

# ADC Follow Up

Wednesday, January 11, 2023 8:57 AM

IR Sensor

Pulse Width : 4 μs

Max Distance : 30 cm

b) N = 100

No Capacitor

```
COM4 - PuTTY
Standard Dev1: 8.582540 Standard Dev2: 8.901685 Standard Dev3: 8.452219
Min1: 8183 Min2: 8178 Min3: 8194 Max1: 8257 Max2: 8256 Max3: 8236
Average1: 8220 Average2: 8221 Average3: 8220
Standard Dev1: 8.724105 Standard Dev2: 11.574541 Standard Dev3: 10.105939
Min1: 8198 Min2: 8175 Min3: 8161 Max1: 8247 Max2: 8272 Max3: 8245
Average1: 8219 Average2: 8220 Average3: 8220
Standard Dev1: 7.897468 Standard Dev2: 7.008566 Standard Dev3: 7.557116
Min1: 8201 Min2: 8187 Min3: 8204 Max1: 8249 Max2: 8242 Max3: 8240
Average1: 8219 Average2: 8221 Average3: 8220
Standard Dev1: 8.226786 Standard Dev2: 5.038849 Standard Dev3: 8.777813
Min1: 8198 Min2: 8210 Min3: 8178 Max1: 8238 Max2: 8235 Max3: 8234
Average1: 8220 Average2: 8221 Average3: 8221
Standard Dev1: 6.565821 Standard Dev2: 5.488169 Standard Dev3: 7.376991
Min1: 8207 Min2: 8205 Min3: 8178 Max1: 8240 Max2: 8233 Max3: 8235
Average1: 8219 Average2: 8221 Average3: 8220
Standard Dev1: 7.239475 Standard Dev2: 7.578918 Standard Dev3: 8.352245
Min1: 8195 Min2: 8171 Min3: 8196 Max1: 8239 Max2: 8237 Max3: 8254
Average1: 8219 Average2: 8221 Average3: 8220
Standard Dev1: 8.134494 Standard Dev2: 8.679862 Standard Dev3: 9.885848
Min1: 8200 Min2: 8186 Min3: 8197 Max1: 8247 Max2: 8258 Max3: 8283
Average1: 8220 Average2: 8221 Average3: 8222
Standard Dev1: 8.675828 Standard Dev2: 7.718808 Standard Dev3: 7.973707
Min1: 8200 Min2: 8188 Min3: 8208 Max1: 8247 Max2: 8247 Max3: 8259
Average1: 8219 A
```

1 μF Capacitor

```
Average1: 8216 Average2: 8214 Average3: 8216
Standard Dev1: 7.840281 Standard Dev2: 9.983987 Standard Dev3: 9.162969
Min1: 8200 Min2: 8143 Min3: 8190 Max1: 8260 Max2: 8230 Max3: 8257
Average1: 8216 Average2: 8215 Average3: 8216
Standard Dev1: 6.823489 Standard Dev2: 10.780074 Standard Dev3: 7.107742
Min1: 8202 Min2: 8156 Min3: 8199 Max1: 8240 Max2: 8278 Max3: 8233
Average1: 8214 Average2: 8217 Average3: 8216
Standard Dev1: 10.829127 Standard Dev2: 10.568349 Standard Dev3: 6.772739
Min1: 8164 Min2: 8167 Min3: 8194 Max1: 8273 Max2: 8289 Max3: 8230
Average1: 8216 Average2: 8215 Average3: 8218
Standard Dev1: 12.653458 Standard Dev2: 7.471278 Standard Dev3: 10.545615
Min1: 8146 Min2: 8193 Min3: 8203 Max1: 8278 Max2: 8243 Max3: 8288
Average1: 8216 Average2: 8215 Average3: 8216
Standard Dev1: 8.327665 Standard Dev2: 9.047099 Standard Dev3: 11.864653
Min1: 8190 Min2: 8187 Min3: 8174 Max1: 8232 Max2: 8267 Max3: 8300
Average1: 8215 Average2: 8217 Average3: 8215
Standard Dev1: 9.373367 Standard Dev2: 6.950540 Standard Dev3: 12.609917
Min1: 8178 Min2: 8203 Min3: 8122 Max1: 8273 Max2: 8255 Max3: 8232
Average1: 8215 Average2: 8216 Average3: 8216
Standard Dev1: 7.180529 Standard Dev2: 8.489994 Standard Dev3: 12.668859
Min1: 8198 Min2: 8181 Min3: 8194 Max1: 8233 Max2: 8264 Max3: 8289
Average1: 8215 Average2: 8216 Average3: 8215
Standard Dev1: 12.917430 Standard Dev2: 7.803204 Standard Dev3: 11.329607
Min1: 8161 Min2:
```

0.1 μF

```
COM4 - PuTTY
Min1: 8150 Min2: 8183 Min3: 8197 Max1: 8243 Max2: 8228 Max3: 8236
Average1: 8214 Average2: 8215 Average3: 8214
Standard Dev1: 9.267146 Standard Dev2: 5.926213 Standard Dev3: 6.929646
```

COM4 - PuTTY

```
Min1: 8150 Min2: 8183 Min3: 8197 Max1: 8243 Max2: 8228 Max3: 8236
Average1: 8214 Average2: 8215 Average3: 8214
Stardard Dev1: 9.267146 Stardard Dev2: 5.926213 Stardard Dev3: 6.929646
Min1: 8170 Min2: 8199 Min3: 8199 Max1: 8233 Max2: 8231 Max3: 8232
Average1: 8215 Average2: 8213 Average3: 8214
Stardard Dev1: 7.303424 Stardard Dev2: 9.020532 Stardard Dev3: 9.487887
Min1: 8201 Min2: 8169 Min3: 8153 Max1: 8234 Max2: 8233 Max3: 8254
Average1: 8216 Average2: 8214 Average3: 8215
Stardard Dev1: 10.591034 Stardard Dev2: 8.200000 Stardard Dev3: 9.007219
Min1: 8177 Min2: 8180 Min3: 8184 Max1: 8271 Max2: 8261 Max3: 8235
Average1: 8215 Average2: 8213 Average3: 8216
Stardard Dev1: 9.859513 Stardard Dev2: 7.237403 Stardard Dev3: 7.293147
Min1: 8199 Min2: 8180 Min3: 8200 Max1: 8278 Max2: 8235 Max3: 8246
Average1: 8215 Average2: 8215 Average3: 8214
Stardard Dev1: 7.352551 Stardard Dev2: 10.213716 Stardard Dev3: 7.088723
Min1: 8161 Min2: 8161 Min3: 8197 Max1: 8238 Max2: 8278 Max3: 8246
Average1: 8214 Average2: 8216 Average3: 8215
Stardard Dev1: 7.130919 Stardard Dev2: 6.124541 Stardard Dev3: 8.089499
Min1: 8198 Min2: 8203 Min3: 8199 Max1: 8236 Max2: 8240 Max3: 8245
Average1: 8214 Average2: 8214 Average3: 8213
Stardard Dev1: 10.625912 Stardard Dev2: 7.355950 Stardard Dev3: 10.414413
Min1: 8172 Min2: 8171 Min3: 8158 Max1: 8275 Max2: 8230 Max3: 8246
```

0,01 μF

```
Stardard Dev1: 10.830974 Stardard Dev2: 9.322553 Stardard Dev3: 6.033241
Min1: 8192 Min2: 8167 Min3: 8198 Max1: 8293 Max2: 8245 Max3: 8232
Average1: 8215 Average2: 8215 Average3: 8214
Stardard Dev1: 8.284926 Stardard Dev2: 7.348469 Stardard Dev3: 6.167658
Min1: 8176 Min2: 8178 Min3: 8200 Max1: 8238 Max2: 8241 Max3: 8231
Average1: 8217 Average2: 8215 Average3: 8215
Stardard Dev1: 11.214277 Stardard Dev2: 6.757958 Stardard Dev3: 8.426743
Min1: 8162 Min2: 8201 Min3: 8188 Max1: 8285 Max2: 8247 Max3: 8248
Average1: 8215 Average2: 8217 Average3: 8211
Stardard Dev1: 11.727745 Stardard Dev2: 6.845436 Stardard Dev3: 11.463856
Min1: 8162 Min2: 8199 Min3: 8136 Max1: 8289 Max2: 8231 Max3: 8228
Average1: 8216 Average2: 8216 Average3: 8214
Stardard Dev1: 6.788962 Stardard Dev2: 6.200806 Stardard Dev3: 8.199390
Min1: 8199 Min2: 8201 Min3: 8188 Max1: 8234 Max2: 8235 Max3: 8245
Average1: 8217 Average2: 8216 Average3: 8214
Stardard Dev1: 10.469957 Stardard Dev2: 8.284926 Stardard Dev3: 6.743886
Min1: 8202 Min2: 8201 Min3: 8197 Max1: 8267 Max2: 8262 Max3: 8231
Average1: 8215 Average2: 8215 Average3: 8215
Stardard Dev1: 8.473488 Stardard Dev2: 7.377669 Stardard Dev3: 9.815294
Min1: 8186 Min2: 8203 Min3: 8189 Max1: 8248 Max2: 8248 Max3: 8274
Average1: 8216 Average2: 8215 Average3: 8216
Stardard Dev1: 11.402193 Stardard Dev2: 9.866104 Stardard Dev3: 8.484103
Min1: 8171 Min2: 8196 Min3: 8176 Max1: 8293 Max2: 8280 Max3: 8251
```

N ≈ 1000

No Capacitor

COM4 - PuTTY

```
Stardard Dev1: 9.264988 Stardard Dev2: 8.325203 Stardard Dev3: 9.393615
Min1: 8168 Min2: 8158 Min3: 8186 Max1: 8278 Max2: 8269 Max3: 8268
Average1: 8218 Average2: 8219 Average3: 8220
Stardard Dev1: 9.093789 Stardard Dev2: 8.002500 Stardard Dev3: 9.589943
Min1: 8173 Min2: 8162 Min3: 8168 Max1: 8261 Max2: 8279 Max3: 8275
Average1: 8219 Average2: 8220 Average3: 8220
Stardard Dev1: 9.276260 Stardard Dev2: 7.757835 Stardard Dev3: 10.032846
Min1: 8185 Min2: 8161 Min3: 8169 Max1: 8275 Max2: 8253 Max3: 8272
Average1: 8218 Average2: 8220 Average3: 8220
Stardard Dev1: 8.968891 Stardard Dev2: 7.833645 Stardard Dev3: 9.658105
Min1: 8177 Min2: 8158 Min3: 8179 Max1: 8259 Max2: 8253 Max3: 8258
Average1: 8218 Average2: 8220 Average3: 8220
Stardard Dev1: 9.435836 Stardard Dev2: 8.057853 Stardard Dev3: 10.008846
Min1: 8157 Min2: 8183 Min3: 8159 Max1: 8253 Max2: 8265 Max3: 8291
```

### COM4 - PuTTY

```
Standard Dev1: 9.264988 Standard Dev2: 8.325203 Standard Dev3: 9.393615
Min1: 8168 Min2: 8158 Min3: 8186 Max1: 8278 Max2: 8269 Max3: 8268
Average1: 8218 Average2: 8219 Average3: 8220
Standard Dev1: 9.093789 Standard Dev2: 8.002500 Standard Dev3: 9.589943
Min1: 8173 Min2: 8162 Min3: 8168 Max1: 8261 Max2: 8279 Max3: 8275
Average1: 8219 Average2: 8220 Average3: 8220
Standard Dev1: 9.276260 Standard Dev2: 7.757835 Standard Dev3: 10.032846
Min1: 8185 Min2: 8161 Min3: 8169 Max1: 8275 Max2: 8253 Max3: 8272
Average1: 8218 Average2: 8220 Average3: 8220
Standard Dev1: 8.968891 Standard Dev2: 7.833645 Standard Dev3: 9.658105
Min1: 8177 Min2: 8158 Min3: 8179 Max1: 8259 Max2: 8253 Max3: 8258
Average1: 8218 Average2: 8220 Average3: 8220
Standard Dev1: 9.435836 Standard Dev2: 8.057853 Standard Dev3: 10.008846
Min1: 8157 Min2: 8183 Min3: 8159 Max1: 8253 Max2: 8265 Max3: 8291
Average1: 8219 Average2: 8219 Average3: 8219
Standard Dev1: 9.356602 Standard Dev2: 7.926475 Standard Dev3: 9.751769
Min1: 8155 Min2: 8161 Min3: 8152 Max1: 8261 Max2: 8279 Max3: 8255
Average1: 8219 Average2: 8219 Average3: 8220
Standard Dev1: 9.250568 Standard Dev2: 7.561085 Standard Dev3: 9.605884
Min1: 8157 Min2: 8172 Min3: 8191 Max1: 8264 Max2: 8253 Max3: 8262
Average1: 8218 Average2: 8220 Average3: 8219
Standard Dev1: 9.599479 Standard Dev2: 8.014487 Standard Dev3: 9.500053
```

### 1uF Capacitor

```
Average1: 8214 Average2: 8215 Average3: 8215
Standard Dev1: 10.271417 Standard Dev2: 9.800051 Standard Dev3: 12.400121
Min1: 8140 Min2: 8158 Min3: 8154 Max1: 8286 Max2: 8277 Max3: 8296
Average1: 8214 Average2: 8215 Average3: 8215
Standard Dev1: 11.582659 Standard Dev2: 10.008347 Standard Dev3: 11.569788
Min1: 8163 Min2: 8159 Min3: 8151 Max1: 8295 Max2: 8283 Max3: 8269
Average1: 8215 Average2: 8214 Average3: 8215
Standard Dev1: 10.921996 Standard Dev2: 9.472434 Standard Dev3: 11.367498
Min1: 8157 Min2: 8161 Min3: 8157 Max1: 8301 Max2: 8283 Max3: 8282
Average1: 8214 Average2: 8215 Average3: 8215
Standard Dev1: 10.105790 Standard Dev2: 9.807956 Standard Dev3: 13.034147
Min1: 8173 Min2: 8152 Min3: 8124 Max1: 8290 Max2: 8285 Max3: 8306
Average1: 8214 Average2: 8215 Average3: 8215
Standard Dev1: 10.542059 Standard Dev2: 11.003818 Standard Dev3: 12.629608
Min1: 8134 Min2: 8127 Min3: 8134 Max1: 8275 Max2: 8289 Max3: 8294
Average1: 8214 Average2: 8215 Average3: 8215
Standard Dev1: 10.532141 Standard Dev2: 9.197771 Standard Dev3: 12.083460
Min1: 8134 Min2: 8153 Min3: 8129 Max1: 8291 Max2: 8300 Max3: 8287
Average1: 8214 Average2: 8214 Average3: 8215
Standard Dev1: 10.163956 Standard Dev2: 10.685083 Standard Dev3: 12.420427
```

### 0.1uF

```
Average1: 8213 Average2: 8214 Average3: 8215
Standard Dev1: 10.743324 Standard Dev2: 11.178953 Standard Dev3: 12.096446
Min1: 8137 Min2: 8143 Min3: 8145 Max1: 8276 Max2: 8314 Max3: 8282
Average1: 8214 Average2: 8215 Average3: 8214
Standard Dev1: 9.763503 Standard Dev2: 10.482557 Standard Dev3: 11.510473
Min1: 8146 Min2: 8161 Min3: 8155 Max1: 8286 Max2: 8298 Max3: 8271
Average1: 8213 Average2: 8214 Average3: 8215
Standard Dev1: 9.783762 Standard Dev2: 11.228312 Standard Dev3: 13.032920
Min1: 8155 Min2: 8152 Min3: 8152 Max1: 8254 Max2: 8287 Max3: 8321
Average1: 8214 Average2: 8214 Average3: 8214
Standard Dev1: 9.912416 Standard Dev2: 9.942535 Standard Dev3: 11.754233
Min1: 8153 Min2: 8152 Min3: 8156 Max1: 8257 Max2: 8265 Max3: 8273
Average1: 8213 Average2: 8214 Average3: 8214
Standard Dev1: 10.937047 Standard Dev2: 11.152533 Standard Dev3: 12.350101
Min1: 8138 Min2: 8149 Min3: 8159 Max1: 8292 Max2: 8306 Max3: 8277
Average1: 8213 Average2: 8215 Average3: 8215
Standard Dev1: 9.888175 Standard Dev2: 10.912378 Standard Dev3: 12.173455
Min1: 8156 Min2: 8168 Min3: 8166 Max1: 8271 Max2: 8298 Max3: 8322
Average1: 8214 Average2: 8213 Average3: 8214
Standard Dev1: 9.844643 Standard Dev2: 10.937184 Standard Dev3: 12.522260
```

0.01μF

```
Average1: 8215 Average2: 8215 Average3: 8215
Standard Dev1: 10.900459 Standard Dev2: 11.233254 Standard Dev3: 12.291298
Min1: 8157 Min2: 8143 Min3: 8151 Max1: 8300 Max2: 8308 Max3: 8288
Average1: 8214 Average2: 8215 Average3: 8214
Standard Dev1: 11.058978 Standard Dev2: 10.296359 Standard Dev3: 12.023228
Min1: 8142 Min2: 8140 Min3: 8160 Max1: 8288 Max2: 8289 Max3: 8293
Average1: 8215 Average2: 8214 Average3: 8215
Standard Dev1: 11.039973 Standard Dev2: 10.679185 Standard Dev3: 12.596349
Min1: 8157 Min2: 8163 Min3: 8159 Max1: 8282 Max2: 8303 Max3: 8297
Average1: 8215 Average2: 8214 Average3: 8215
Standard Dev1: 11.382706 Standard Dev2: 10.767451 Standard Dev3: 12.136721
Min1: 8140 Min2: 8147 Min3: 8146 Max1: 8290 Max2: 8272 Max3: 8304
Average1: 8215 Average2: 8215 Average3: 8215
Standard Dev1: 11.088688 Standard Dev2: 9.855252 Standard Dev3: 11.897353
Min1: 8140 Min2: 8167 Min3: 8140 Max1: 8268 Max2: 8278 Max3: 8290
Average1: 8215 Average2: 8215 Average3: 8215
Standard Dev1: 9.964487 Standard Dev2: 10.510519 Standard Dev3: 12.348279
Min1: 8177 Min2: 8147 Min3: 8156 Max1: 8283 Max2: 8297 Max3: 8295
Average1: 8215 Average2: 8214 Average3: 8215
Standard Dev1: 10.560114 Standard Dev2: 10.266353 Standard Dev3: 12.446244
Min1: 8168 Min2: 8147 Min3: 8148 Max1: 8296 Max2: 8277 Max3: 8302
```

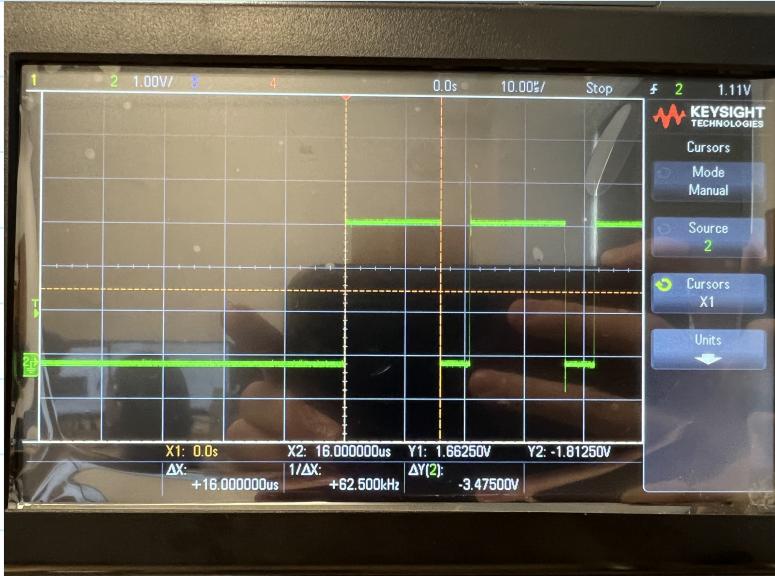
Code

```
50#include <stdint.h>
51#include <stdio.h>
52#include <math.h>
53#include "msp.h"
54#include "Clock.h"
55#include "UART0.h"
56#include "ADC14.h"
57
58uint32_t v17, v21, v22, v23;
59
60int main(void){
61    char ch;
62    int temp1 = 0;
63    int temp2 = 0;
64    int temp3 = 0;
65    int average1 = 0;
66    int average2= 0;
67    int average3= 0;
68    int data1[1000];
69    int data2[1000];
70    int data3[1000];
71    int min1 = 0;
72    int min2 = 0;
73    int min3 = 0;
74    int max1 = 0;
75    int max2 = 0;
76    int max3 = 0;
77    double stddev1 = 0;
78    double stddev2 = 0;
79    double stddev3 = 0;
80    int bump = 0, lastbump=0;
```

```

81     uint8_t* where;
82     uint32_t try32;
83     uint16_t try16;
84     uint8_t out;
85     uint32_t n = 0;
86     Clock_Init48MHz(); // makes SMCLK=12 MHz
87     UART0_Initprintf(); // initialize UART and printf
88     UART0_OutString("\nTest program for UART and ADC\n");
89     P8->SEL0 &= ~0xE1; // configure P8 0,5,6,7 GPIO output
90     P8->SEL1 &= ~0xE1;
91     P8->DIR |= 0xE1; // P8 0,5,6,7 output
92     where = &(P8->DIR);
93     P4->SEL0 &= ~0xFD;
94     P4->SEL1 &= ~0xFD; // 1) configure P4 as GPIO (except .1)
95     P4->DIR &= ~0xFD; // 2) make P4 in
96     P4->REN |= 0xFD; // 3) enable pull resistors on P4
97     ADC0_InitSWTriggerCh17_21_23();
98     while (1) {
99         ADC_In17_21_23(&v17, &v21, &v23);
100        data1[n]=v17;
101        data2[n]=v21;
102        data3[n]=v23;
103        temp1 = temp1 + data1[n];
104        temp2 = temp2 + data2[n];
105        temp3 = temp3 + data3[n];
106        n++;
107        if(n == 1000){
108            average1 = temp1/1000;
109            average2 = temp2/1000;
110            average3 = temp3/1000;
111            for(int i=0;i<n;i++){
112                stddev1 += pow(data1[i]-average1,2);
113                stddev2 += pow(data2[i]-average2,2);
114                stddev3 += pow(data3[i]-average3,2);
115                if(data1[i] < data1[min1]){
116                    min1 = i;
117                }
118                if(data2[i] < data2[min2]){
119                    min2 = i;
120                }
121                if(data3[i] < data3[min3]){
122                    min3 = i;
123                }
124                if(data1[i] > data1[max1]){
125                    max1 = i;
126                }
127                if(data2[i] > data2[max2]){
128                    max2 = i;
129                }
130                if(data3[i] > data3[max3]){
131                    max3 = i;
132                }
133            }
134            printf("Average1:%d Average2:%d Average3:%d \r\n", average1, average2, average3);
135            printf("Standard Dev1: %f Standard Dev2: %f Standard Dev3: %f \r\n", sqrt(stddev1/1000),sqrt(stddev2/1000),sqrt(stddev3/1000));
136            printf("Min1: %d Min2: %d Min3: %d Max1: %d Max2: %d Max3: %d \r\n", data1[min1],data2[min2],data3[min3],data1[max1],data2[max2],data3[max3]);
137            temp1 = 0;
138            temp2 = 0;
139            temp3 = 0;
140            stddev1 = 0;
141            stddev2 = 0;
142            stddev3 = 0;
143            min1=0;
144            min2=0;
145            min3=0;
146            max1=0;
147            max2=0;
148            max3=0;
149            n = 0;
150        }
151
152
153        //printf("%d %d\r\n", v17, v21, v23);
154        bump = (int)(P4->IN&0xFD);
155        if ((EUSCI_A0->IFG&0x01) != 0) {
156            printf("%c\r\n", (char)(EUSCI_A0->RXBUF));
157            where = &(P8->OUT);
158            out = *where;
159            out = out ^ 0xE1;
160            *where = out;
161            // verbose version of P8->OUT ^= 0xE1; // toggle
162        }
163        if (bump != lastbump) {
164            printf("%x\r\n", (int)(bump));
165            lastbump = bump;
166            where = &(P8->OUT);
167            out = *where;
168            out = out ^ 0xE1;
169            *where = out;
170            // verbose version of P8->OUT ^= 0xE1; // toggle
171        }
172
173
174

```



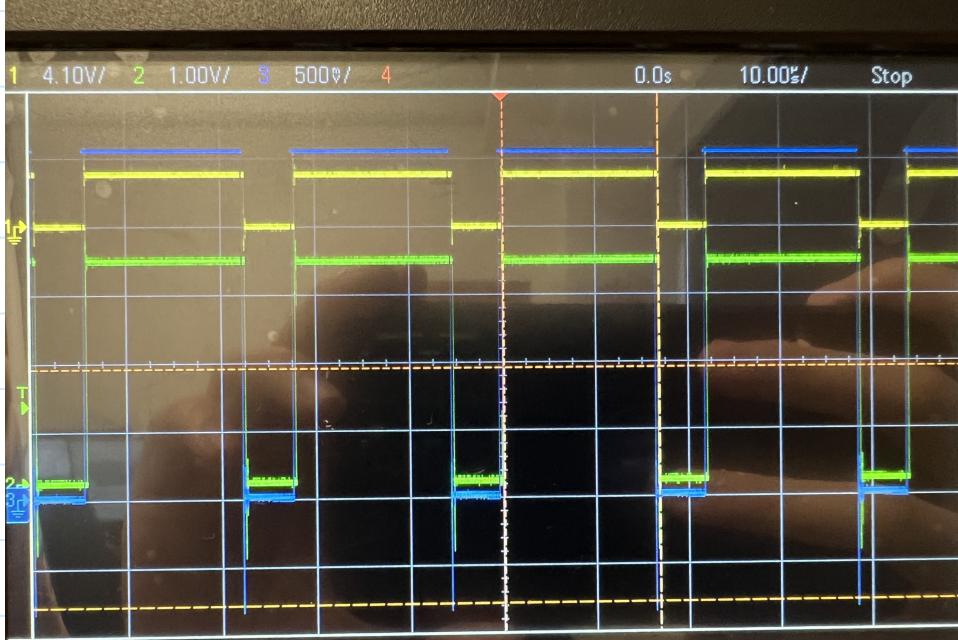
Code LED

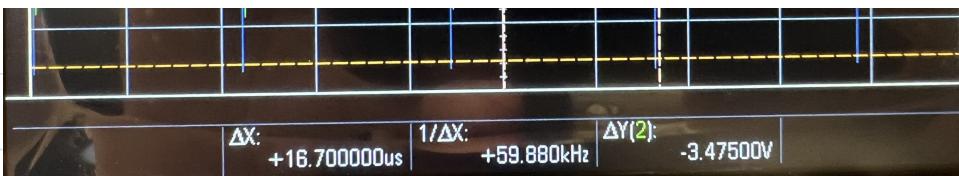
```

/ P10->OUT = 0;
| P1->DIR |= 0x01;
| P1->OUT = 0;
ADC0_InitSWTriggerCh17_21_23();
while (1) {
/     P6->OUT |= 0x04;
/     P10->OUT |= 0x05;
/     Clock_Delay1ms(1);
|     P1->OUT |= 0x01
    ADC_In17_21_23(&v17, &v21, &v23);
/     P6->OUT &= ~0x04;
/     P10->OUT &= ~0x05;
|     P1->OUT &= ~0x01
}

```

2a) Three LED sign before ADC





2b) Added code for delay 1 3 red

```

90 P8->SEL1 &= ~0xE1;
91 P8->DIR |= 0xE1;           // P8 0,5,6,7 output
92 where = &(P8->DIR);
93 P4->SEL0 &= ~0xFD;
94 P4->SEL1 &= ~0xFD;        // 1) configure P4 as GPIO (except .1)
95 P4->DIR &= ~0xFD;         // 2) make P4 in
96 P4->REN |= 0xFD;          // 3) enable pull resistors on P4
97 P6->DIR |= 0x04;
98 P6->OUT = 0;
99 P10->DIR |= 0x05;
100 P10->OUT = 0;
101 ADC0_InitSWTriggerCh17_21_23();
102 while (1) {
103     P6->OUT |= 0x04;
104     P10->OUT |= 0x05;
105     Clock_Delay1ms(1);
106     ADC_In17_21_23(&v17, &v21, &v23);
107     P6->OUT &= ~0x04;
108     P10->OUT &= ~0x05;

```

2c) 1ms delay

