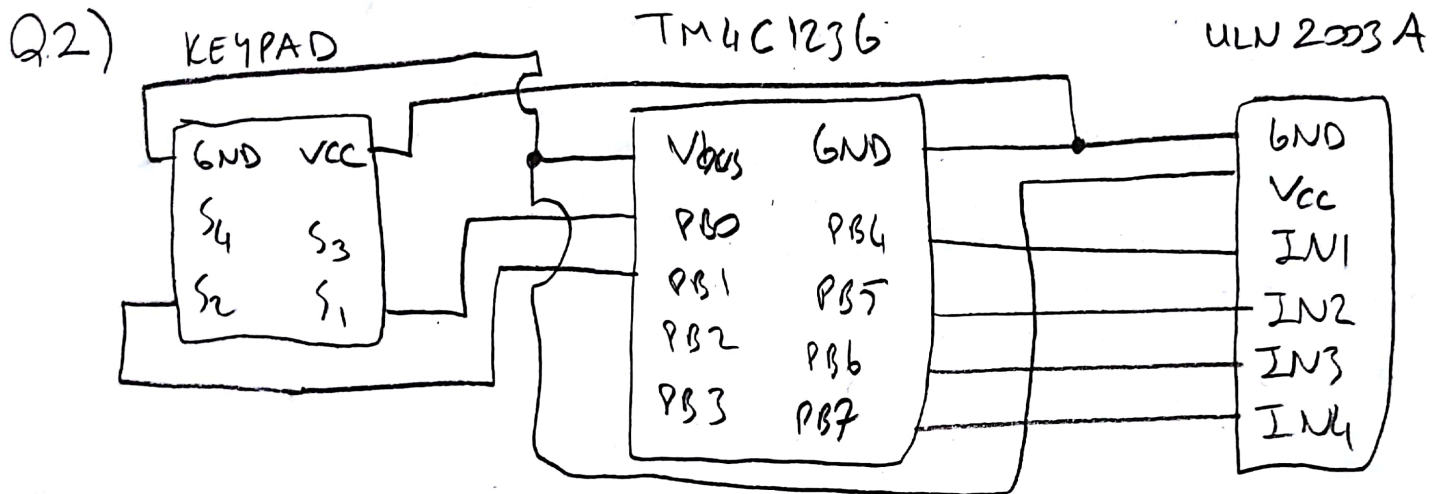


VIDEO OF USER DRIVEN STEP MOTOR: [VIDEO](#)

VIDEO OF USER OPERATED MCU DRIVEN STEP MOTOR: [VIDEO](#)

```
1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                ISR OF THE Q1                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5  PB_OUT            EQU      0X400053C0
6  GPIO_PORTB_ICR    EQU      0X4000541C
7  GPIO_PORTB_RIS     EQU      0X40005414
8
9  ; LABEL          DIRECTIVE  VALUE          COMMENT
10 ;                AREA isr,   CODE,    READONLY,  ALIGN=2
11 ;                THUMB
12
13 ;                EXPORT  My_ST_ISR
14
15 My_ST_ISR         PROC
16     CMP           R5, #0
17     BNE           CCW
18     LDR           R1, =PB_OUT
19     LDR           R0, [R1]
20     LSL           R0, #1
21     CMP           R0, #0X100
22     MOVEQ         R0, #0X10
23     STR           R0, [R1]
24     B             EXIT
25     LDR           R1, =PB_OUT
26     LDR           R0, [R1]
27     LSR           R0, #1
28     CMP           R0, #0X08
29     MOVEQ         R0, #0X80
30     STR           R0, [R1]
31
32
33 EXIT              BX        LR
34
35                 ALIGN
36                 ENDP
37                 END
```



I connected Vbss and GND of TM4C to GND and Vcc of Keypad in order. Because I am enabling Pull-down resistors of input pins of TM4C. Therefore if no keys are pressed 00 is read. 01 if first key, 02 if second, 04 if third, 08 if fourth key is pressed.

First button is for CW direction, second button is for CCW direction.

```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                MAIN OF THE Q3                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5  PB_INP            EQU      0X4000503C
6  PB_OUT            EQU      0X400053C0
7
8  ;LABEL            DIRECTIVE  VALUE            COMMENT
9                    AREA main, CODE,   READONLY, ALIGN=2
10                   THUMB
11
12                   ;IMPORT      InitSysTick
13                   IMPORT      PORTB_Init
14                   IMPORT      DELAY100
15                   EXPORT      __main
16
17
18  __main            PROC
19                   ;BL          InitSysTick
20                   BL          PORTB_Init
21                   MOV          R5,#2            ;IF R5 = 1 CW, R5 = 2 CCW, FIRST AND SECOND BUTTON CAN
BE USED TO CHANGE THE DIRECTION                ;IF ITS UNWANTED, R5 CAN BE CHANGED TO #2 IN ORDER TO
22 SEE THE CCW ACTION.
23
24  LOOP              LDR          R0,=PB_INP      ;PORTB_DATA REGISTERININ ADRESINI R0'YA KAYDEDIYORUM
25                   LDRB         R1,[R0]         ;PORTB_DATA REGISTERINDEKI DEGERI R1'E KAYDEDIYORUM
26                   BL          DELAY100         ;100MSEC BEKLIYORUM
27                   LDRB         R2,[R0]         ;PORTB_DATA REGISTERINDEKI DEGERI R2'YE KAYDEDIYORUM
28                   CMP          R1,R2          ;DEBOUNCING ICIN KARSILASTIRMA YAPIYORUM
29                   BNE          LOOP            ;DEGILSE YANLISLIK OLMUS, TEKRAR INPUT ALIYORUM
30                   CMP          R1,#0X00        ;R1 VE R2 AYNI OLMASINA RAGMEN 0X00 ISELER, HICBIR TUSA
BASILMAMIS DEMEKTIR, TEKRAR INPUT ALIYORUM
31                   BEQ          LOOP
32                   CPY          R4,R1
33  RELEASE           LDRB         R1,[R0]         ;PORTB_DATA'DA SAKLANAN DEGERI R1'E YUKLUYORUM
34                   BL          DELAY100
35                   LDRB         R2,[R0]         ;PORTB_DATA'DA SAKLANAN DEGERI R2'YE YUKLUYORUM
36                   CMP          R1,R2          ;DEBOUNCING
37                   BNE          RELEASE
38                   CMP          R1,#0X00        ;EGER HALA TUSA BASILI ISE BIRAKANA KADAR BEKLIYORUM,
RELEASE'YE DONUYORUM
39                   BNE          RELEASE        ;EGER TUS BIRAKILDIYSA, R1'E 0XF0 YUKLENIYOR VE BU
LOOP'TAN CIKILIYOR
40                   CPYEQ        R5,R4          ;
41
42                   CMP          R5,#1
43                   BNE          CCW
44
45  CW                LDR          R1,=PB_OUT      ;IF THE CW IS SELECTED
46                   LDR          R0,[R1]         ;CURRENT STEP IS LOADED TO R0
47                   LSL          R0,#1          ;R0 IS SHIFTED LEFT TO MOVE ON TO THE NEXT STEP
48                   CMP          R0,#0X100       ;IF WE EXCEEDED THE STEP 4
49                   MOVEQ        R0,#0X10       ;MOVE TO STEP 1
50                   STR          R0,[R1]         ;STORE IT
51                   B            EXIT
52
53  CCW               LDR          R1,=PB_OUT      ;IF THE CCW IS SELECTED
54                   LDR          R0,[R1]         ;CURRENT STEP IS LOADED TO R0
55                   LSR          R0,#1          ;R0 IS SHIFTED RIGHT TO MOVE ON TO THE PREVIOUS STEP
56                   CMP          R0,#0X08       ;IF WE GO BELOW THE STEP 1
57                   MOVEQ        R0,#0X80       ;MOVE TO STEP 4
58                   STR          R0,[R1]         ;STORE IT
59
60  EXIT              B            LOOP
61
62
63
64                   ENDP
65
66
67

```

68

69

END

```
1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                ISR OF THE Q3                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5
6  PB_OUT      EQU      0X400053C0
7  ;LABEL      DIRECTIVE  VALUE      COMMENT
8              AREA isr,   CODE,      READONLY,  ALIGN=2
9              THUMB
10
11              EXPORT  My_ST_ISR
12
13  My_ST_ISR   PROC
14
15              CMP      R5,#1
16              BNE      CCW
17
18  CW          LDR      R1,=PB_OUT          ;IF THE CW IS SELECTED
19              LDR      R0,[R1]            ;CURRENT STEP IS LOADED TO R0
20              LSL      R0,#1              ;R0 IS SHIFTED LEFT TO MOVE ON TO THE NEXT STEP
21              CMP      R0,#0X100          ;IF WE EXCEEDED THE STEP 4
22              MOVEQ     R0,#0X10          ;MOVE TO STEP 1
23              STR      R0,[R1]            ;STORE IT
24              B        EXIT
25
26  CCW         LDR      R1,=PB_OUT          ;IF THE CCW IS SELECTED
27              LDR      R0,[R1]            ;CURRENT STEP IS LOADED TO R0
28              LSR      R0,#1              ;R0 IS SHIFTED RIGHT TO MOVE ON TO THE PREVIOUS STEP
29              CMP      R0,#0X08          ;IF WE GO BELOW THE STEP 1
30              MOVEQ     R0,#0X80          ;MOVE TO STEP 4
31              STR      R0,[R1]            ;STORE IT
32
33
34  EXIT        BX      LR
35              ALIGN
36              ENDP
37              END
```

Q4) Same as Q2. except I connect PB2 to S3, PB3 to S4. Therefore, I am going to use the third button to speed up, fourth button to speed down.

Note: Also I forgot to mention, in both questions the stepper motor connect to ULN2003A motor driver motor should be as below.

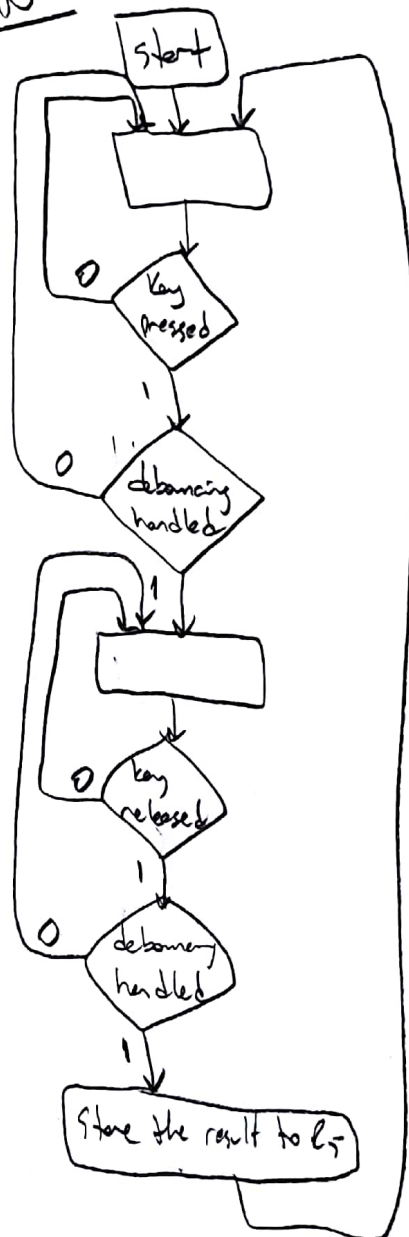
ULN2003A

•	BLUE
•	PINK
•	RED
•	GREEN
•	YELLOW

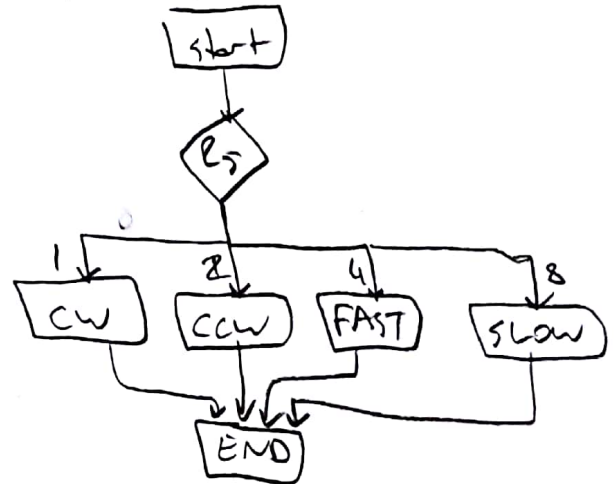
Q5) I have used the SysTick Timer to generate an interrupt and determine the action inside the interrupt subroutine according to the pressed key.

So, in the main, I am taking input from keypad in an infinite loop. If all the problems are handled well like debouncing on pressing and releasing, I load the information of the key number to a register (R5). When an interrupt occurs, according to the R5, I change the direction or the speed of the motor.

MAIN



INTERUPT




```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                MAIN OF THE Q5                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5  PB_INP          EQU      0X4000503C
6
7  ;LABEL          DIRECTIVE  VALUE          COMMENT
8                  AREA main, CODE,   READONLY,   ALIGN=2
9                  THUMB
10
11                 IMPORT      InitSysTick
12                 IMPORT      PORTB_Init
13                 IMPORT      DELAY100
14                 EXPORT      __main
15
16
17  __main          PROC
18                 BL          InitSysTick
19                 BL          PORTB_Init
20                 MOV         R5, #1          ;IF R5 = 1 CW, R5 = 2 CCW
21
22  LOOP            LDR         R0,=PB_INP      ;PORTB_DATA REGISTERININ ADRESINI R0'YA KAYDEDİYORUM
23                 LDRB        R1,[R0]         ;PORTB_DATA REGISTERINDEKI DEGERI R1'E KAYDEDİYORUM
24                 BL          DELAY100        ;100MSEC BEKLIYORUM
25                 LDRB        R2,[R0]         ;PORTB_DATA REGISTERINDEKI DEGERI R2'YE KAYDEDİYORUM
26                 CMP         R1,R2          ;DEBOUNCING ICIN KARSILASTIRMA YAPIYORUM
27                 BNE         LOOP            ;DEGILSE YANLISLIK OLMUS, TEKRAR INPUT
28
29                 ALIYORUM
30                 CMP         R1,#0X00        ;R1 VE R2 AYNI OLMASINA RAGMEN 0X00 ISELER,
31                 HICBIR TUSA BASILMAMIS DEMEKTIR, TEKRAR INPUT ALIYORUM
32                 BEQ         LOOP
33                 CPY         R4,R1
34                 LDRB        R1,[R0]         ;PORTB_DATA'DA SAKLANAN DEGERI R1'E YUKLUYORUM
35                 BL          DELAY100
36                 LDRB        R2,[R0]         ;PORTB_DATA'DA SAKLANAN DEGERI R2'YE YUKLUYORUM
37                 CMP         R1,R2          ;DEBOUNCING
38                 BNE         RELEASE
39                 CMP         R1,#0X00        ;EGER HALA TUSA BASILI ISE BIRAKANA KADAR
40                 BEKLIYORUM, RELEASE'YE DONUYORUM
41                 BNE         RELEASE        ;EGER TUS BIRAKILDIYSA, R1'E 0XF0
42                 YUKLENIYOR VE BU LOOP'TAN CIKILIYOR
43                 CPYEQ       R5,R4
44                 B           LOOP
45
46
47                 ENDP
48
49                 END

```

```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                ISR OF THE Q5                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5  PB_OUT            EQU      0X400053C0
6  GPIO_PORTB_ICR    EQU      0X4000541C
7  GPIO_PORTB_RIS    EQU      0X40005414
8  NVIC_ST_RELOAD    EQU      0XE000E014                ;24 BIT, WHEN THE COUNTER REACHES 0, IT IS RELOADED
9  WITH THIS VALUE
10 NVIC_ST_CURRENT    EQU      0XE000E018                ;THE CURRENT VALUE OF THE COUNTER
11
12 RELOAD_VALUE       EQU      0X20000400                ;ADDRESS FOR RELOAD VALUE
13
14
15 ;LABEL            DIRECTIVE  VALUE            COMMENT
16                 AREA isr,    CODE,    READONLY,  ALIGN=2
17                 THUMB
18
19                 EXPORT      My_ST_ISR
20
21 My_ST_ISR          PROC
22                 CMP         R5,#0X01            ;CW
23                 BEQ         CW
24                 CMP         R5,#0X02            ;CCW
25                 BEQ         CCW
26                 CMP         R5,#0X04            ;FAST
27                 BEQ         FAST
28                 CMP         R5,#0X08            ;SLOW
29                 BEQ         SLOW
30
31 FAST              LDR         R1,=RELOAD_VALUE
32                 LDR         R0,[R1]
33                 CMP         R0,#0X3000
34                 CPYEQ       R5,R6
35                 BEQ         EXIT
36                 SUB         R0,#0X3000
37                 STR         R0,[R1]
38                 LDR         R1,=NVIC_ST_RELOAD
39                 STR         R0,[R1]
40                 ;LDR         R1,=NVIC_ST_CURRENT
41                 ;STR         R0,[R1]
42                 CPY         R5,R6
43                 B           EXIT
44
45
46
47
48 SLOW              LDR         R1,=RELOAD_VALUE
49                 LDR         R0,[R1]
50                 ADD         R0,#0X3000
51                 STR         R0,[R1]
52                 LDR         R1,=NVIC_ST_RELOAD
53                 STR         R0,[R1]
54                 ;LDR         R1,=NVIC_ST_CURRENT
55                 ;STR         R0,[R1]
56                 CPY         R5,R6
57                 B           EXIT
58
59
60
61
62 CW               LDR         R1,=PB_OUT
63                 LDR         R0,[R1]
64                 LSL         R0,#1
65                 CMP         R0,#0X100
66                 MOVEQ       R0,#0X10
67                 STR         R0,[R1]
68                 CPY         R6,R5
69                 B           EXIT
70
71

```

```
72     CCW                LDR        R1,=PB_OUT
73                        LDR        R0,[R1]
74                        LSR        R0,#1
75                        CMP        R0,#0x08
76                        MOVEQ     R0,#0x80
77                        STR        R0,[R1]
78                        CPY        R6,R5
79                        B          EXIT
80
81
82     EXIT                BX         LR
83
84                        ALIGN
85                        ENDP
86                        END
```

```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;          GPIO PORTB INITIALIZATION OF Q5          ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5
6  PB_INP          EQU      0X4000503C
7  PB_OUT          EQU      0X400053C0
8  GPIO_PORTB_DIR_R EQU      0X40005400
9  GPIO_PORTB_AFSEL_R EQU     0X40005420
10 GPIO_PORTB_DEN_R EQU      0X4000551C
11 GPIO_PORTB_AMSEL_R EQU     0X40005528
12 GPIO_PORTB_PDR EQU      0X40005514 ;514
13 SYSCCTL_RCGC2_R EQU      0X400FE608
14 GPIO_PORTB_IS EQU      0X40005404
15 GPIO_PORTB_IBE EQU      0X40005408
16 GPIO_PORTB_IEV EQU      0X4000540C
17 GPIO_PORTB_IM EQU      0X40005410
18 GPIO_PORTB_ICR EQU      0X4000541C
19 GPIO_PORTB_RIS EQU      0X40005414
20
21
22 ;LABEL          DIRECTIVE  VALUE          COMMENT
23                AREA init_gpio, CODE,    READONLY,    ALIGN=2
24                THUMB
25
26                EXPORT      PORTB_Init
27
28
29 PORTB_Init PROC
30     ;ACTIVATE CLOCK
31     LDR        R1,=SYSCCTL_RCGC2_R
32     LDR        R0,[R1]
33     ORR        R0,R0,#0X02 ;only port b
34     STR        R0,[R1]
35     NOP
36     NOP
37     NOP
38     ;SET DIRECTION REGISTER
39     LDR        R1,=GPIO_PORTB_DIR_R
40     LDR        R0,[R1]
41     ORR        R0,R0,#0XF0
42     BIC        R0,R0,#0X0F ;1111_0000 OUTPUT_INPUT
43     STR        R0,[R1]
44     ;REGULAR PORT FUNCTION
45     LDR        R1,=GPIO_PORTB_AFSEL_R
46     LDR        R0,[R1]
47     BIC        R0,R0,#0XFF
48     STR        R0,[R1]
49     ;PULLDOWN RESISTORS ON SWITCH PINS
50     LDR        R1,=GPIO_PORTB_PDR
51     MOV        R0,#0X0F
52     STR        R0,[R1]
53     ;ENABLE DIGITAL PORT
54     LDR        R1,=GPIO_PORTB_DEN_R
55     LDR        R0,[R1]
56     ORR        R0,R0,#0XFF
57     STR        R0,[R1]
58     ;DISABLE ANALOG PORT
59     LDR        R1,=GPIO_PORTB_AMSEL_R
60     LDR        R0,[R1]
61     BIC        R0,R0,#0XFF
62     STR        R0,[R1]
63     ;CONFIGURE INTERRUPT FOR PORTB PINS 0-3=INPUT
64     ;LDR        R1,=GPIO_PORTB_IS
65     ;LDR        R2,=GPIO_PORTB_IBE
66     ;LDR        R3,=GPIO_PORTB_IEV
67     ;LDR        R4,=GPIO_PORTB_IM
68     ;LDR        R5,=GPIO_PORTB_ICR
69
70     ;MOV        R0,#0X00
71     ;STR        R0,[R1]
72     ;STR        R0,[R2]

```

```
73             ;MOV      R0,#0X0F
74             ;STR      R0,[R3]
75             ;STR      R0,[R4]
76             ;STR      R0,[R5]
77
78             ;CONFIGURE NVIC
79             ;LDR      R1,=NVIC_ISER0
80             ;LDR      R0,[R1]
81             ;ORR      R0,R0,#02
82             ;STR      R0,[R1]
83             ;CPSIE    I
84
85             LDR      R1,=PB_OUT
86             MOV      R0,#0X20
87             STR      R0,[R1]
88
89             BX      LR
90             ENDP
91             END
```

```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;          SYSTICK INITIALIZATION OF Q5          ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5  NVIC_ST_CTRL    EQU      0xE000E010              ;ILK BIT TIMER ENABLE, 2.BIT INTERRUPT ENABLE, 3. BIT
   TIMER_SOURCE (0:PIOSC/4 1:SYSTEM CLOCK), 16.BIT
6  NVIC_ST_RELOAD  EQU      0xE000E014              ;24 BIT, WHEN THE COUNTER REACHES 0, IT IS RELOADED
   WITH THIS VALUE
7  NVIC_ST_CURRENT EQU      0xE000E018              ;THE CURRENT VALUE OF THE COUNTER
8  SHP_SYSPRI3     EQU      0xE000ED20              ;BITS 31:29, PRIORITY LEVEL MUST BE 1 OR GREATER TO
   ENABLE SYSTICK INTERRUPTS
9  PB_OUT          EQU      0x400053C0
10
11 RELOAD_VALUE     EQU      0x0000C000              ;RANDOMLY SELECTED
12 RELOAD_ADDRESS   EQU      0x20000400
13
14 ;LABEL          DIRECTIVE  VALUE                COMMENT
15 AREA init_isr,  CODE,    READONLY,  ALIGN=2
16 THUMB
17
18 EXPORT          InitSysTick
19
20
21 InitSysTick      PROC
22 ; FIRST DISABLE SYSTEM TIMER AND THE RELATED INTERRUPT THEN CONFIGURE IT TO USE INTERNAL OSCILLATOR
   PIOSC/4
23             LDR      R1,=NVIC_ST_CTRL
24             MOV      R0,#0
25             STR      R0,[R1]
26 ; NOW SET THE TIMEOUT PERIOD
27             LDR      R1,=NVIC_ST_RELOAD
28             LDR      R0,=RELOAD_VALUE
29             STR      R0,[R1]
30             LDR      R1,=RELOAD_ADDRESS
31             STR      R0,[R1]
32 ;NOW SET THE CURRENT TIMER VALUE TO TIME OUT VALUE
33             LDR      R1,=NVIC_ST_CURRENT
34             LDR      R0,=RELOAD_VALUE
35             STR      R0,[R1]
36 ;NOW SET THE PRIORITY LEVEL
37             LDR      R1,=SHP_SYSPRI3
38             MOV      R0,#0x40000000              ;PRIORITY SET TO 2
39             STR      R0,[R1]
40 ;NOW ENABLE SYSTEM TIMER AND THE RELATED INTERRUPT
41             LDR      R1,=NVIC_ST_CTRL
42             MOV      R0,#0x03
43             STR      R0,[R1]
44             CPSIE    I
45
46             BX      LR
47 ENDP
48 END

```

```
1          AREA subroutine, READONLY, CODE
2          THUMB
3          EXPORT DELAY100
4
5  DELAY100
6          PUSH    {R0}
7          MOV32   R0, #600000 ; 16MHZ TO 100MSEC ASSUMING 3 CYCLE THE LOOP TAKES -1.600.000-
8  LOOP     SUBS   R0, #1
9          BNE     LOOP
10         POP     {R0}
11         BX      LR
12         ALIGN
13         END
```