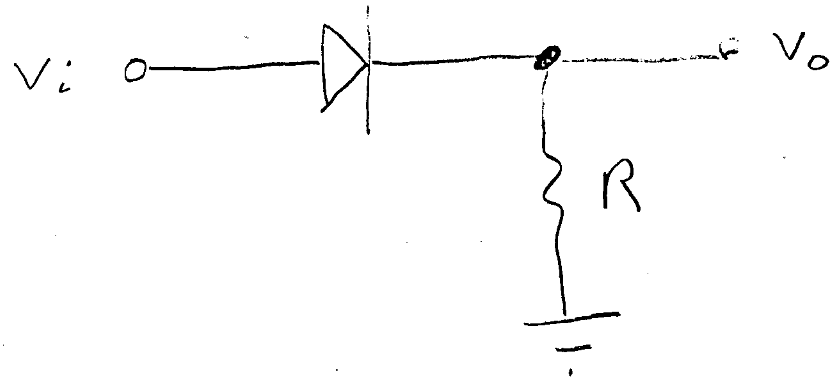
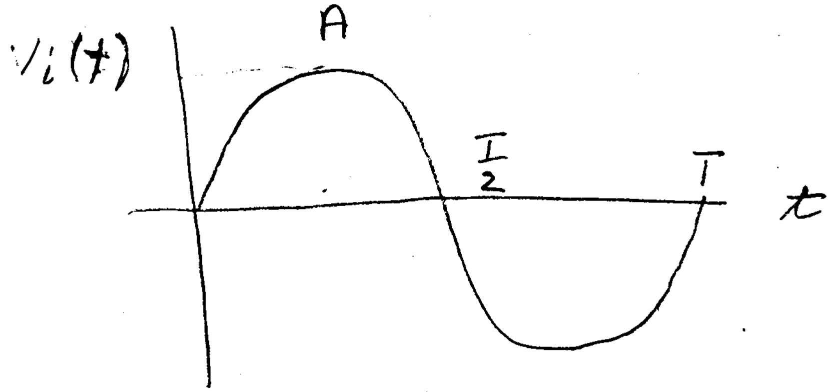
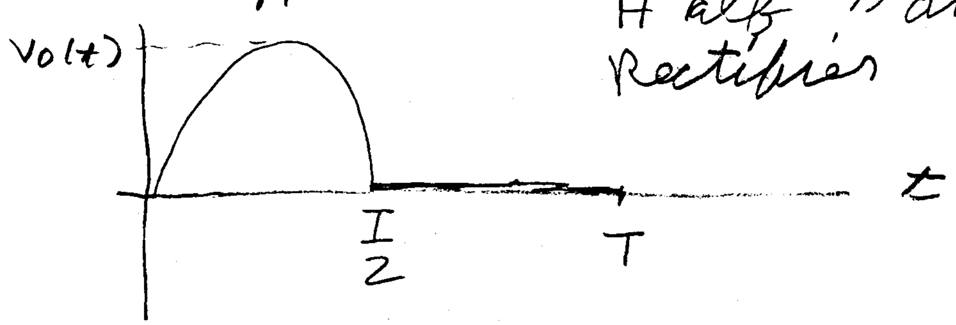


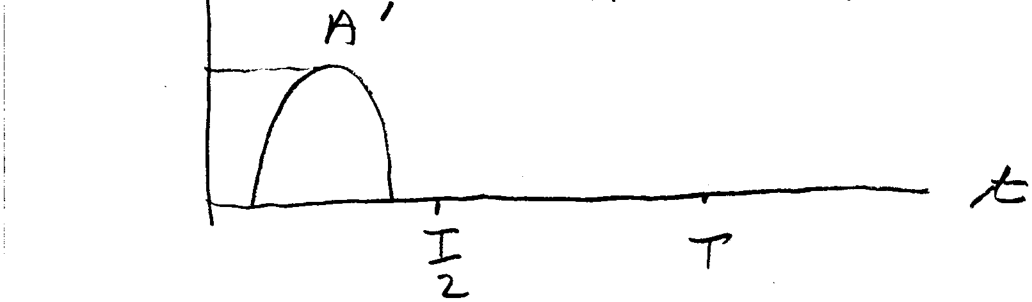

Half wave Rectifier

Ideal Diode



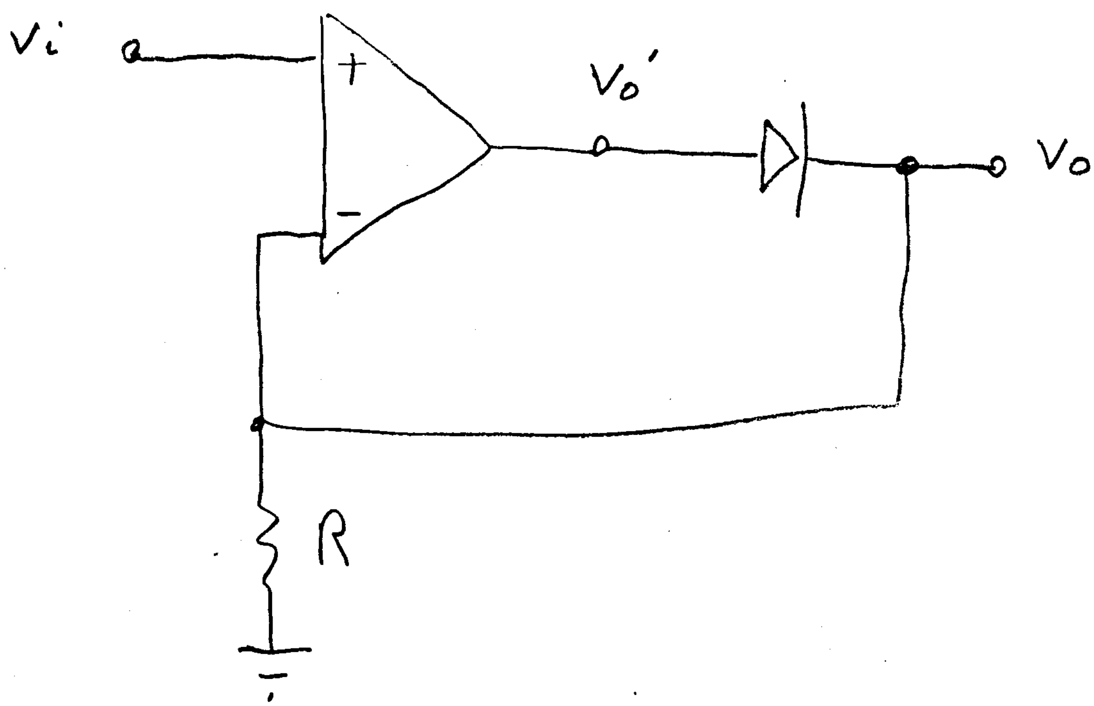

$A' = A - V_r$

Physical Diode



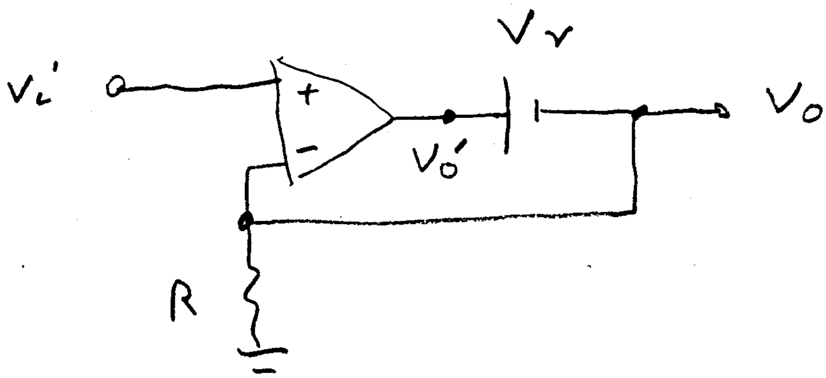

$V_r \equiv$ on voltage $\approx 0.65V$

# Precision Half Wave Rectifier




$V_i > 0$ & $V_o' > V_r$

Diode Forward Biased

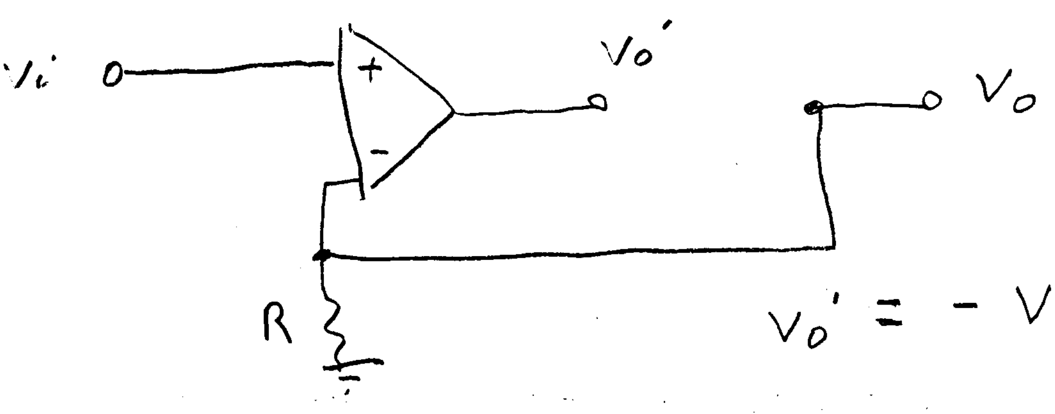



$V_o = V_i$

$V_o' = V_o + V_r$

$V_i < 0$

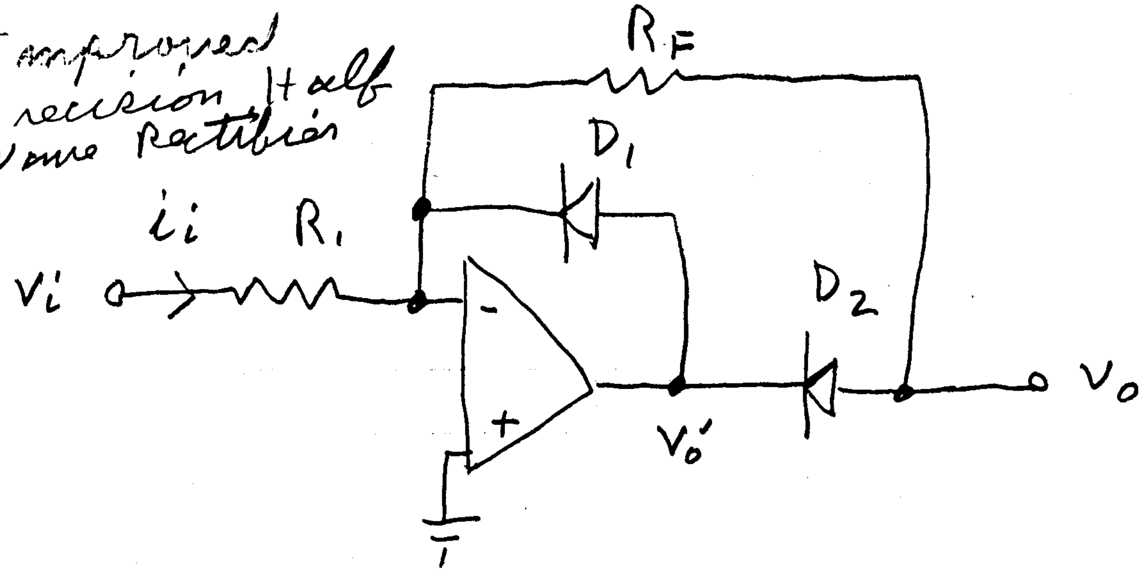
Diode Reverse Biased



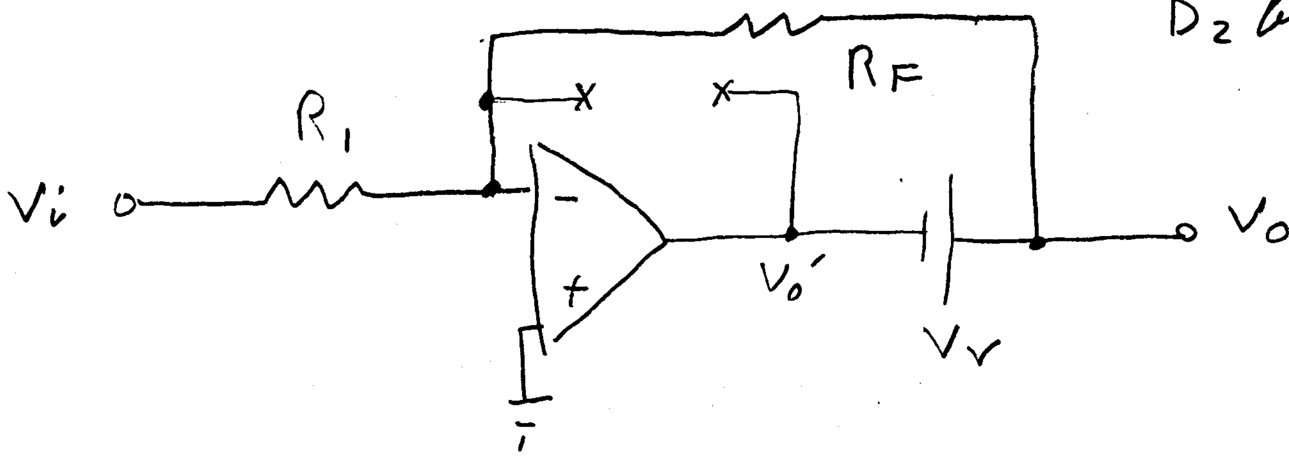

$V_o = 0$

$V_o' = -V_{SAT}$

Improved Precision Half Wave Rectifier

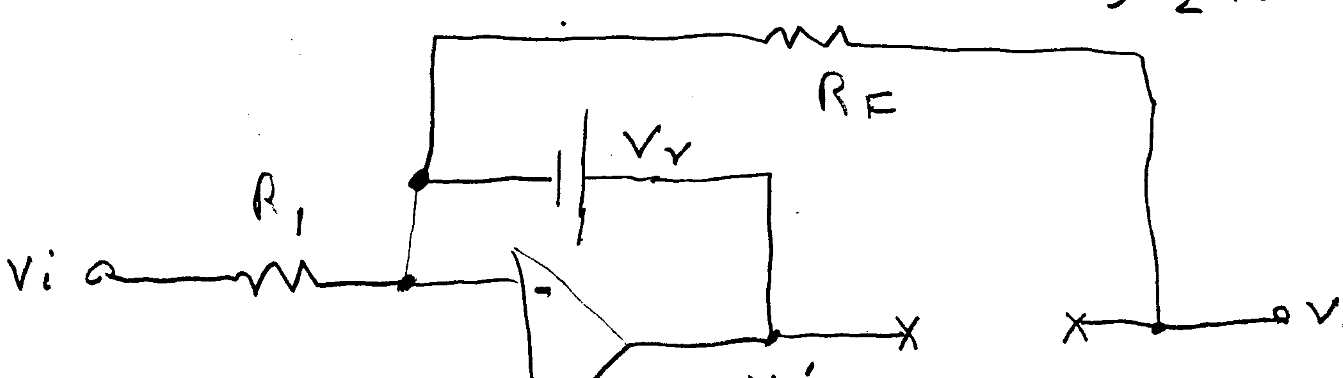



$V_i > 0$ $\quad V_o' < V_r$ $\quad$ $D_1$ reverse, $D_2$ forward



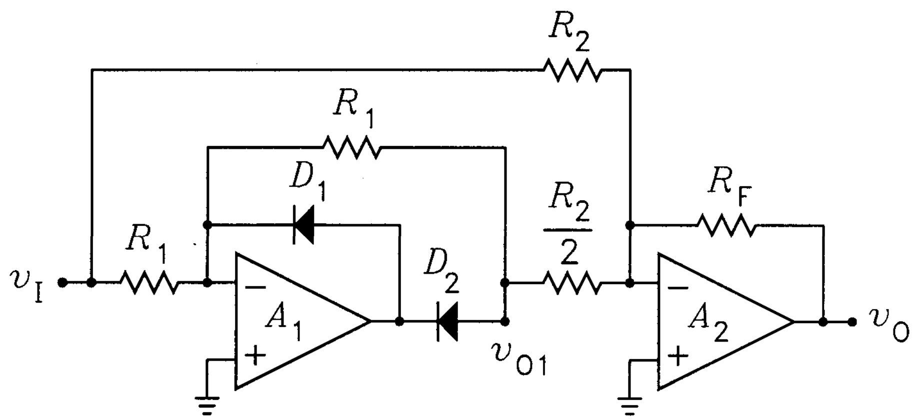

$$V_o = -\frac{R_F}{R_1} V_i \qquad V_o' = V_o - V_r$$

$V_i < 0$ $\quad$ & $\quad V_o' > V_r$ $\quad$ $D_1$ forward, $D_2$ reverse




$V_o = 0$

$V_o' = +V_r$




First Precision Full Wave Rectifier

$V_i > 0$ $D_1$ off $D_2$ on

$$V_{01} = -\frac{R_1}{R_1} V_i = -V_i$$

$$V_o = -\frac{R_F}{R_2} V_i - \frac{R_F}{\frac{R_2}{2}} V_{01} = -\frac{R_F}{R_2} V_i - \frac{2R_F}{R_2}(-V_i)$$

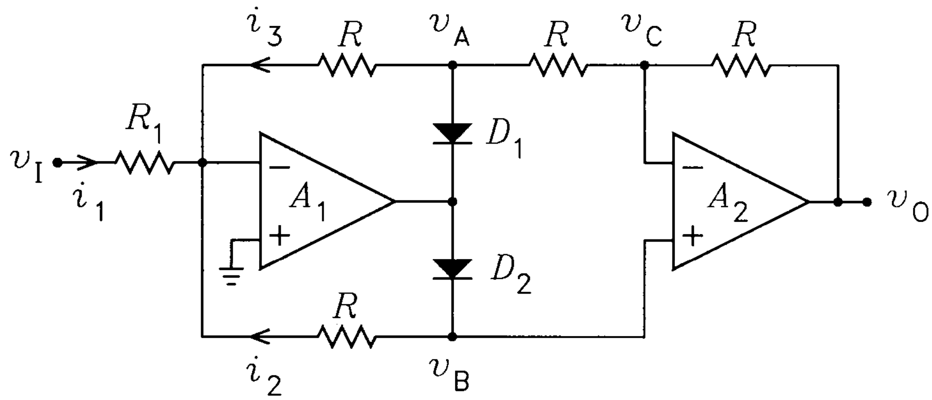
$$V_o = \frac{R_F}{R_2} V_i$$

$V_i < 0$ $D_1$ on $D_2$ off $V_{01} = 0$

$$V_o = -\frac{R_F}{R_2} V_i$$

$$V_o = \frac{R_F}{R_2} |V_i|$$

Absolute Value Circuit or Full Wave Rectifier




Second Precision Full Wave Rectifier

$V_i > 0$ $D_1$ on $D_2$ off

$i_2 = 0$ $\quad V_o = -\frac{R}{R} V_A \quad V_A = -\frac{R}{R_1} V_i$

$$V_o = \frac{R}{R_1} V_i$$

$V_i < 0$ $D_1$ off $D_2$ on

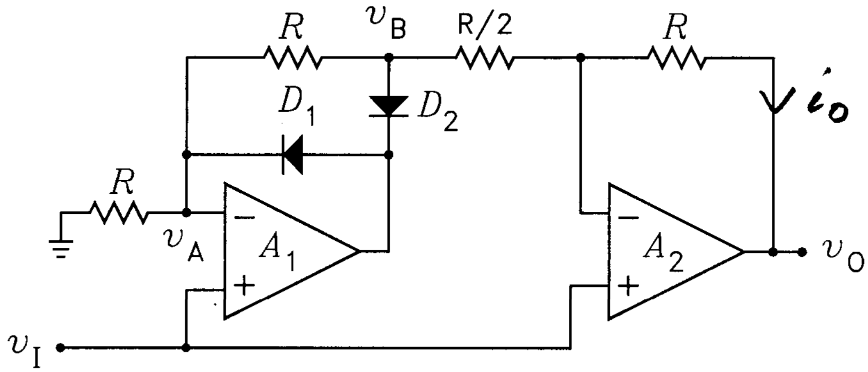
$$V_o = \left[1 + \frac{R}{2R}\right] V_B = \frac{3}{2} V_B$$

$$V_B = -\frac{R \| (2R)}{R_1} V_i = -\frac{2}{3} \frac{R}{R_1} V_i$$

$$V_o = -\frac{R}{R_1} V_i$$

$$V_o = \frac{R}{R_1} |V_i|$$

absolute value circuit or full wave rectifier




Third Precision Full Wave Rectifier

$V_i > 0$ $D_1$ on $D_2$ off

$i_o = 0$ $V_o = V_i$

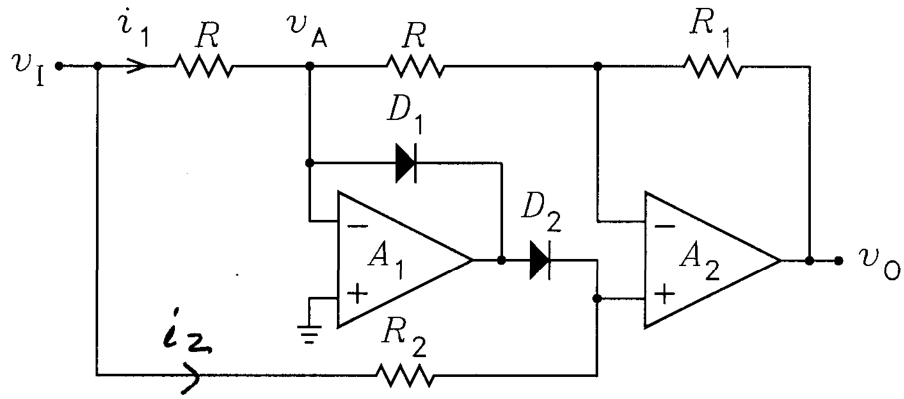
$V_i < 0$ $D_1$ off $D_2$ on

$V_B = 2V_i$

$$i_o = \frac{V_B - V_i}{\frac{R}{2}} = \frac{2V_i}{R}$$

$V_o = V_i - i_o R = V_i - 2V_i = -V_i$

$V_o = |V_i|$ Absolute Value circuit or Full Wave Rectifier




Fourth Precision Full Wave Rectifier

$v_i > 0$ $D_1$ on $D_2$ off

$i_2 = 0$

$$V_o = \left[1 + \frac{R_1}{R}\right] V_i$$

$V_i < 0$ $D_1$ off $D_2$ on

$$i_1 = \frac{V_i}{R}$$

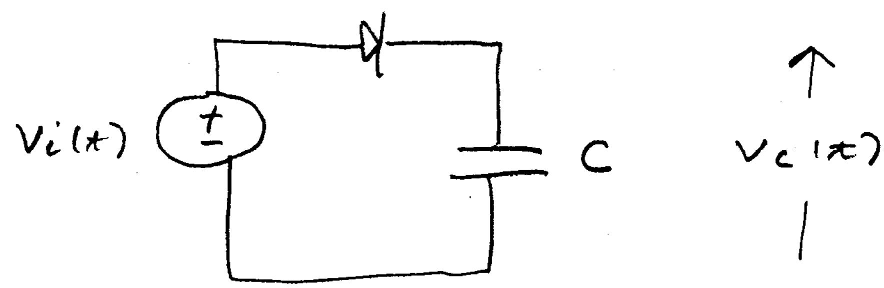
$$V_o = -i_1 [R + R_1] = -\frac{R + R_1}{R} V_i$$

$$V_o = -\left[1 + \frac{R_1}{R}\right] V_i$$

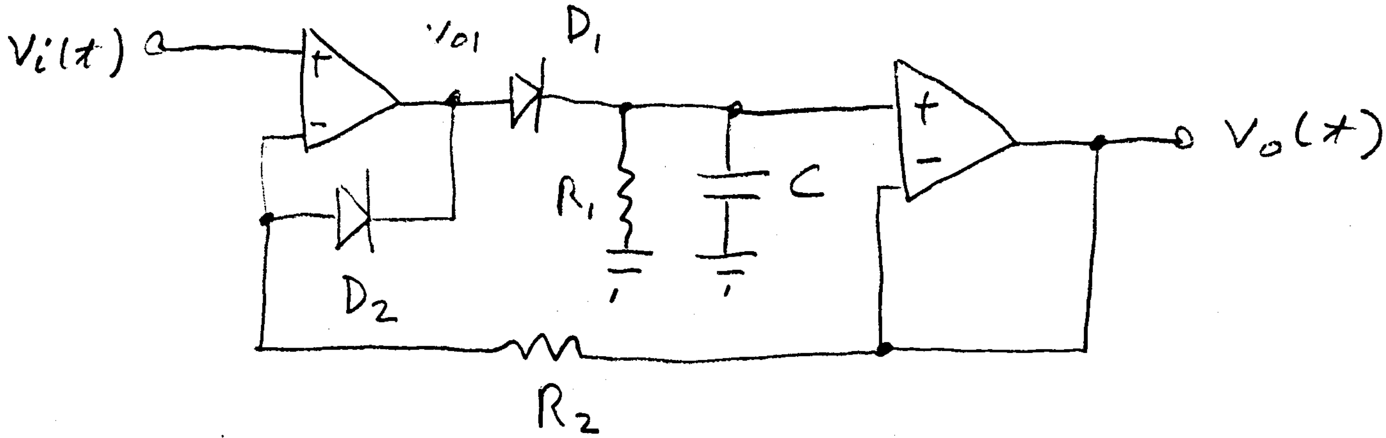
$$V_o = \left[1 + \frac{R_1}{R}\right] |V_i|$$

absolute value circuit or full wave rectifier

# Peak Hold Circuit



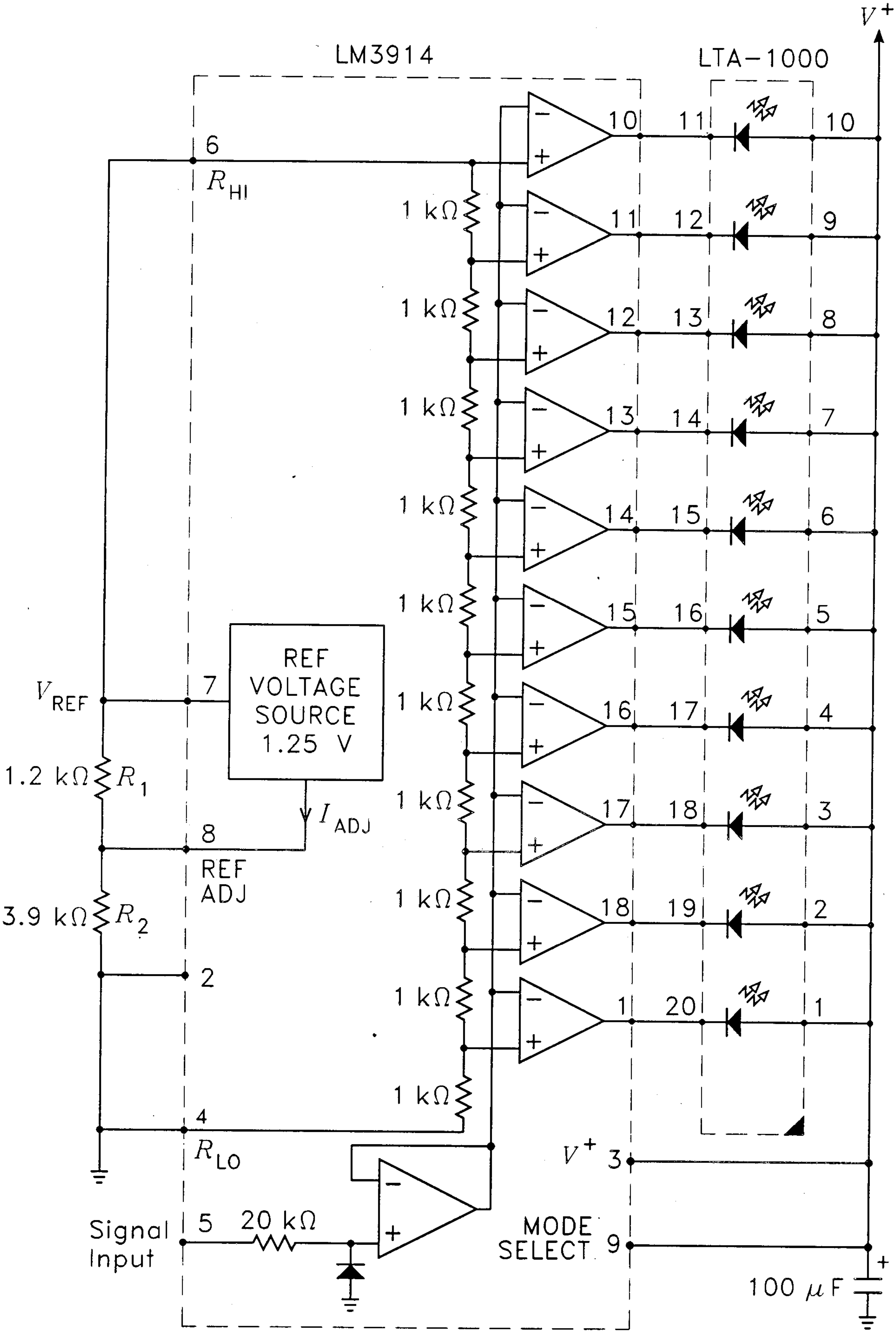

If diode is ideal $V_c(t)$ is a constant equal to the peak value of $V_i(t)$. It would hold it forever




If $R_1 = \infty$ $V_o(t)$ is the peak of $V_i(t)$

For peak tracking pick

$\tau = R_1 C$ to be a few seconds.



LM3914
LTA−1000
V+
6
RHI
1 kΩ
10
11
12
13
14
15
16
17
18
1
19
20
9
8
7
5
4
3
2
VREF
REF VOLTAGE SOURCE 1.25 V
1.2 kΩ R1
3.9 kΩ R2
IADJ
REF ADJ
RLO
Signal Input
20 kΩ
MODE SELECT
100 μF

# Georgia Institute of Technology

## School of Electrical and Computer Engineering

ECE 3042 Microelectronic Circuits Laboratory Verification Sheet

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NAME:________________________________________ SECTION:_____________________________

GT NUMBER:____________________________________ GTID:_________________________________

Experiment 5: Non-Linear Op-Amp Circuits

| Procedure | Time Completed | Date Completed | Verification (Must demonstrate circuit) | Points Possible | Points Received |
|---|---|---|---|---|---|
| 2. Half-Wave Rectifiers | | | | 30 | |
| 3. Full-Wave Rectifier *(See Table Below) | | | | 10 | |
| 4. Peak Hold Circuit | | | | 10 | |
| **5. Bar-Graph Array** | | | | 10 | |
| 6. Level Indicator *(See Table Below) | | | | 40 | |

* Build only one of the full-wave rectifier circuits shown in the lab manual. From the table below, determine which full-wave rectifier circuit to build and the input voltage for the level indicator.

| Last Digit of GTID | 0,1,2 | 3,4,5 | 6,7 | 8,9 |
|---|---|---|---|---|
| FWR Circuit | 1 | 2 | 3 | 4 |
| Input Voltage for Level Indicator | 1 Vrms | 2 Vrms | 3 Vrms | 5 Vrms |

To be permitted to complete the experiment during the open lab hours, you must complete at least **four** procedures during your scheduled lab period or spend your entire scheduled lab session attempting to do so. A signature below by your lab instructor, Dr. Brewer, or Dr. Robinson permits you to attend the open lab hours to complete the experiment and receive full credit on the report. Without this signature, you may use the open lab to perform the experiment at a 50% penalty.

SIGNATURE:_____________________________________ DATE:_____________________________________

## ECE 3042 Check-off Requirements for Experiment 5

Make sure you have made all required measurements before requesting a check-off. For all check-offs, you must demonstrate the circuit or measurement to a lab instructor. All screen captures must have a time/date stamp.

2. Half-Wave Rectifiers
   - ✓ Screen captures displaying input and output of the three rectifiers for 100Hz, 10kHz, and 100kHz input frequencies. Show measured Vpp for each channel.
   - ✓ Screen captures displaying XY plots of the three rectifiers for 100 Hz, 10kHz, and 100kHz input frequencies.
3. Full-Wave Rectifier
   - ✓ Screen capture displaying input and output of rectifier for 100Hz input frequency. Show measured Vpp for each channel.
   - ✓ Screen capture displaying XY plot of rectifier for 100 Hz input frequency.
4. Peak-Hold Circuit
   - ✓ Screen capture displaying input sine wave and output dc voltage. Make sure the volts per division settings are the same for both channels and that both channels are dc coupled. Also set the ground level for both channels to be the same (use the vertical position control to place the ground level indicators on the left side of the scope trace on top of each other).
   - ✓ Description of how the output responds as the input is varied both up and down.
   - ✓ Answer to question: Why does the output voltage go up faster than it goes down?
   - ✓ Retain this circuit for possible use in procedure 6.
5. Bar-Graph Array
   - Note that there is a 10k pot and a fixed 10k resistor in the circuit of Fig. 5.10. The wiper of the pot connects to pin 5 of the bar graph display. The dmm is connected between pin 5 and ground to measure the dc voltage.
   - ✓ Table of voltages at which each LED in the array lights.
6. Level Indicator
   - ✓ Demonstration of designed circuit. The last LED must just turn on for the input voltage found from the table on the verification sheet. Remember, the voltage at pin 5 must be a dc voltage but the input signal is a sinusoid.
   - ✓ Schematic of designed circuit.