

EE447 – PRELIMINARY WORK 2

- a. How can you detect whether any key is pressed?

I read from the GPIODATA register of port B, if it is not 0xF0 then it means that the user pressed a key. Because, if no keys are pressed 0xF0 is stored in GPIODATA register, when the user pressed the key, the column information is stored in the GPIODATA register.

- b. How can you detect whether a pressed key is released?

After I do the necessary steps to determine which key is pressed, again I read from the GPIODATA register of port B, if it is 0xF0 then it means the user released the key. Otherwise GPIODATA register should contain 0xE0, 0xD0, 0xB0 or 0x70.

- c. Assuming that you have detected that a key is pressed. Explain your algorithm to determine which one is pressed.

If I detected that a key is pressed, I store the current value in GPIODATA register, because it contains the column information. I understand the column from this data, if I press any key in column 1 the data becomes 0xE0, if column 2 0xD0, and goes on as 0xB0, 0x70 – one of the bits becomes 0- . After that, I write 0001, 0010, 0100, 1000 to the output pins (B7-B4) in order in a loop. Then, I check the input pins. One of the input pins is 0 because we are pressing it, however if I write 1 to the corresponding row, the input becomes 1 and I understand in which row the pressed key is.

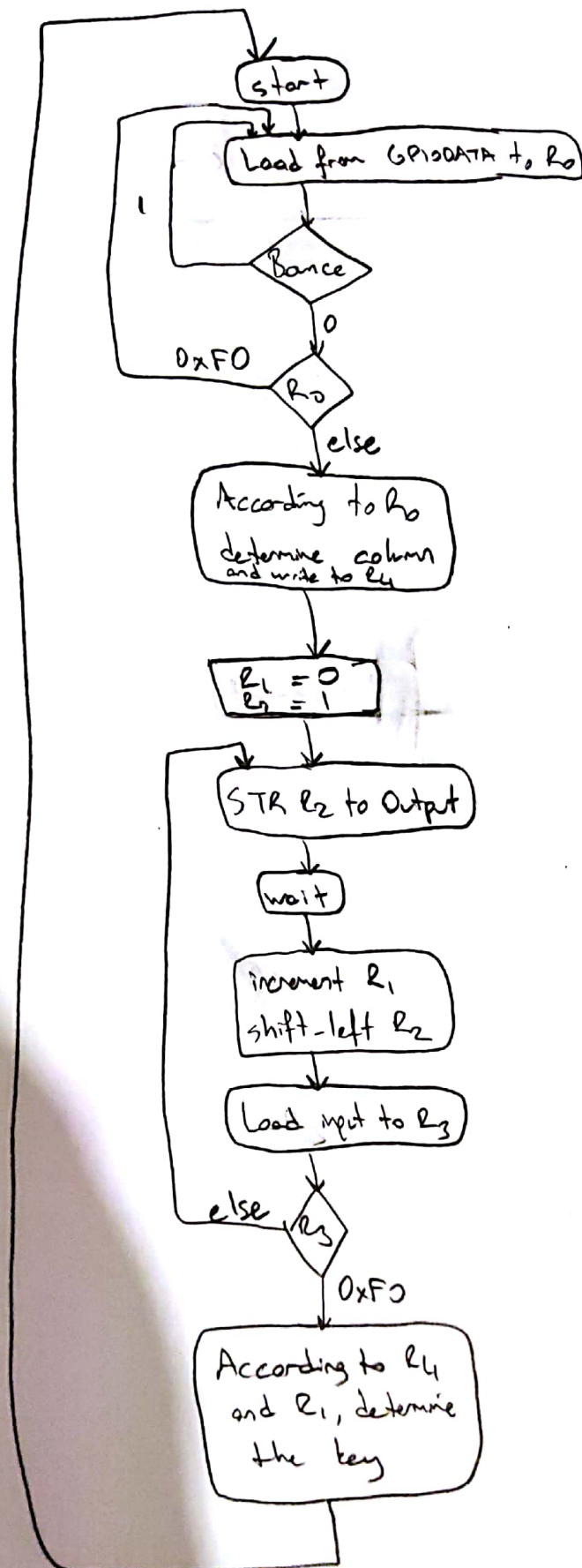
- d. Discuss what can happen due to bouncing. How can you avoid bouncing effects?

Due to bouncing, the program can detect the user pressed to a key multiple time even if the user is pressed once. To avoid bouncing, after the program understands that the user pressed to a key, the program should wait a little in order to wait the oscillations to stop and check the GPIODATA register again and compare with the previous result. If they are the same, it means that the user is pressed to a key.

Video to demonstration of Q2: [VIDEO2](#)

Video to demonstration of Q3: [VIDEO3](#)

e)



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1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                      Q1                      ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4      AREA subroutine,      READONLY,      CODE
5      THUMB
6      EXPORT  DELAY100
7
8  DELAY100
9      PUSH    {R0}
10     MOV32   R0,#600000      ; 16MHZ TO 100MSEC ASSUMING 3 CYCLE THE LOOP TAKES -1.600.000-
11     LOOP    SUBS    R0,#1
12     BNE     LOOP
13     POP     {R0}
14     BX      LR
15     ALIGN
16     END
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2  ;                      MAIN OF THE Q2                      ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5      AREA      main,      READONLY,      CODE
6      THUMB
7      EXTERN  Start
8      EXTERN  DELAY100
9      EXTERN  DELAY5SEC
10     EXPORT  __main
11
12     GPIO_PORTB_DATA      EQU      0X400053FC  ;DATA ADDRESS TO ALL PINS
13     GPIO_PORTB_DIR       EQU      0X40005400
14     GPIO_PORTB_AFSEL     EQU      0X40005420
15     GPIO_PORTB_DEN       EQU      0X4000551C
16     GPIO_PORTB_PUR       EQU      0X40005510
17     PUB
18     IOB                EQU      0XF0          ;FIRST FOUR IS INPUT
19     GPIO_PORTE_DATA      EQU      0X400243FC  ;DATA ADDRESS TO ALL PINS
20     GPIO_PORTE_DIR       EQU      0X40024400
21     GPIO_PORTE_AFSEL     EQU      0X40024420
22     GPIO_PORTE_DEN       EQU      0X4002451C
23     IOE                EQU      0X00          ;EVERY BIT IS INPUT
24     SYSCTL_RCGCGPIO     EQU      0X400FE608
25
26     __main
27     BL  Start
28     INPUT  LDR      R0,=GPIO_PORTB_DATA
29     loop   LDRB     R1,[R0]          ;LOAD THE DATA
30           BL      DELAY100          ;DEBOUNCING
31           LDRB    R2,[R0]          ;DEBOUNCING
32           CMP     R1,R2            ;DEBOUNCING
33           BNE     loop
34           CMP     R1,#0XFF          ;IF ANY OF THE KEYS IS NOT PRESSED, GO BACK
35           BEQ     INPUT
36           LSL     R2,#4             ;SHIFT THE INPUT 4 BITS TO LEFT IN ORDER TO WRITE IT TO OUTPUT PINS
37           LDR     R0,=GPIO_PORTB_DATA ;OUTPUT PINS
38           LDR     R1,=0X400053C0
39           AND     R1,R0,R1          ;CORRESPONDING PIN WILL BE 1, CORRESPONDING LED WILL BE ON
40           STRB    R2,[R1]
41           BL      DELAY5SEC          ;WAIT 5 SEC
42           LDR     R1,=0X400053C0
43           MOV     R2,#0XFF          ;REASSIGN OUTPUT PINS TO 0
44           STRB    R2,[R1]
45           B       INPUT
46     LOOP   B       LOOP
47           ALIGN
48           END

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2  ;                LITTLEDELAY IN Q3                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5          AREA subroutine,      READONLY,      CODE
6          THUMB
7          EXPORT  littledelay
8
9  littledelay
10         PUSH    {R0}
11         MOV32   R0,#40000
12  LOOP    SUBS   R0,#1
13         BNE     LOOP
14         POP     {R0}
15         BX      LR
16         ALIGN
17         END
```

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1  GPIO_PORTB_DATA      EQU      0X400053FC    ;DATA ADDRESS TO ALL PINS
2  GPIO_PORTB_DIR       EQU      0X40005400
3  GPIO_PORTB_AFSEL     EQU      0X40005420
4  GPIO_PORTB_DEN       EQU      0X4000551C
5  GPIO_PORTB_PUR       EQU      0X40005510
6  PUB                  EQU      0XF0
7  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
8  ;                      START OF Q2                      ;
9  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
10
11 IOB                   EQU      0XF0          ;3-0 INPUT, 7-4 OUTPUT
12 GPIO_PORTE_DATA      EQU      0X400243FC    ;DATA ADDRESS TO ALL PINS
13 GPIO_PORTE_DIR       EQU      0X40024400
14 GPIO_PORTE_AFSEL     EQU      0X40024420
15 GPIO_PORTE_DEN       EQU      0X4002451C
16 IOE                   EQU      0X00          ;EVERY BIT IS INPUT
17 SYSTCTL_RCGCGPIO     EQU      0X400FE608
18
19                      AREA      subroutine, READONLY, CODE, ALIGN=2
20                      THUMB
21                      EXPORT   Start
22
23 Start                 LDR      R1,=SYSTCTL_RCGCGPIO
24                      LDR      R0,[R1]
25                      ORR      R0,R0,#0X12
26                      STR      R0,[R1]
27                      NOP
28                      NOP
29                      NOP                      ;LET GPIO CLOCK STABILIZE
30
31                      LDR      R0,=GPIO_PORTB_PUR
32                      MOV      R1,#PUB
33                      STR      R1,[R0]
34
35                      LDR      R1,=GPIO_PORTB_DIR      ; CONFIG. OF PORT B STARTS
36                      LDR      R0,[R1]
37                      BIC      R0,#0XFF
38                      ORR      R0,#IOB
39                      STR      R0,[R1]
40                      LDR      R1,=GPIO_PORTB_AFSEL
41                      LDR      R0,[R1]
42                      BIC      R0,#0XFF
43                      STR      R0,[R1]
44                      LDR      R1,=GPIO_PORTB_DEN
45                      LDR      R0,[R1]
46                      ORR      R0,#0XFF
47                      STR      R0,[R1]                      ;CONFIG. OF PORT B ENDS
48
49                      LDR      R1,=GPIO_PORTE_DIR      ; CONFIG. OF PORT E STARTS
50                      LDR      R0,[R1]
51                      ORR      R0,#IOE
52                      STR      R0,[R1]
53                      LDR      R1,=GPIO_PORTE_AFSEL
54                      LDR      R0,[R1]
55                      BIC      R0,#0XFF
56                      STR      R0,[R1]
57                      LDR      R1,=GPIO_PORTB_DEN
58                      LDR      R0,[R1]
59                      ORR      R0,#0XFF
60                      STR      R0,[R1]                      ;CONFIG. OF PORT E ENDS
61
62                      BX      LR
63                      ALIGN
64                      END

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1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                MAIN OF THE Q3                ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5      AREA      main,      READONLY,      CODE
6      THUMB
7      EXTERN    Start
8      EXTERN    DELAY100
9      EXTERN    OutChar
10     EXTERN    littledelay
11     EXPORT    __main
12
13 ;7-4 INPUT, 3-0 OUTPUT
14 ;INPUT IS PULLED UP
15 ;CONNECTION IS: L1=B0,L2=B1,L3=B2,L4=B3,R1=B4,R2=B5,R3=B6,R4=B7
16
17
18 GPIO_PORTB_DATA      EQU      0X40005000      ;DATA ADDRESS TO ALL PINS
19
20 __main
21         BL      Start
22
23 INPUT    LDR      R0,=GPIO_PORTB_DATA          ;PORTB_DATA REGISTERININ ADRESINI R0'YA KAYDEDIYORUM
24         LDRB     R1,[R0,#0X3FC]                ;PORTB_DATA REGISTERINDEKI DEGERI R1'E KAYDEDIYORUM
25         BL      DELAY100                      ;100MSEC BEKLIYORUM
26         LDRB     R2,[R0,#0X3FC]                ;PORTB_DATA REGISTERINDEKI DEGERI R2'YE KAYDEDIYORUM
27         CMP      R1,R2                        ;DEBOUNCING ICIN KARSILASTIRMA YAPIYORUM
28         BEQ      TRY                          ;AYNI ISE DEVAM
29         BNE      INPUT                        ;DEGILSE YANLISLIK OLMUS, TEKRAR INPUT ALIYORUM
30 TRY     CMP      R1,#0XF0                      ;R1 VE R2 AYNI OLMASINA RAGMEN 0XF0 ISELER, HICBIR
31         TUSA BASILMAMIS DEMEKTIR, TEKRAR INPUT ALIYORUM
32         BEQ      INPUT
33         CPY      R5,R1                        ;BURAYA SAKLANAN DEGER E,D,B,7'DEN BIRI. SIRAYLA
34         MOV      R6,#00                      ;R6'DA SAKLANACAK OLAN DEGER ILE HANGI ROW OLDUGUNU
35         OGRENECEZ
36         MOV      R2,#01                      ;R2'YI OUTPUTLARI SIRAYLA 0001, 0010, 0100, 1000
37         YAPMAK ICIN KULLANIYORUM
38 LOOP    STR      R2,[R0,#0X03C]                ;OUTPUTA R2 DEGERI YAZILINCA INPUT DEGISIYOR
39         BL      littledelay                  ;OUTPUTA YAZILAN DEGERIN ULASMASINI BEKLIYORUM
40         LDRB     R3,[R0,#0X3C0]                ;INPUTUN NE OLDUGUNU KAYDEDIYORUM
41         ADD      R6,#1                        ;1=1.ROW, 2=2.ROW, 3=3.ROW, 4=4.ROW
42         LSL      R2,#01                      ;R2'YI KAYDIRIYORUM
43         CMP      R3,#0XF0                      ;EGER INPUTUM F ISE, O ROWDAKI TUSA BASMISIM DEMEKTIR
44         BNE      LOOP
45
46         ;R5 BENIM COLUMN BELIRLEYENIM, R6 BENIM ROW BELIRLEYENIM
47         CMP      R5,#0XE0                      ;1. COLUMN
48         BEQ      COL1
49         CMP      R5,#0XD0                      ;2. COLUMN
50         BEQ      COL2
51         CMP      R5,#0XB0                      ;3. COLUMN
52         BEQ      COL3
53         CMP      R5,#0X70                      ;4. COLUMN
54         BEQ      COL4
55
56 COL1     CMP      R6,#1                        ;R6=1 ISE 1. COLUMN 1. ROW, 0. TUS
57         MOVEQ     R0,#0
58         CMP      R6,#2                        ;R6=2 ISE 1. COLUMN 2. ROW, 4. TUS
59         MOVEQ     R0,#4
60         CMP      R6,#3                        ;R6=3 ISE 1. COLUMN 3. ROW, 8. TUS
61         MOVEQ     R0,#8
62         CMP      R6,#4                        ;R6=4 ISE 1. COLUMN 4. ROW, 12. TUS
63         MOVEQ     R0,#12
64         B        FINISH
65
66 COL2     CMP      R6,#1                        ;R6=1 ISE 2. COLUMN 1. ROW, 1. TUS
67         MOVEQ     R0,#1
68         CMP      R6,#2                        ;R6=2 ISE 2. COLUMN 2. ROW, 5. TUS
69         MOVEQ     R0,#5

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69             CMP     R6, #3                ;R6=3 ISE 2. COLUMN 3. ROW, 9. TUS
70             MOVEQ   R0, #9
71             CMP     R6, #4                ;R6=4 ISE 2. COLUMN 4. ROW, 13. TUS
72             MOVEQ   R0, #13
73             B       FINISH
74
75
76 COL3         CMP     R6, #1                ;R6=1 ISE 3. COLUMN 1. ROW, 2. TUS
77             MOVEQ   R0, #2
78             CMP     R6, #2                ;R6=2 ISE 3. COLUMN 2. ROW, 6. TUS
79             MOVEQ   R0, #6
80             CMP     R6, #3                ;R6=3 ISE 3. COLUMN 3. ROW, 10. TUS
81             MOVEQ   R0, #10
82             CMP     R6, #4                ;R6=4 ISE 3. COLUMN 4. ROW, 14. TUS
83             MOVEQ   R0, #14
84             B       FINISH
85
86
87 COL4         CMP     R6, #1                ;R6=1 ISE 4. COLUMN 1. ROW, 3. TUS
88             MOVEQ   R0, #3
89             CMP     R6, #2                ;R6=2 ISE 4. COLUMN 2. ROW, 7. TUS
90             MOVEQ   R0, #7
91             CMP     R6, #3                ;R6=3 ISE 4. COLUMN 3. ROW, 11. TUS
92             MOVEQ   R0, #11
93             CMP     R6, #4                ;R6=4 ISE 4. COLUMN 4. ROW, 15. TUS
94             MOVEQ   R0, #15
95             B       FINISH
96
97
98
99 FINISH       CPY     R5, R0                ;R0'DAKI ASIL DEGERI R5'E ALDIM CUNKU OUTCHAR R5
100            ISTIYOR
101
102            LDR      R0, =GPIO_PORTB_DATA
103            MOV      R1, #0
104            STRB     R1, [R0, #0X03C]      ;OUTPUTU 0'LIYORUM KI BASA DONDUGUMDE SORUN CIKMASIN
105            BL       littledelay          ;OUTPUTU DEGISTIRDIGIM ICIN BIRAZ BEKLIYORUM
106
107 RELEASE      LDRB    R1, [R0, #0X3FC]     ;PORTB_DATA'DA SAKLANAN DEGERI R1'E YUKLUYORUM
108            BL       DELAY100
109            LDRB     R2, [R0, #0X3FC]     ;PORTB_DATA'DA SAKLANAN DEGERI R2'YE YUKLUYORUM
110            CMP      R1, R2               ;DEBOUNCING
111            BNE      RELEASE
112            CMP      R1, #0XF0            ;EGER HALA TUSA BASILI ISE BIRAKANA KADAR
113            BEKLIYORUM, RELEASE'YE DONUYORUM
114            BNE      RELEASE              ;EGER TUS BIRAKILDIYSA, R1'E 0XF0 YUKLENIYOR VE BU
115            LOOP'TAN CIKILIYOR
116
117            CMP      R5, #9                ;KARSILASTIRMA YAPIYORUM
118            ADDHI     R5, #55              ;9'DAN BUYUK ISE KARAKTER BASMAM LAZIM, 55
119            EKLEMELIYIM KI ASCII OLSUN
120            ADDLS     R5, #48              ;9'DAN KUCUK ESIT ISE RAKAM BASMAM LAZIM, 48
121            EKLEMELIYIM KI ASCII OLSUN
122            BL       OutChar
123            B       INPUT
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1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                      5 SEC DELAY IN Q2                      ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4      AREA subroutine,      READONLY,      CODE
5      THUMB
6      EXPORT  DELAY5SEC
7
8  DELAY5SEC
9      PUSH    {R0}
10     MOV32   R0,#30000000    ;
11  LOOP     SUBS    R0,#1
12         BNE     LOOP
13     POP     {R0}
14     BX      LR
15     ALIGN
16     END
```

```

1  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
2  ;                      START OF Q3                      ;
3  ;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;;
4
5
6  GPIO_PORTB_DATA      EQU      0X400053FC  ;DATA ADDRESS TO ALL PINS
7  GPIO_PORTB_DIR       EQU      0X40005400
8  GPIO_PORTB_AFSEL     EQU      0X40005420
9  GPIO_PORTB_DEN       EQU      0X4000551C
10 GPIO_PORTB_PUR       EQU      0X40005510
11 PUB                 EQU      0XF0        ;INPUT IS PULLED UP
12 IOB                 EQU      0X0F        ;7-4 INPUT
13 GPIO_PORTE_DATA      EQU      0X400243FC  ;DATA ADDRESS TO ALL PINS
14 GPIO_PORTE_DIR       EQU      0X40024400
15 GPIO_PORTE_AFSEL     EQU      0X40024420
16 GPIO_PORTE_DEN       EQU      0X4002451C
17 IOE                 EQU      0X00        ;EVERY BIT IS INPUT
18 SYSCTL_RCGCGPIO     EQU      0X400FE608
19
20                     AREA      subroutine, READONLY, CODE, ALIGN=2
21                     THUMB
22                     EXPORT   Start
23
24 Start
25     LDR      R1,=SYSCTL_RCGCGPIO
26     LDR      R0,[R1]
27     ORR      R0,R0,#0X12
28     STR      R0,[R1]
29     NOP
30     NOP
31     NOP                                ;LET GPIO CLOCK STABILIZE
32
33     LDR      R0,=GPIO_PORTB_PUR
34     MOV      R1,#PUB
35     STR      R1,[R0]
36
37     LDR      R1,=GPIO_PORTB_DIR        ; CONFIG. OF PORT B STARTS
38     LDR      R0,[R1]
39     BIC      R0,#0XFF
40     ORR      R0,#IOB
41     STR      R0,[R1]
42     LDR      R1,=GPIO_PORTB_AFSEL
43     LDR      R0,[R1]
44     BIC      R0,#0XFF
45     STR      R0,[R1]
46     LDR      R1,=GPIO_PORTB_DEN
47     LDR      R0,[R1]
48     ORR      R0,#0XFF
49     STR      R0,[R1]                    ;CONFIG. OF PORT B ENDS
50
51     LDR      R1,=GPIO_PORTE_DIR        ; CONFIG. OF PORT E STARTS
52     LDR      R0,[R1]
53     ORR      R0,#IOE
54     STR      R0,[R1]
55     LDR      R1,=GPIO_PORTE_AFSEL
56     LDR      R0,[R1]
57     BIC      R0,#0XFF
58     STR      R0,[R1]
59     LDR      R1,=GPIO_PORTB_DEN
60     LDR      R0,[R1]
61     ORR      R0,#0XFF
62     STR      R0,[R1]                    ;CONFIG. OF PORT E ENDS
63
64     BX      LR
65     ALIGN
66     END

```