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CHARGE REDISTRIBUTION ADC EXAMPLE

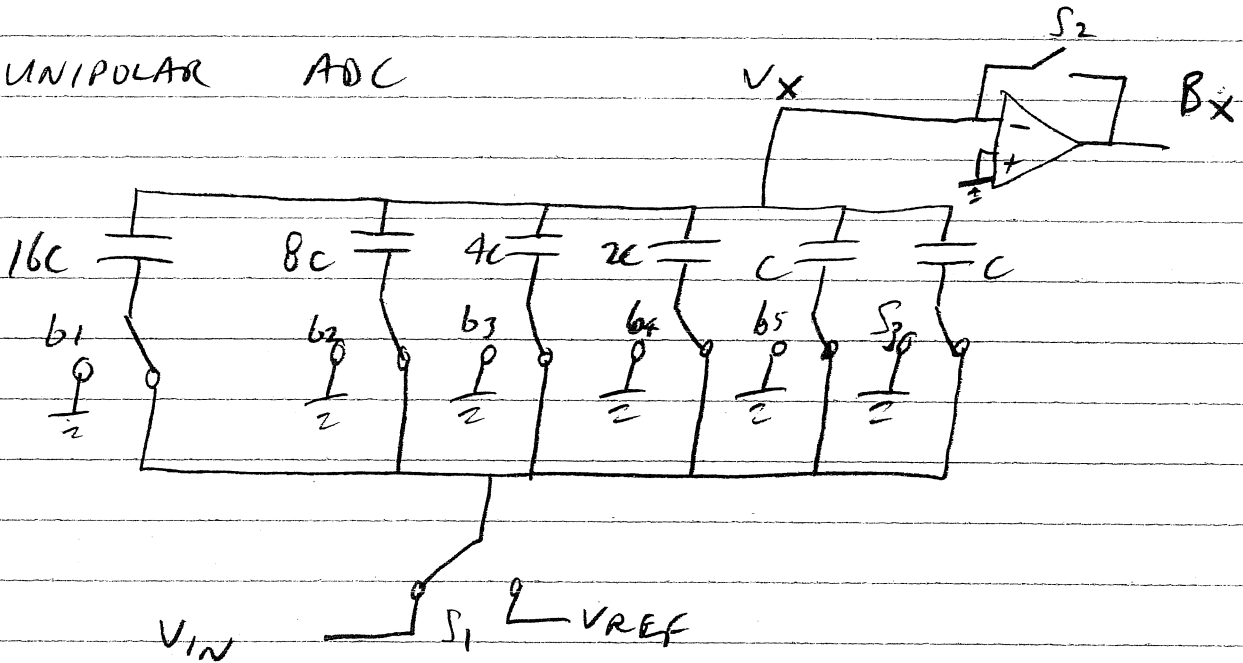
$$V_{REF} = 5V$$

5 BIT ADC SO

$$V_{LSB} = \frac{5V}{2^5} = \frac{5}{32} = 0.1563V$$

$$V_{LSB} = 0.1563V$$

UNIPOLAR ADC



- 1) S_1 SWITCHED TO V_{IN}
 S_2 CLOSED
 b_i, S_3 ALL SWITCHED TO V_{IN}
 SAMPLE V_{IN} ON $32C$

- 2) S_2 OPENED
 b_i, S_3 ALL SWITCHED TO GND
 $V_x = -V_{IN}$
 S_1 SWITCHED TO V_{REF}

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3) BIT CYCLING

SWITCH b_1 TO V_{REF}

CHECK IF $V_x > 0$

IF $V_x > 0$ SWITCH b_1 BACK TO GND

IF $V_x \leq 0$ LEAVE b_1 ATTACHED TO V_{REF}

CONTINUE TO b_2, b_3, b_4, b_5

FINAL DIGITAL VALUE IS

$b_1 b_2 b_3 b_4 b_5$ WHERE $b_i = 1$
IF ATTACHED TO V_{REF}

ASSUME $V_{IN} = 1.23 V$

$V_{REF} = 5V$
 $V_{LSB} = 0.1563$

$$V_x = -V_{IN} = -1.23V$$

$$1) V_x = -1.23 + \frac{16}{32} \times 5 = 1.27 \Rightarrow b_1 = 0$$

$$2) V_x = -1.23 + \frac{8}{32} \times 5 = 0.02 \Rightarrow b_2 = 0$$

$$3) V_x = -1.23 + \frac{4}{32} \times 5 = -0.605 \Rightarrow b_3 = 1$$

$$4) V_x = -0.605 + \frac{2}{32} \times 5 = -0.2925 \Rightarrow b_4 = 1$$

$$5) V_x = -0.2925 + \frac{1}{32} \times 5 = -0.1362 \Rightarrow b_5 = 1$$

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SO $B_{out} = 00111 = 7/32$

$B_{out} V_{REF} = \frac{7}{32} \times (5V) = 1.0938$

$V_{IN} = 1.23$

$B_{out} V_{REF} - V_{IN} = V_Q = -0.1362$

+ $V_x = -0.1362$ SO REMAINING

V_x IS QUANTIZATION ERROR!

REPEAT EXAMPLE BUT ASSUME

8C PARASITIC CAP ON V_x NODE

$V_x = \frac{32}{32+8} \times -V_{IN} = -0.984 V$

1) $V_x = -0.984 + \frac{16}{40} \times 5 = 1.016 V \Rightarrow b_1 = 0$

2) $V_x = -0.984 + \frac{8}{40} \times 5 = 0.016 \Rightarrow b_2 = 0$

3) $V_x = -0.984 + \frac{4}{40} \times 5 = -0.484 \Rightarrow b_3 = 1$

4) $V_x = -0.484 + \frac{2}{40} \times 5 = -0.234 \Rightarrow b_4 = 1$

5) $V_x = -0.234 + \frac{1}{40} \times 5 = -0.109 \Rightarrow b_5 = 1$

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$$\text{SO } B_{\text{OUT}} = 00111 = \frac{7}{32}$$

$$B_{\text{OUT}} V_{\text{REF}} - V_{\text{IN}} = V_Q = -0.1362 \quad \text{AS BEFORE}$$

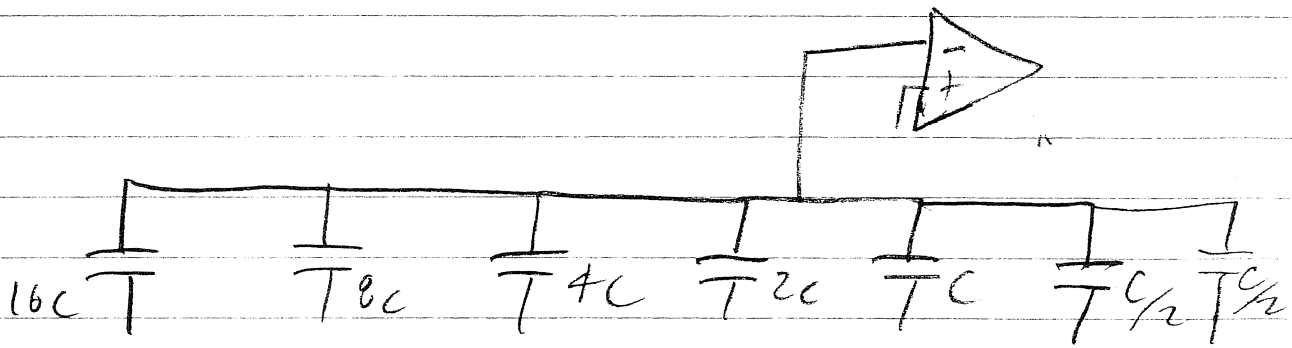
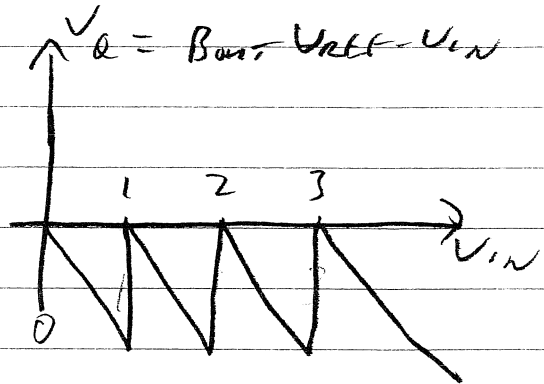
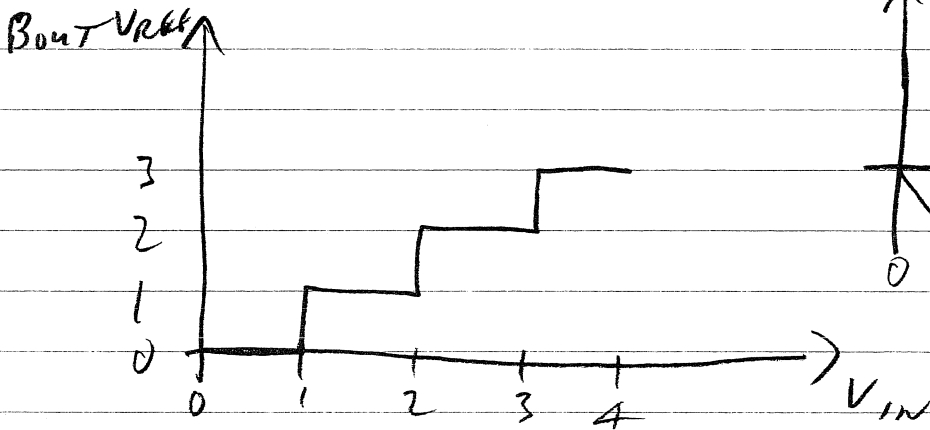
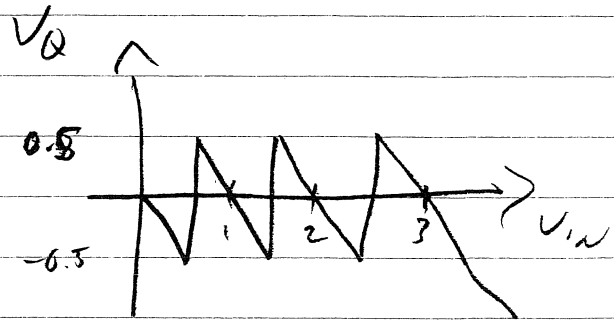
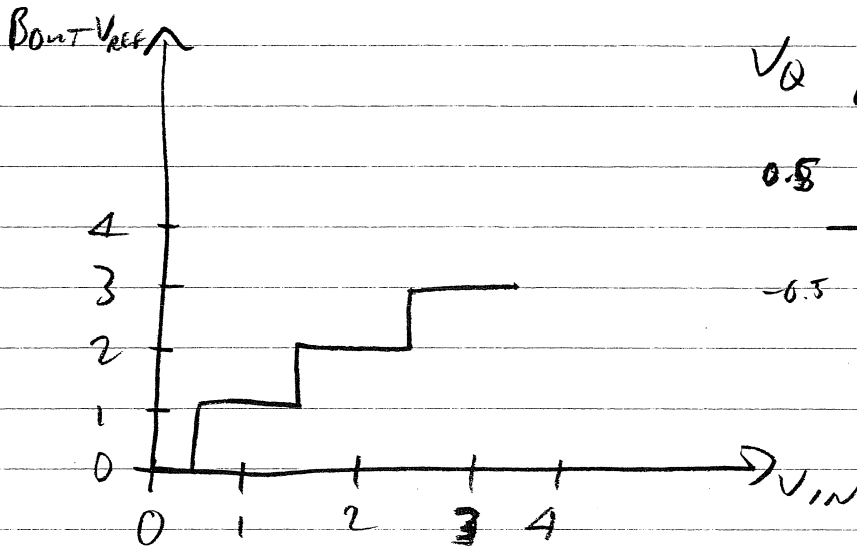
$$\underline{\text{BUT}} \quad V_X = -0.109$$

IT IS A SCALED VERSION OF QUANTIZATION ERROR V_Q

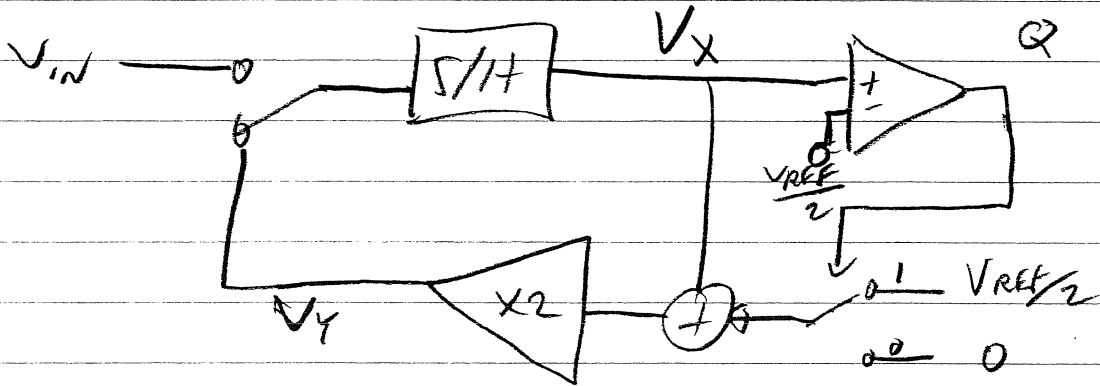
$$V_X = \frac{32}{40} \times V_Q = 0.8 V_Q$$

DUE TO PARASITIC CAP.

$$V_Q = B_{out} V_{REF} - V_{IN}$$



UNIPOLAR



$$V_{IN} = 1.23 \quad V_{REF} = 5V$$

| CYCLE | V_X | Q | V_Y |
|-------|-------|---|-------|
| 1 | 1.23 | 0 | 2.46 |
| 2 | 2.46 | 0 | 4.92 |
| 3 | 4.92 | 1 | 4.84 |
| 4 | 4.84 | 1 | 4.68 |
| 5 | 4.68 | 1 | 4.36 |

$$B_{OUT} = 00111$$

$$\underline{\underline{4.36}} = V_Q \times 2^5$$

$$V_Q = 0.1362$$