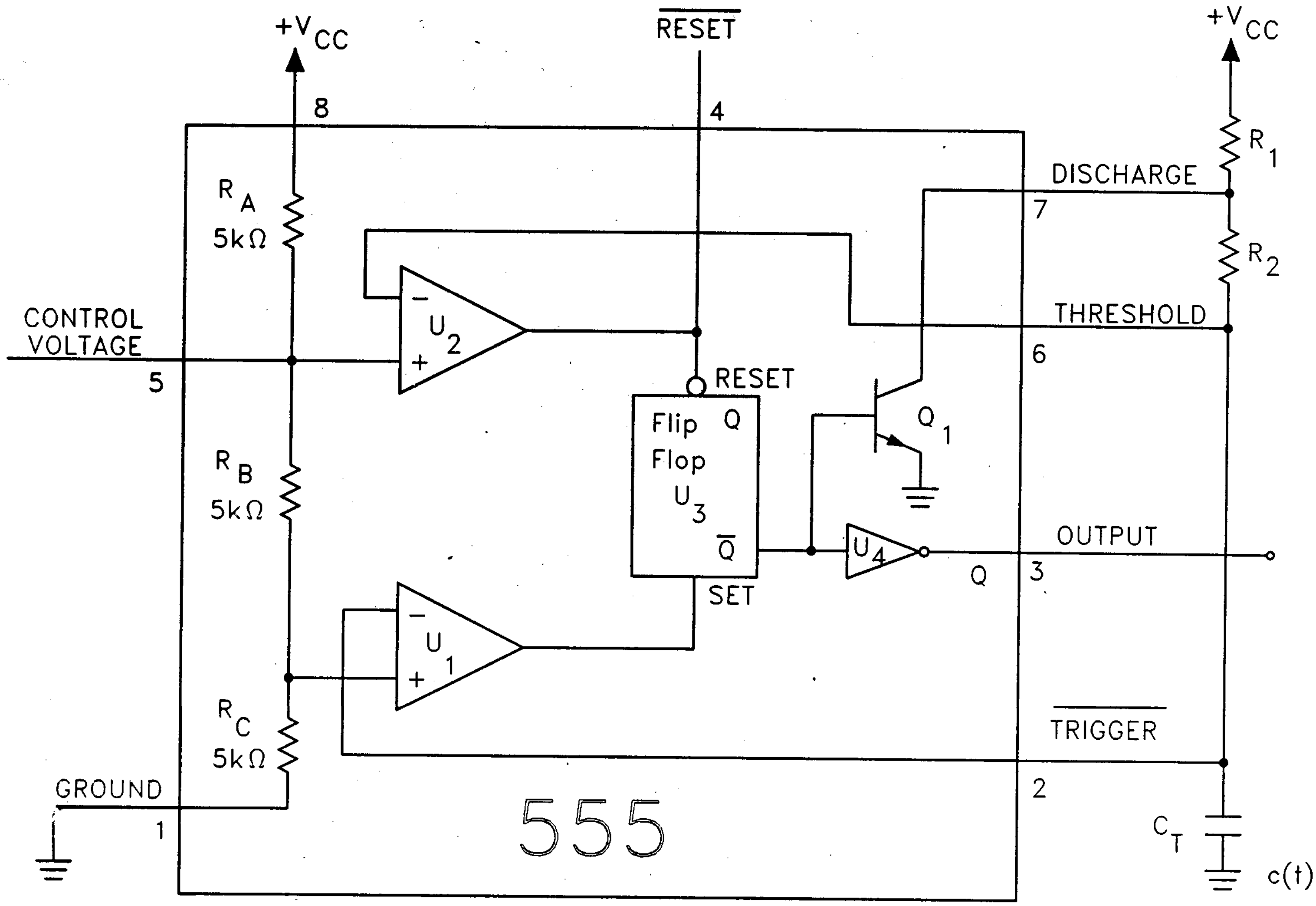


S	R	Q	$\bar{Q}$
L	L	Same	
L	H	L	H
H	L	H	L
H	H	No Way	

S	$\bar{R}$	Q	$\bar{Q}$
L	L	L	H
L	H	Same	
H	L	No Way	
H	H	H	L

When $\bar{Q}$ is L cap charges through $R_1 + R_2$ in series with Vcc

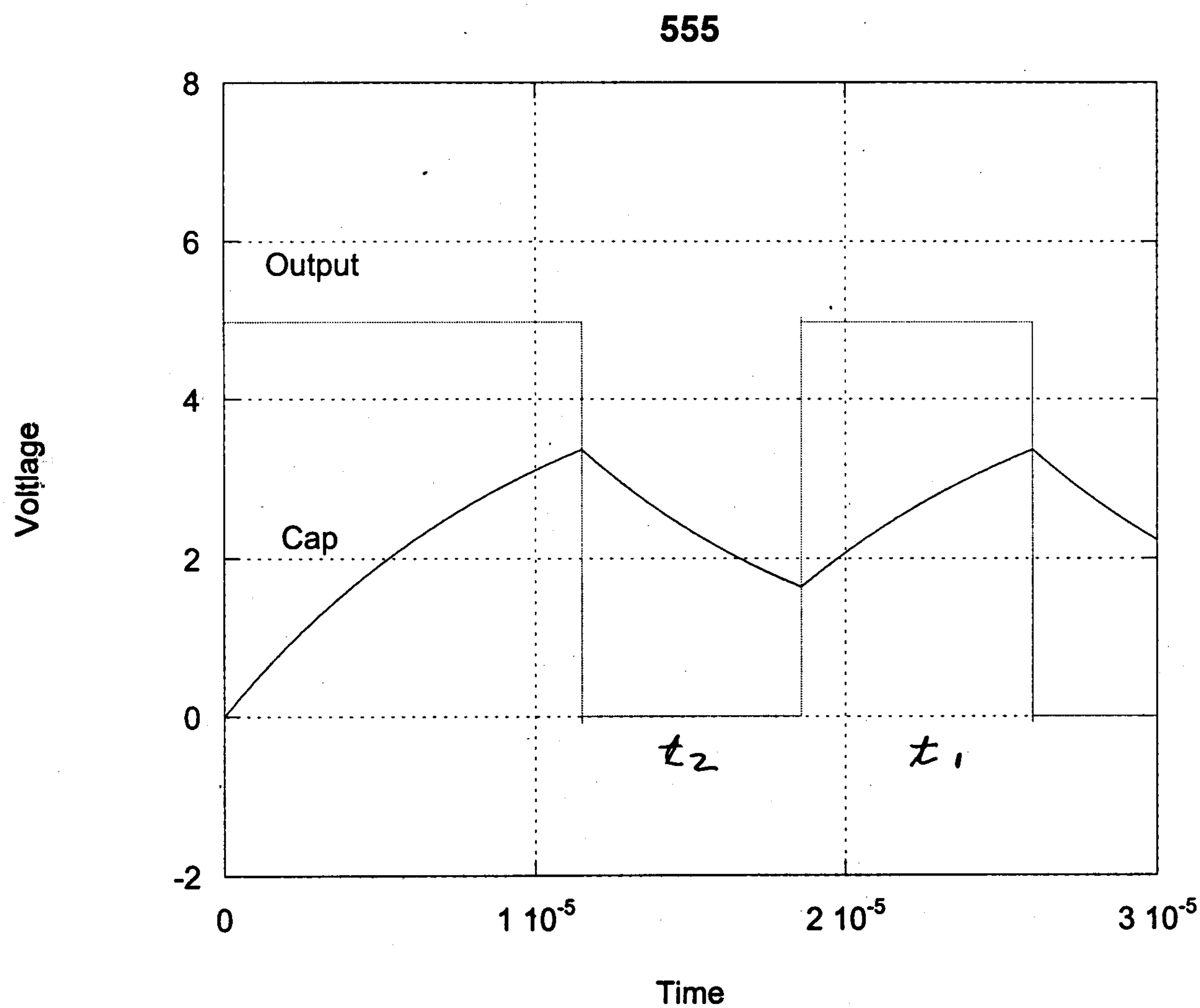
When $\bar{Q}$ is H cap discharges through R_2

$$t_1 = 0.693\,(R_1 + R_2)\,C_T$$

$$t_2 = 0.693\,R_2\,C_T$$

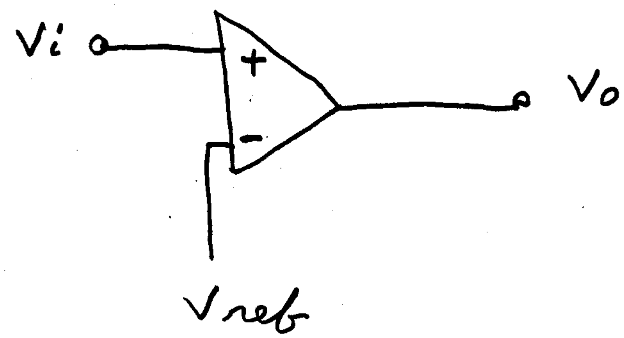
$$T = t_1 + t_2$$

$$f = \frac{1}{T} = \frac{1.44}{(R_1 + 2R_2)\,C_T}$$

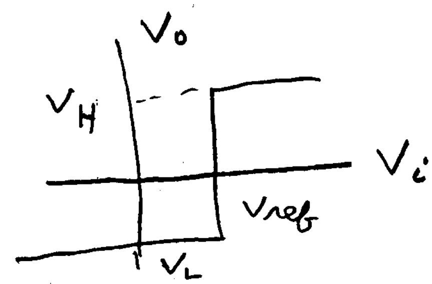


$$d \equiv \text{duty cycle} \equiv \frac{t_1}{t_1 + t_2} = \frac{R_1 + R_2}{R_1 + 2R_2}$$

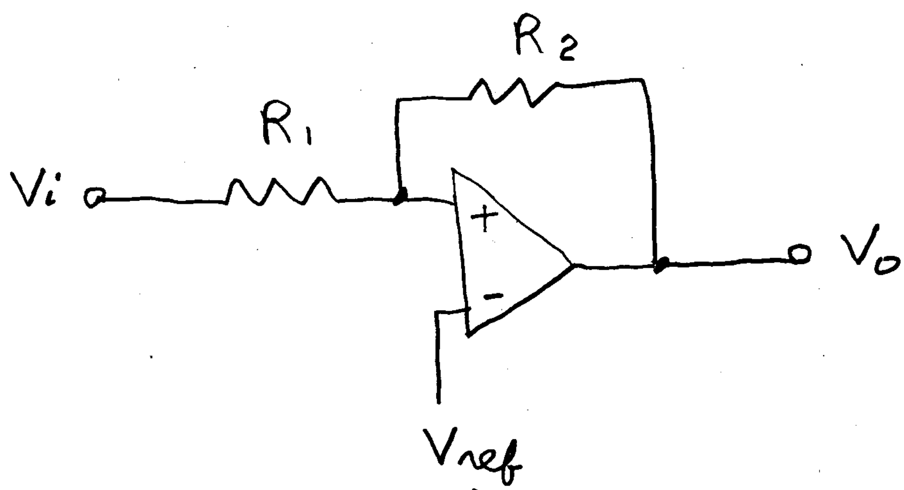
Comparator



No hysteresis



$$V_o = \begin{cases} V_H & V_i > V_{ref} \\ V_L & V_i < V_{ref} \end{cases}$$

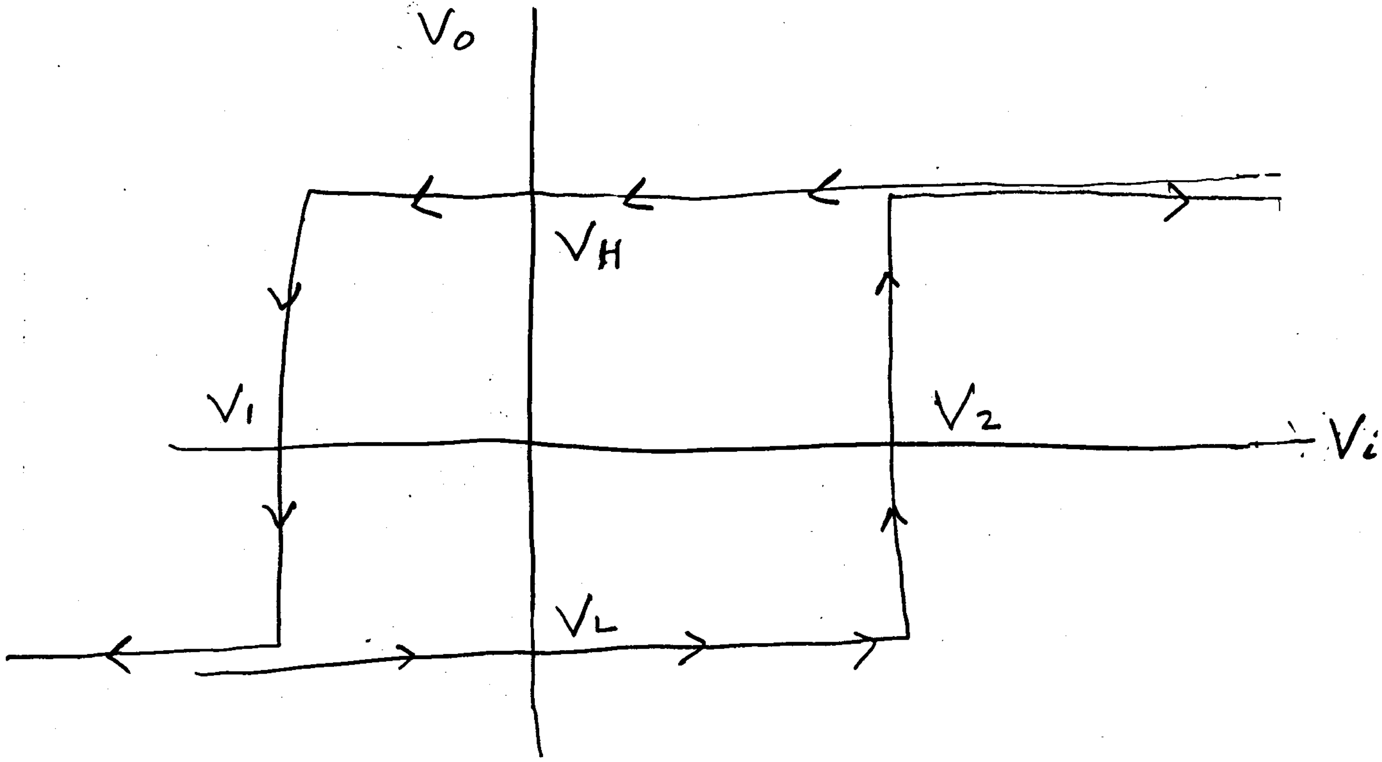


Positive Feedback

V_o is either V_H or V_L

$$V_+ = V_i \frac{R_2}{R_1 + R_2} + V_o \frac{R_1}{R_1 + R_2}$$

$$V_o = \begin{cases} V_H & \text{if} \quad V_+ > V_{ref} \\ V_L & \text{if} \quad V_+ < V_{ref} \end{cases}$$



$$V_+ = V_{ref} = V_1 \frac{R_2}{R_1 + R_2} + V_H \frac{R_1}{R_1 + R_2}$$

$$V_+ = V_{ref} = V_2 \frac{R_2}{R_1 + R_2} + V_L \frac{R_1}{R_1 + R_2}$$

$$V_1 = \frac{V_{ref}(R_1 + R_2) - V_H R_1}{R_2}$$

$$V_2 = \frac{V_{ref}(R_1 + R_2) - V_L R_1}{R_2}$$

$$\Delta V_h = V_2 - V_1 = \frac{R_1}{R_2}(V_H - V_L)$$

$\Delta V_h \equiv$ the hysteresis of the comparator

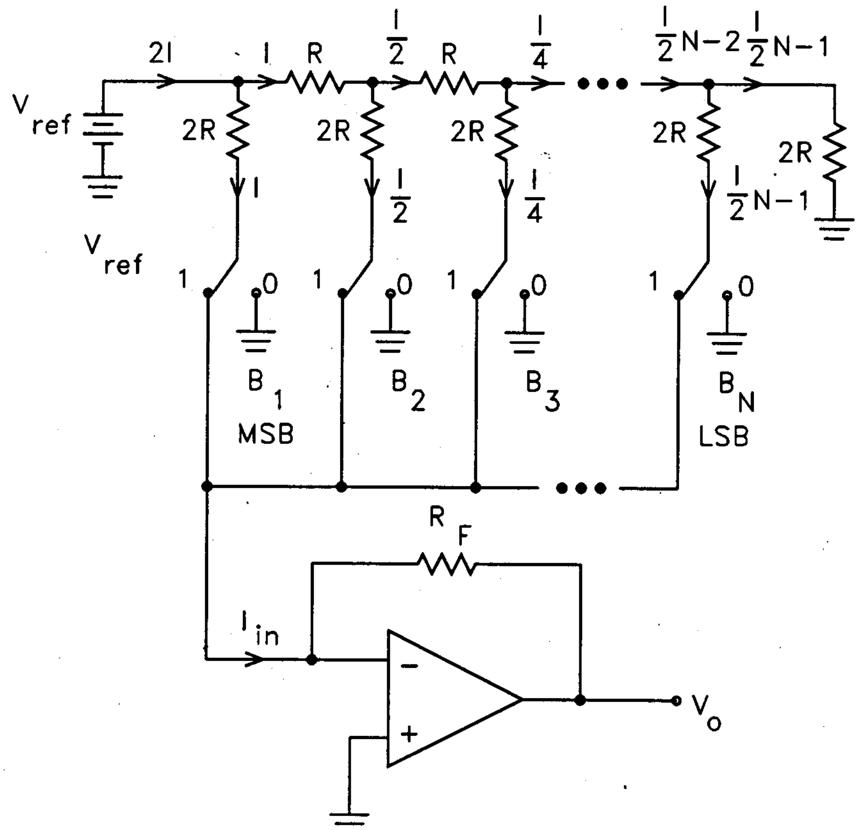


Figure 9-4

$$2I = \frac{V_{ref}}{R}, \quad I = \frac{V_{ref}}{2R}$$

$$I_{in} = I \sum_{i=1}^{N} \frac{B_i}{2^{i-1}}$$

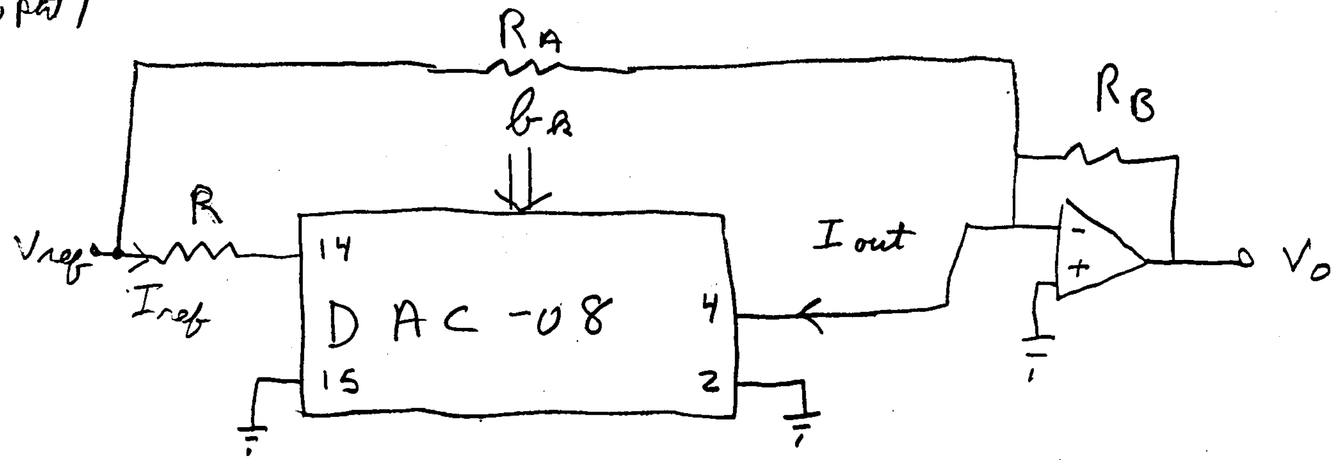
$(B_1, B_2, \cdots B_N)$ Input Digital Code Word

MSB . LSB

$$V_o = -I_{in} R_F$$

$$V_o = -V_{ref} \frac{R_F}{2R} \sum_{i=1}^{N} \frac{B_i}{2^{i-1}}$$

b part 1



$$I_{ref} = \frac{V_{ref}}{R}$$

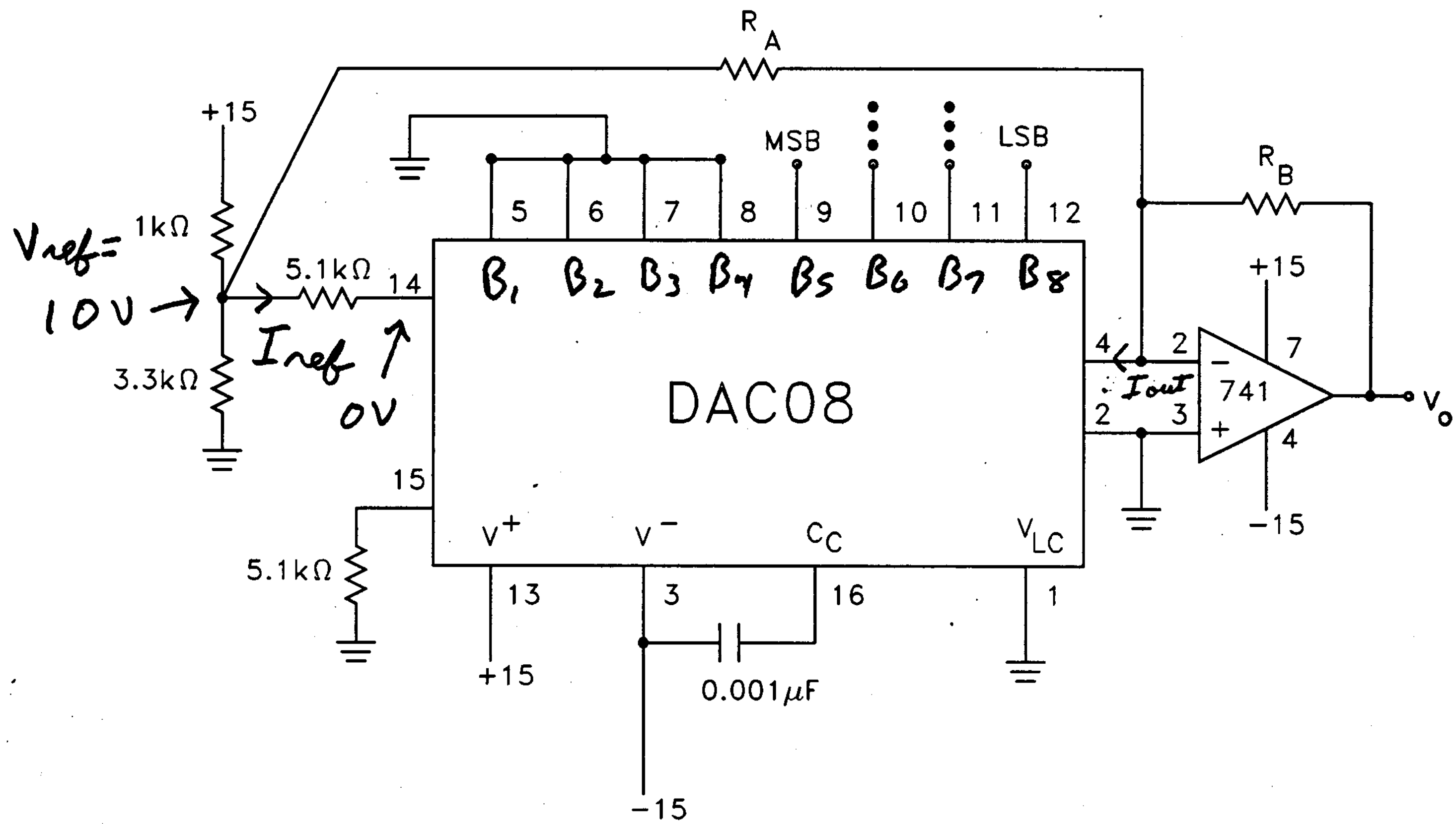
$$V_o = -V_{ref}\frac{R_B}{R_A} + I_{out} R_B$$

$$V_z = -V_{ref}\frac{R_B}{R_A}$$

$$V_1 = -V_{ref}\frac{R_B}{R_A} + R_B I_{ref}(1-2^{-N})$$

$$V_F = V_1 - V_z + \Delta V = I_{ref} R_B$$

$$\Delta V = \frac{V_F}{2^N}$$



4 Bit DAC

$$I_{ref} = \frac{10}{5.1} \text{ mA} = \frac{V_{ref}}{5.1}$$

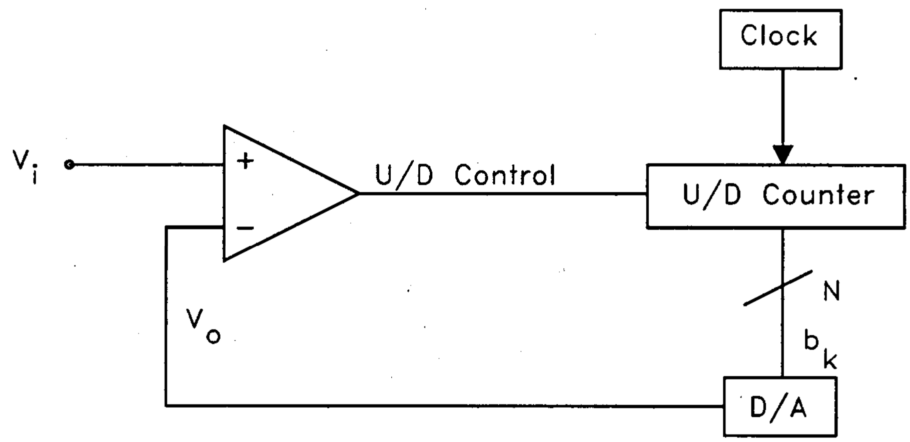
$$I_{out} = I_{ref} \sum_{i=1}^{8} \frac{B_i}{2^i} = I_{ref}\left[\frac{B_5}{32} + \frac{B_6}{64} + \frac{B_7}{128} + \ldots\right.$$

$$V_o = V_{ref}\left(-\frac{R_B}{R_A}\right) + I_{out} R_B$$

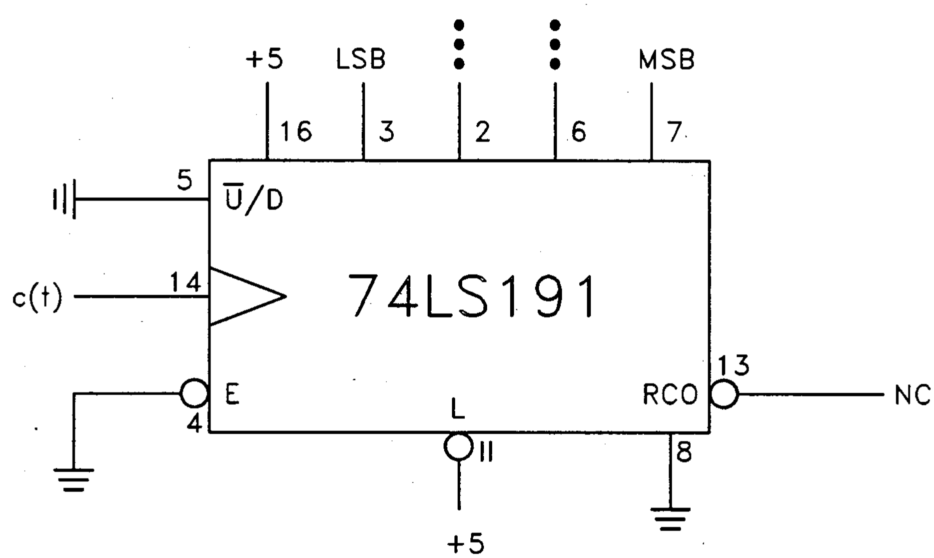
$$V_o = V_z = -\frac{R_B}{R_A} V_{ref} \quad \text{all 0s}$$

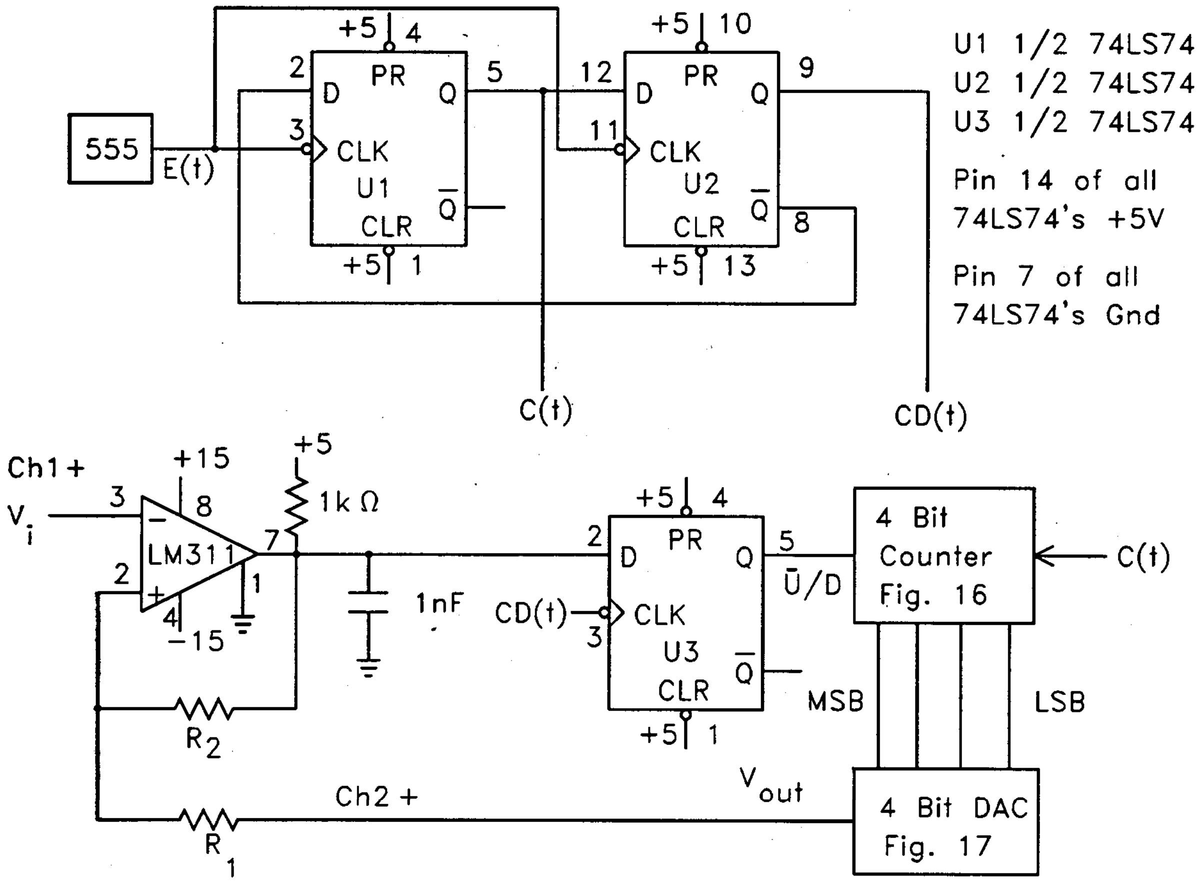
all 1s $\quad V_1 = V_z + I_{out} R_B$, $\quad V_1 - V_o = V_F(1-2^{-N})$

$$I_{out} R_B = V_F(1-2^{-N})$$



Tracking A/D Converter
Only accurate to N-1 bits




555
E(t)
D
PR
CLK
U1
CLR
Q
+5
C(t)
U2
CD(t)
U1 1/2 74LS74
U2 1/2 74LS74
U3 1/2 74LS74
Pin 14 of all 74LS74's +5V
Pin 7 of all 74LS74's Gnd
Ch1+
Vi
+15
-15
LM311
1k Ω
1nF
U3
Ū/D
4 Bit Counter Fig. 16
MSB
LSB
R2
R1
Ch2 +
Vout
4 Bit DAC Fig. 17

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 9: Analog to Digital Conversion Systems

Procedure	Time Completed	Date Completed	Verification (Must demonstrate circuit)	Points Possible	Points Received
3. Clock				30	
5. Four Bit D/A				30	
6. Four Bit A/D				30	
8. Eight Bit D/A				30	
9. Eight Bit A/D				80	

To be permitted to complete the experiment during the open lab hours, you must complete at least **three** 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 9

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.

3. Clock
   - ✓ Screen capture displaying clock output (pin 3 on 555) on CH 1 and pin 2 waveform on CH 2. Display frequency and duty cycle measurements.

5. Four Bit D/A Converter
   - Use equations 9.22, 9.20, and 9.19, and the specifications given in the homework to determine the values of R_A and R_B. Place a 10 pF cap in parallel with R_B to smooth the output.
   - ✓ Screen capture displaying D/A converter output.
   - ✓ Measurement of the height and width of a single step with scope cursors.
   - ✓ Measurement of the maximum and minimum voltages at the output with the scope cursors.

6. Four Bit A/D System
   - Omit the LED state indicators described in the lab manual.
   - Use equation 9.11 to determine the values of R1 and R2 to set the hysteresis < 0.01. Choose R1 = 1k.
   - ✓ Demonstration of circuit as pot is varied from one end of its range to the other.
   - ✓ Table of input voltage required for each “step up” of the square wave.
   - ✓ Screen capture of input 50 Hz triangle wave and output.
   - ✓ Screen capture showing the input and output waveforms for the frequency at which the output can no longer track the input triangle wave. Display the frequency measurement.
   - ✓ Screen capture of input 50 Hz square wave and output.
   - ✓ Screen capture showing the input and output waveforms for the frequency at which the output can no longer track the input square wave. Display the frequency measurement.
   - ✓ The previous four screen captures for the clock frequency increased by a factor of ten.

8. Eight Bit D/A Converter
   - Use equations 9.26, 9.25, and 9.23, and the specifications given in the homework to determine the values of R_A and R_B. Place a 10 pF cap in parallel with R_B to smooth the output.
   - ✓ Screen capture displaying D/A converter output.
   - ✓ Screen capture displaying magnified view of the output so that the step heights and widths can be measured.
   - ✓ Measurement of the height and width of a single step with scope cursors.
   - ✓ Measurement of the maximum and minimum voltages at the output with the scope cursors.

9. Eight Bit A/D System
   - Use equation 9.11 to determine the values of R1 and R2 to set the hysteresis < 0.01. Choose R1 = 1k.
   - ✓ Screen capture of input 50 Hz triangle wave and output.
   - ✓ Screen capture showing the input and output waveforms for the frequency at which the output can no longer track the input triangle wave. Display the frequency measurement.
   - ✓ Screen capture of input 50 Hz square wave and output.
   - ✓ Screen capture showing the input and output waveforms for the frequency at which the output can no longer track the input square wave. Display the frequency measurement.
   - ✓ The previous four screen captures for the clock frequency increased by a factor of ten.