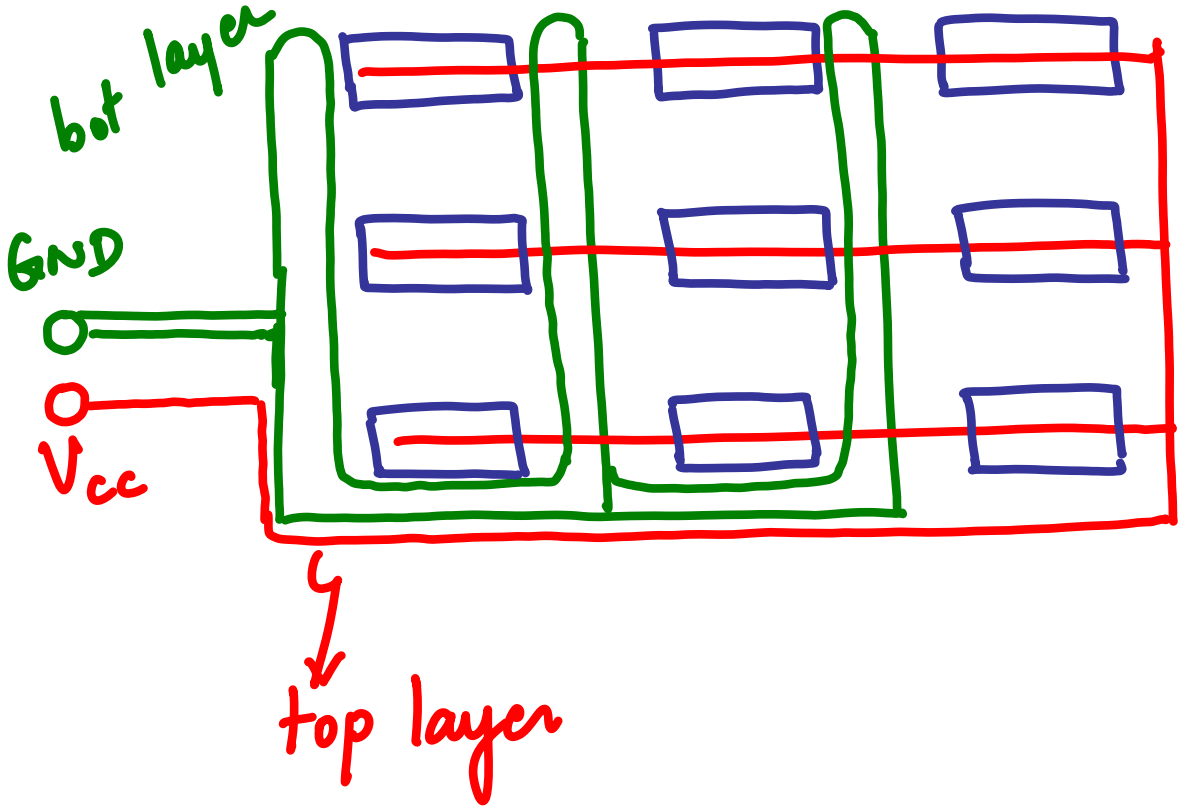
Routing

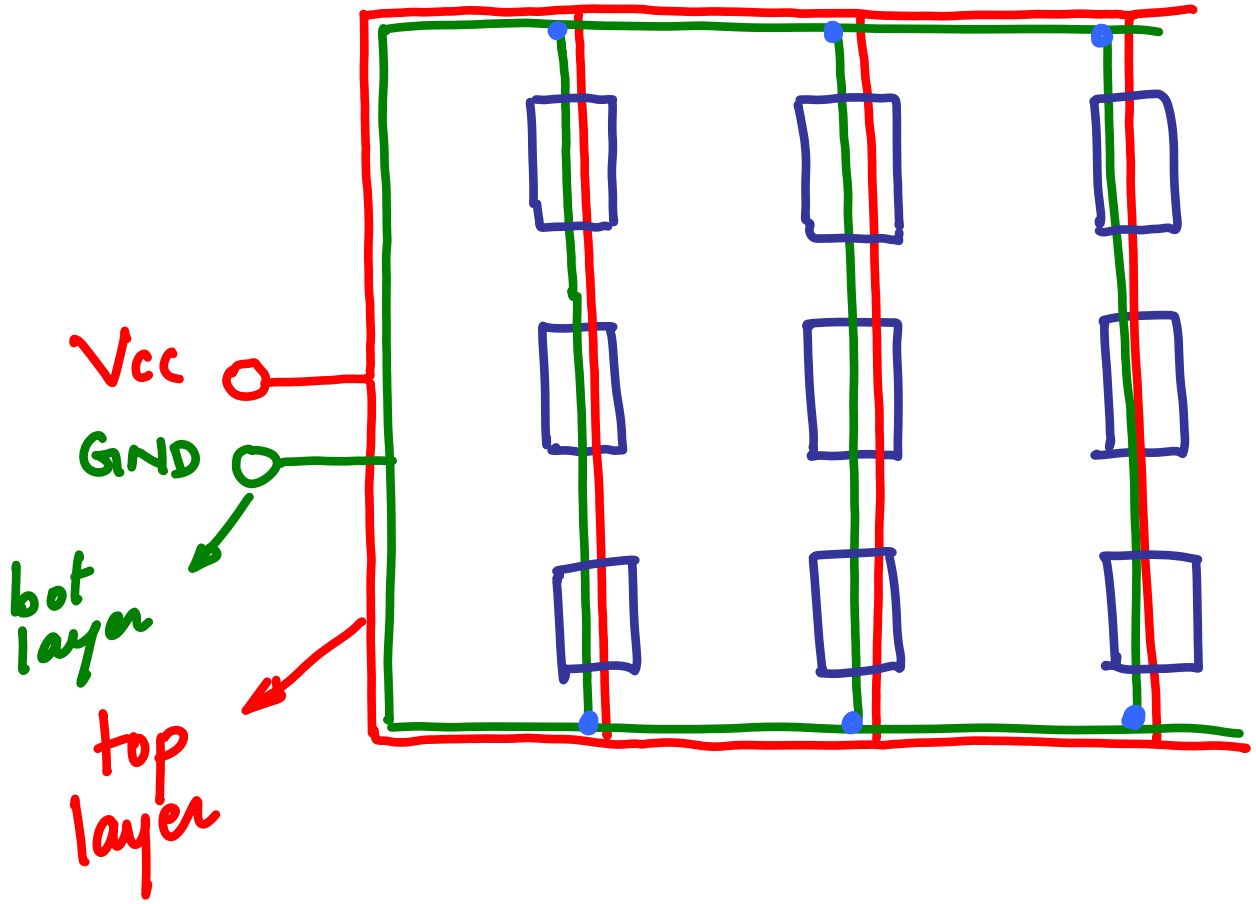
1. Supply and Ground

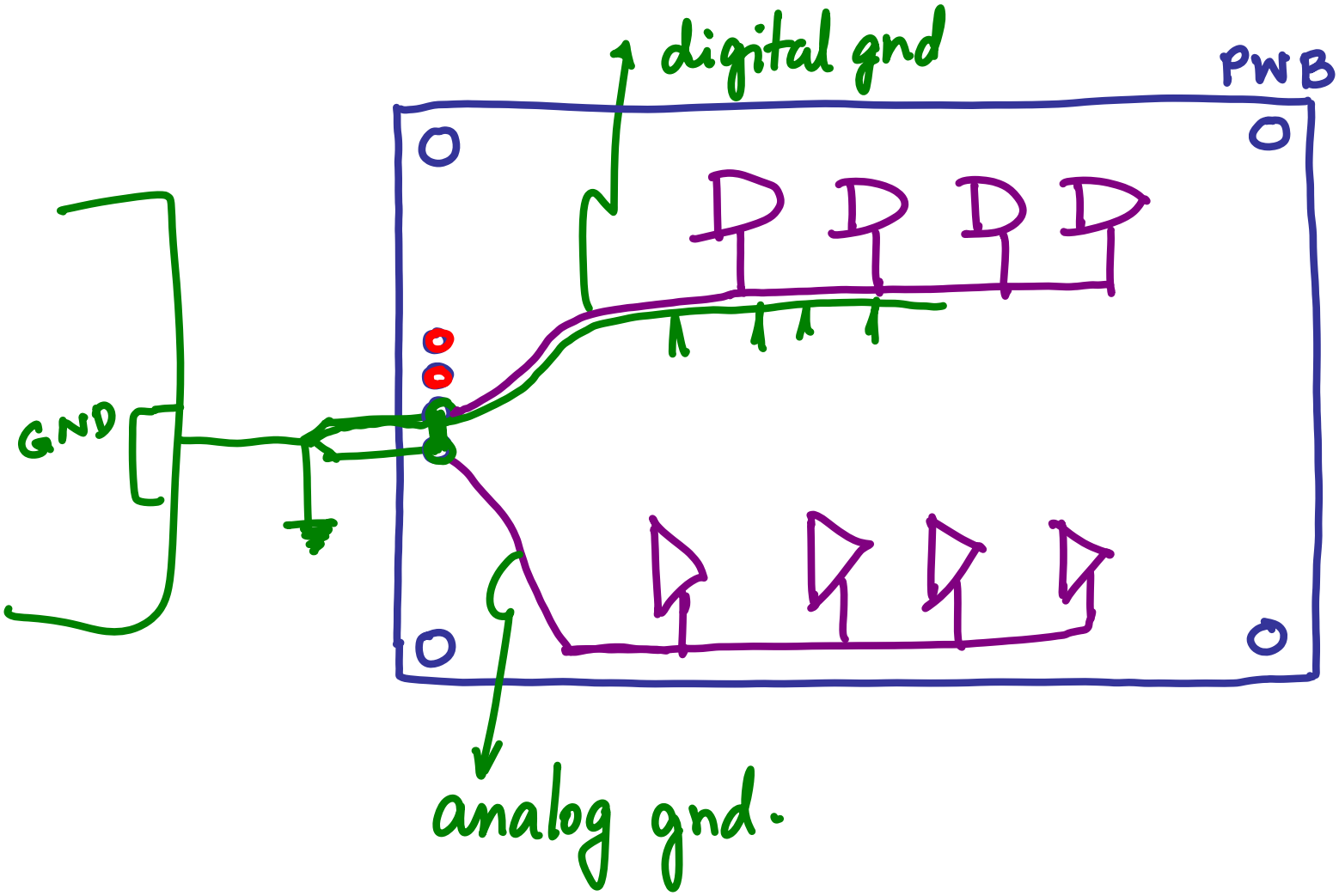
STABILITY

$$W_{GROUND} > W_{SUPPLY} > W_{SIGNAL}$$

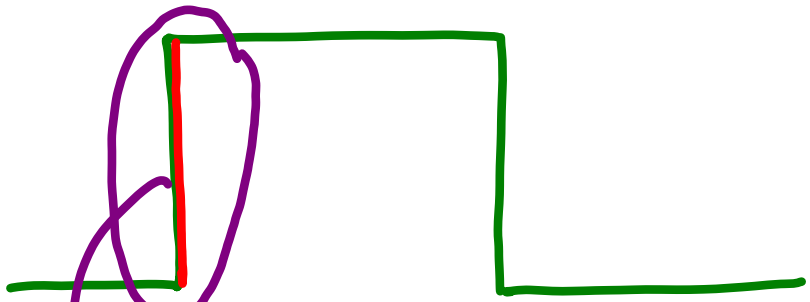
SUPPLY – Layer 1 (top layer)
GROUND – Layer 2 (bot layer)


bot layer
GND
V_{cc}
top layer


Vcc
GND
bot layer
top layer


digital gnd
PWB
GND
analog gnd.

REFLECTIONS

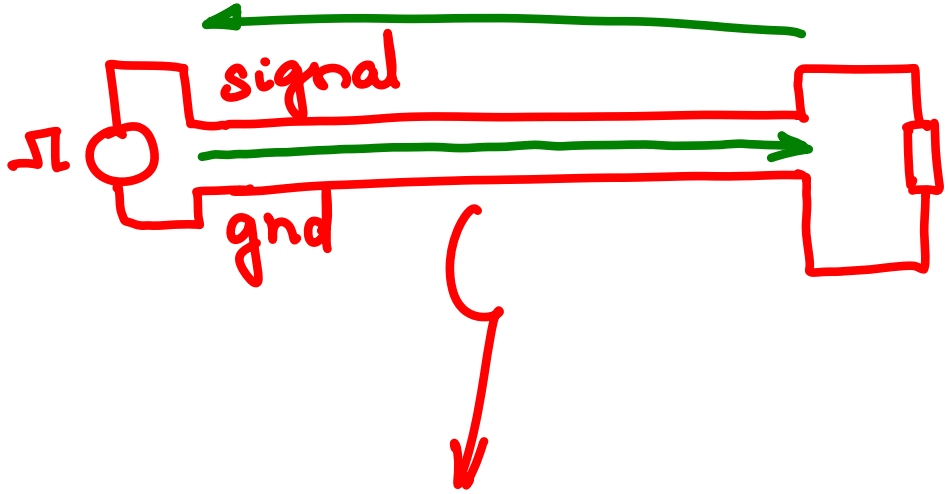


very high freq

t_r ns

bandwidth

$$= \frac{0.35}{t_r} =$$



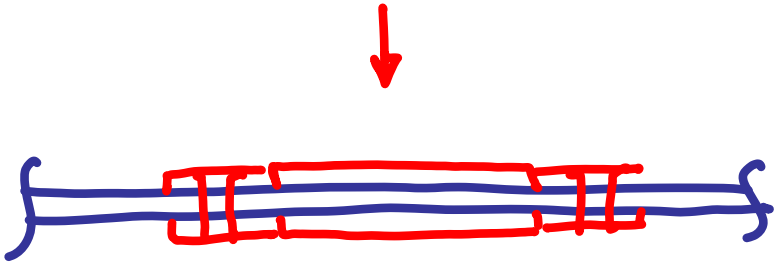
transmission lines

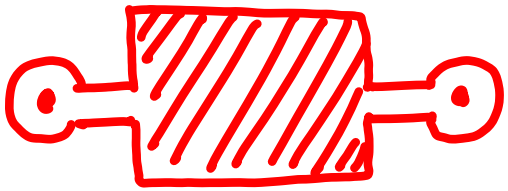
$$Z_w = \sqrt{\frac{L/cm}{C/cm}}$$

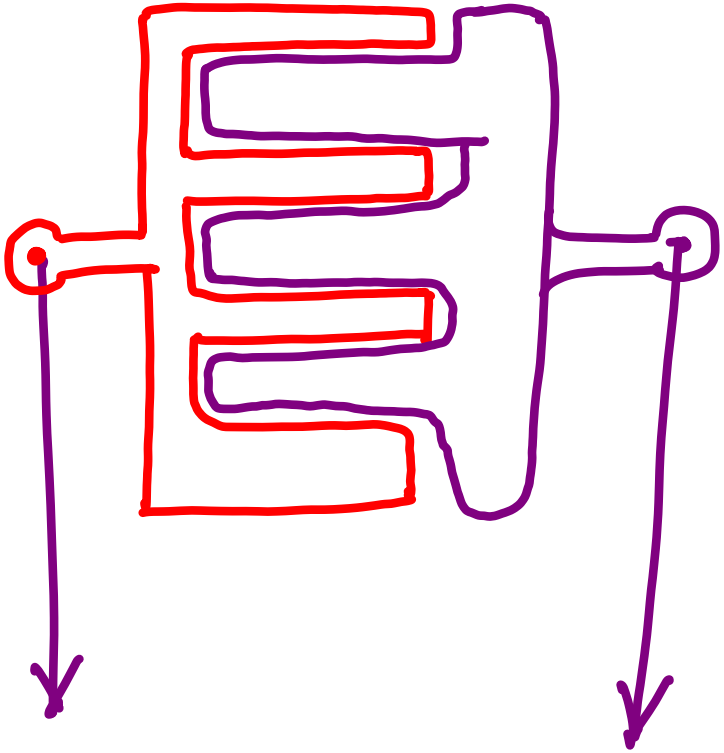
Z_0

$$R_S = Z_W = \sqrt{\frac{L_{cm}}{C_{cm}}} \qquad Z_W = R_O$$

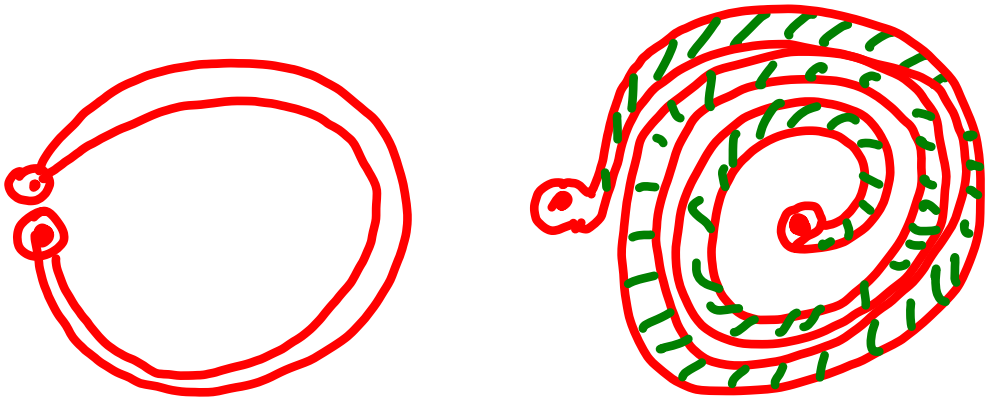
Printed Capacitor

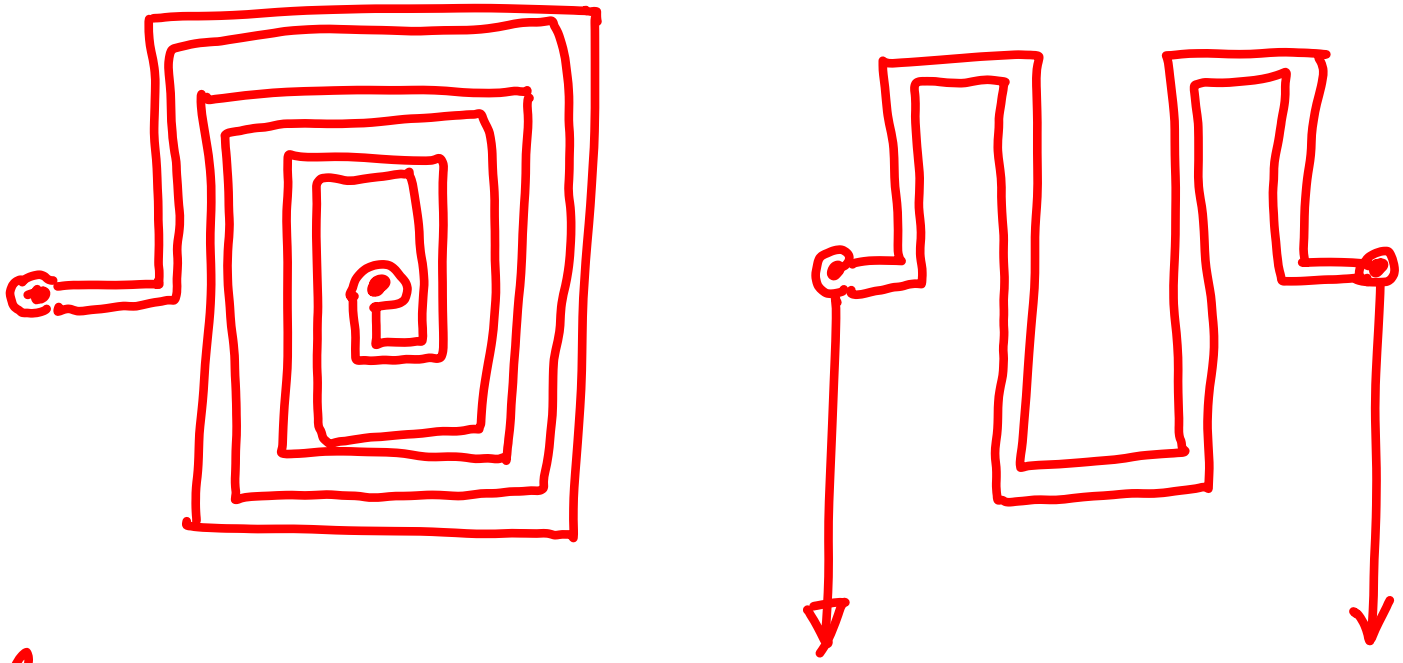






Printed Inductors

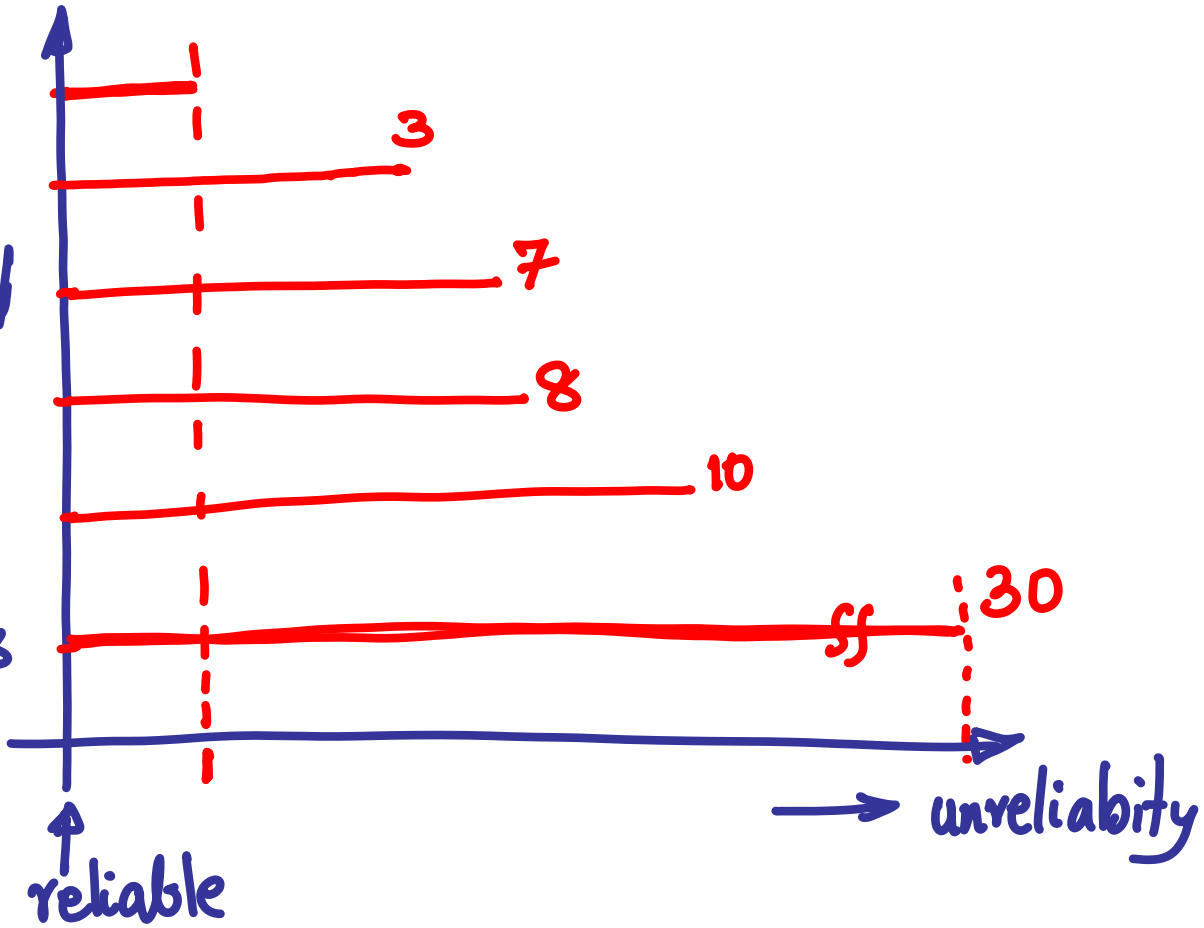


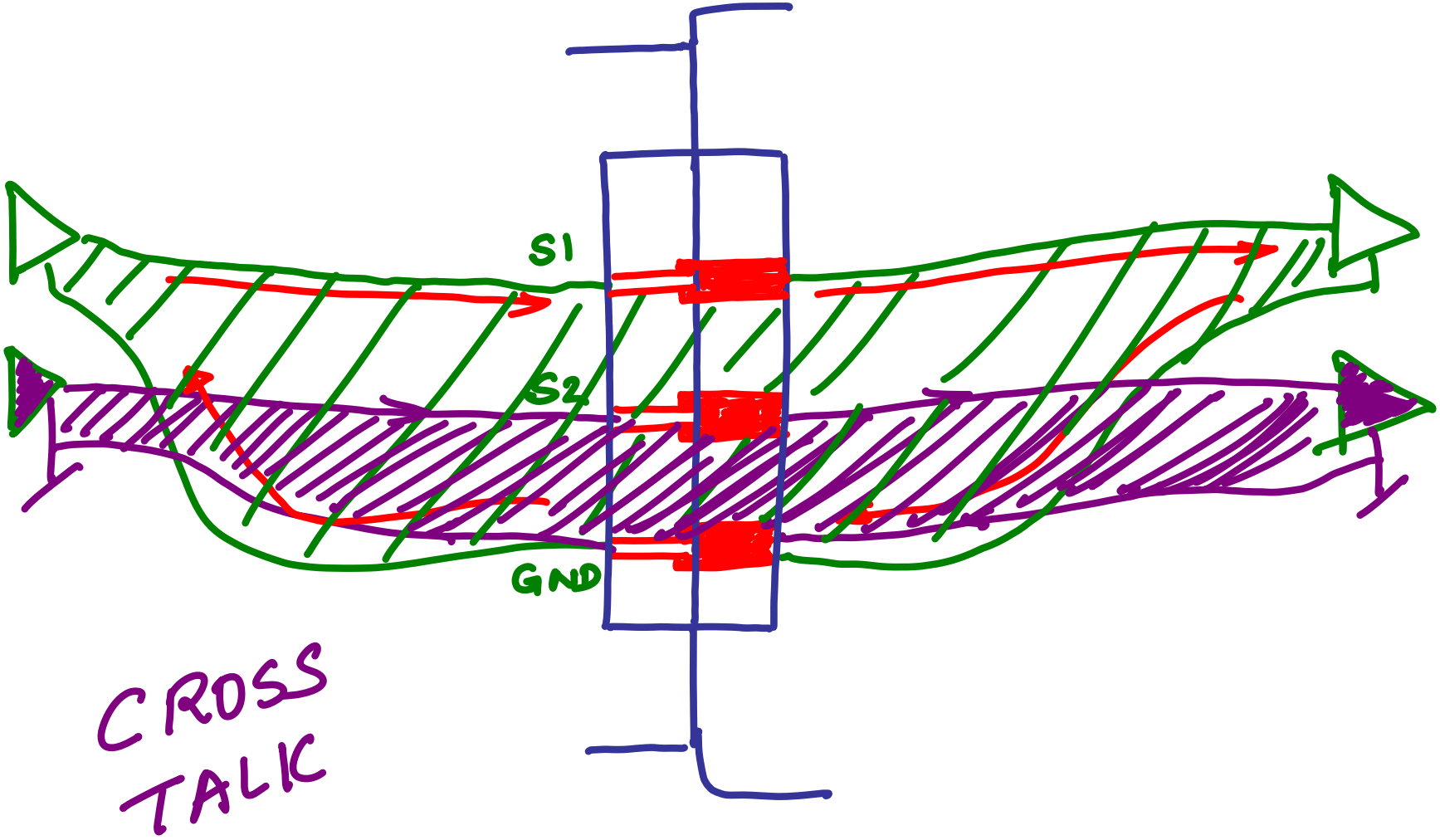


L

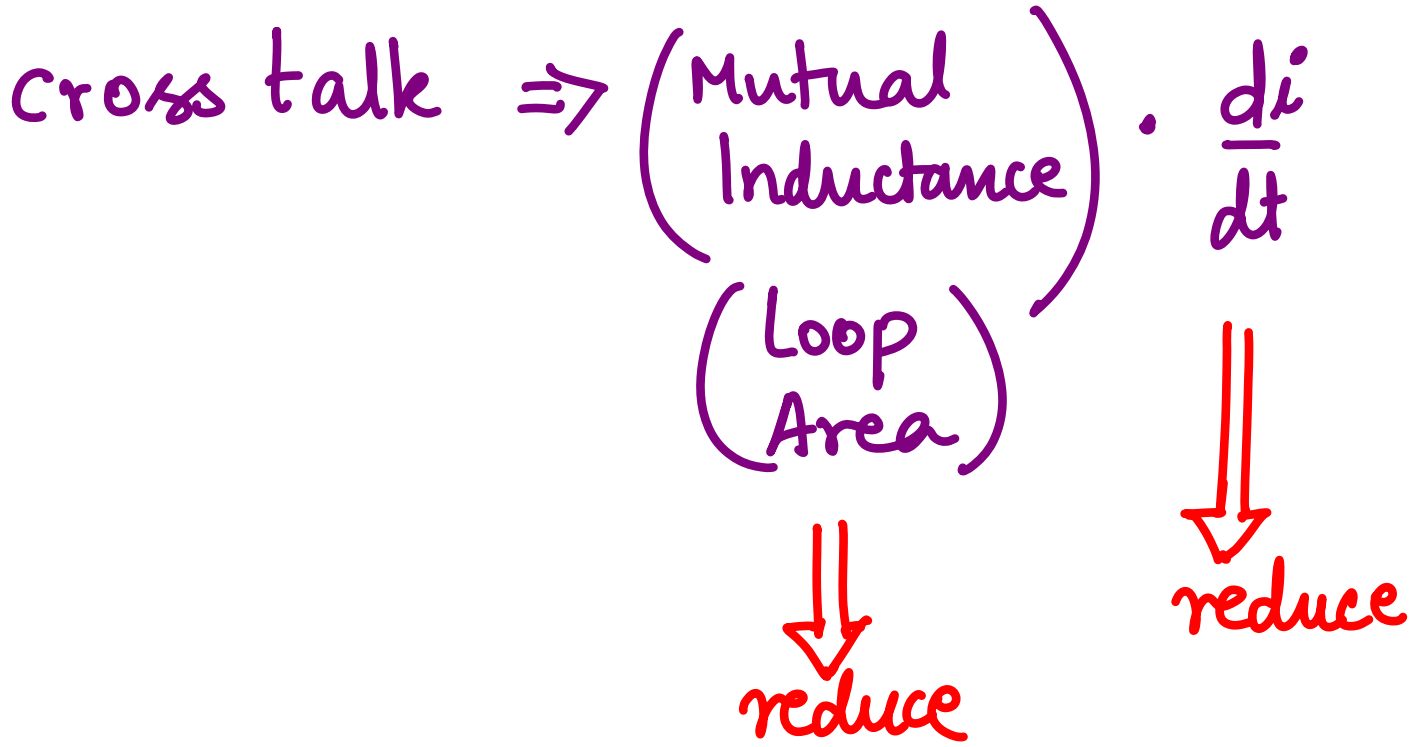
Connectors

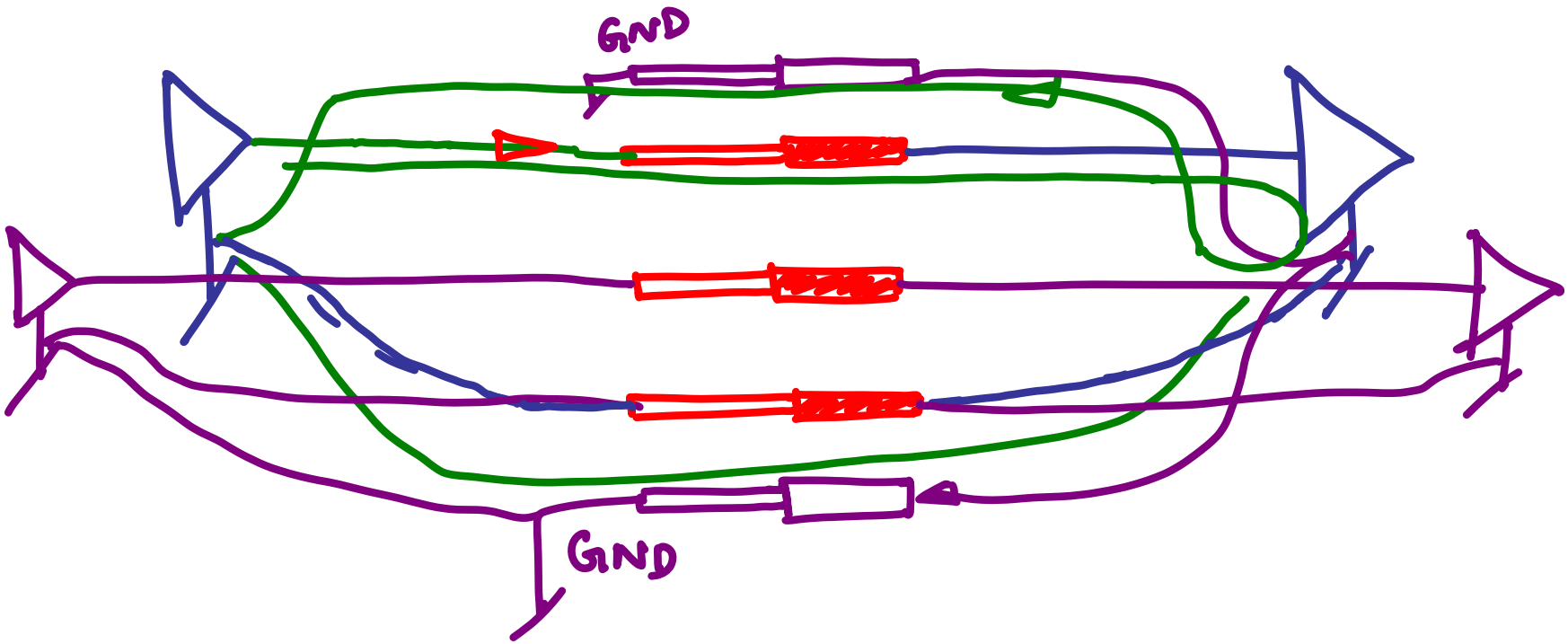
1. Wrapped Joints
2. Welded joints
3. Machine soldered
4. Crimped Joints
5. Hand soldered
6. Edge connectors

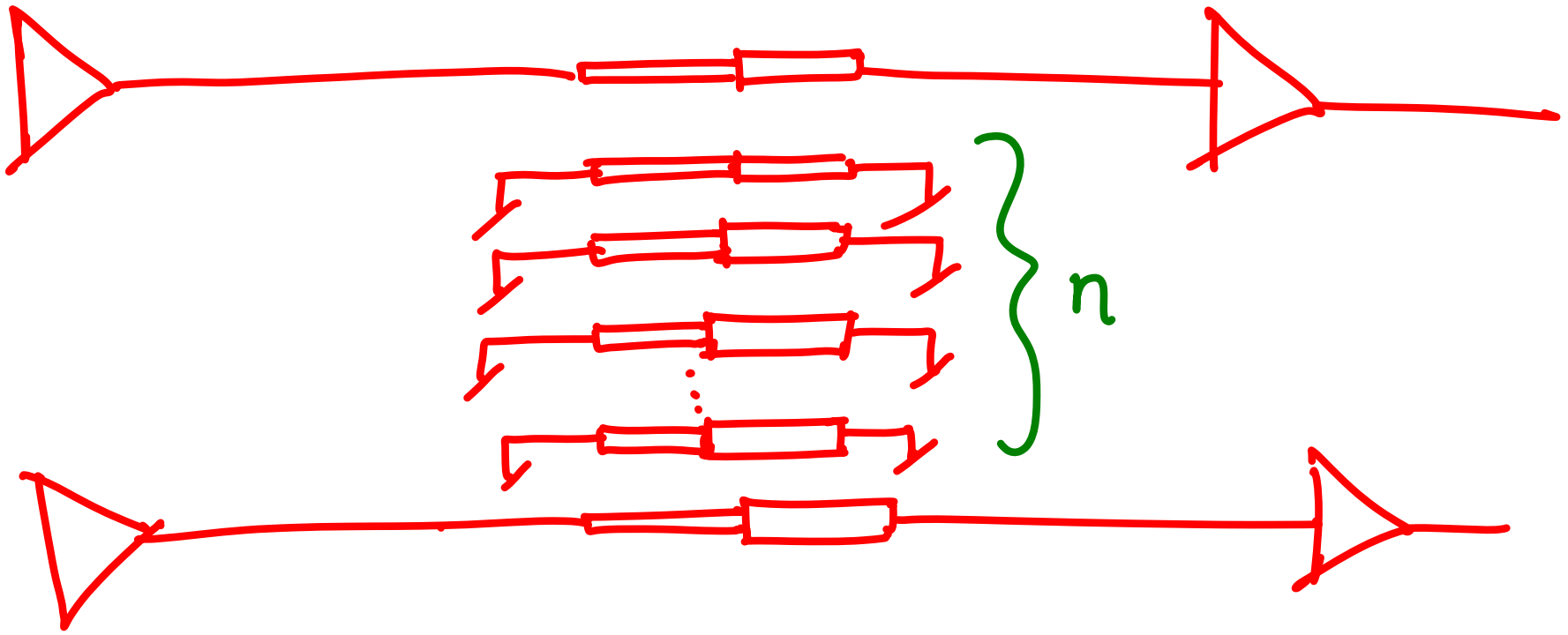




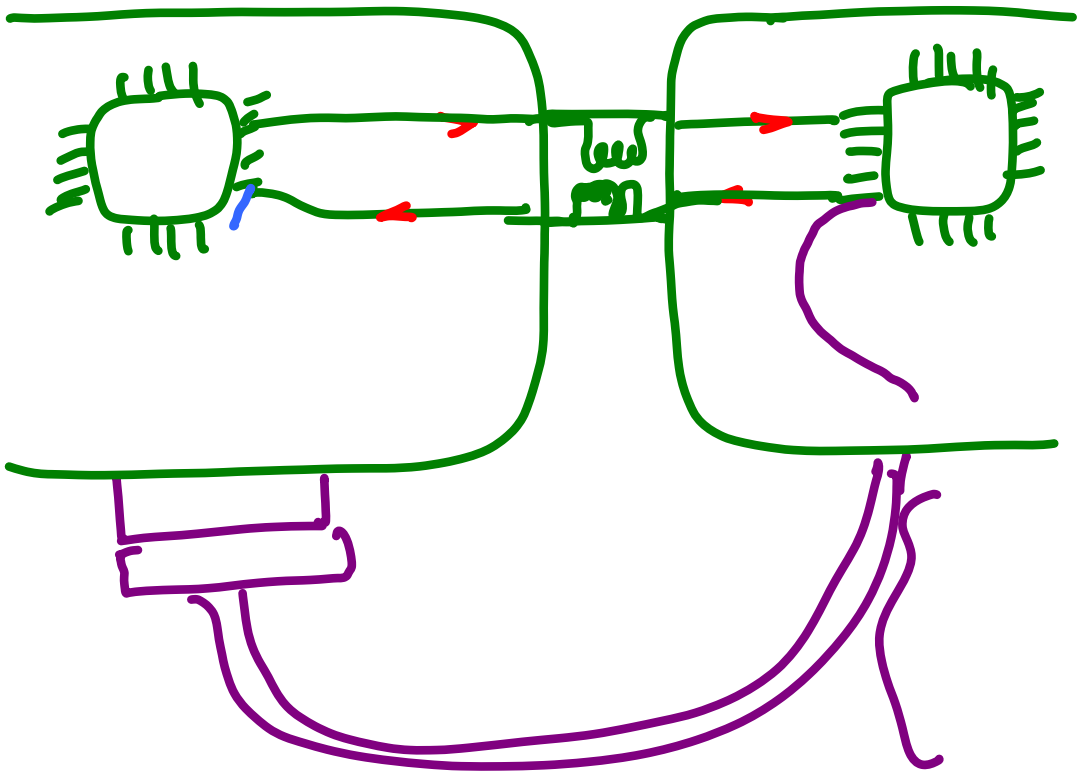
CROSS TALK


Cross talk ⇒
Mutual Inductance
Loop Area
di/dt
reduce
reduce

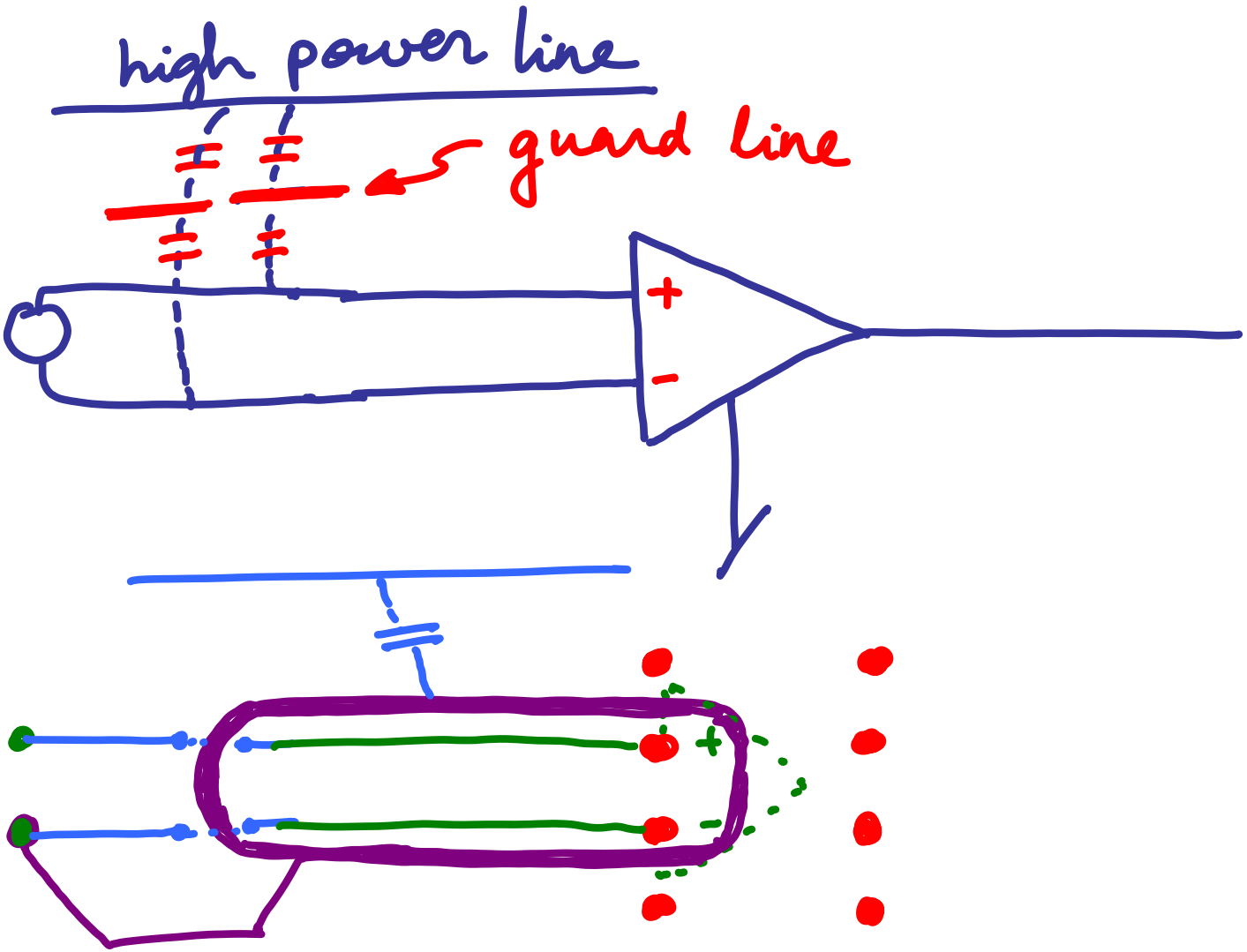

GND
GND



$$\frac{1}{n^2+1}$$



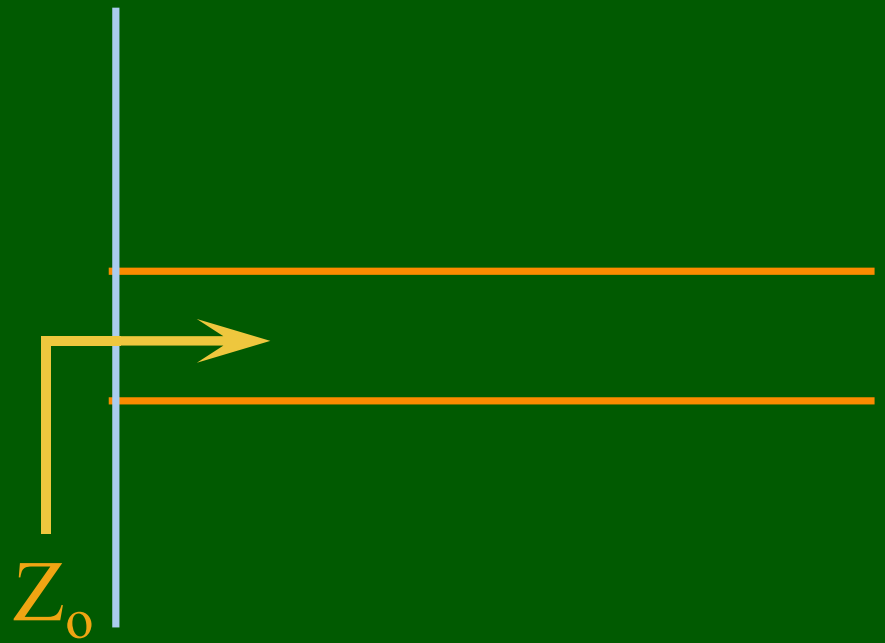
Reduce
Loop
area


high power line
guard line
+
-

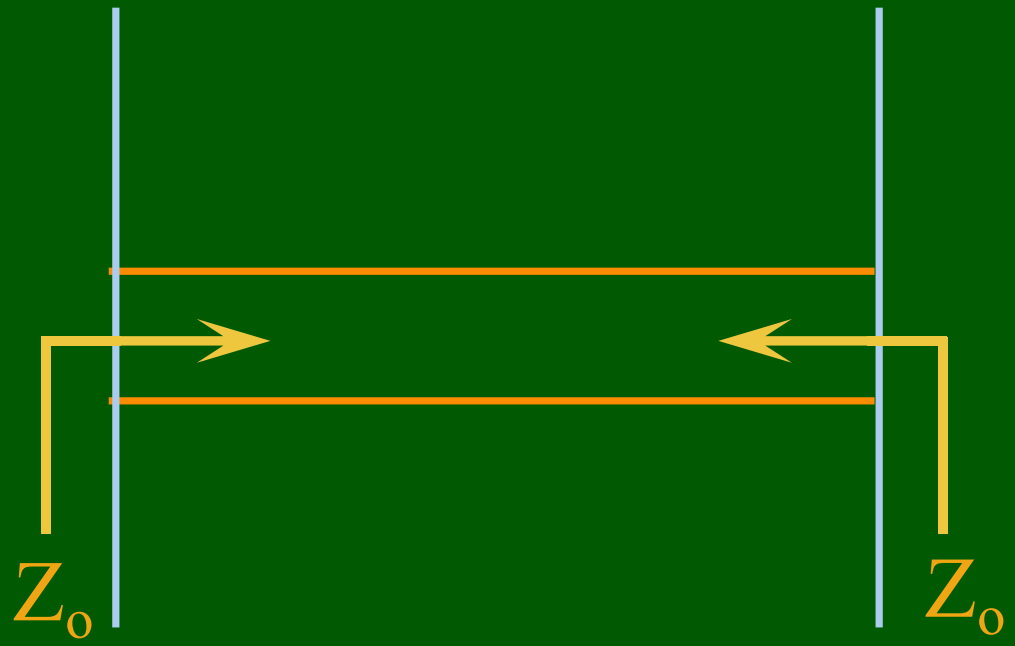
REFLECTION PROBLEM

REFLECTION PROBLEM

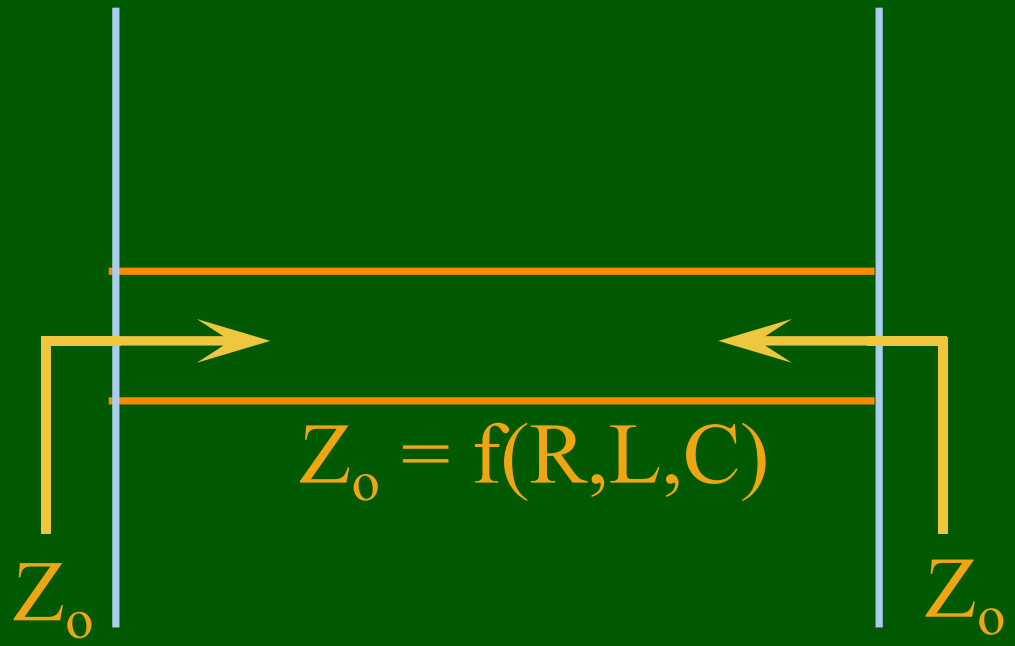
REFLECTION PROBLEM



REFLECTION PROBLEM



REFLECTION PROBLEM



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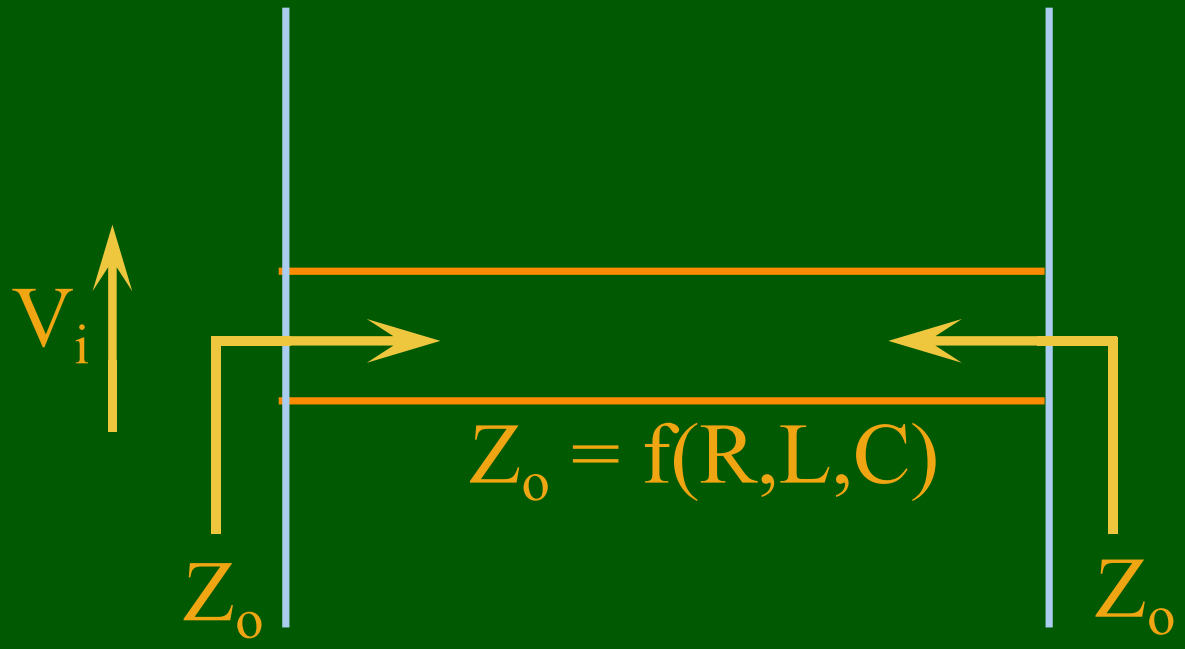

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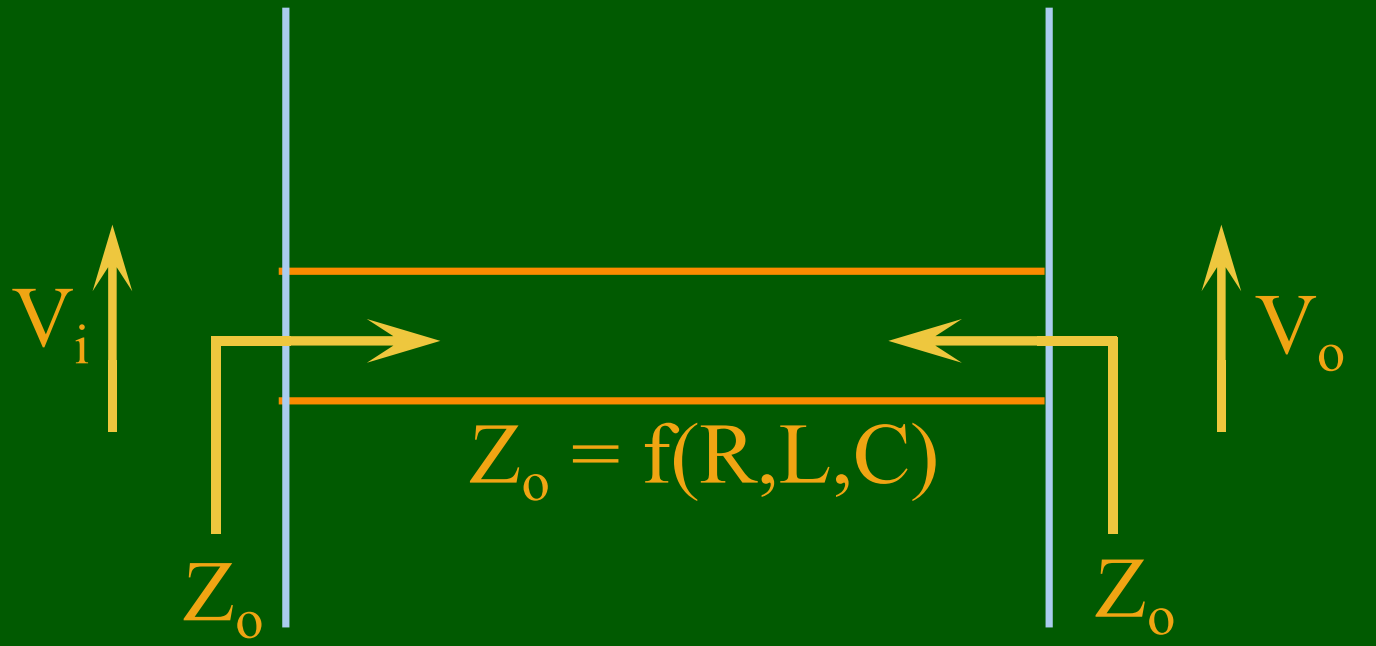

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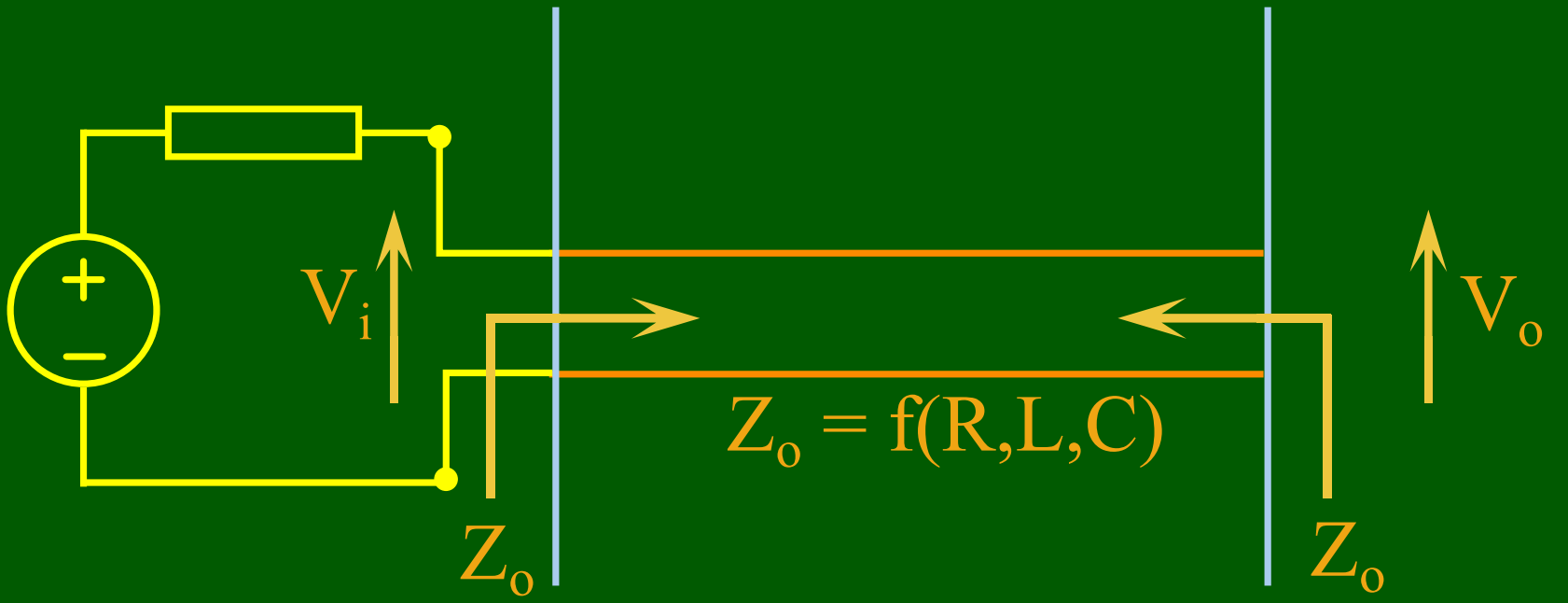

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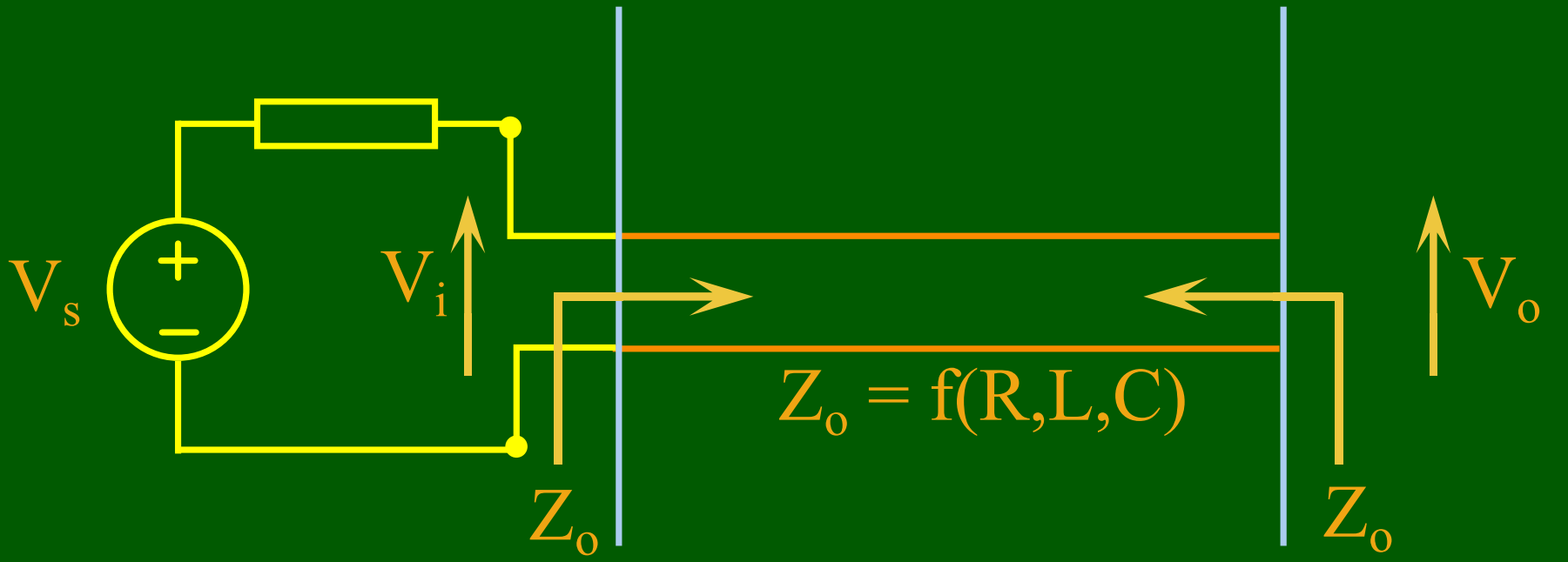

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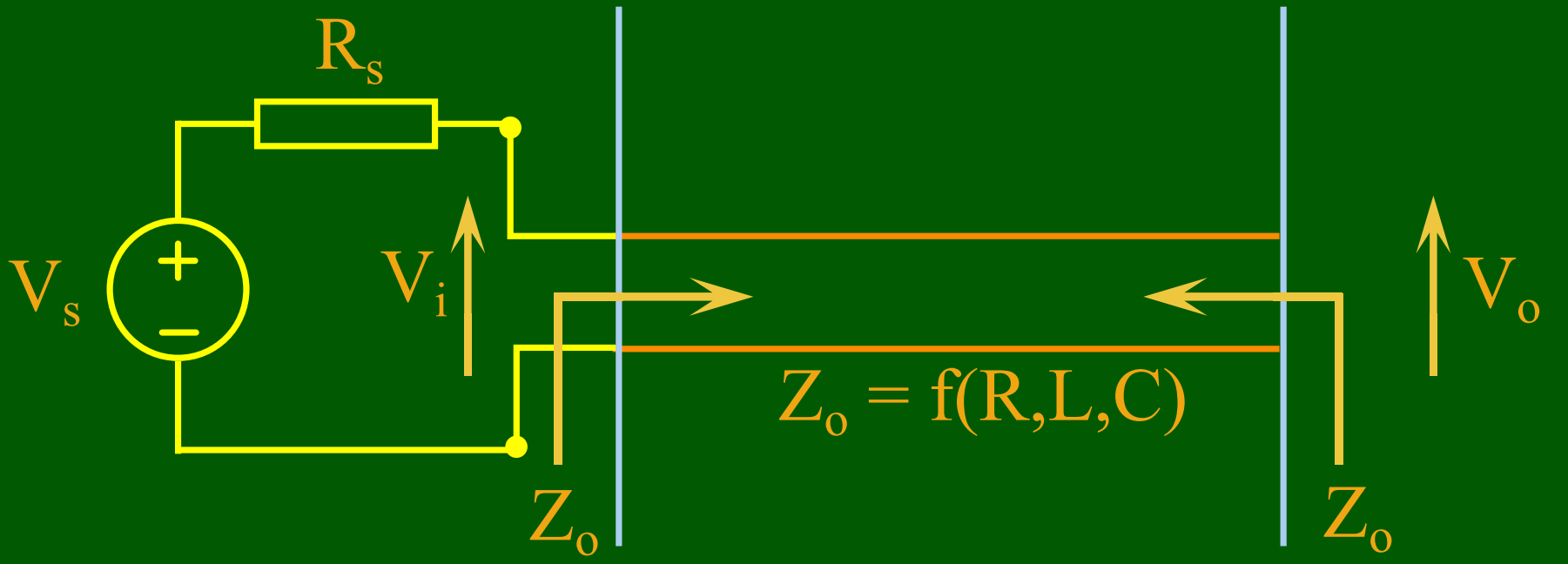

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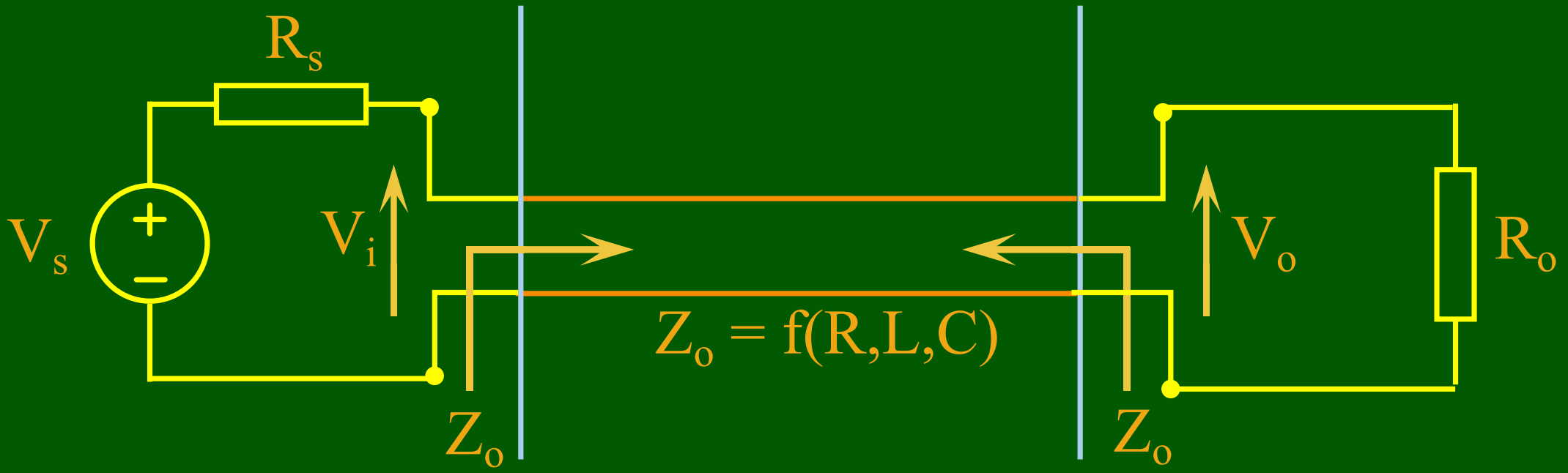

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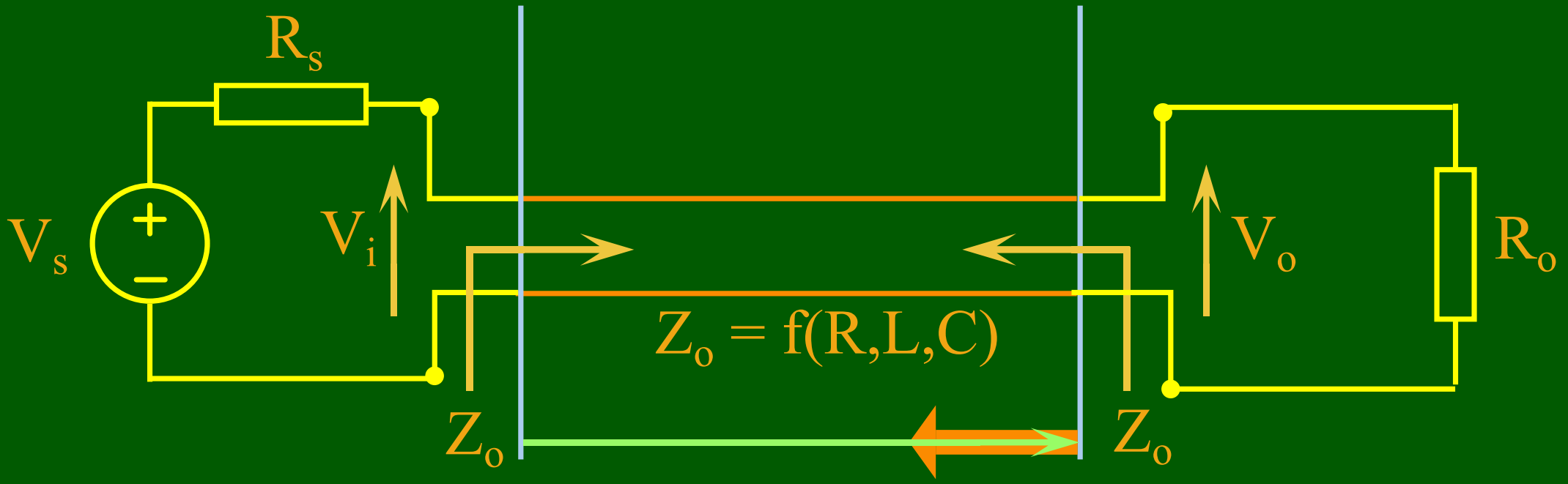
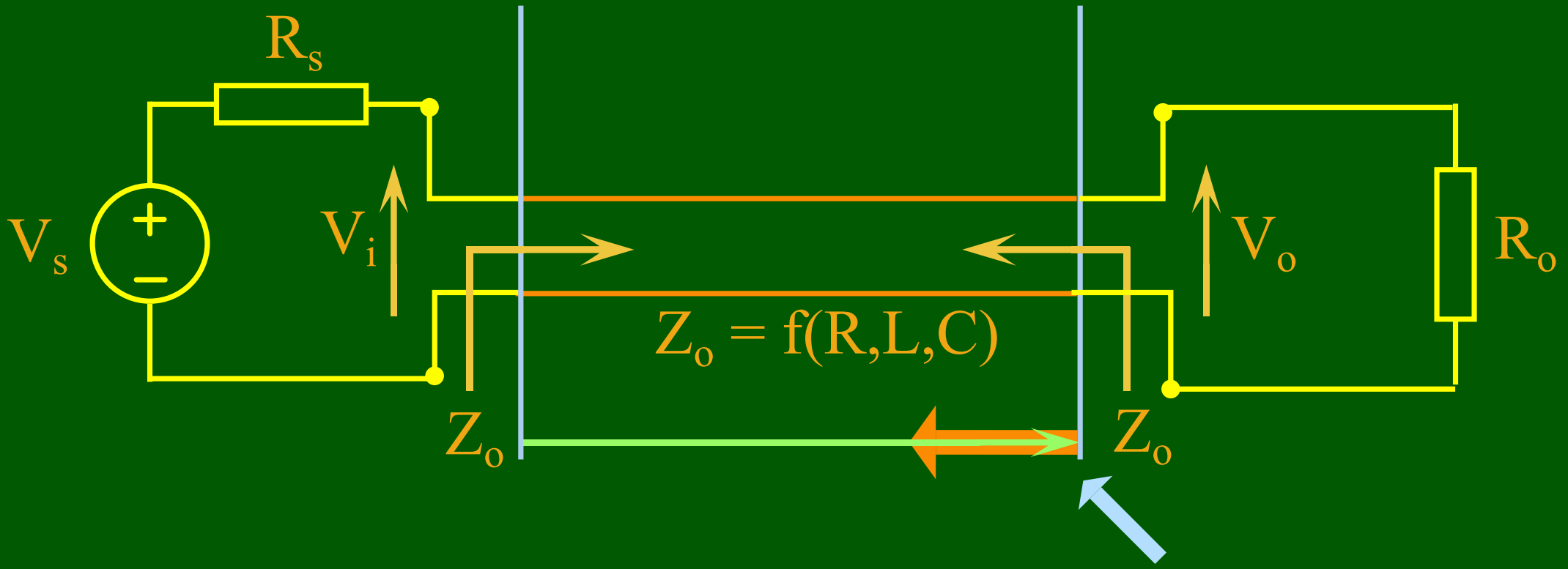
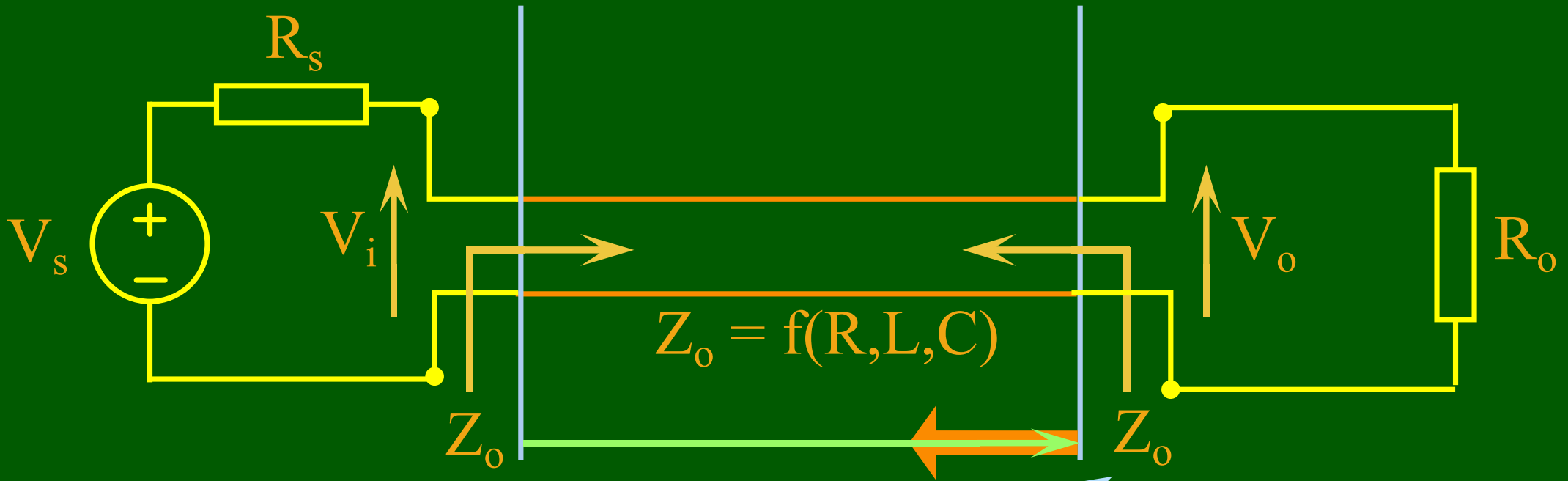


REFLECTION PROBLEM



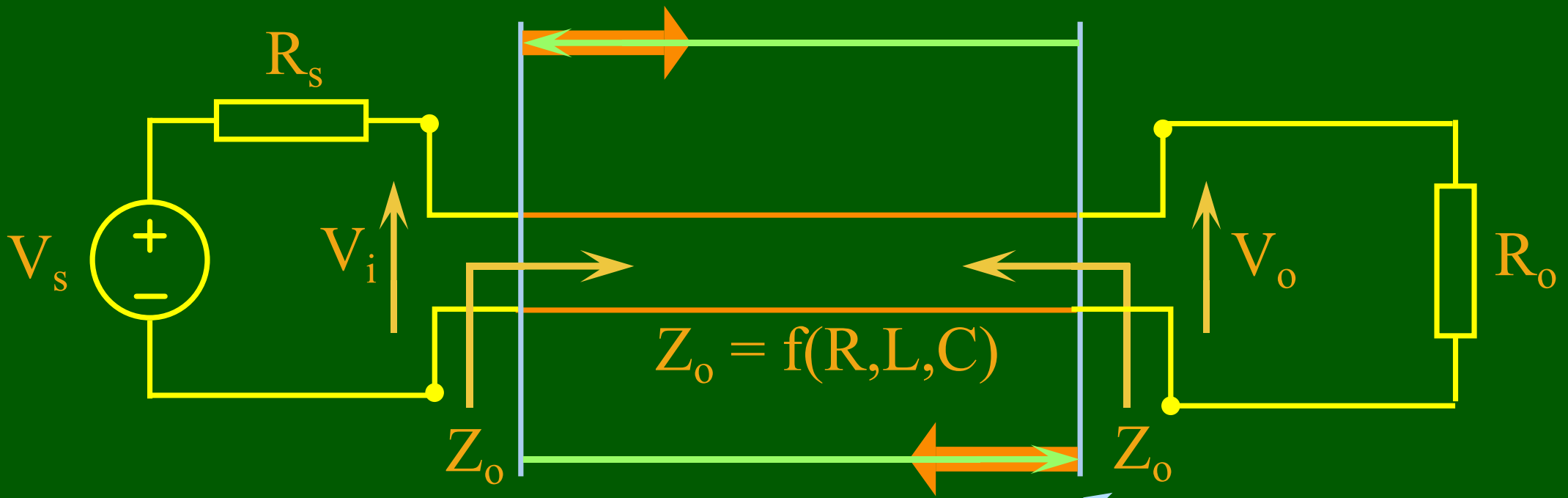
Coefficient of reflection

REFLECTION PROBLEM



$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o} \right)$$ Coefficient of reflection

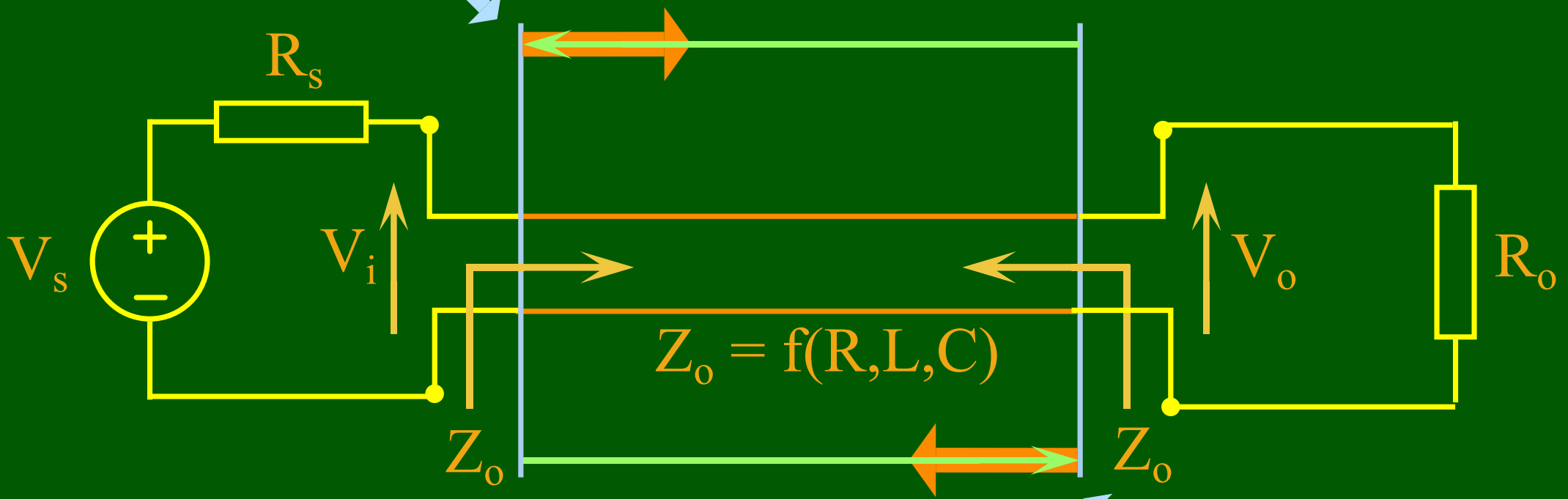
REFLECTION PROBLEM



$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o} \right)$$ Coefficient of reflection

REFLECTION PROBLEM

$$\rho_s = \left(\frac{R_s - Z_o}{R_s + Z_o} \right)$$



$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o} \right)$$ Coefficient of reflection

REFLECTION PROBLEM

REFLECTION PROBLEM

- $R_o = 300$ ohms
- $R_s = 25$ ohms
- $Z_o = 50$ ohms

REFLECTION PROBLEM

- R_o = 300 ohms
- R_s = 25 ohms
- Z_o = 50 ohms
- V_s = 3.6V (TTL)

REFLECTION PROBLEM

- R_o = 300 ohms
- R_s = 25 ohms
- Z_o = 50 ohms
- V_s = 3.6V (TTL)

$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o}\right) = 0.71$$

REFLECTION PROBLEM

- R_o = 300 ohms
- Z_o = 50 ohms
- R_s = 25 ohms
- V_s = 3.6V (TTL)

$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o}\right) = 0.71$$

$$\rho_s = \left(\frac{R_s - Z_o}{R_s + Z_o}\right) = -0.33$$

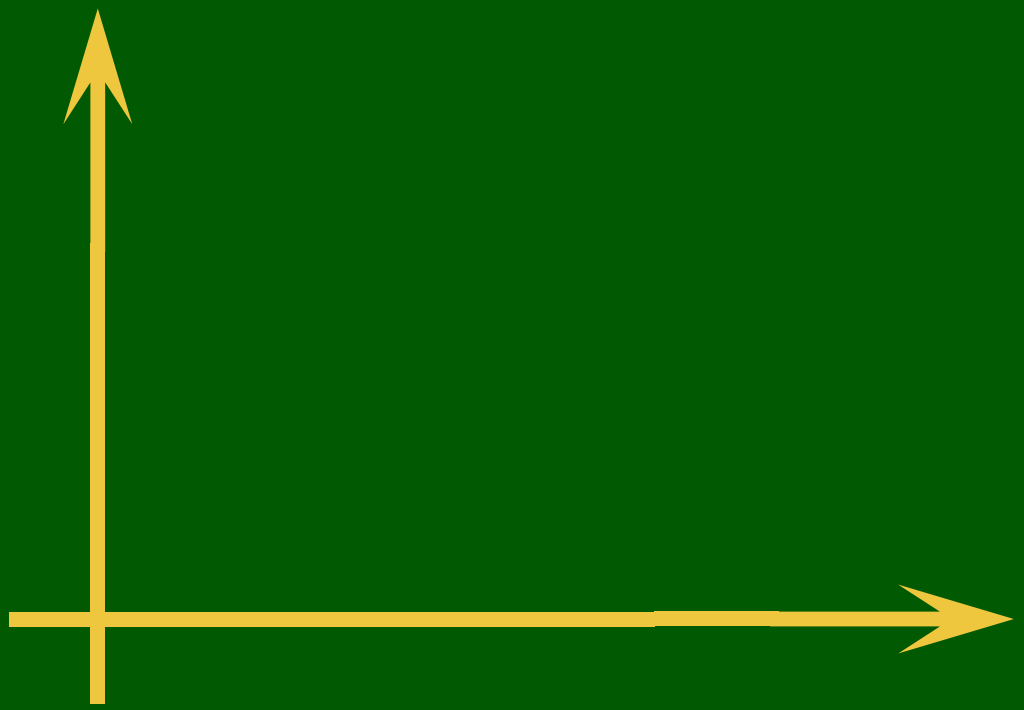
REFLECTION PROBLEM

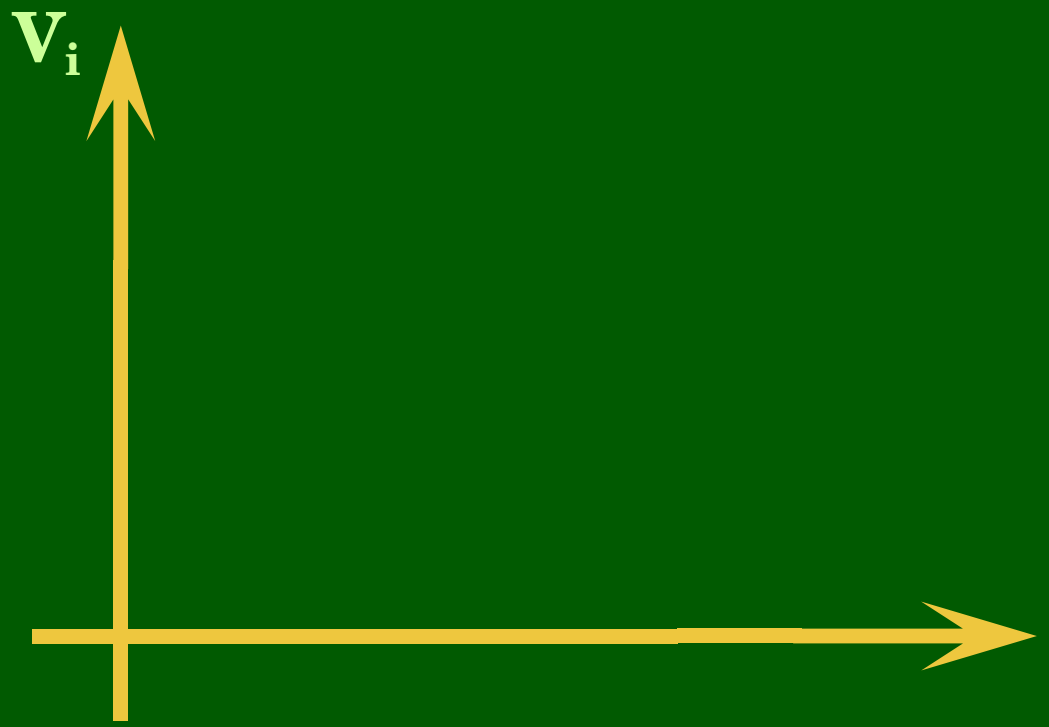
- R_o = 300 ohms
- Z_o = 50 ohms
- R_s = 25 ohms
- V_s = 3.6V (TTL)

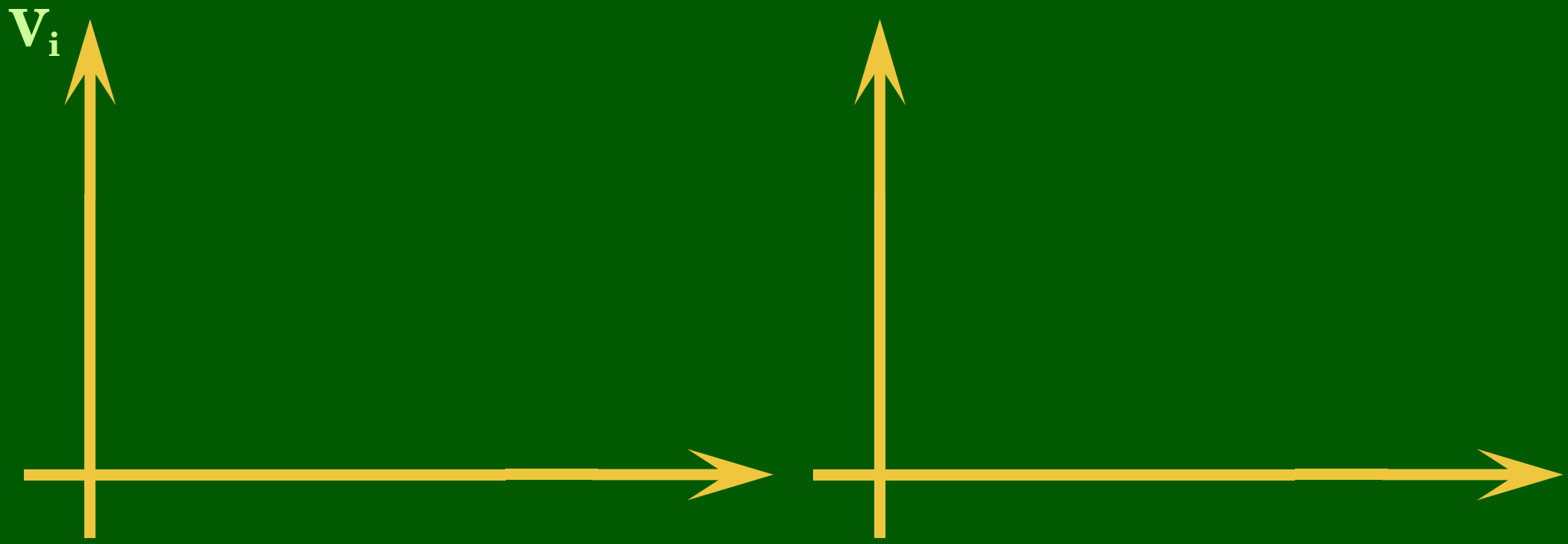
$$\rho_o = \left(\frac{R_o - Z_o}{R_o + Z_o}\right) = 0.71$$

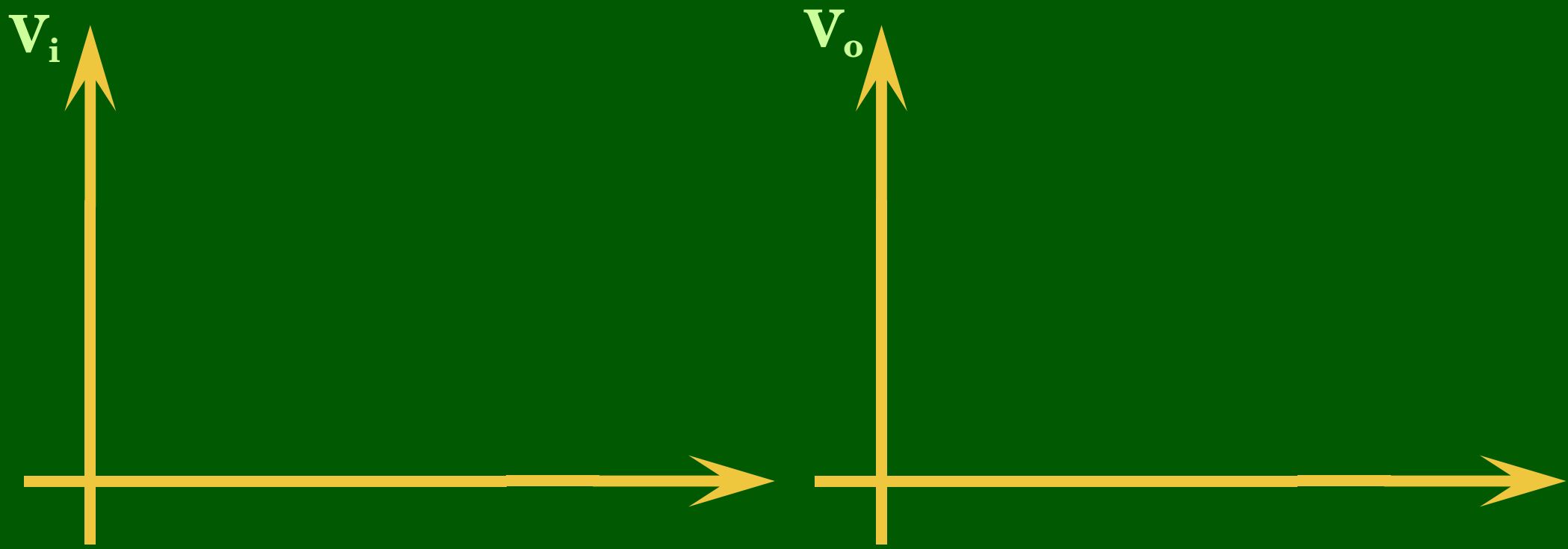
$$\rho_s = \left(\frac{R_s - Z_o}{R_s + Z_o}\right) = -0.33$$

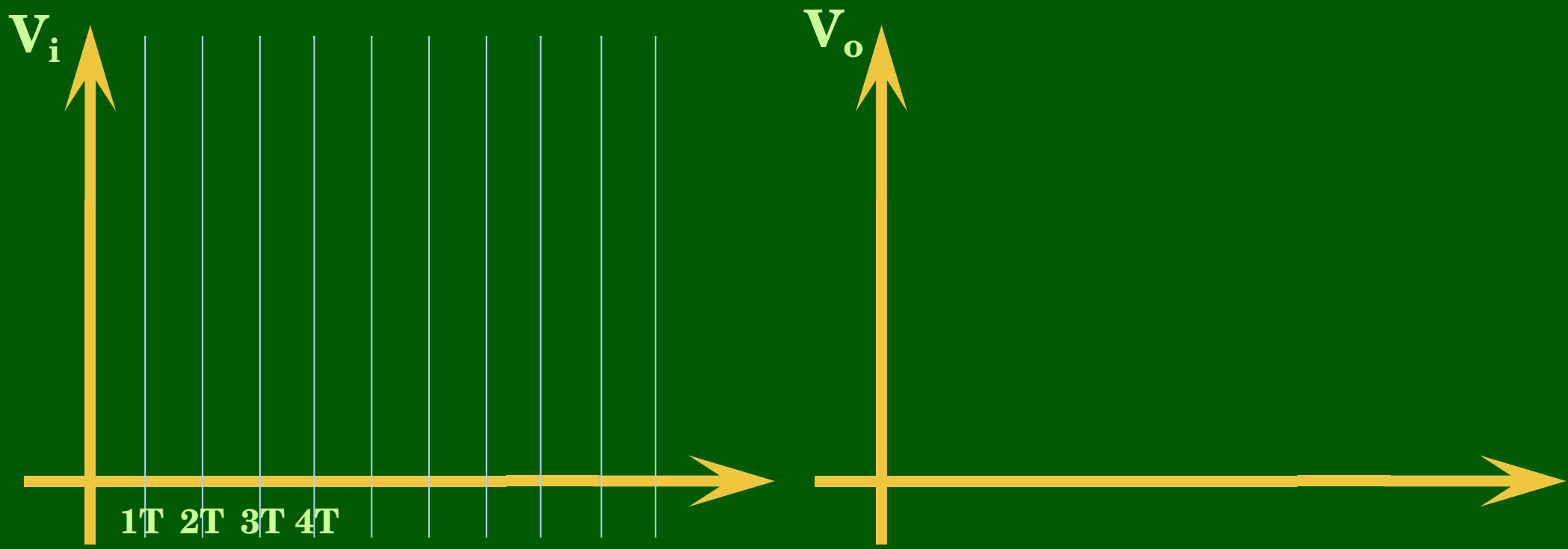
$$V_i = \left(\frac{Z_o}{R_s + Z_o}\right) \cdot V_s = \left(\frac{50}{50+25}\right) \cdot 3.6 = 2.4V$$

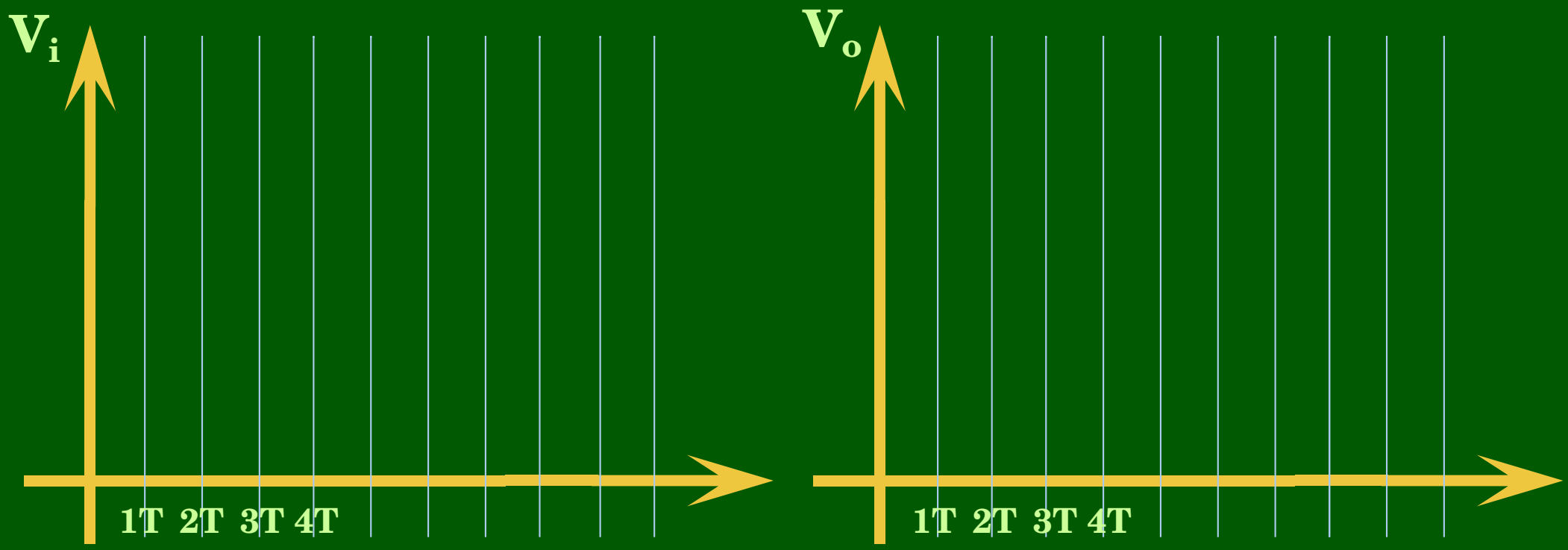


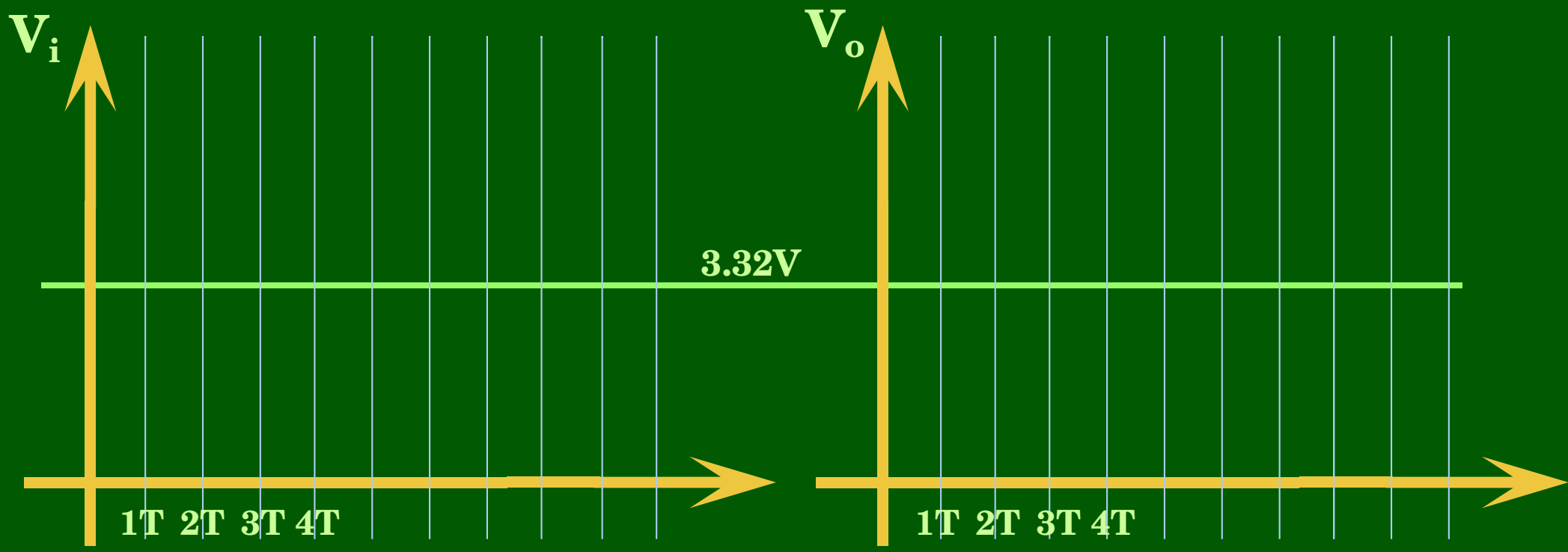

V_i

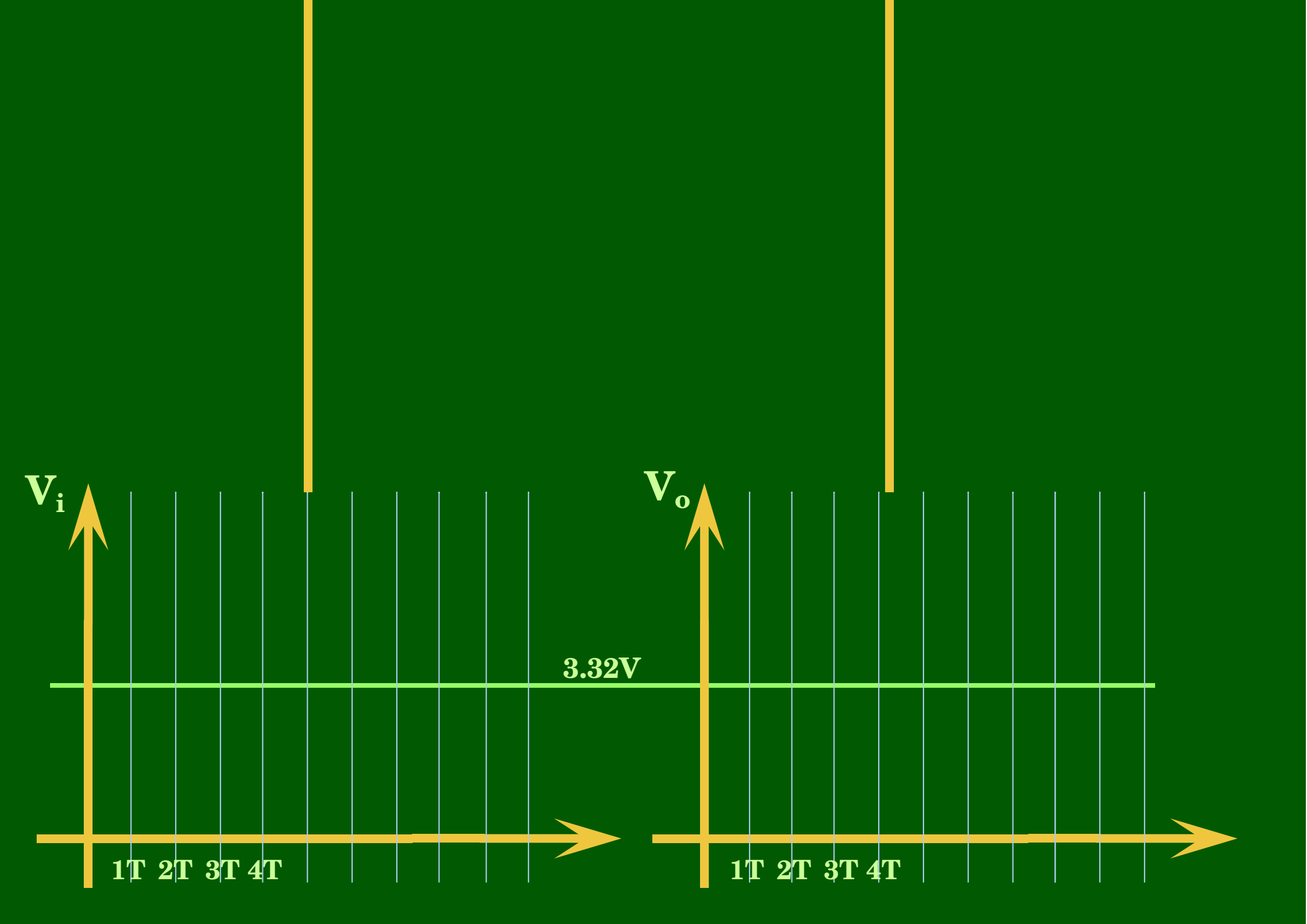

V_i


V_i
V_o


V_i
V_o
1T 2T 3T 4T

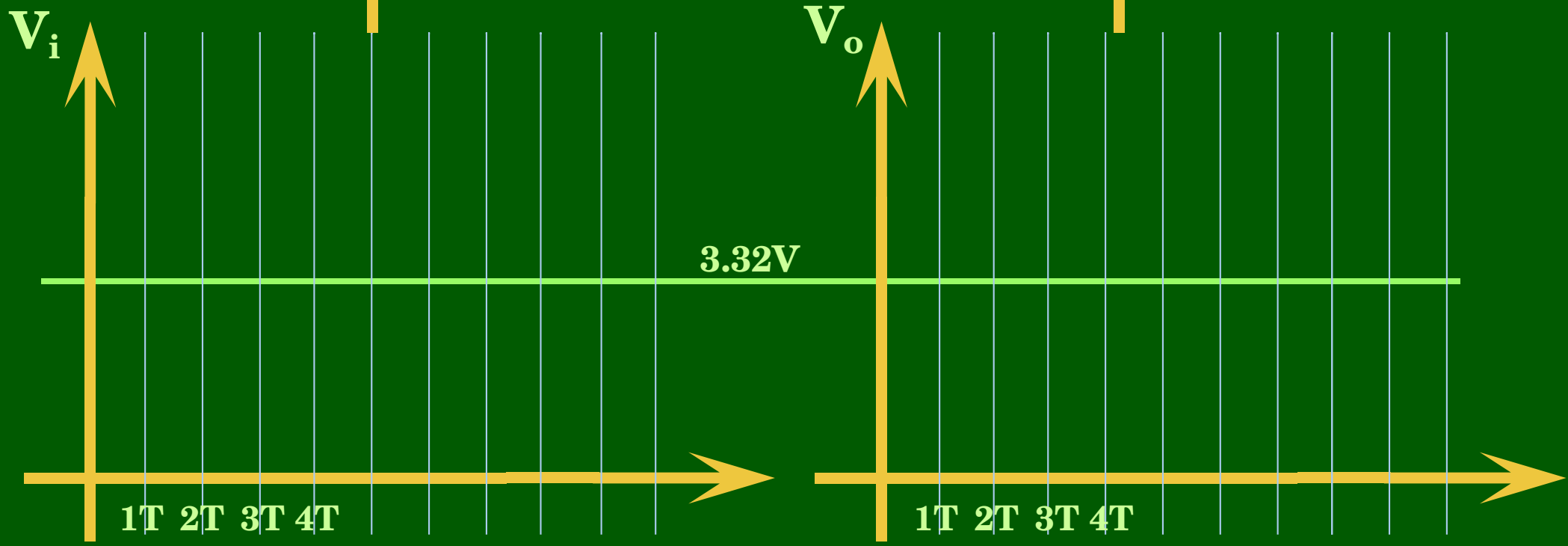

V_i
1T 2T 3T 4T
V_o
1T 2T 3T 4T


V_i
V_o
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


V_i
V_o
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

$\rho_s = -0.33$

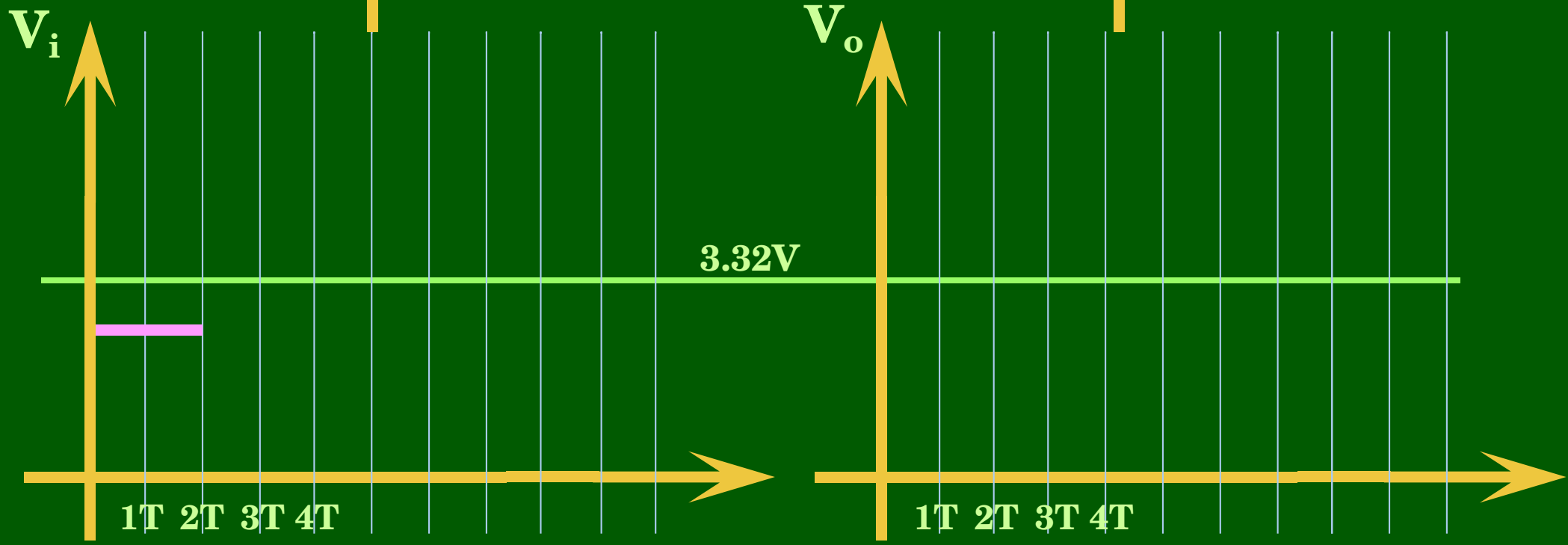
$\rho_o = 0.71$

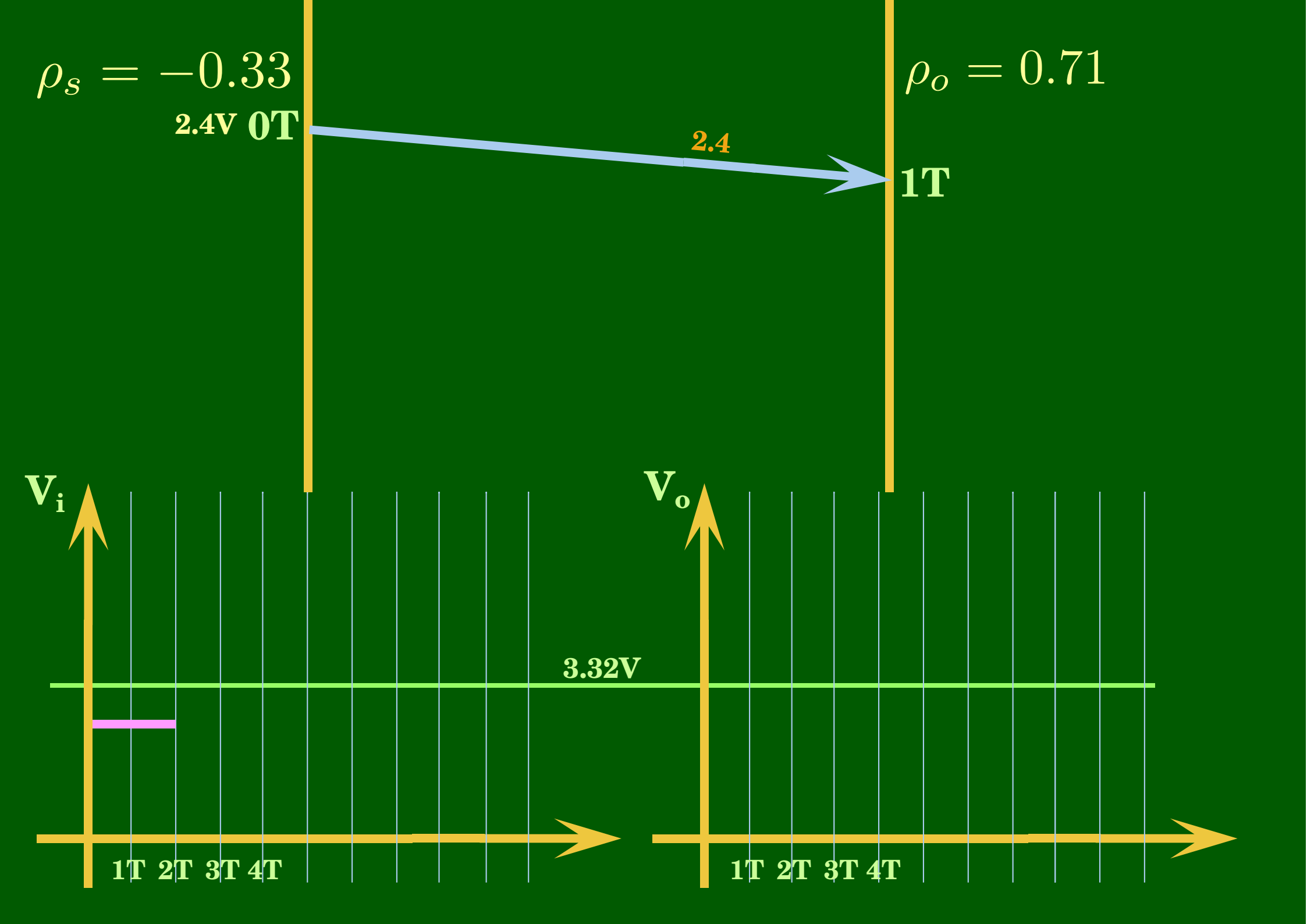


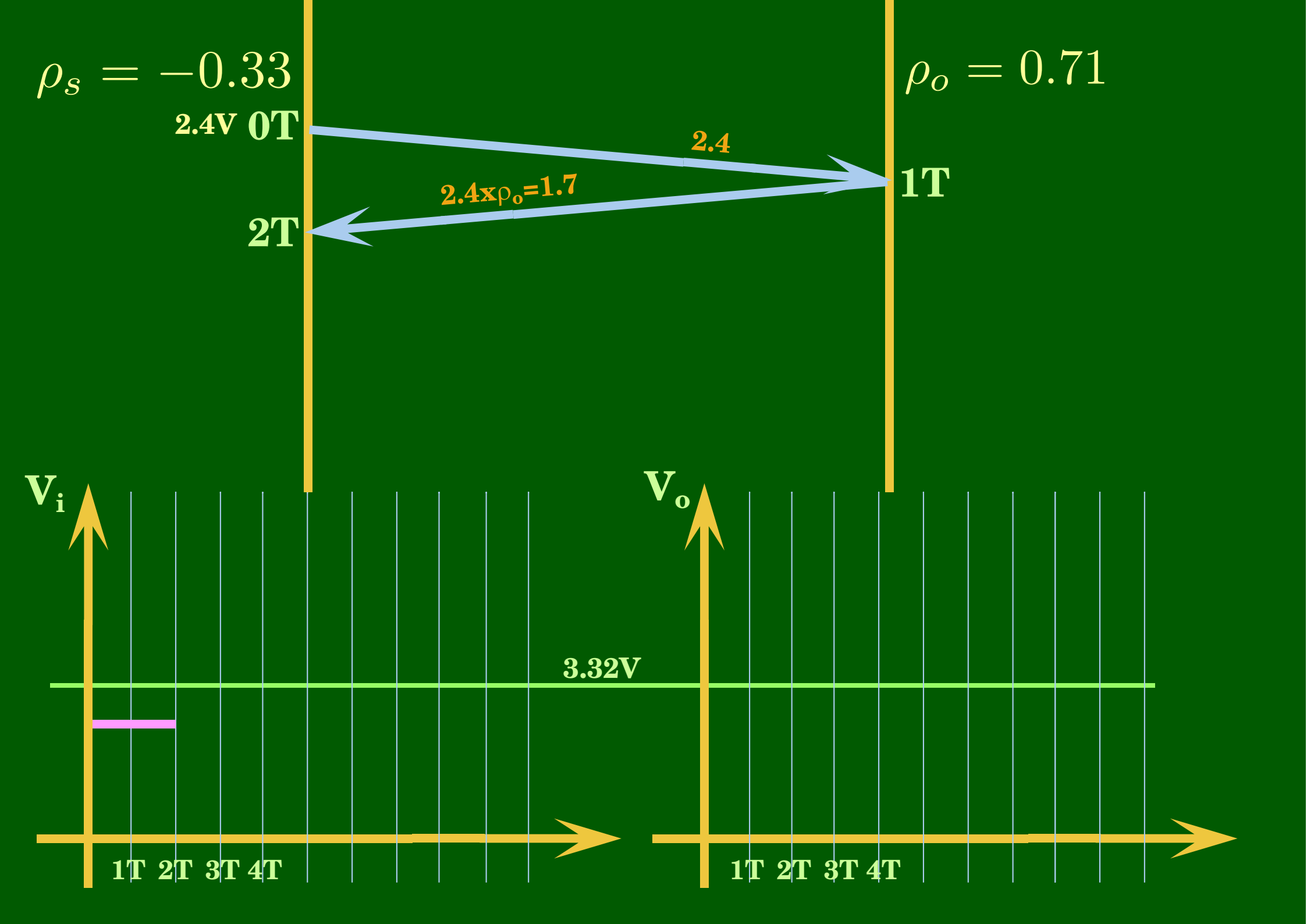
$\rho_s = -0.33$

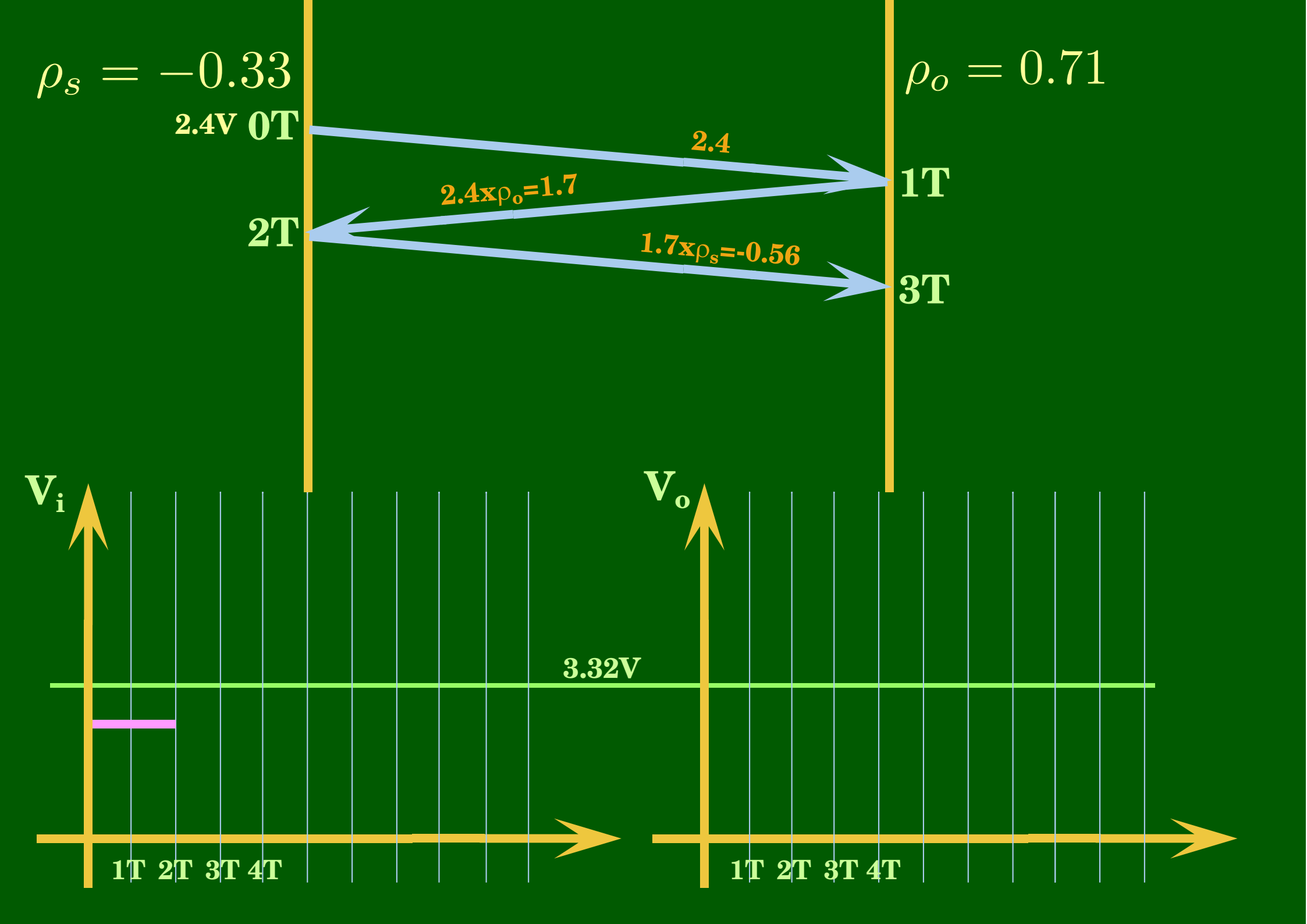
2.4V 0T

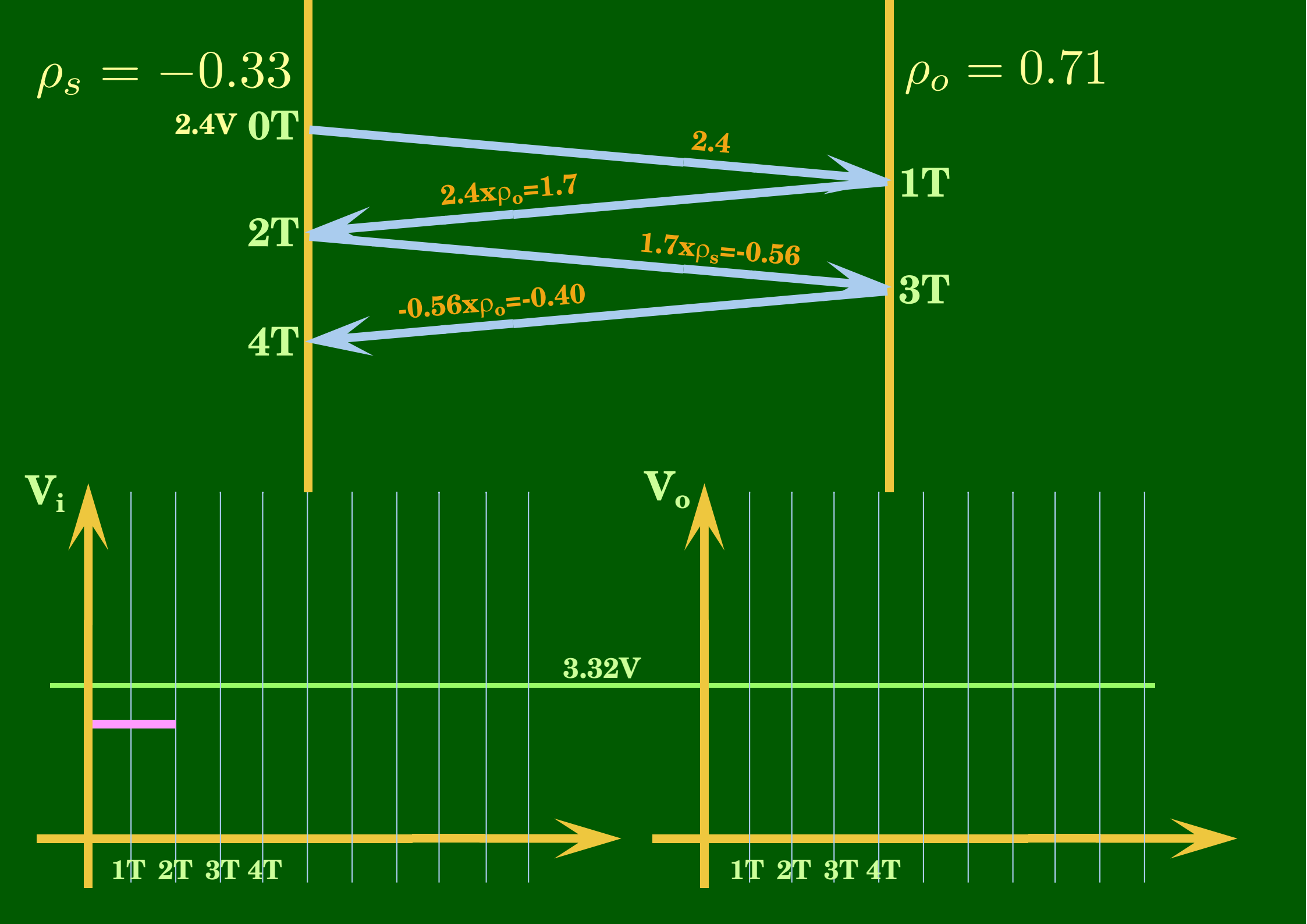
$\rho_o = 0.71$

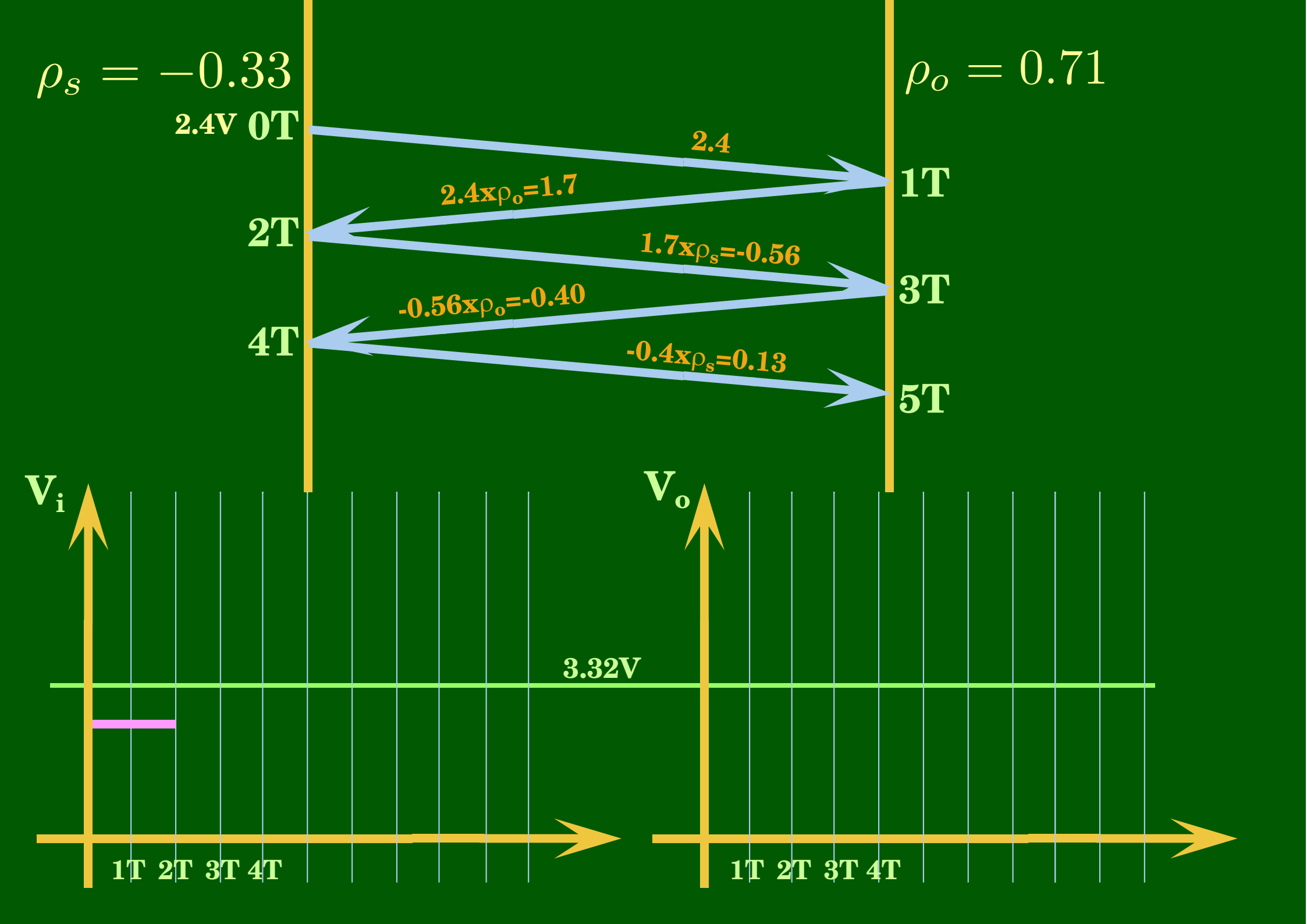


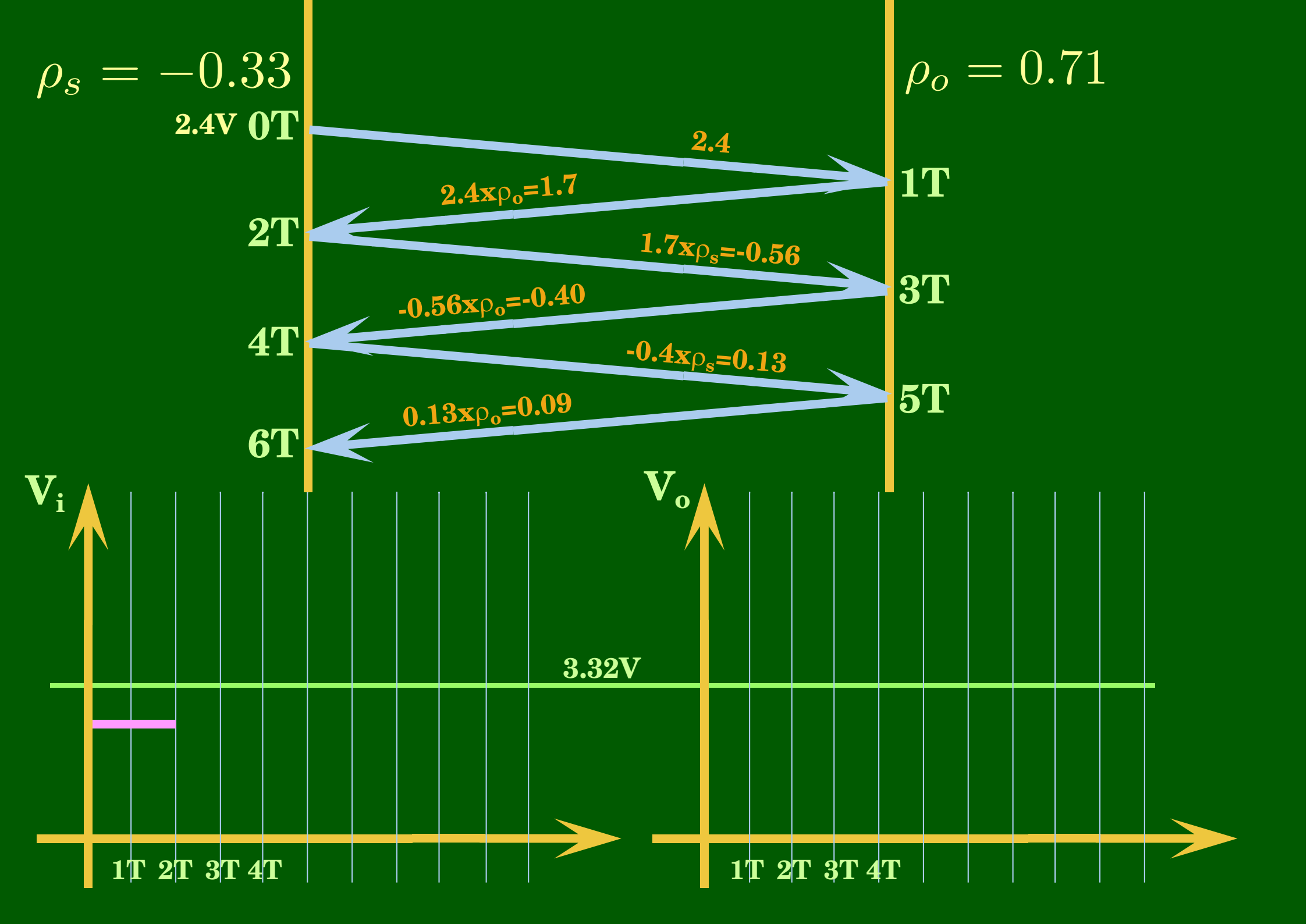

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
V_i
V_o
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

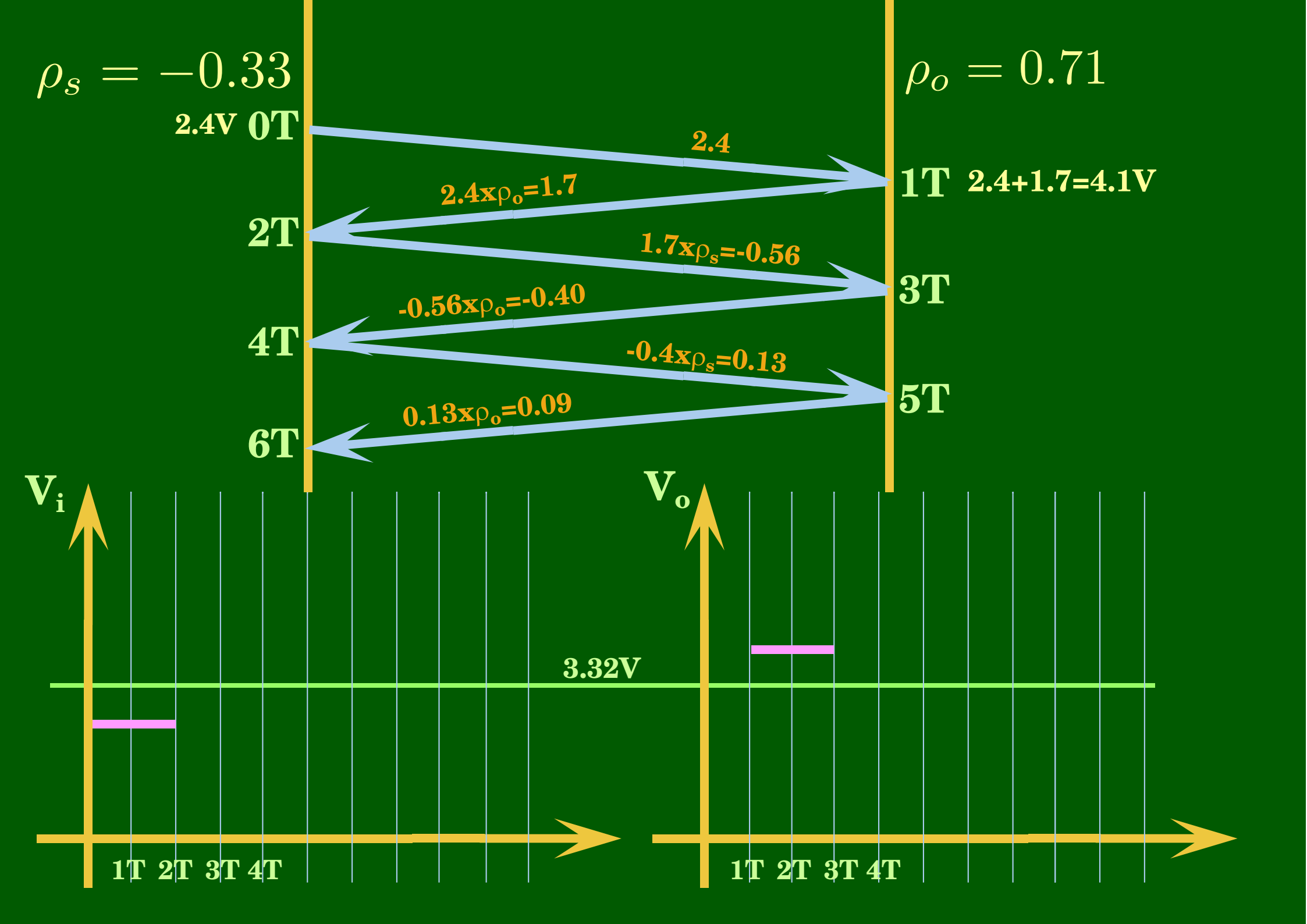

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
2.4xρo=1.7
2T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

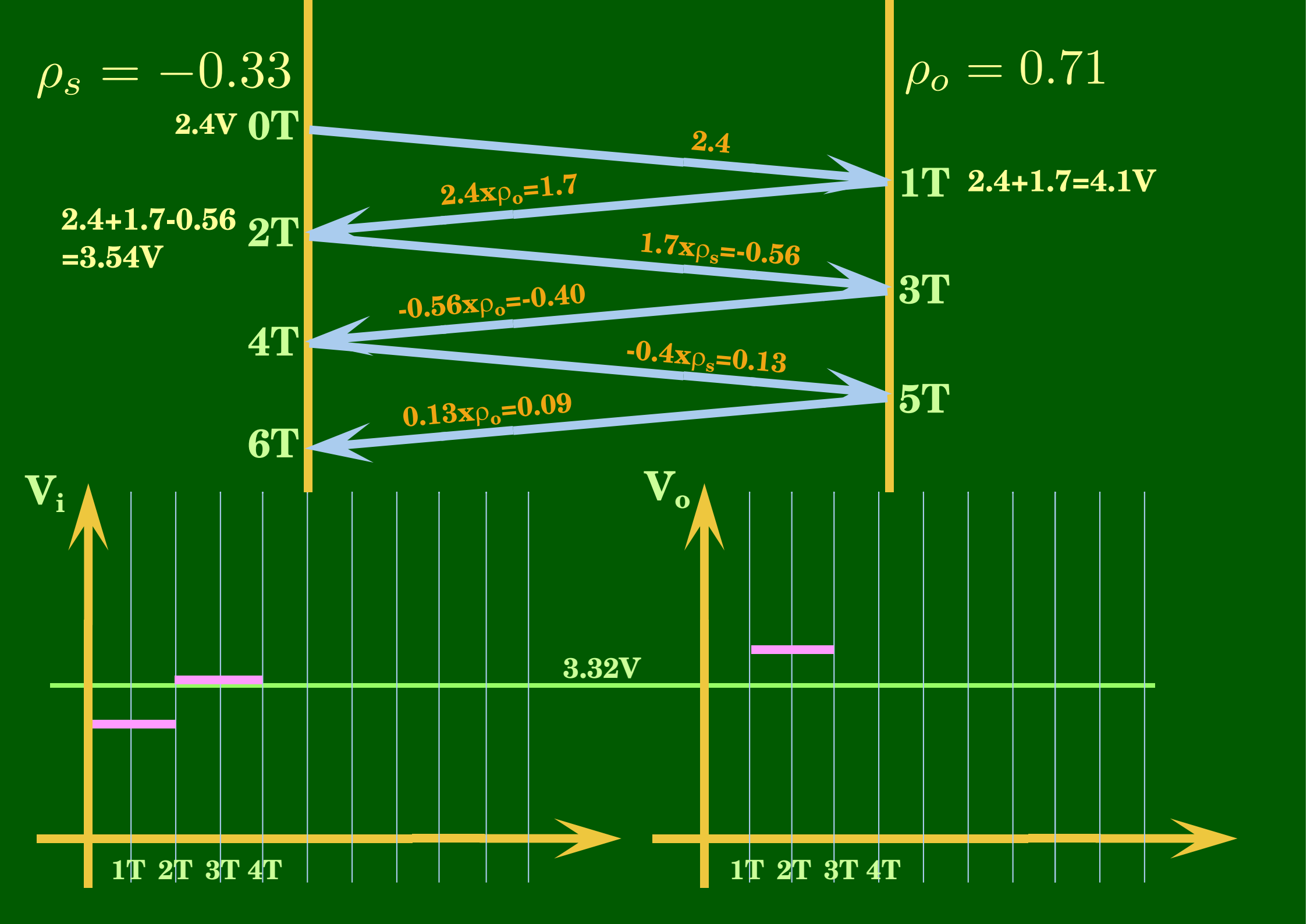

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
2.4xρo=1.7
2T
1.7xρs=-0.56
3T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

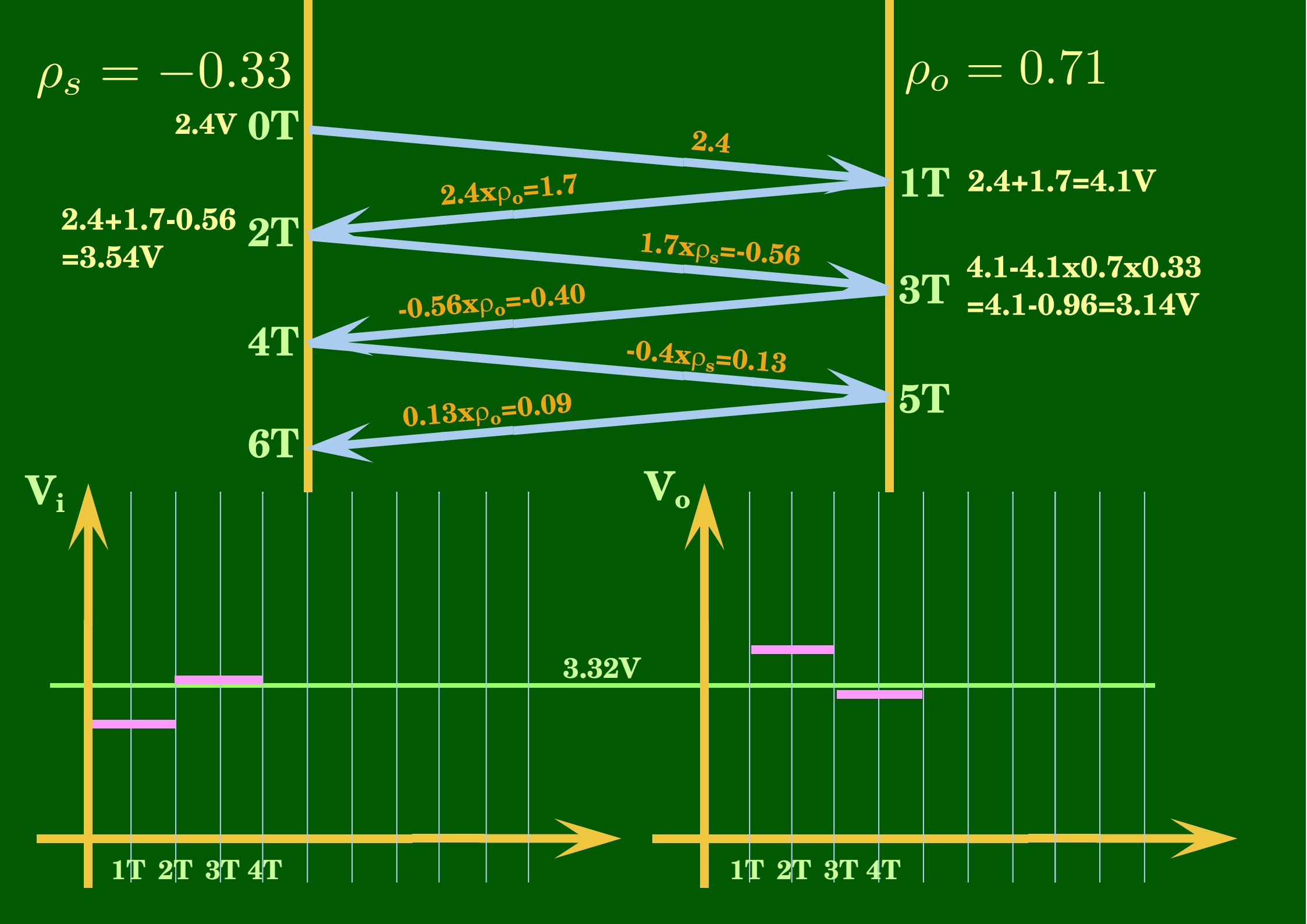

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
2.4xρo=1.7
2T
1.7xρs=-0.56
3T
-0.56xρo=-0.40
4T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

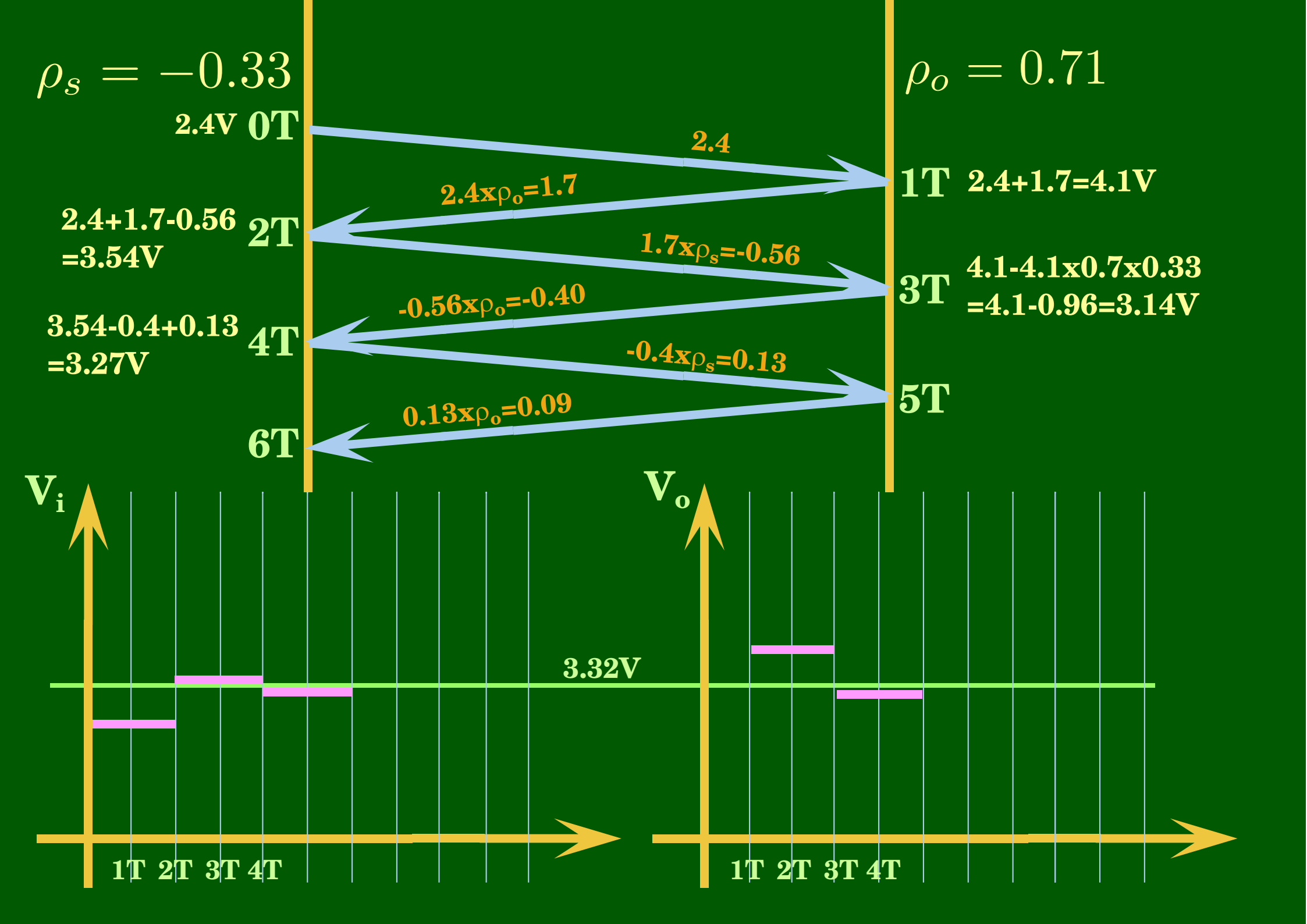

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
2.4xρo=1.7
2T
1.7xρs=-0.56
3T
-0.56xρo=-0.40
4T
-0.4xρs=0.13
5T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

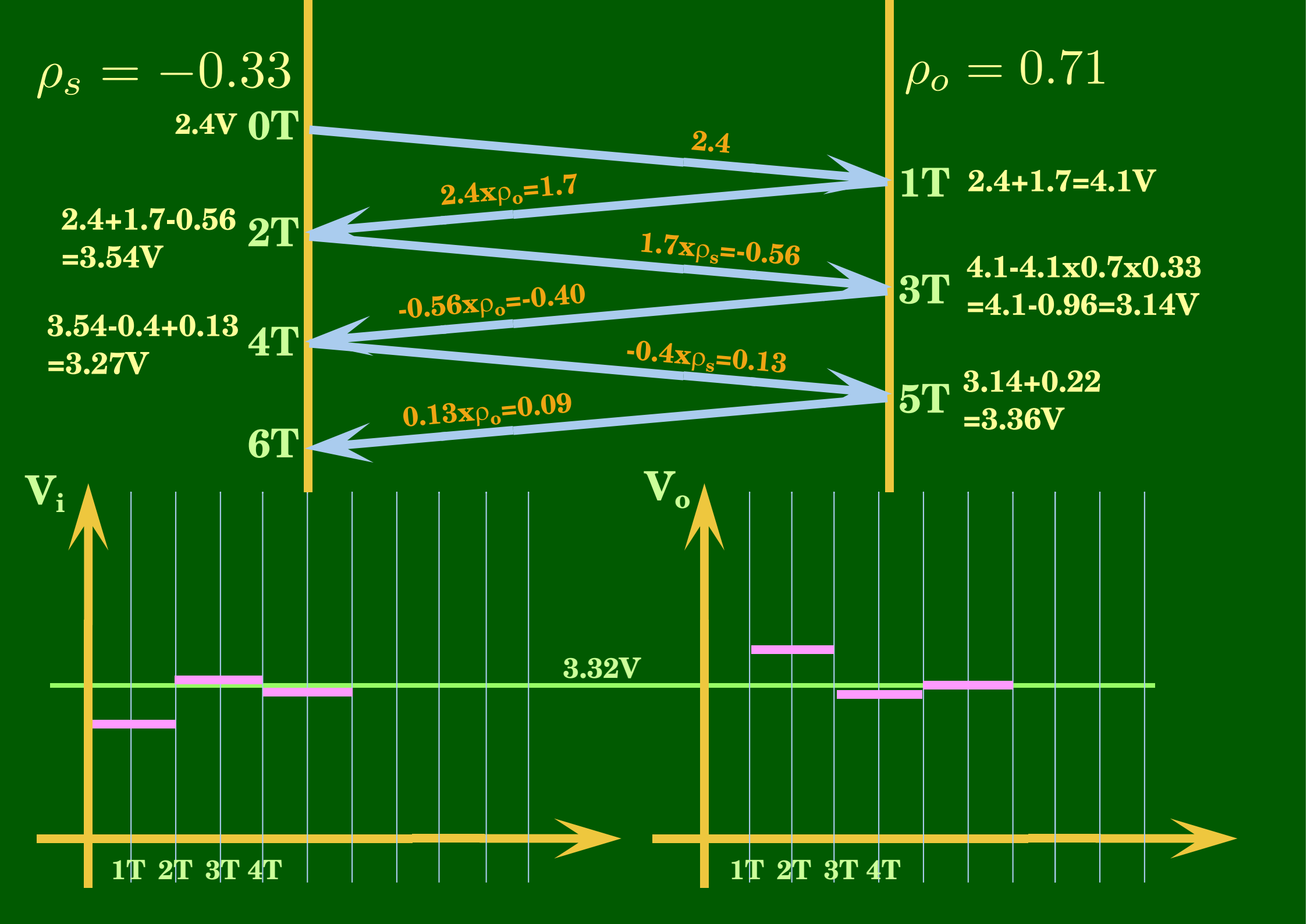

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T
2.4xρo=1.7
2T
1.7xρs=-0.56
3T
-0.56xρo=-0.40
4T
-0.4xρs=0.13
5T
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T

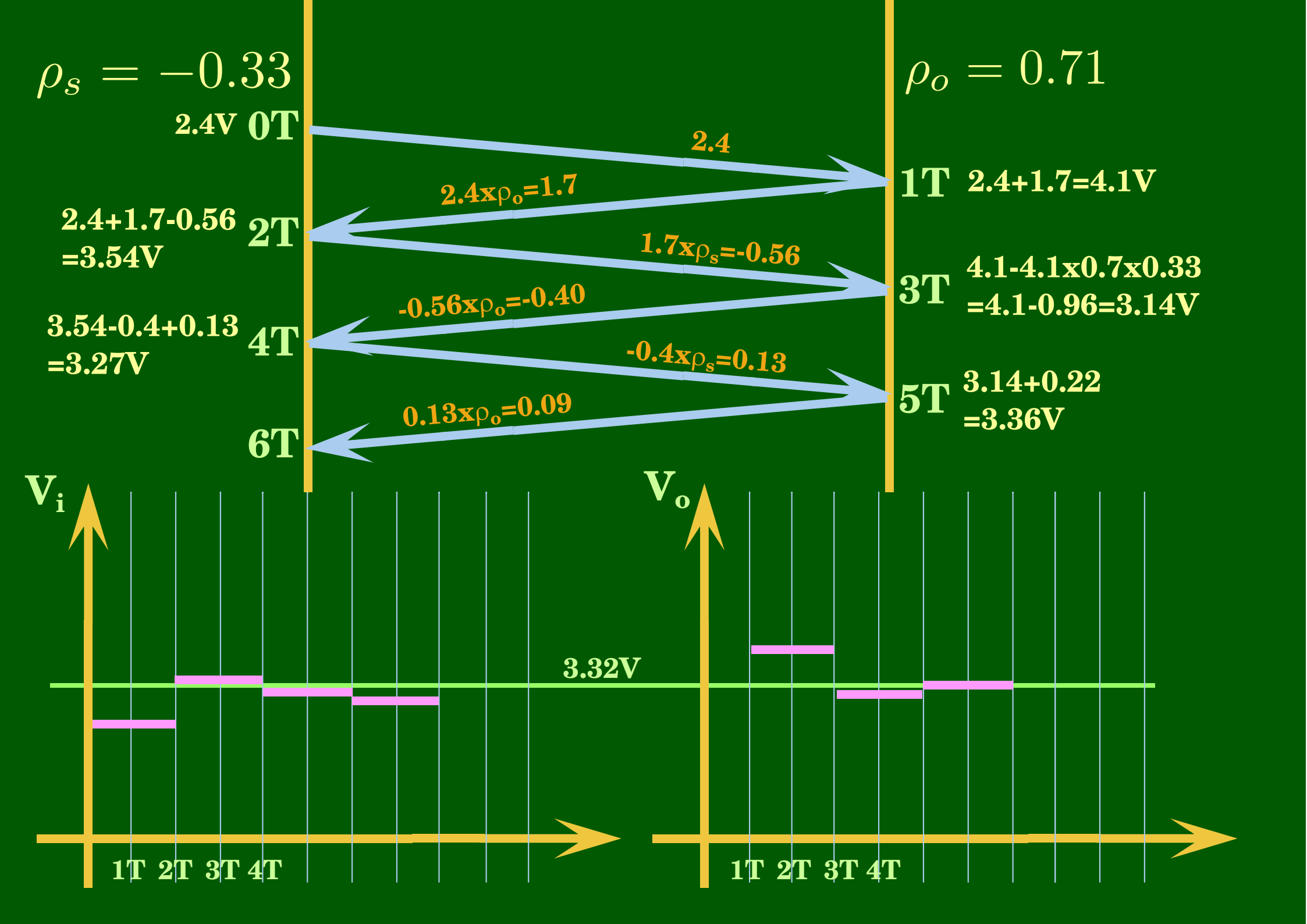

$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2T
1.7xρs=-0.56
3T
-0.56xρo=-0.40
4T
-0.4xρs=0.13
5T
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2.4+1.7-0.56
=3.54V
2T
1.7xρs=-0.56
3T
-0.56xρo=-0.40
4T
-0.4xρs=0.13
5T
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2.4+1.7-0.56
=3.54V
2T
1.7xρs=-0.56
3T
4.1-4.1x0.7x0.33
=4.1-0.96=3.14V
-0.56xρo=-0.40
4T
-0.4xρs=0.13
5T
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2.4+1.7-0.56
=3.54V
2T
1.7xρs=-0.56
3T
4.1-4.1x0.7x0.33
=4.1-0.96=3.14V
-0.56xρo=-0.40
3.54-0.4+0.13
=3.27V
4T
-0.4xρs=0.13
5T
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2.4+1.7-0.56
=3.54V
2T
1.7xρs=-0.56
3T 4.1-4.1x0.7x0.33
=4.1-0.96=3.14V
-0.56xρo=-0.40
3.54-0.4+0.13
=3.27V
4T
-0.4xρs=0.13
5T 3.14+0.22
=3.36V
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T


$\rho_s = -0.33$
$\rho_o = 0.71$
2.4V 0T
2.4
1T 2.4+1.7=4.1V
2.4xρo=1.7
2.4+1.7-0.56
=3.54V
2T
1.7xρs=-0.56
3T 4.1-4.1x0.7x0.33
=4.1-0.96=3.14V
-0.56xρo=-0.40
3.54-0.4+0.13
=3.27V
4T
-0.4xρs=0.13
5T 3.14+0.22
=3.36V
0.13xρo=0.09
6T
Vi
Vo
3.32V
1T 2T 3T 4T
1T 2T 3T 4T