wells

EE 420
LAB #1

SEPT 18, 1974

EXPERIMENT IN PULSED TRANSMISSION LINES

PURPOSE: The purpose of this experiment is:
1) to demonstrate the traveling wave phenomenon in a transmission line and,
2) to demonstrate the reflections of such waves by various terminations on the line

GENERAL: Figure 1 illustrates the laboratory setup to be used. A long coaxial transmission line has been created by patching together all of the RG-8/U cables between the various laboratories on the third floor of Coover Hall, so that both ends of the line ("A" & "B" in figure 1) are available side by side in the Microwave Lab.

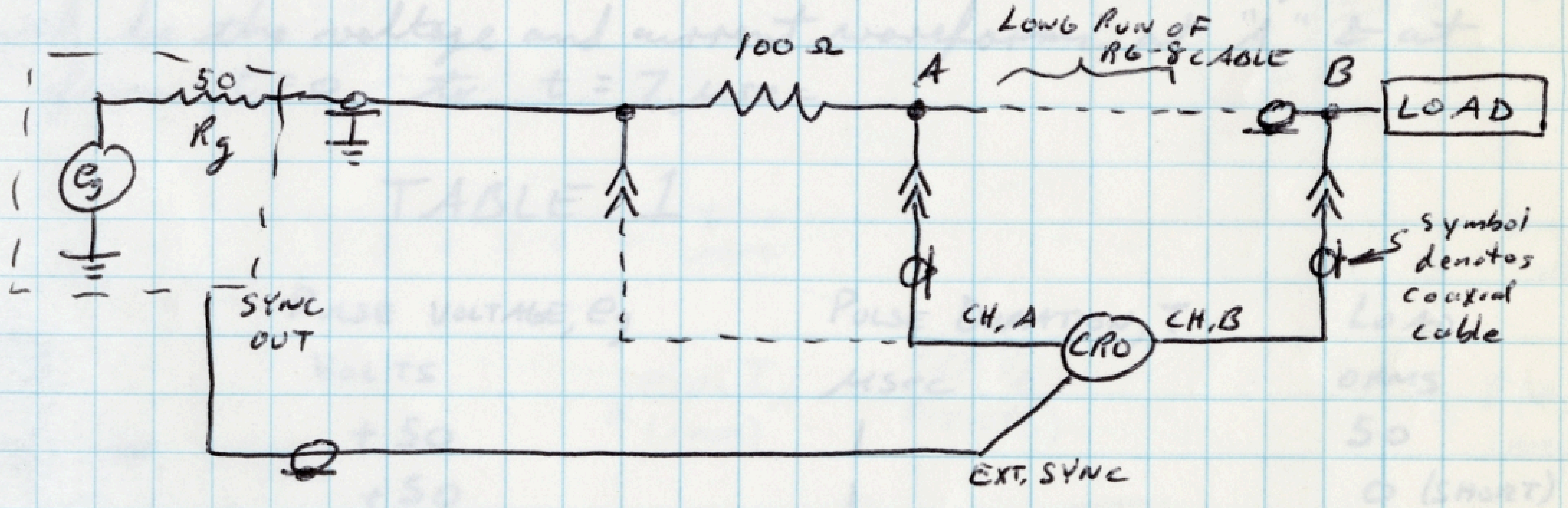

FIGURE 1

PRELIMINARY

1. Type RG-8/U cable has characteristic impedence $R_o = 50.0\ \Omega$ and a capacitance $C = 29.5$ pf per foot. [This data obtained from Reference Data for Radio Engineers, 4TH ED., page 608]

$$V = \frac{1}{\sqrt{LC}} \qquad R_o = \sqrt{\frac{L}{C}} \Rightarrow L = R_o^2 C$$

$$\therefore V = \frac{1}{R_o C} = \frac{1}{(50)(29.5 \cdot 10^{-12})} \text{ ft/sec} = \overset{6.780 \cdot 10^{8} \text{ ft/sec}}{\cancel{6.780 \text{ ft/sec}}}$$

$$c = (1.86 \cdot 10^{5} \text{ mi/sec})(5280 \text{ ft/mi}) = \overset{9.821 \cdot 10^{8} \text{ ft/sec}}{\cancel{9.821 \text{ ft/sec}}}$$

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$$\text{so} \quad \frac{V}{c} = \frac{6.780\cdot10^8}{9,821\cdot10^8} = 0.690 \Rightarrow V = 69\% \text{ OF } C$$

where c = speed of light in a vacuum ≈ speed of light in air

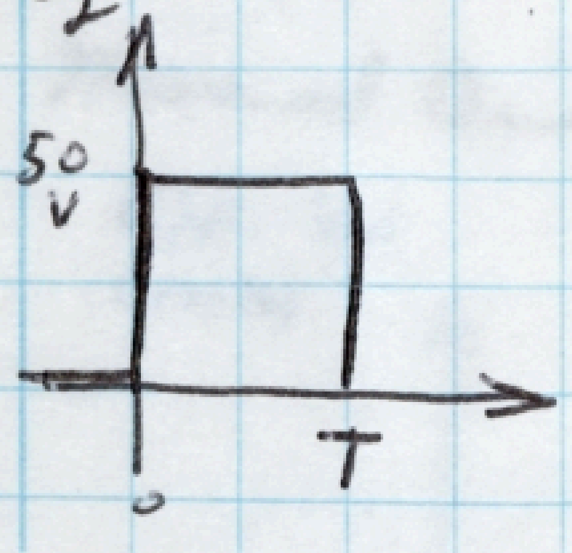
2. Define delay constant as the time required for a traveling wave to move a distance of one meter in the cable.

$$D = v t_d \Rightarrow t_d = \frac{1\,m}{v} = \frac{1\,m}{.69c}$$

$$t_d = \frac{1\,m}{(.69)(3\cdot10^8\,m/sec)} = 4.831 \text{ nsec}$$

3. Assume that the length of the cable from "A" to "B", L_{AB}, is 200 meters. Given the conditions in Table 1, what would be the voltage and current waveforms at "A" & at "B" from t=0 to t=7 μsec

TABLE 1



PULSE VOLTAGE, e_g VOLTS	PULSE DURATION, T μSEC	LOAD OHMS
+50	1	50
+50	1	0 (SHORT)
+50	1	OPEN
+50	3	OPEN

With a generator amplitude of 50 V, the voltage which appears at "A" would be given by

$$V_A = \frac{R_o \quad e_g}{R_o + R_g + 100} = \frac{50}{50+50+100} e_g = .25\, e_g = 12.5 \text{ Volts}$$

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$K_A = \frac{150-50}{200} = 0.5$

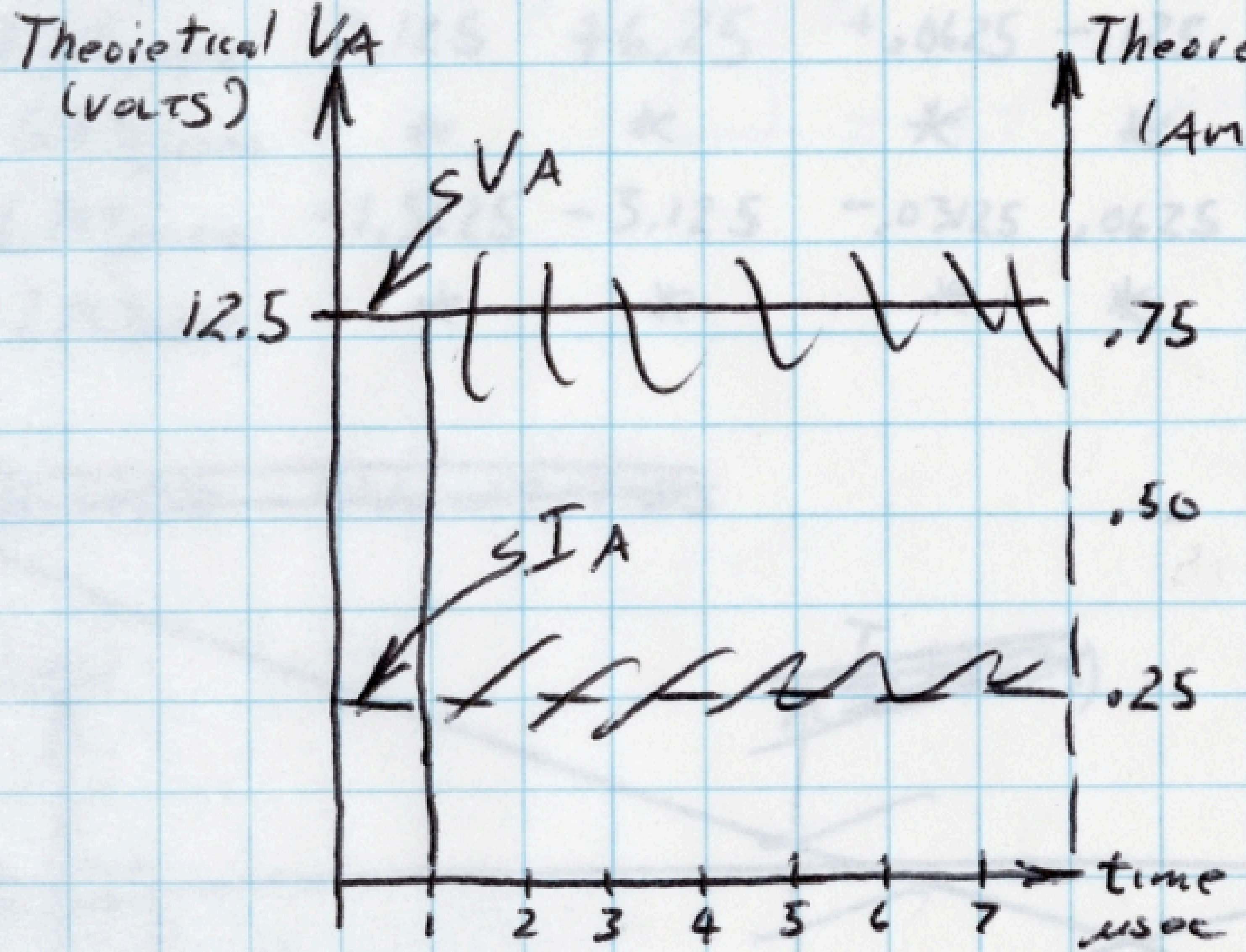
$U = 1m/4.831\ nsec = 207\ m/\mu sec$

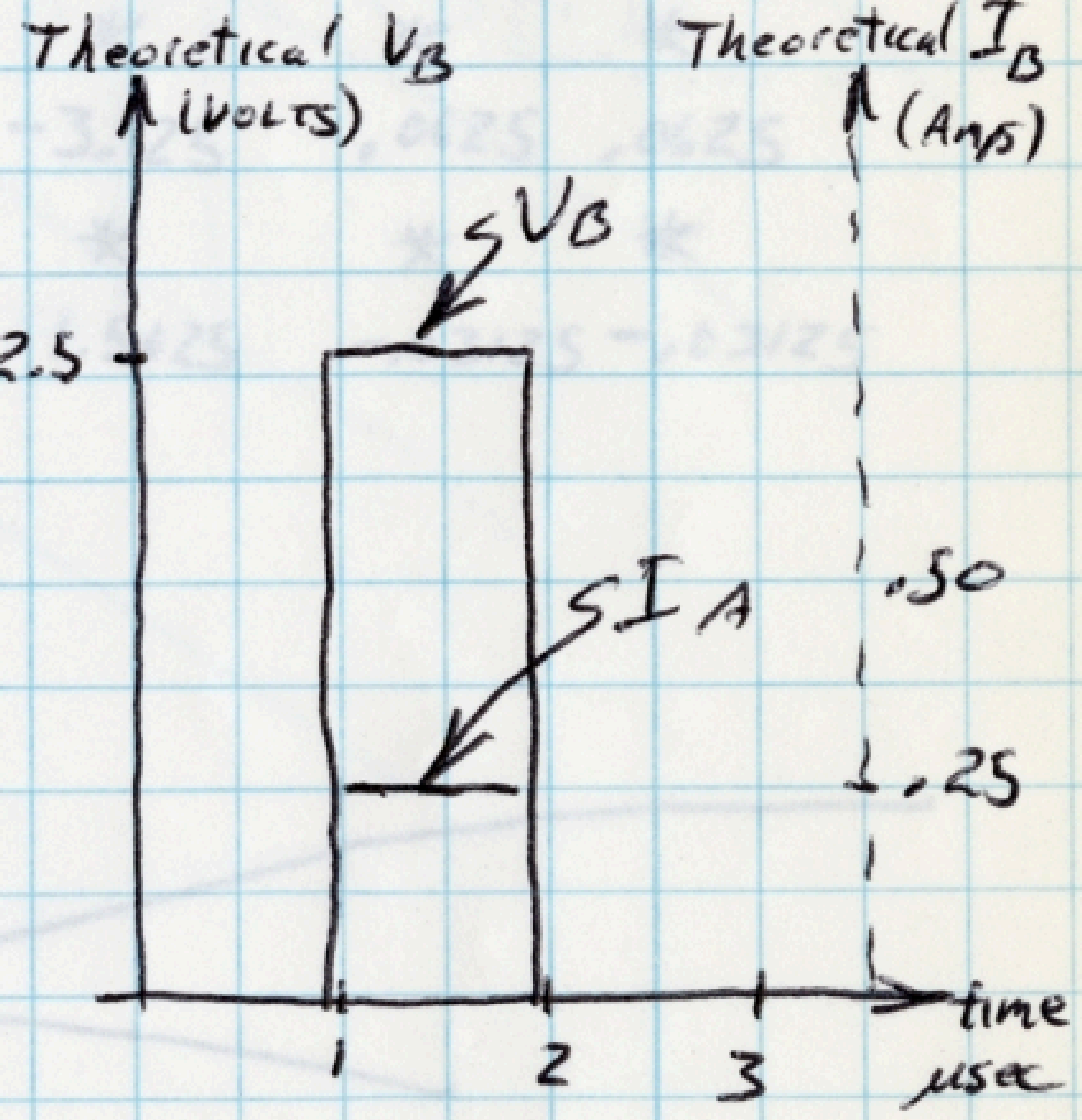
$K_B = \frac{50-50}{100} = 0$

Case I : $R_L = 50\ \Omega$, $T = 1\ \mu sec$, $L_{AB} = 200\ m$, $v = 1m/4.831\ nsec$

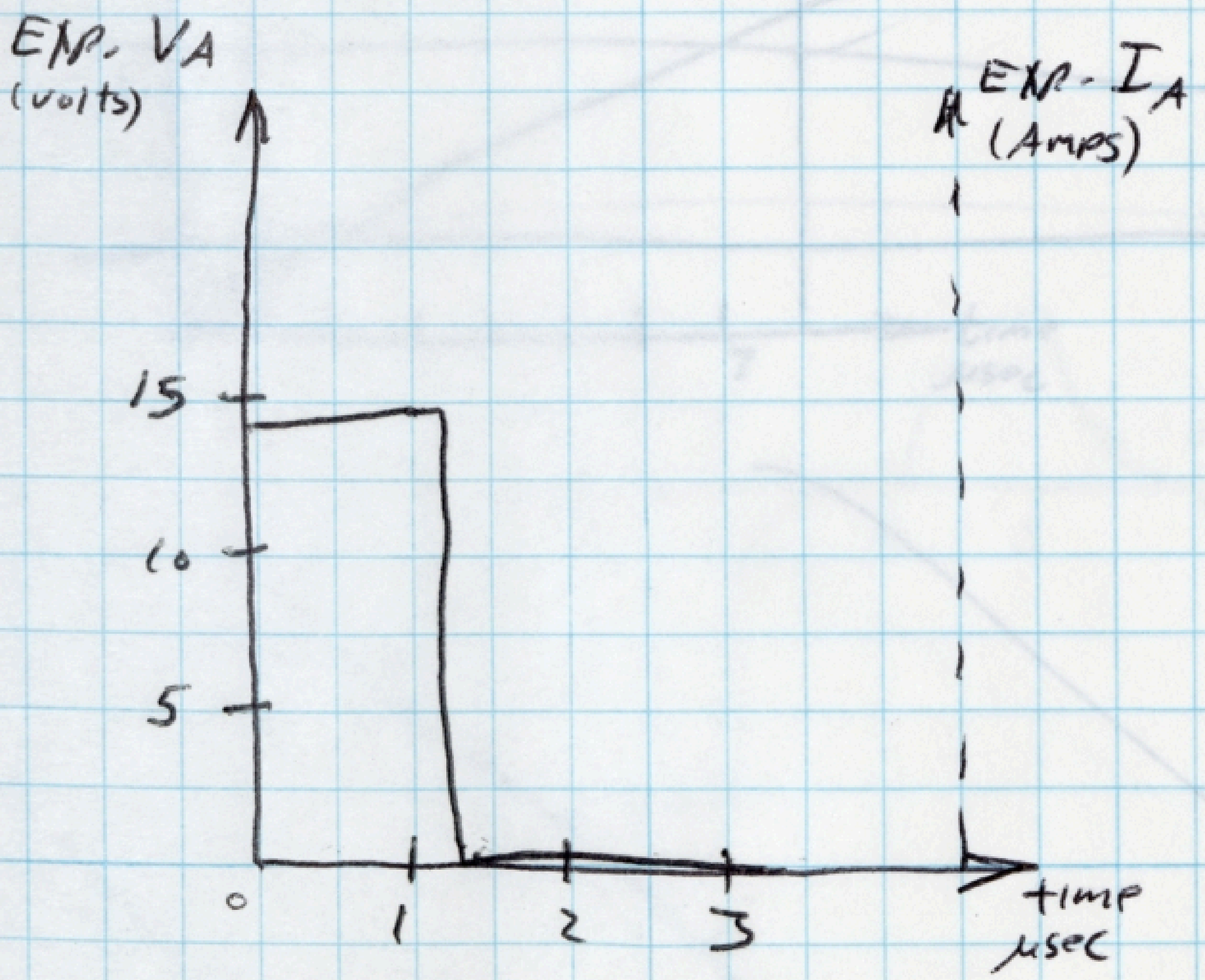
time interval	V_A^+	V_A^-	I_A^+	I_A^-	V_B^+	V_B^-	I_B^+	I_B^-
0 - 1 μsec	12.5	0	+.25	0	*	*	*	*
0.966 - 1.966 μsec	*	* 0	*	*	12.5	0	0.25	0
1.933 - 2.933 μsec	0	~~12.~~	0	0	0	0	0	0

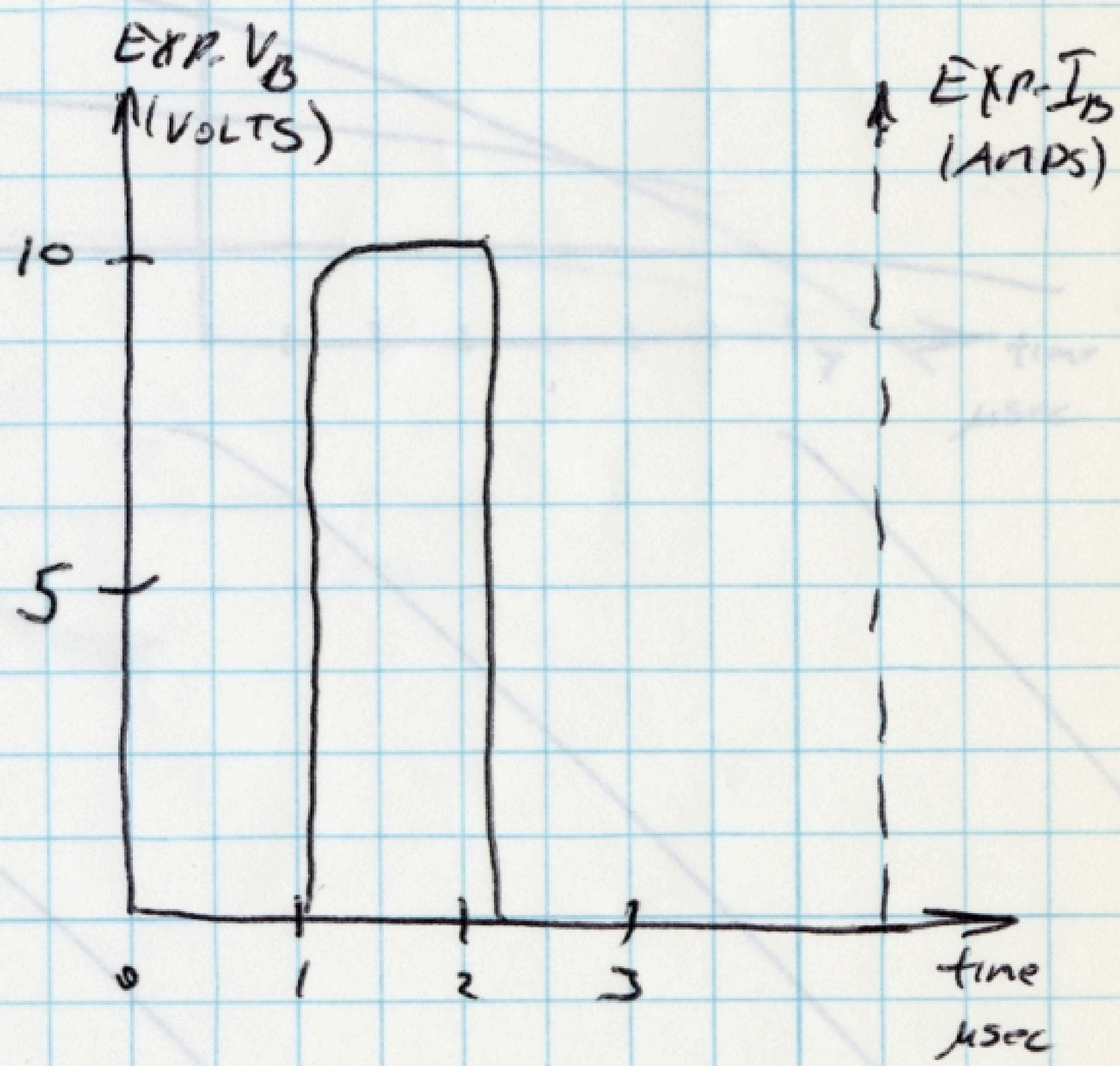
When the load is matched to the line, there is no reflection





Measured Quantities





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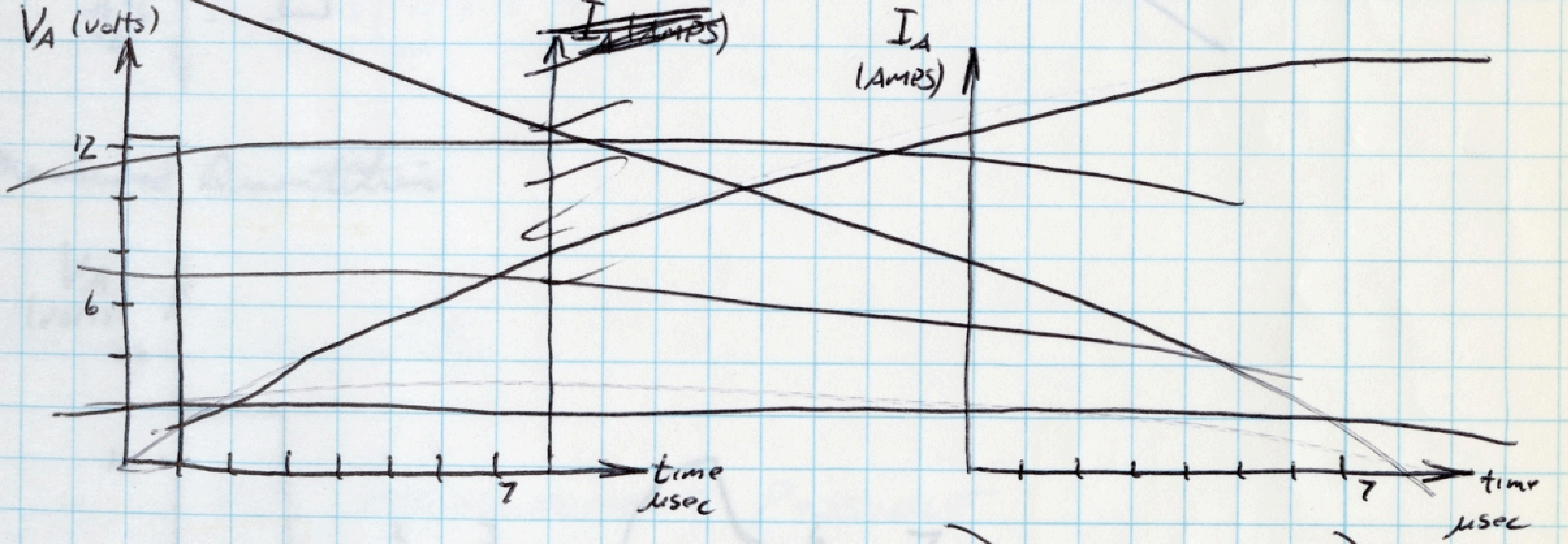
Case 2: $R_L = 0$, $V = 207$ m/µsec, $T = 1$ µsec $L_{AB} = 200$ m

$K_A = \frac{150-50}{200} = 0.5$ $K_B = \frac{0-50}{0+50} = -1$ $V_A = V_A^+ + V_A^-$ $I_A = I_A^+ + I_A^-$

* INDICATES ~~#~~ NO CALCULATION MADE $V_B = V_B^+ + V_B^-$ $I_B = I_B^+ + I_B^-$

time interval	V_A^+	V_A^-	I_A^+	I_A^-	V_B^+	V_B^-	I_B^+	I_B
0-1µsec	12.5	0	0.25	0	*	*	*	*
0.966-1.966µsec	*	*	*	*	12.5	-12.5	+0.25	+0.25
1.932-2.932µsec	-6.25	-12.5	-.125	+0.25	*	*	*	*
2.899-3.899µsec	*	*	*	*	-6.25	+6.25	-.125	-.125
3.865-4.865µsec	3.125	+6.25	+.0625	-.125	*	*	*	*
4.831-5.831µsec	*	*	*	*	3.125	-3.125	.0625	.0625
5.797-6.797µsec	-1.5625	-3.125	-.03125	.0625	*	*	*	*
6.763-7.763µsec	*	*	*	*	-1.5625	1.5625	-.03125	-.03125

~~CALCULATED QUANTITIES~~



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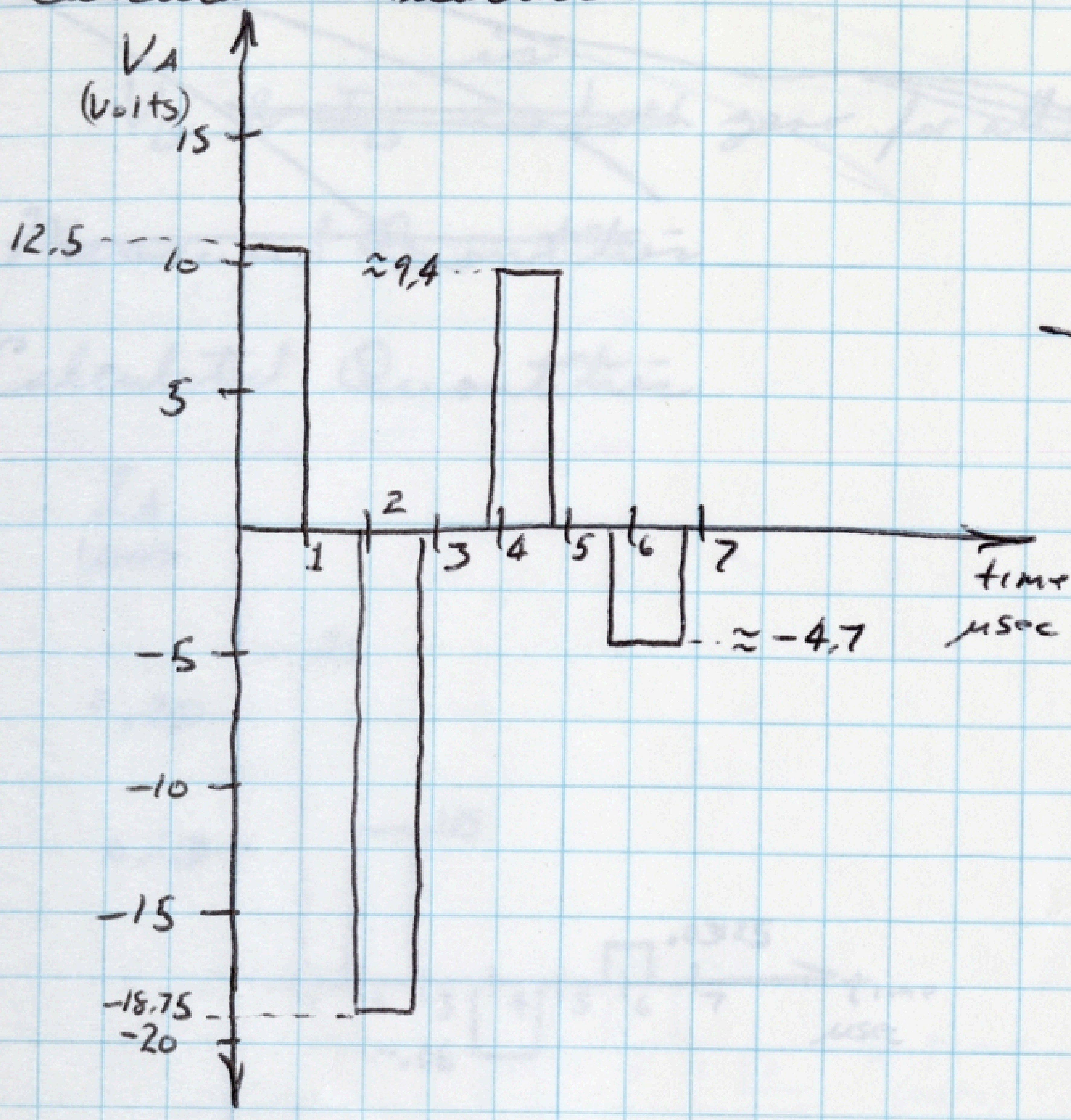
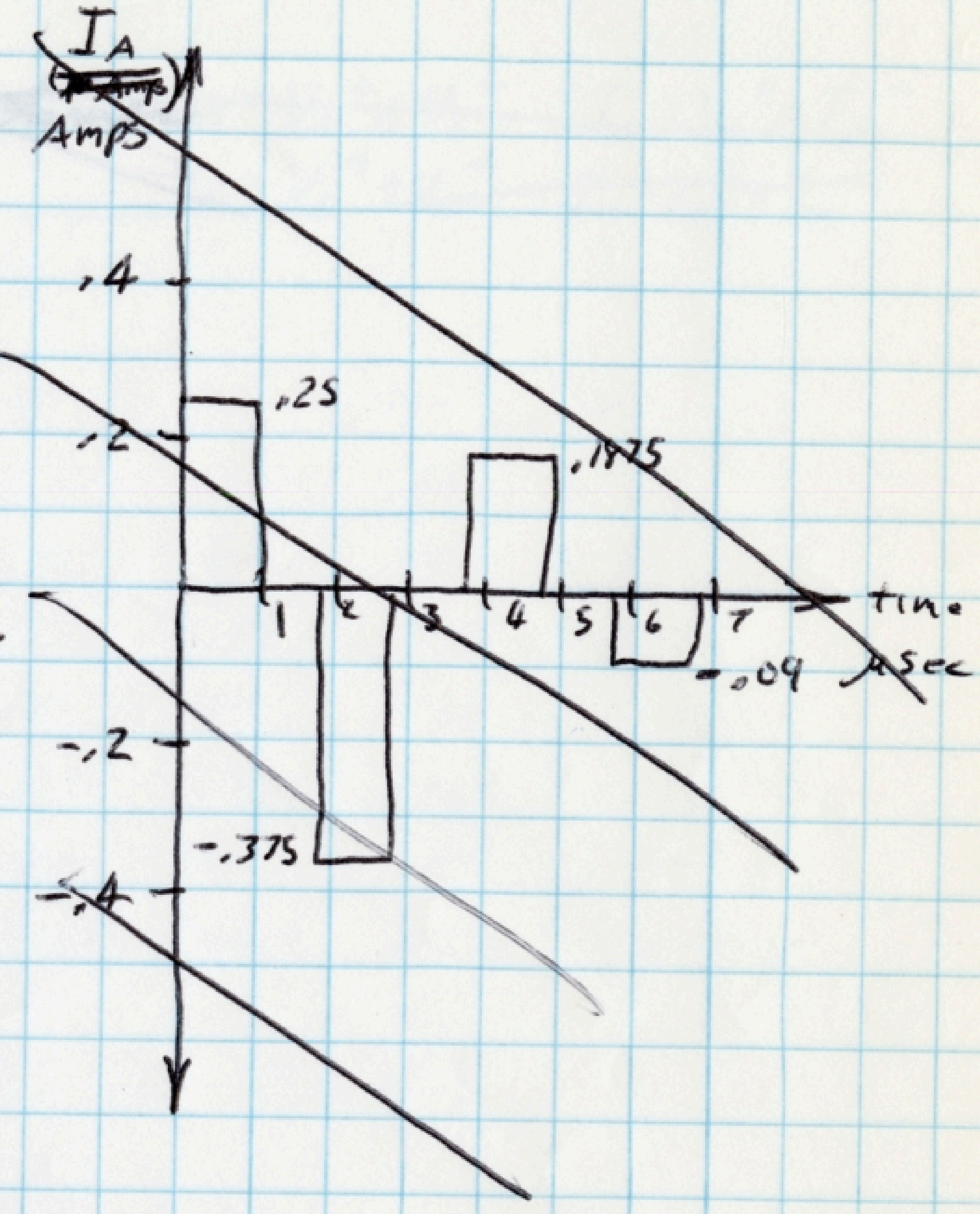
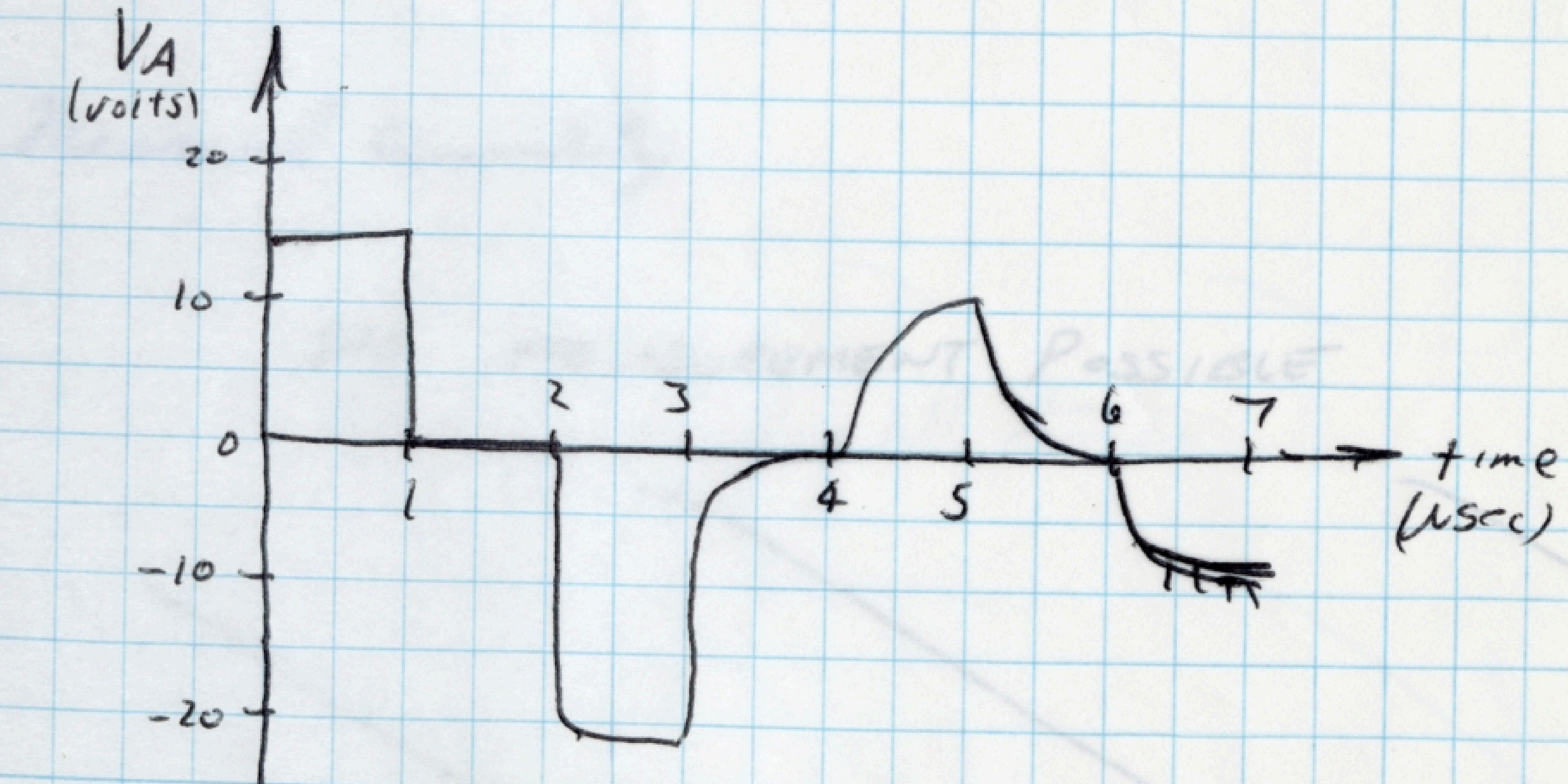
Calculated Quantities





Measured Quantities



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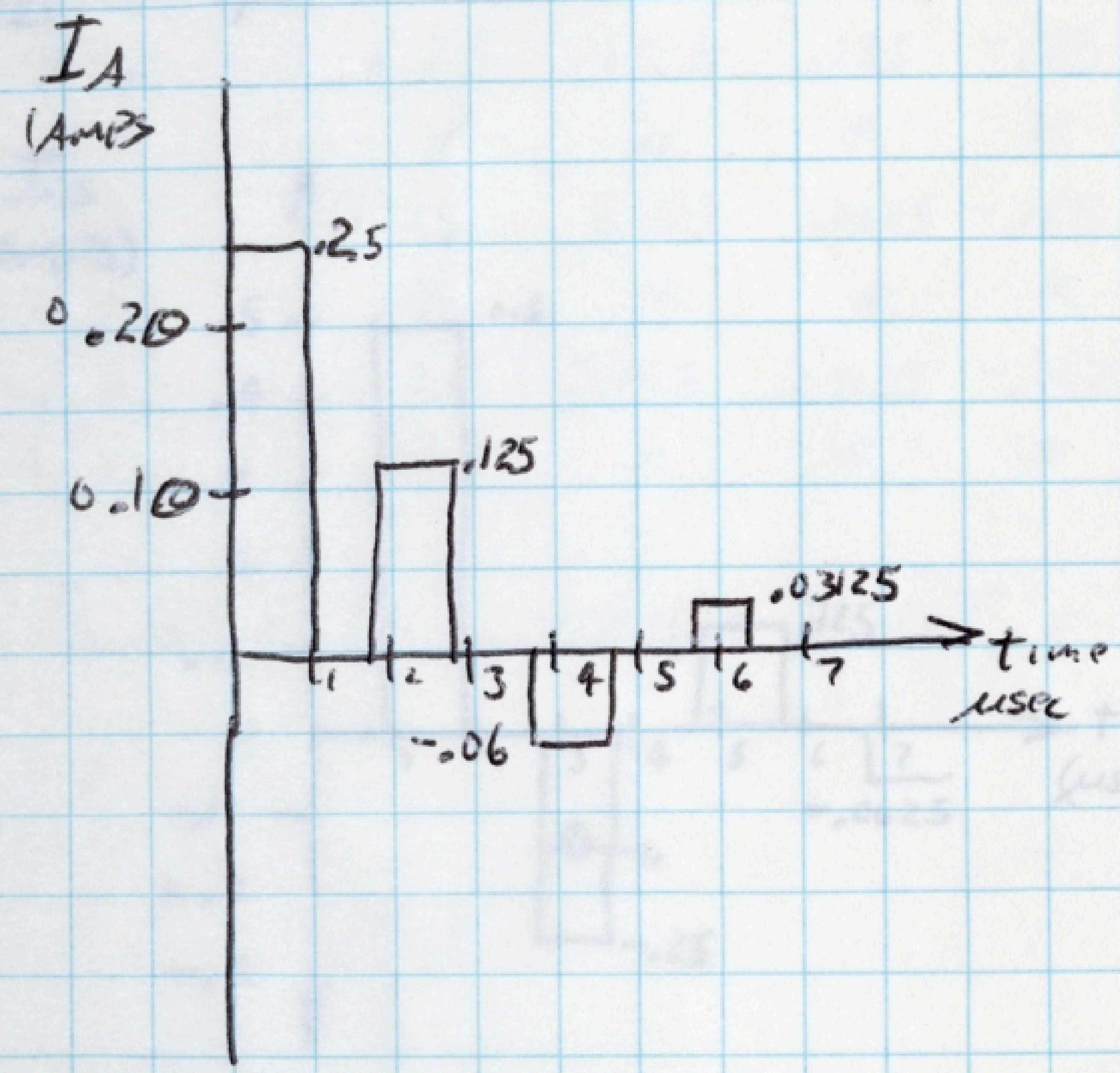
Exp #1

~~Calculated Quantities~~

~~V_B & I_B are both~~ is ~~zero for all times~~

~~Measured Quantities~~

Calculated Quantities



Measured Quantity

NO MEASUREMENT POSSIBLE

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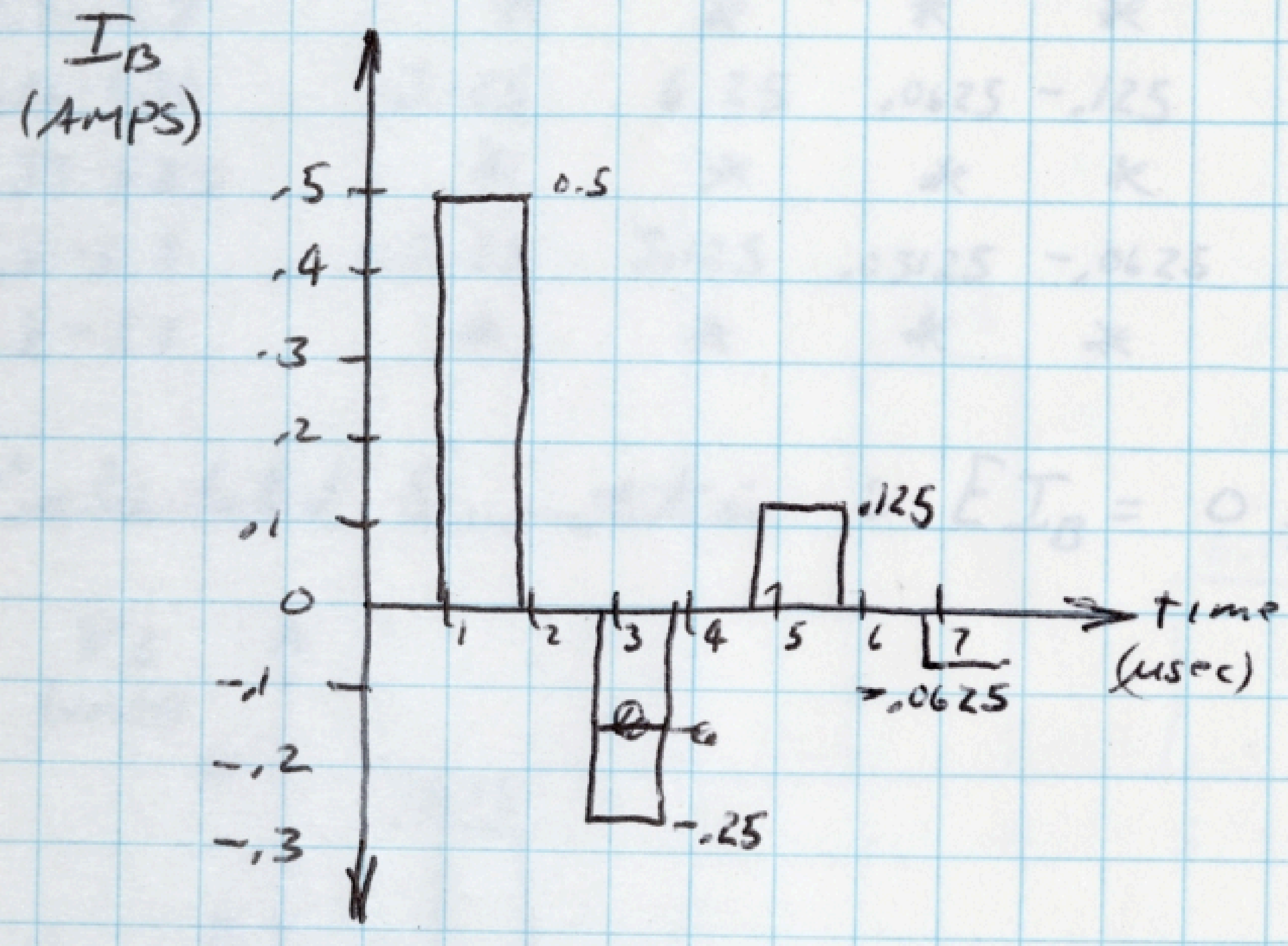
~~Case 3 : $R_L = \infty$, $T = 1 \mu sec$ $v = 207 m/\mu sec$~~

~~$K_A = \frac{150-50}{200} = 0.5$ $K_B = +1$ $V_A = V_A^+ + V_A^-$ $I_A = I_A^+ + I_A^-$~~

~~$V_B = V_B^+ + V_B^-$ $I_B = I_B^+ + I_B^-$~~

Calculated Quantities

$V_B = 0$ for all times



Measured Quantities

V_B = Zero for all times

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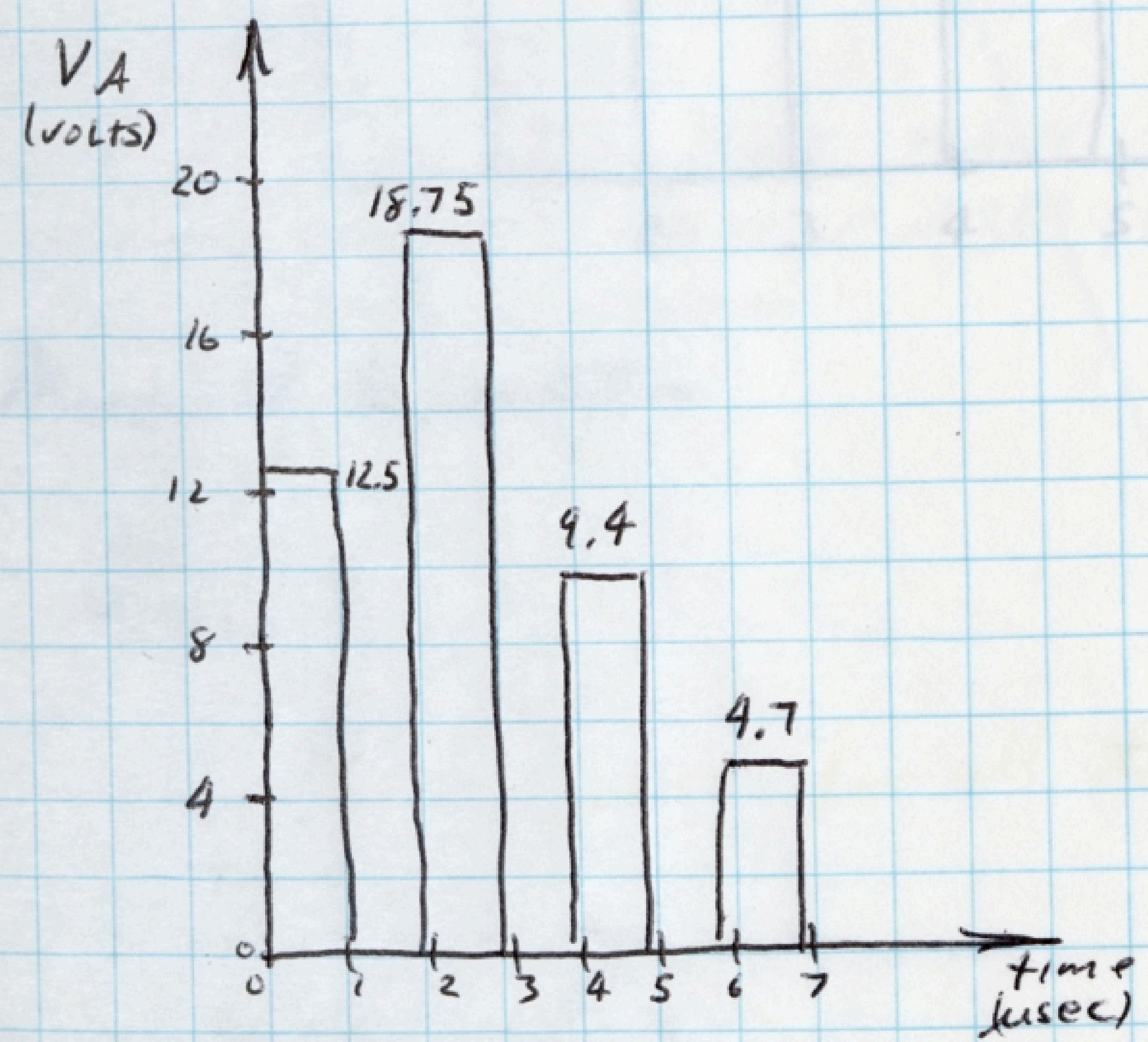
Case 3 $R_o = 50$, $R_L = \infty$ $v = 207\ m/\mu sec$ $R_g + 100 = 150$ $T = 1\ \mu sec$

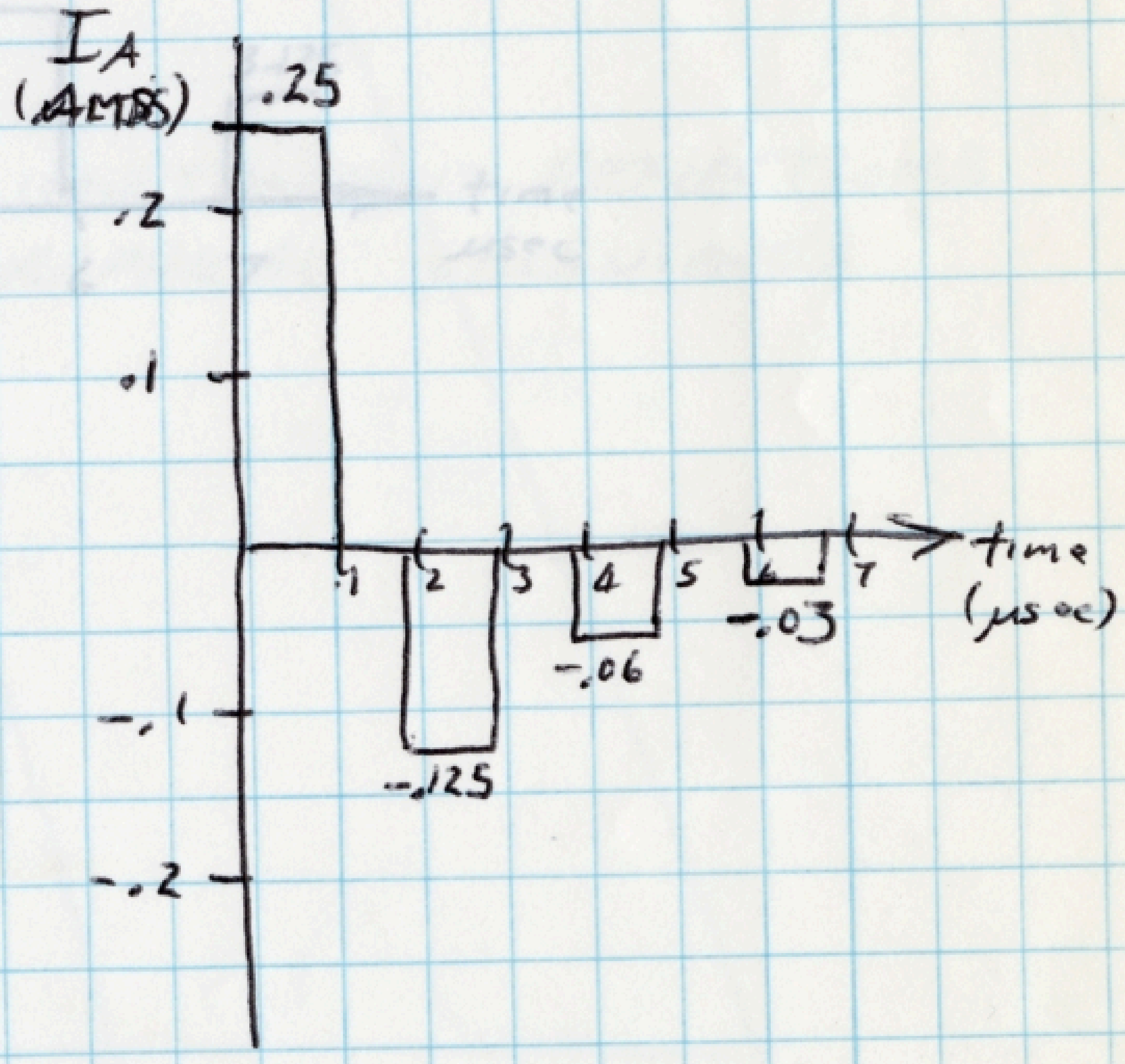
$V^- = V^+ K_L$

$K_A = 0.5$ $K_B = +1$ $V = V^+ + V^-$ $I = I^+ + I^-$ $I^- = I^+(-K_L)$

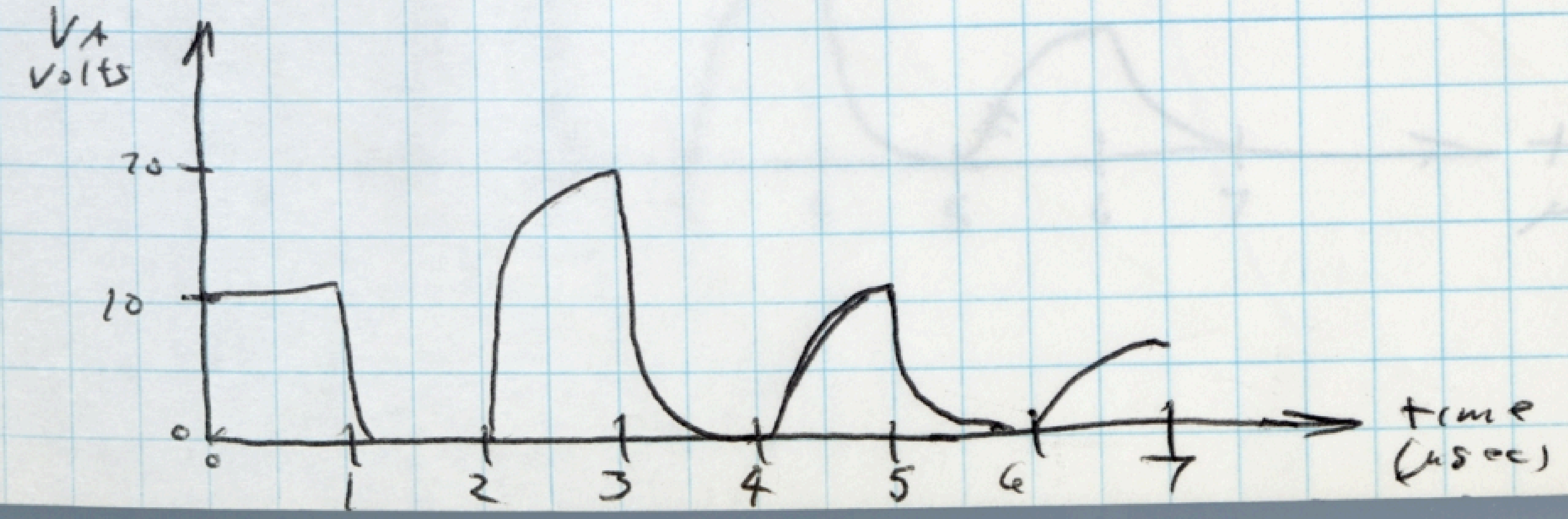
time interval (μsec)	V_A^+	V_A^-	I_A^+	I_A^-	V_B^+	V_B^-	I_o^+	I_B^-
0 - 1	12.5	0	0.25	0	*	*	*	*
0.97 - 1.97	*	*	*	*	12.5	12.5	.25	-.25
1.93 - 2.93	6.25	12.5	.125	-.25	*	*	*	*
2.9 - 3.9	*	*	*	*	6.25	6.25	.125	-.125
3.86 - 4.86	3.125	6.25	.0625	-.125	*	*	*	*
4.83 - 5.83	*	*	*	*	3.125	3.125	.0625	-.0625
5.8 - 6.8	1.5625	3.125	.03125	-.0625	*	*	*	*
6.8 - 7.8	*	*	*	*	1.5625	1.5625	.03125	-.03125

Calculated Quantities : [$I_B = 0$ for all times]





Measured Quantities



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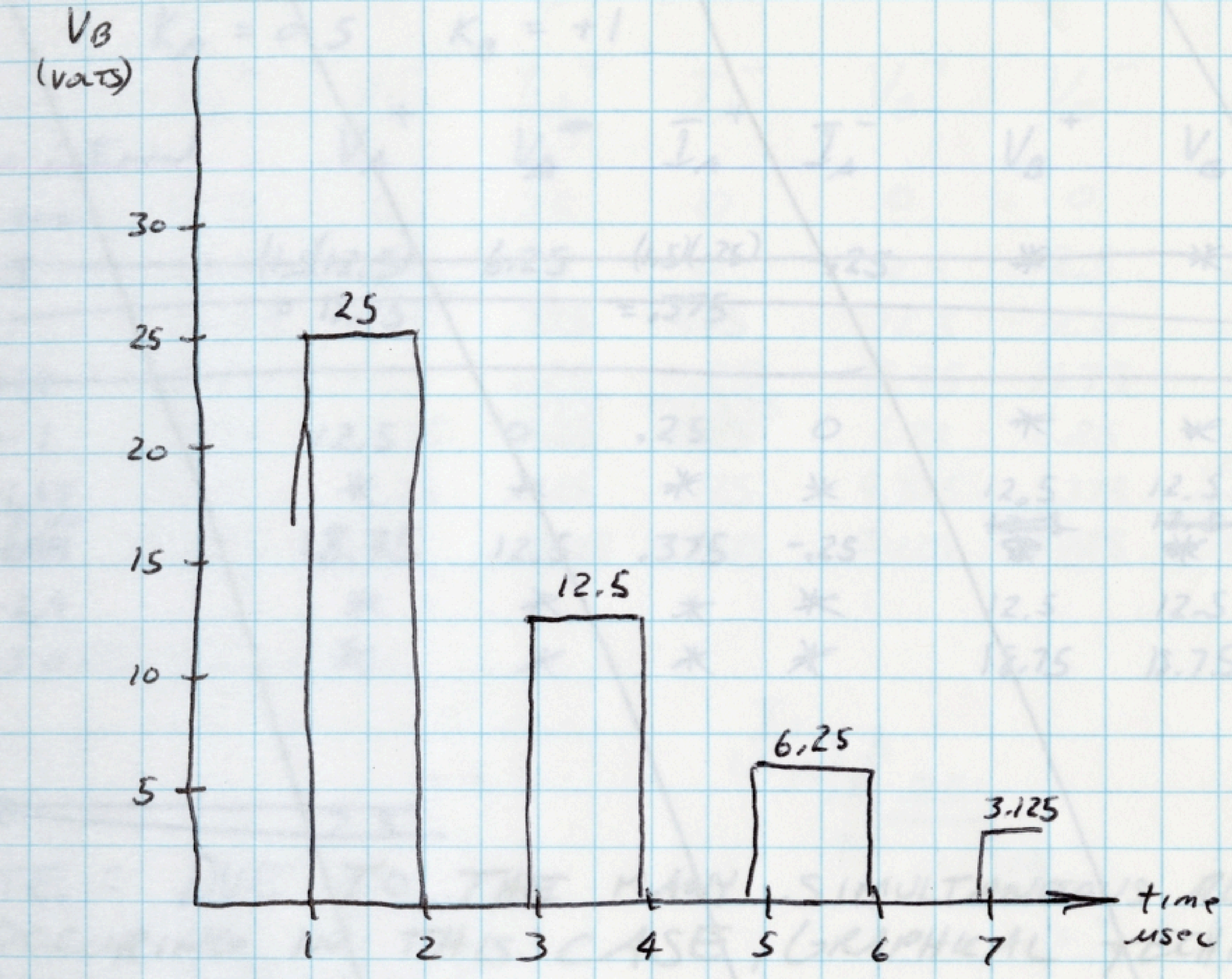
Calculated Quantities [$I_B = 0$ for all times]



Measured Quantities