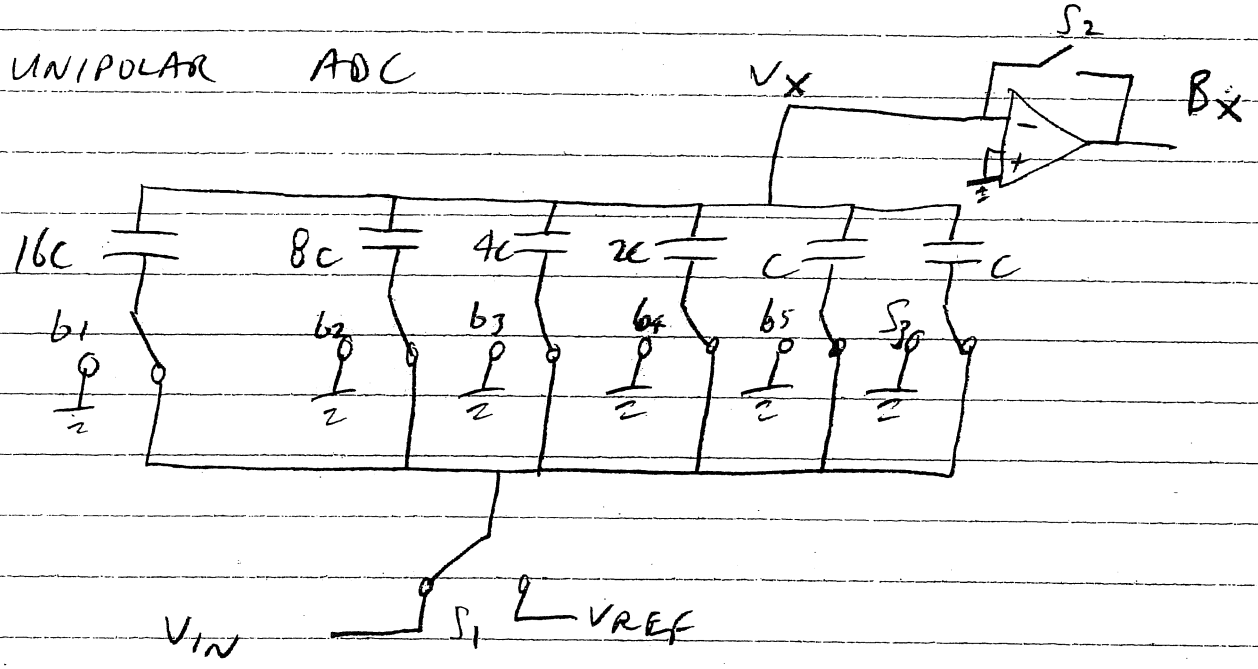
CHARGE REDISTRIBUTION ADC EXAMPLE

$V_{REF} = 5V$ 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}

3) BIT CYCLING

SWITCH b_1 TO VREF

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 VREF

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 $V_{IN} = 1.23V$ $V_{REF} = 5V$, $V_{LSB} = 0.1563$

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

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

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

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

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

BUT $V_X = -0.109$

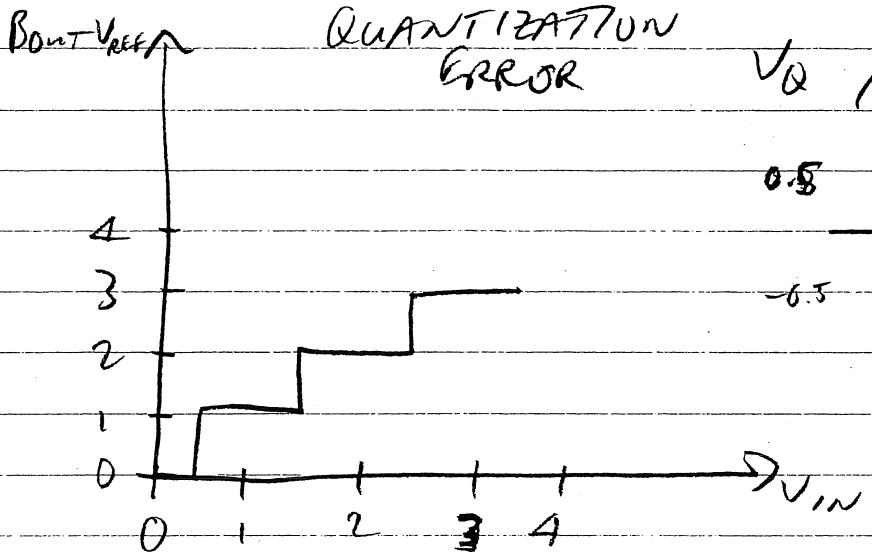
IT IS A SCALED VERSION OF QUANTIZATION ERROR V_Q

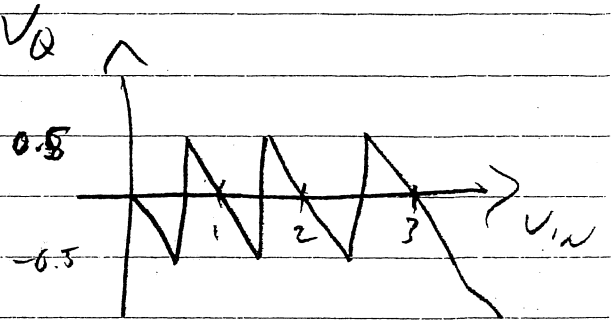
$$V_X = \frac{32}{40} \times V_Q = 0.8\, V_Q$$

DUE TO PARASITIC CAP.

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

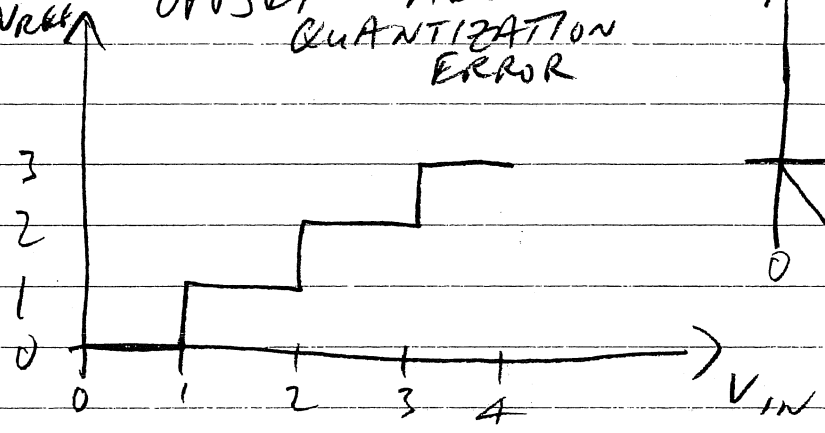
NORMAL ADC QUANTIZATION ERROR

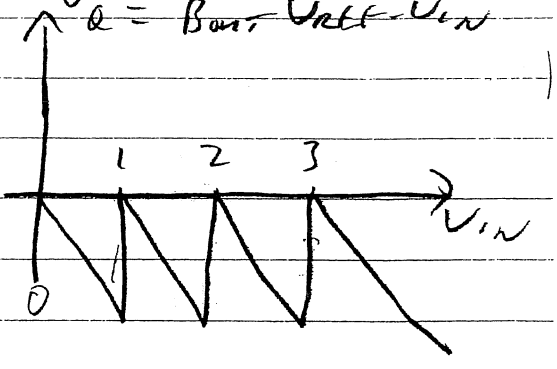




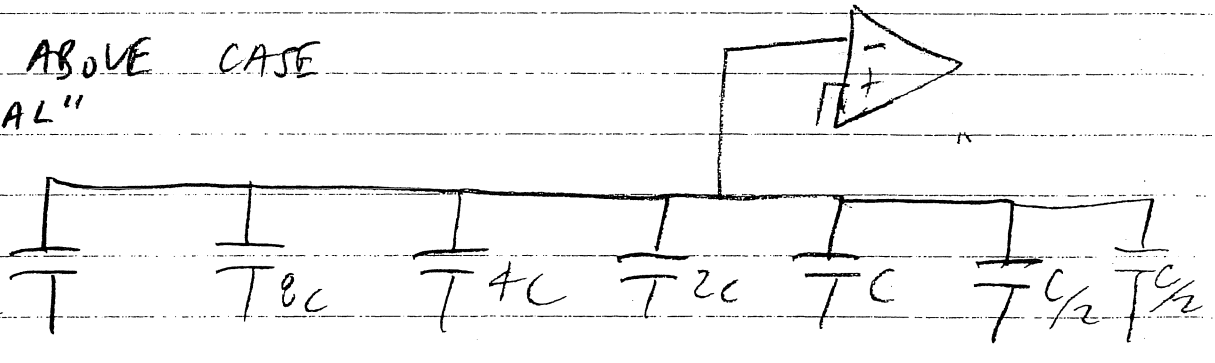
ABOVE CASE

OFFSET ADC QUANTIZATION ERROR



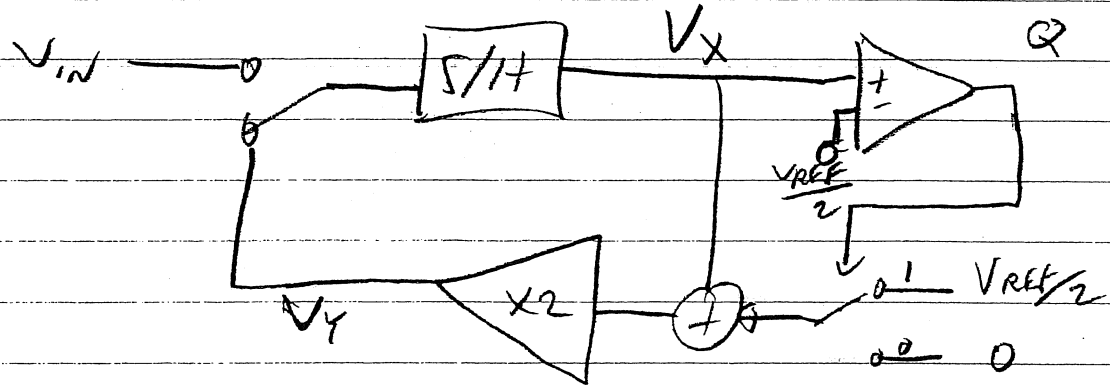


TO FIX ABOVE CASE TO "NORMAL"



BREAK "C" INTO $C/2 + C/2$ AND ATTACH TO VREF

UNIPOLAR



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

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

$B_{OUT} = 00111$

$4.36 = V_Q \times 2^5$

$V_Q = 0.1362$