

2022년 IoT기반 스마트 솔루션 개발자 양성과정



Embedded Application

7-Switch Input

담당 교수 : 윤 종 이

010-9577-1696

ojo1696@naver.com

<https://cafe.naver.com/yoons2022>



충북대학교 공동훈련센터

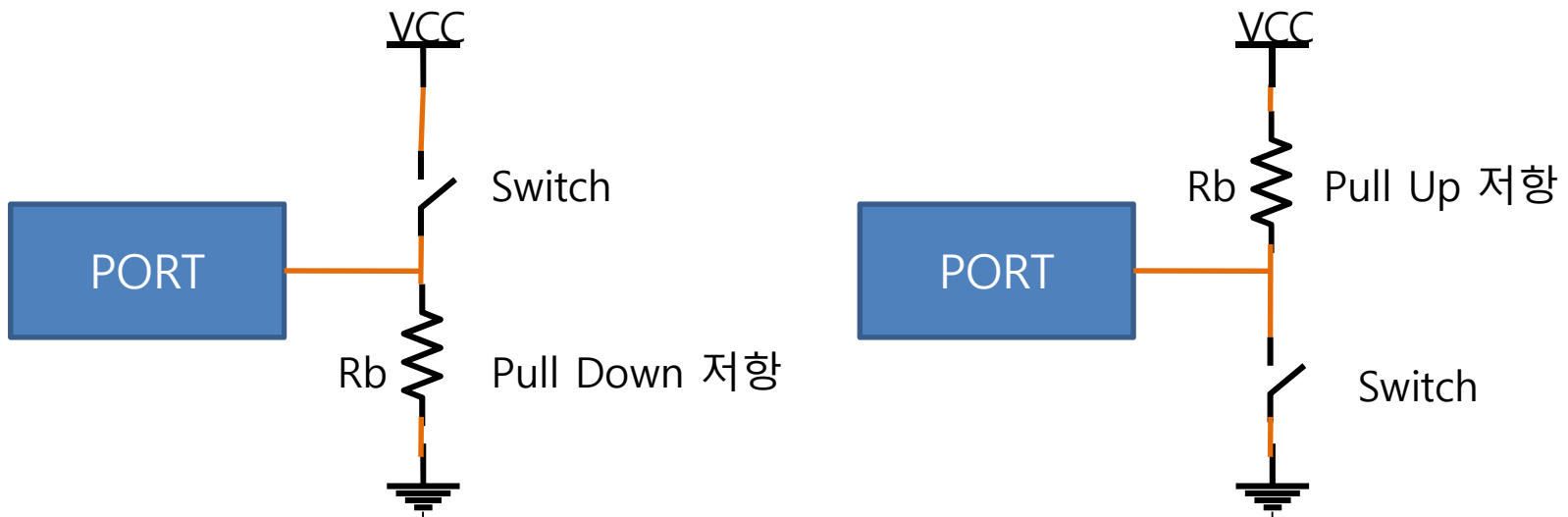
스위치

- 전류의 흐름을 개폐함(On/OFF)
- 신호의 입력용으로 사용(Tact Switch)
- Off시 입력 논리값을 명확히 함
 - Pull Up / Pull Down 저항을 함께 연결

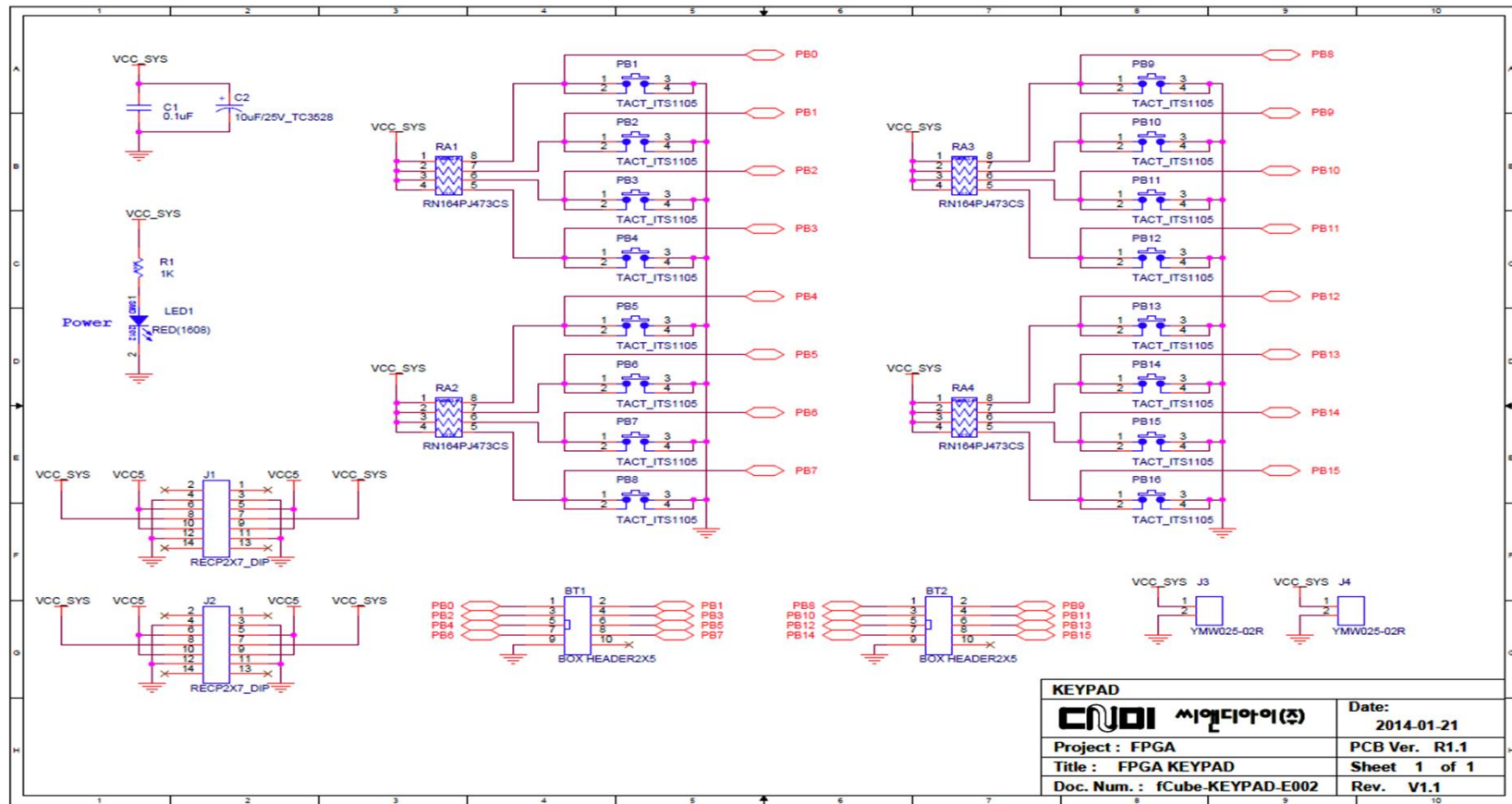


스위치의 사용

- 정논리 입력 : 스위치를 누르면 1(High Voltage)
- 부논리 입력 : 스위치를 누르면 0(Low Voltage)
- Pull Up/ Pull Down 저항 : 4.7K~10K Ω



Keypad Schematic



충북대학교 공동훈련센터

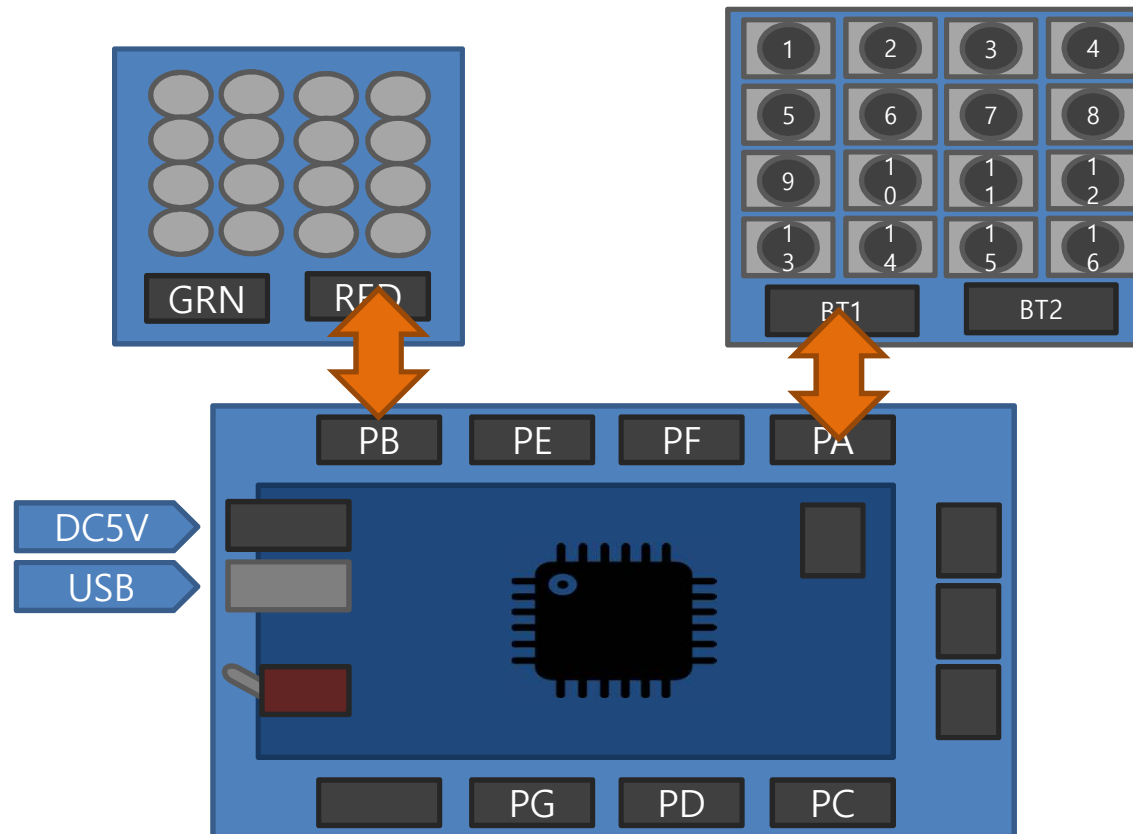
Keypad Layout

BT1 : SW1~SW8

BT2 : SW9~SW16



Ex-1 : Wiring

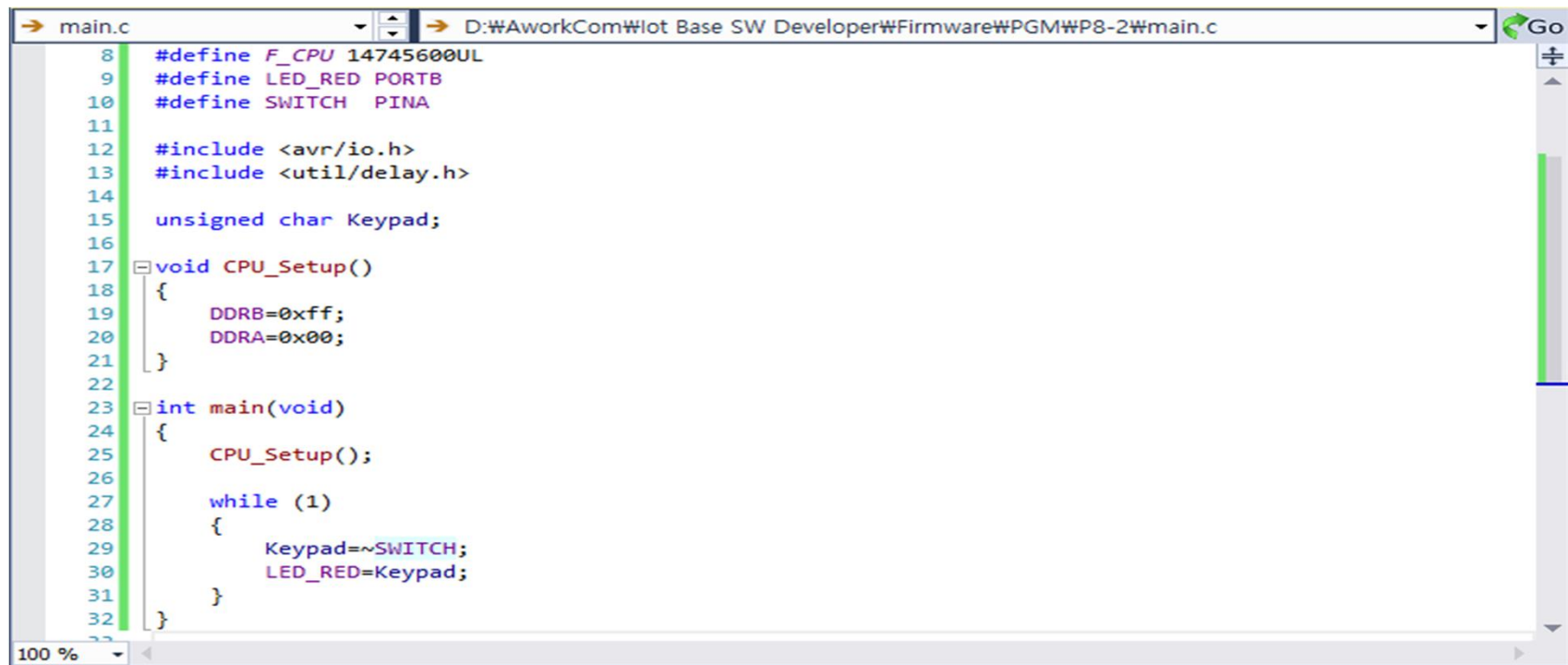


Ex-1 : Switch Input(부논리)

```
main.c D:\AworkCom\Iot Base SW Developer\Firmware\PGM\WP8-1\main.c Go
8  #define F_CPU 14745600UL
9  #define LED_RED PORTB
10 #define SWITCH PINA
11
12 #include <avr/io.h>
13 #include <util/delay.h>
14
15 unsigned char Keypad;
16
17 void CPU_Setup()
18 {
19     DDRB=0xff;
20     DDRA=0x00;
21 }
22
23 int main(void)
24 {
25     CPU_Setup();
26
27     while (1)
28     {
29         Keypad=SWITCH;
30         LED_RED=Keypad;
31     }
32 }
```



Ex-2 : Switch Input(정논리)



```
main.c  D:\AworkCom\Iot Base SW Developer\Firmware\PGM\WP8-2\main.c  Go
8  #define F_CPU 14745600UL
9  #define LED_RED PORTB
10 #define SWITCH PINA
11
12 #include <avr/io.h>
13 #include <util/delay.h>
14
15 unsigned char Keypad;
16
17 void CPU_Setup()
18 {
19     DDRB=0xff;
20     DDRA=0x00;
21 }
22
23 int main(void)
24 {
25     CPU_Setup();
26
27     while (1)
28     {
29         Keypad=~SWITCH;
30         LED_RED=Keypad;
31     }
32 }
```

100 %



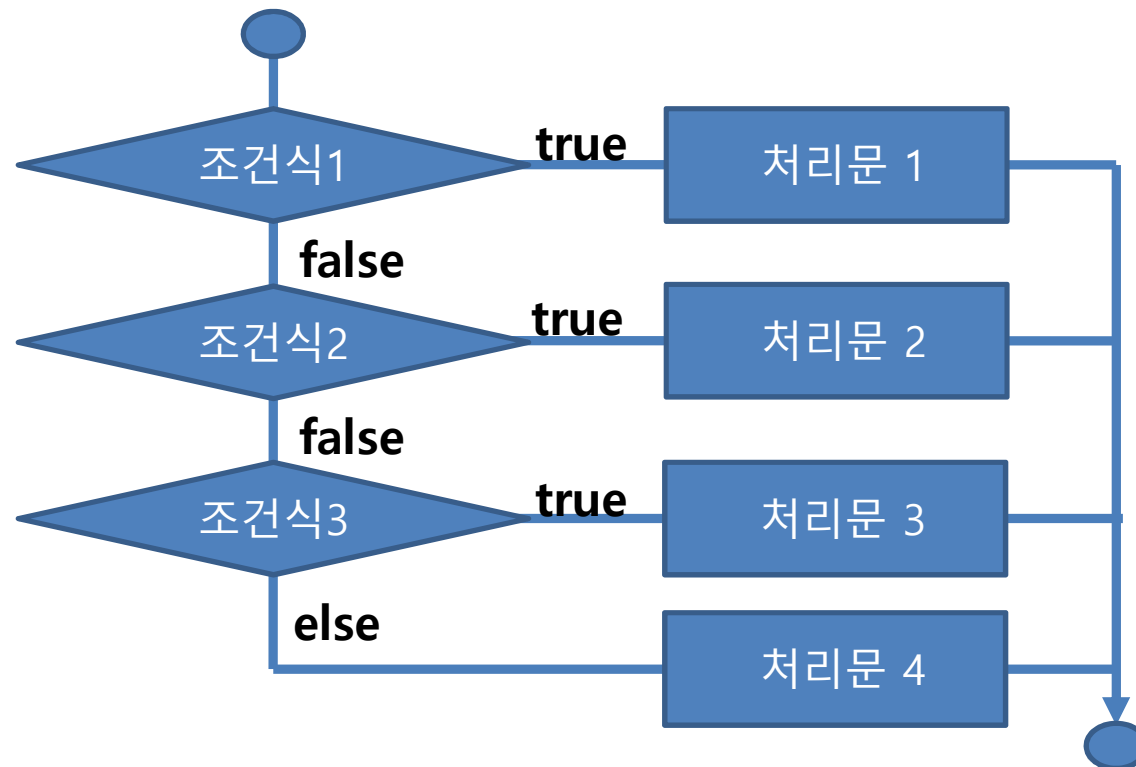
if 문(비교문)

- 조건에 따라 다른 문장을 실행

```
if (조건식1) {  
    처리문 1  
}  
else if (조건식2) {  
    처리문 2  
}  
else if (조건식3) {  
    처리문 3  
}  
else {  
    처리문 4  
}
```



if 문 플로우차트



Ex-3 : Switch Input(if~)

- 스위치 1번-> 1번 LED
- 스위치 2번-> 1,2번 LED
- 스위치 3번-> 1,2,3번 LED
- 스위치 4번-> 1,2,3,4번 LED
- 스위치 5번-> 1,2,3,4,5번 LED
- 스위치 6번-> 1,2,3,4,5,6번 LED
- 스위치 7번-> 1,2,3,4,5,6,7번 LED
- 스위치 8번-> 1,2,3,4,5,6,7,8번 LED
- 기타 -> LED OFF

```
23 int main(void)
24 {
25     CPU_Setup();
26
27     while (1)
28     {
29         Keypad=~SWITCH;
30         if (Keypad==0x01){ LED_RED=0x01; }
31         else if (Keypad==0x02){ LED_RED=0x03; }
32         else if (Keypad==0x04){ LED_RED=0x07; }
33         else if (Keypad==0x08){ LED_RED=0x0f; }
34         else if (Keypad==0x10){ LED_RED=0x1f; }
35         else if (Keypad==0x20){ LED_RED=0x3f; }
36         else if (Keypad==0x40){ LED_RED=0x7f; }
37         else if (Keypad==0x80){ LED_RED=0xff; }
38         else { LED_RED=0x00; }
39     }
40 }
```



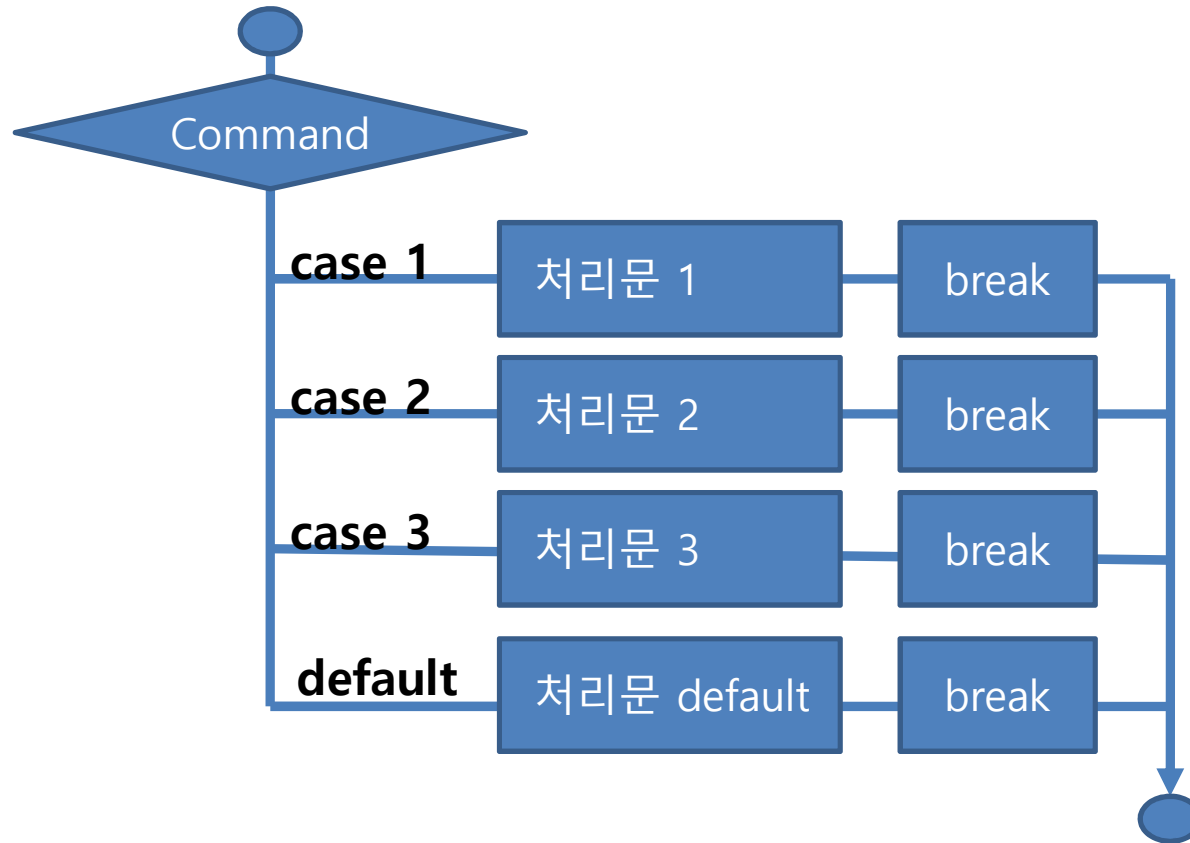
switch 문(분기문)

- 조건에 따라 다른 문장을 실행

```
switch ( 조건 ) {  
  case 1:  
    //Exp가 1 이면  
    break;  
  case 2:  
    //Exp가 2 이면  
    break;  
  case 3:  
    //Exp가 3 이면  
    break;  
  default:  
    //그 외에  
    break;  
}
```



switch 문 플로우차트



Ex-4 : Switch Input(switch~)

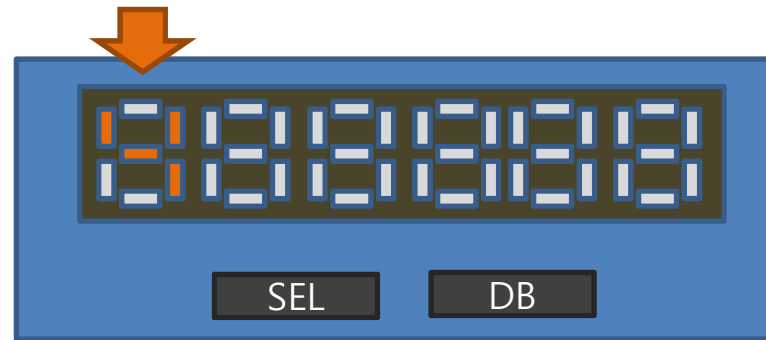
- 스위치 1번-> 1번 LED
- 스위치 2번-> 1,2번 LED
- 스위치 3번-> 1,2,3번 LED
- 스위치 4번-> 1,2,3,4번 LED
- 스위치 5번-> 1,2,3,4,5번 LED
- 스위치 6번-> 1,2,3,4,5,6번 LED
- 스위치 7번-> 1,2,3,4,5,6,7번 LED
- 스위치 8번-> 1,2,3,4,5,6,7,8번 LED
- 기타 -> LED OFF

```
23 int main(void)
24 {
25     CPU_Setup();
26
27     while (1) {
28         Keypad=~SWITCH;
29         switch ( Keypad ) {
30             case 0x01: LED_RED=0x01; break;
31             case 0x02: LED_RED=0x03; break;
32             case 0x04: LED_RED=0x07; break;
33             case 0x08: LED_RED=0x0f; break;
34             case 0x10: LED_RED=0x1f; break;
35             case 0x20: LED_RED=0x3f; break;
36             case 0x40: LED_RED=0x7f; break;
37             case 0x80: LED_RED=0xff; break;
38             default: LED_RED=0x00; break;
39         }
40     }
41 }
```

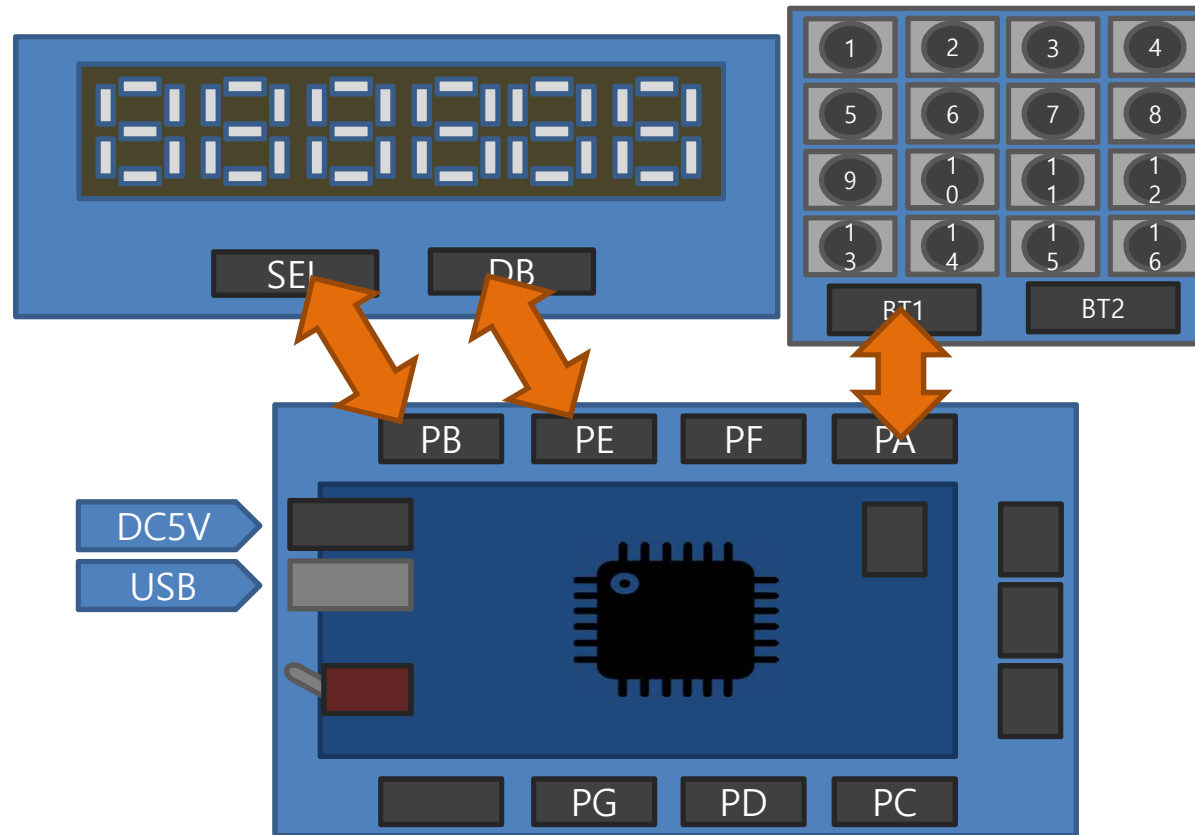


Ex-5 : 버튼 숫자 Display

- 스위치 1번-> 0
- 스위치 2번-> 1
- 스위치 3번-> 2
- 스위치 4번-> 3
- 스위치 5번-> 4
- 스위치 6번-> 5
- 스위치 7번-> 6
- 스위치 8번-> 7
- 기타 -> -



Ex-5 : Wiring



Ex-5 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH PINA

#include <avr/io.h>

unsigned char FND[11]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f, 0x40};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char Keypad;

unsigned long Count=0;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRA=0x00;
}
```



Ex-5 : Program-main

```
int main(void) {  
    CPU_Setup( );  
  
    while (1) {  
        Keypad=~SWITCH;  
        FND_SEL=DGT[5];  
        switch ( Keypad ) {  
            case 0x01: FND_DB=FND[0]; break;  
            case 0x02: FND_DB=FND[1]; break;  
            case 0x04: FND_DB=FND[2]; break;  
            case 0x08: FND_DB=FND[3]; break;  
            case 0x10: FND_DB=FND[4]; break;  
            case 0x20: FND_DB=FND[5]; break;  
            case 0x40: FND_DB=FND[6]; break;  
            case 0x80: FND_DB=FND[7]; break;  
            default: FND_DB=FND[10]; break;  
        }  
    }  
}
```



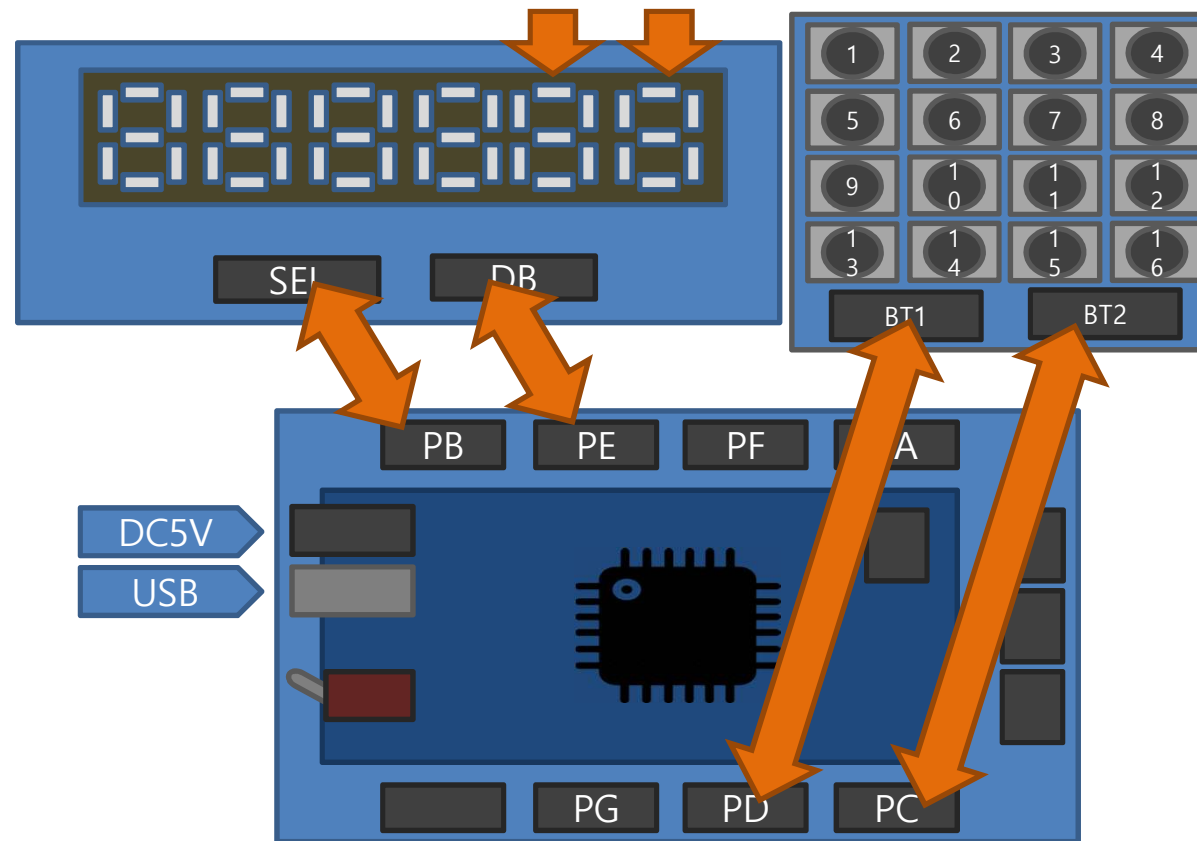
Ex-6 : sub function

```
char SwitchIn(void) {  
    char KeyNo;  
    unsigned char KeyIn = ~SWITCH  
  
    switch ( KeyIn ) {  
        case 0x01: KeyNo =0; break;  
        case 0x02: KeyNo =1; break;  
        case 0x04: KeyNo =2; break;  
        case 0x08: KeyNo =3; break;  
        case 0x10: KeyNo =4; break;  
        case 0x20: KeyNo =5; break;  
        case 0x40: KeyNo =6; break;  
        case 0x80: KeyNo =7; break;  
        default: KeyNo =10; break;  
    }  
    return KeyNo;  
}
```

```
int main(void) {  
    CPU_Setup( );  
  
    while (1) {  
        Keypad=SwitchIn( );  
        FND_SEL=DGT[5];  
        FND_DB=FND[Keypad];  
    }  
}
```



Ex-7 : 16key Input



Ex-7 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH1 PIND
#define SWITCH2 PINC
#define dTime 3

#include <avr/io.h>
#include <util/delay.h>

unsigned char FND[11]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f, 0x40};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char NUM[6]={0x00, 0x00, 0x00, 0x00, 0x00, 0x00};
unsigned char Keypad;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRC=0x00;
    DDRD=0x00;
}
```



Ex-7 : sub function

```
char SwitchIn(void) {
    char KeyNo;
    unsigned int KeyIn = (~SWITCH2 < 8) | (~SWITCH1 & 0x00ff);

    switch ( KeyIn ) {
        case 0x0001: KeyNo = 0; break;
        case 0x0002: KeyNo = 1; break;
        case 0x0004: KeyNo = 2; break;
        case 0x0008: KeyNo = 3; break;
        case 0x0010: KeyNo = 4; break;
        case 0x0020: KeyNo = 5; break;
        case 0x0040: KeyNo = 6; break;
        case 0x0080: KeyNo = 7; break;
        case 0x0100: KeyNo = 8; break;
        case 0x0200: KeyNo = 9; break;
        case 0x0400: KeyNo = 10; break;
        case 0x0800: KeyNo = 11; break;
        case 0x1000: KeyNo = 12; break;
        case 0x2000: KeyNo = 13; break;
        case 0x4000: KeyNo = 14; break;
        case 0x8000: KeyNo = 15; break;
        default: KeyNo = 16; break;
    }
    return KeyNo;
}
```

```
void Hex2Dec(unsigned char No) {
    NUM[1] = No / 10;
    NUM[0] = No % 10;
}

int main(void) {
    CPU_Setup( );

    while (1) {
        Keypad = SwitchIn( );
        if (Keypad > 15) {
            NUM[1] = 10; NUM[0] = 10;
        } else {
            Hex2Dec(Keypad);
        }

        for (unsigned char k = 0; k < 2; k++) {
            FND_SEL = DGT[k];
            FND_DB = FND[ NUM[k] ];
            _delay_ms(dTime);
        }
    }
}
```

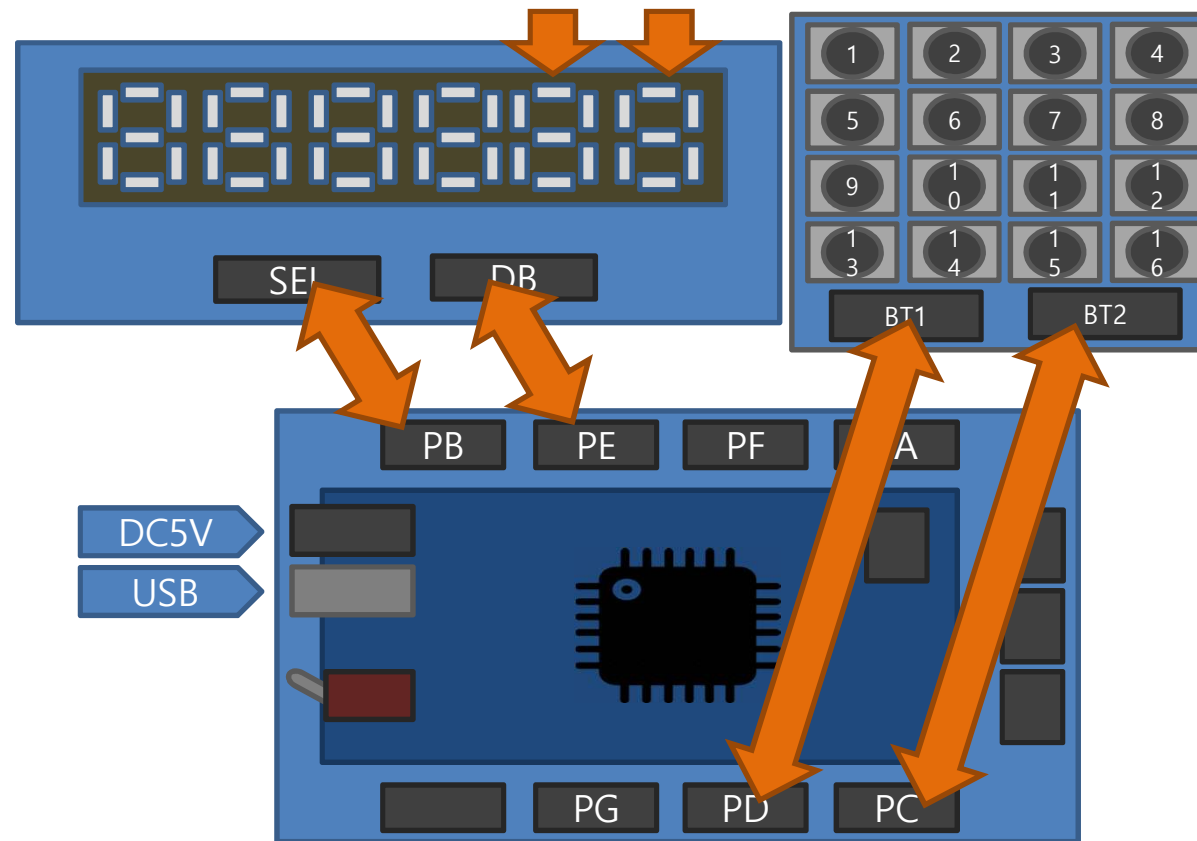


Ex-8 : Hex Key Pad

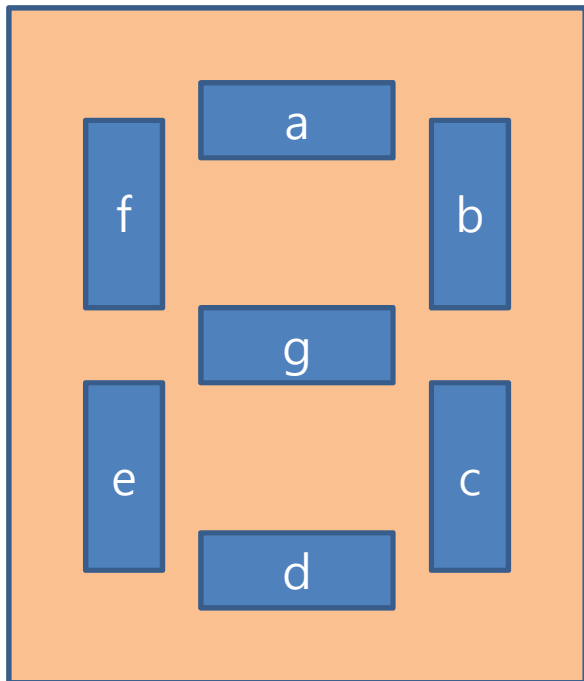
- Keypad의 배열을 다음과 같이 바꾸어 보자



Ex-8 : wiring



FND Lookup Table



No	x	g	f	e	d	c	b	a	Hex
0	0	0	1	1	1	1	1	1	3f
1	0	0	0	0	0	1	1	0	06
2	0	1	0	1	1	0	1	1	5b
3	0	1	0	0	1	1	1	1	4f
4	0	1	1	0	0	1	1	0	66
5	0	1	1	0	1	1	0	1	6d
6	0	1	1	1	1	1	0	1	7d
7	0	0	1	0	0	1	1	1	27
8	0	1	1	1	1	1	1	1	7f
9	0	1	1	0	1	1	1	1	6f
A	0	1	1	1	0	1	1	1	77
B	0	1	1	1	1	1	0	0	7c
C	0	1	0	1	1	0	0	0	58
D	0	1	0	1	1	1	1	0	5e
-	0	1	0	0	0	0	0	0	40
=	0	1	0	0	1	0	0	1	49



FND Lookup Table

```
unsigned char FND[17]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f,  
0x77, 0x7c, 0x58, 0x5e, 0x40, 0x49, 0x08};
```

```
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
```

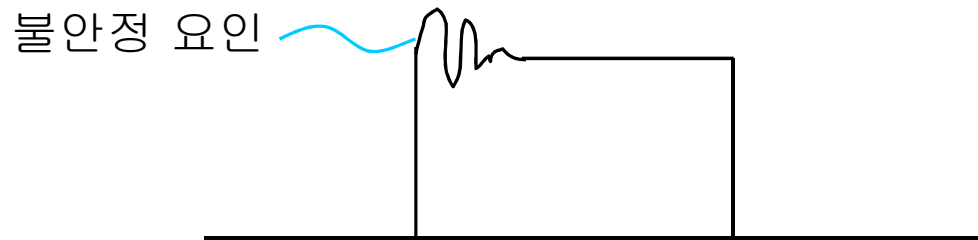
```
unsigned char NUM[6]={0x00, 0x00, 0x00, 0x00, 0x00, 0x00};
```

```
unsigned char Keypad;
```

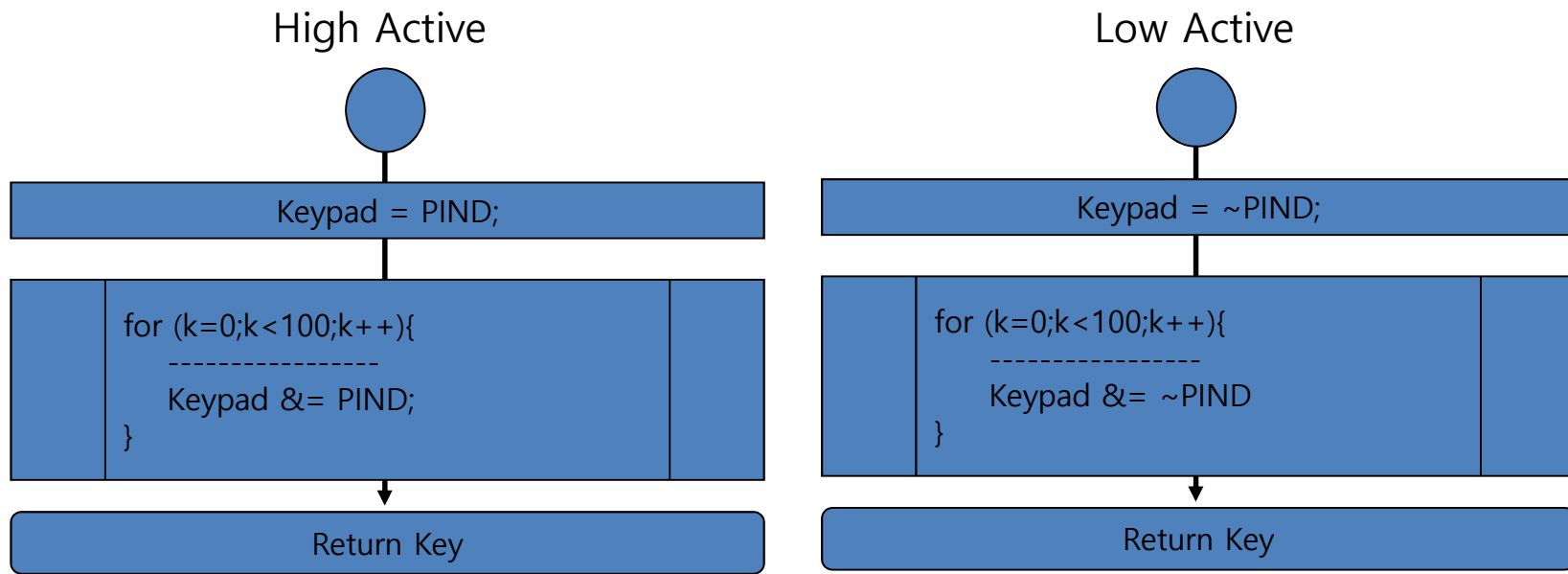


채터링[Chattering]

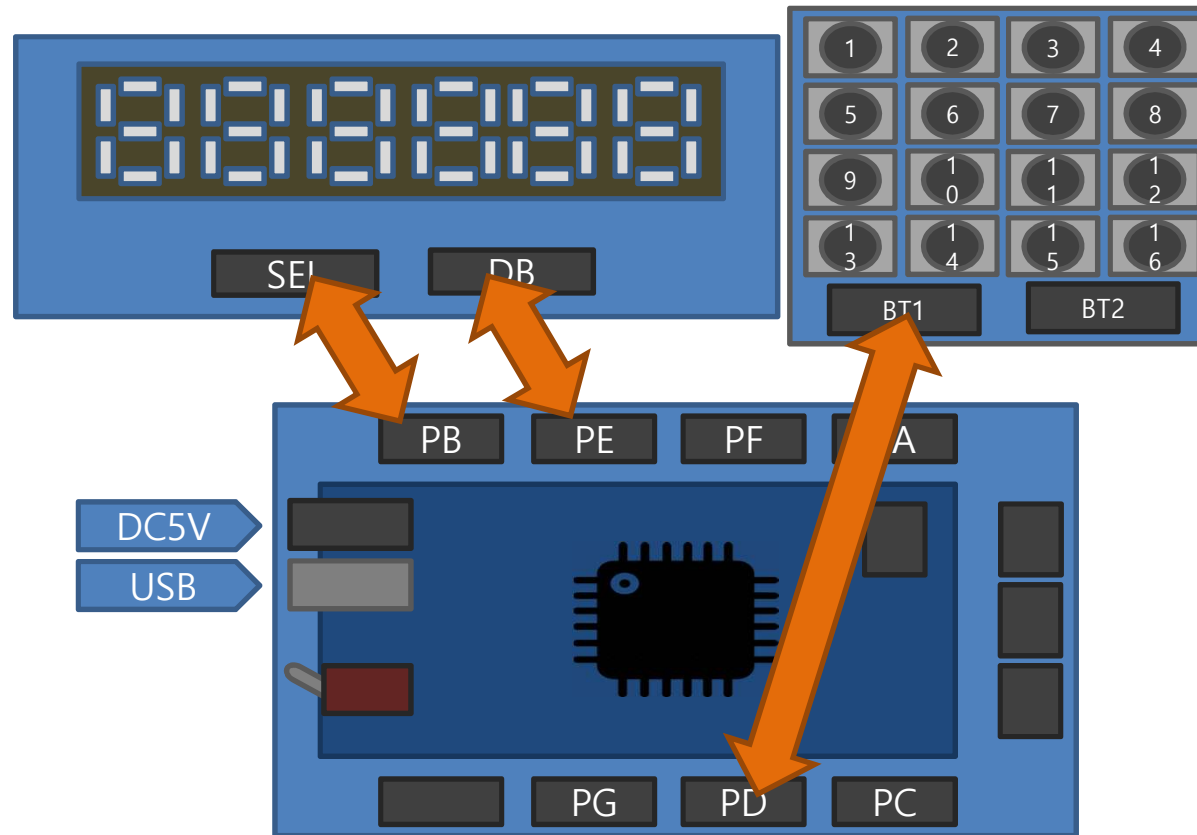
- 전자 회로내에 접점이 ON/OFF되는 순간 접점이 붙었다가 떨어지는 반복적인 현상
- 하드웨어적인 방지
 - 지연 회로 또는 적분 회로를 사용함
- 소프트웨어적인 방지
 - 접점의 상태를 논리적으로 반복하여 적분함



KeyIn Flow



Ex-9 : 채터링 제거



Ex-9 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH1 PIND
#define dTime 3

#include <avr/io.h>
#include <util/delay.h>

unsigned char FND[10]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char NUM[6]={0x00, 0x00, 0x00, 0x00, 0x00, 0x00};
signed int A;
signed int B;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRD=0x00;
}
```



Ex-9 : KeyProc

```
unsigned char KeyIn( ) {  
    unsigned char Key = ~SWITCH1;  
    for ( int k=0;k<100;k++){  
        Key &= ~SWITCH1;  
    }  
    return Key;  
}  
  
void KeyProc( ) {  
    unsigned char tKey= KeyIn( );  
    switch ( tKey ){  
        case 0x01:  if (++A>999) A=999;  break;  
        case 0x08:  if (++B>999) B=999;  break;  
        case 0x10:  if (--A<0)  A=0;    break;  
        case 0x80:  if (--B<0)  B=0;    break;  
    }  
}
```



Ex-9 : sub function

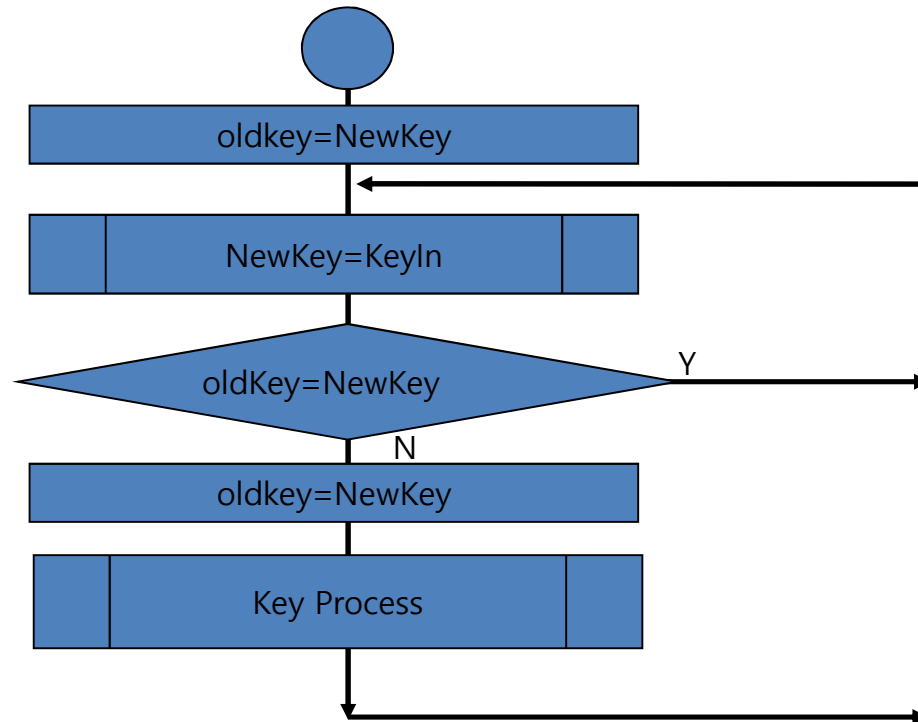
```
void Hex2Dec( ){  
    unsigned int tmp=A;  
    NUM[5]=tmp/100;  
    tmp=tmp%100;  
    NUM[4]=tmp/10;  
    NUM[3]=tmp%10;  
  
    tmp=B;  
    NUM[2]=tmp/100;  
    tmp=tmp%100;  
    NUM[1]=tmp/10;  
    NUM[0]=tmp%10;  
}
```

```
int main(void) {  
    CPU_Setup( );  
  
    while (1) {  
        for (unsigned char k=0; k<6; k++) {  
            FND_SEL=DGT[k];  
            FND_DB=FND[ NUM[k] ];  
            _delay_ms(dTime );  
        }  
        KeyProc( );  
        Hex2Dec( );  
    }  
}
```



중복처리 방지

- Key가 계속 눌러있을때 처리하지 않음

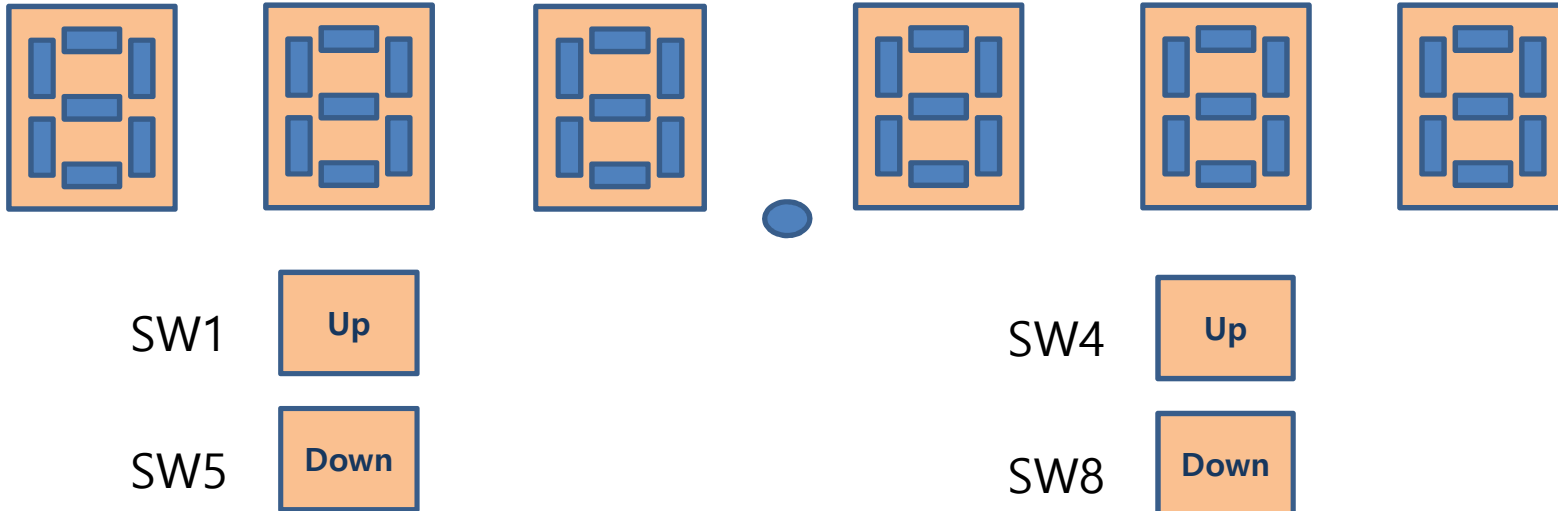


Ex-10

- SW를 누를때마다 1증가 또는 1 감소하게 하자

A: 000~999 (초기값 : 123)

B: 000~999분 (초기값 : 456)



Ex-10 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH1 PIND
#define SWITCH2 PINC
#define dTime 3

#include <avr/io.h>
#include <util/delay.h>

unsigned char FND[10]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char NUM[6]={0x00, 0x00, 0x00, 0x00, 0x00, 0x00};
unsigned char NewKey;
unsigned char oldKey;
int A;
int B;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRD=0x00;
}
```



Ex-10 : KeyProc

```
unsigned char KeyIn( ) {  
    unsigned char Key = ~SWITCH1;  
    for ( int k=0;k<100;k++){  
        Key &= ~SWITCH1;  
    }  
    return Key;  
}  
  
void KeyProc( ) {  
    unsigned char tKey= KeyIn( );  
    NewKey=KeyIn( );  
    if (NewKey != oldKey){  
        switch ( tKey ){  
            case 0x01: if (++A>999) A=999; break;  
            case 0x08: if (++B>999) B=999; break;  
            case 0x10: if (--A<0) A=0; break;  
            case 0x80: if (--B<0) B=0; break;  
        }  
        oldKey=NewKey;  
    }  
}
```



Ex-10 : sub function

```
void Hex2Dec( ){  
    unsigned int tmp=A;  
    NUM[5]=tmp/100;  
    tmp=tmp%100;  
    NUM[4]=tmp/10;  
    NUM[3]=tmp%10;  
  
    tmp=B;  
    NUM[2]=tmp/100;  
    tmp=tmp%100;  
    NUM[1]=tmp/10;  
    NUM[0]=tmp%10;  
}
```

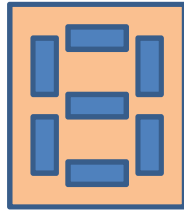
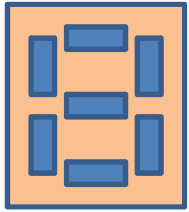
```
int main(void) {  
    CPU_Setup( );  
  
    while (1) {  
        for (unsigned char k=0; k<6; k++) {  
            FND_SEL=DGT[k];  
            FND_DB=FND[ NUM[k] ];  
            _delay_ms(dTime );  
        }  
        KeyProc( );  
        Hex2Dec( );  
    }  
}
```



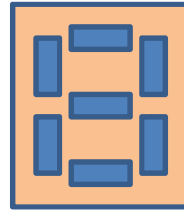
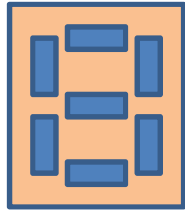
Ex-11 : 시간 설정

- SW를 누를때마다 1증가 또는 1 감소하게 하자
- 단, 분값이 59보다 크면 시 증가하게 하여야 함

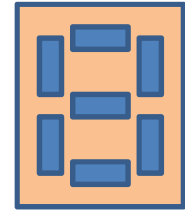
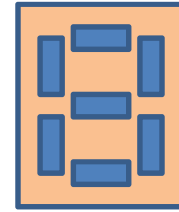
A: 00~12 시 (초기값 : 11시)



B: 00~59분 (초기값 : 30 분)



C: 00~59초 (초기값 : 30 초)



SW1

Up

SW2

Up

SW3

Up

SW5

Down

SW6

Down

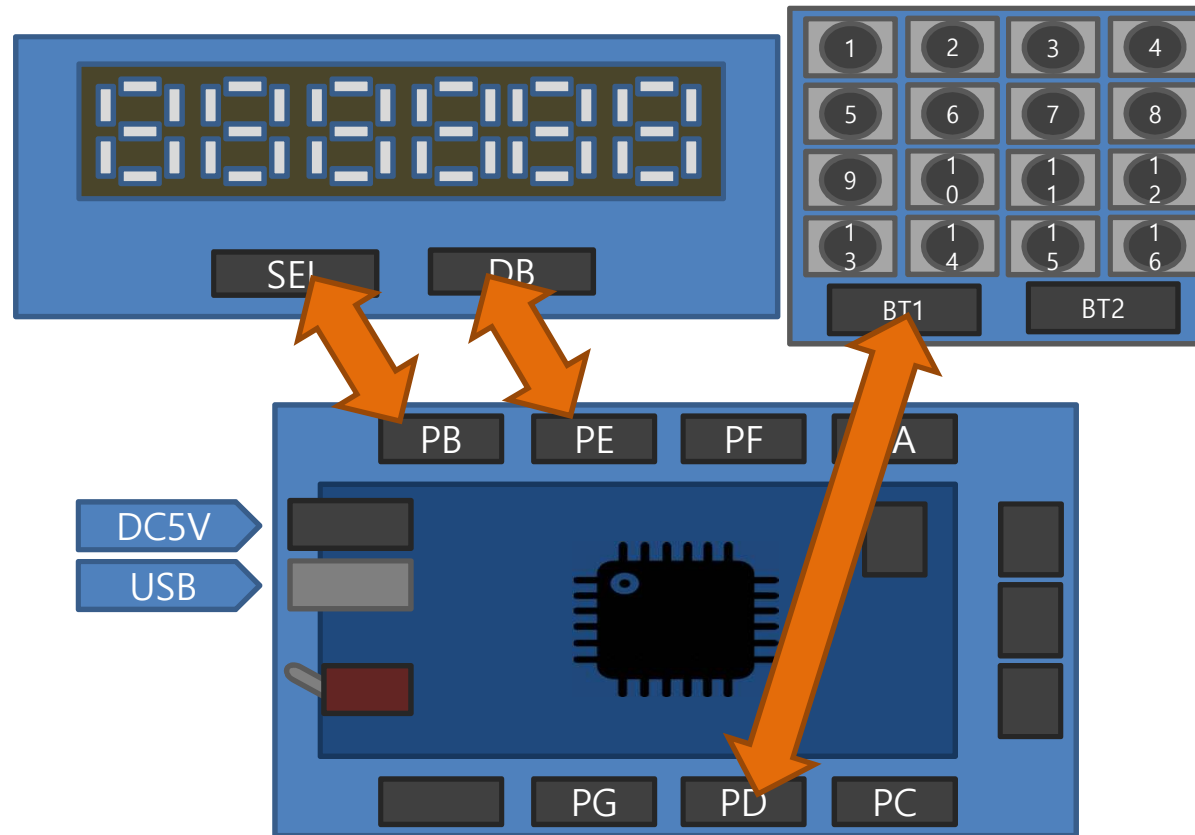
SW7

Down



충북대학교 공동훈련센터

Ex-11 : wiring



Ex-11 : Program



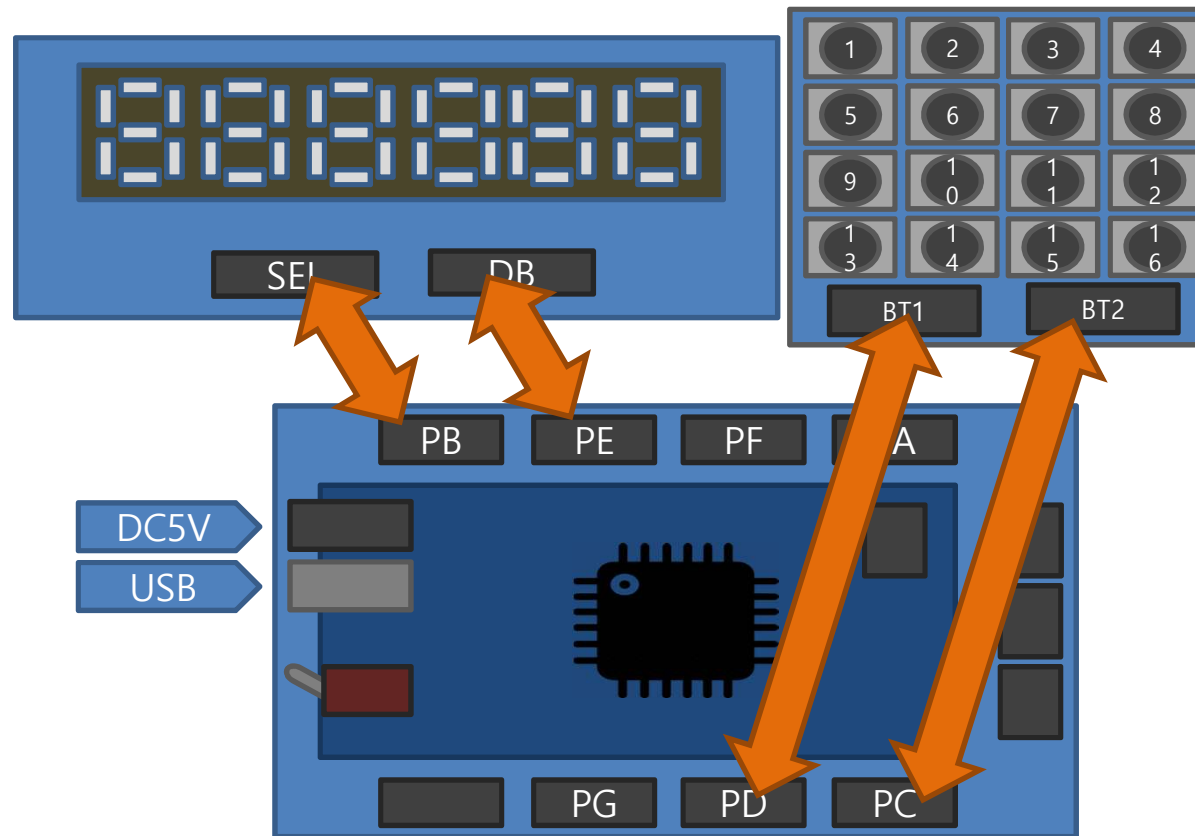
충북대학교 공동훈련센터

Ex-12 : 10Key Input

- Key button을 눌러 10진수 숫자를 입력하자
- 숫자는 우측에서 좌측으로 쉬프트



Ex-12 : wiring



Ex-12 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH1 PIND
#define SWITCH2 PINC
#define dTime 3

#include <avr/io.h>
#include <util/delay.h>

unsigned char FND[17]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f, 0x77,
                      0x7c, 0x58, 0x5e, 0x40, 0x49, 0x08};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char NUM[6]={0x00, 0x00, 0x00, 0x00, 0x00, 0x00};
unsigned char NewKey=16;
unsigned char oldKey=16;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRC=0x00;
    DDRD=0x00;
}
```



Ex-12 : sub function

```
char SwitchIn(void) {  
    char KeyNo;  
    unsigned int KeyIn =(~SWITCH2<<8) | (~SWITCH1 & 0x00ff);  
  
    switch ( KeyIn ) {  
        case 0x0001: KeyNo =1; break;  
        case 0x0002: KeyNo =2; break;  
        case 0x0004: KeyNo =3; break;  
        case 0x0008: KeyNo =10; break;  
        case 0x0010: KeyNo =4; break;  
        case 0x0020: KeyNo =5; break;  
        case 0x0040: KeyNo =6; break;  
        case 0x0080: KeyNo =11; break;  
        case 0x0100: KeyNo =7; break;  
        case 0x0200: KeyNo =8; break;  
        case 0x0400: KeyNo =9; break;  
        case 0x0800: KeyNo =12; break;  
        case 0x1000: KeyNo =14; break;  
        case 0x2000: KeyNo =0; break;  
        case 0x4000: KeyNo =15; break;  
        case 0x8000: KeyNo =13; break;  
        default: KeyNo =16; break;  
    }  
    return KeyNo;  
}
```



Ex-12 : main function

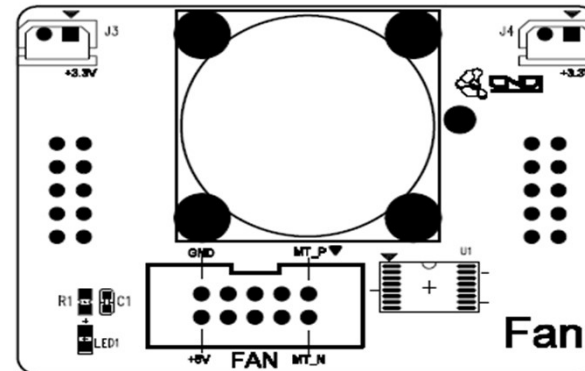
```
int main(void) {
    CPU_Setup( );

    while (1) {
        NewKey=SwitchIn( );
        if (NewKey != oldKey){
            oldKey=NewKey;
            if (NewKey != 16){
                for (unsigned char k=5;k>0;k--){
                    NUM[k]=NUM[k-1];
                }
                NUM[0]=NewKey;
            }
        }

        for (unsigned char k=0; k<6; k++) {
            FND_SEL=DGT[k];
            FND_DB=FND[ NUM[k] ];
            _delay_ms(dTime );
        }
    }
}
```

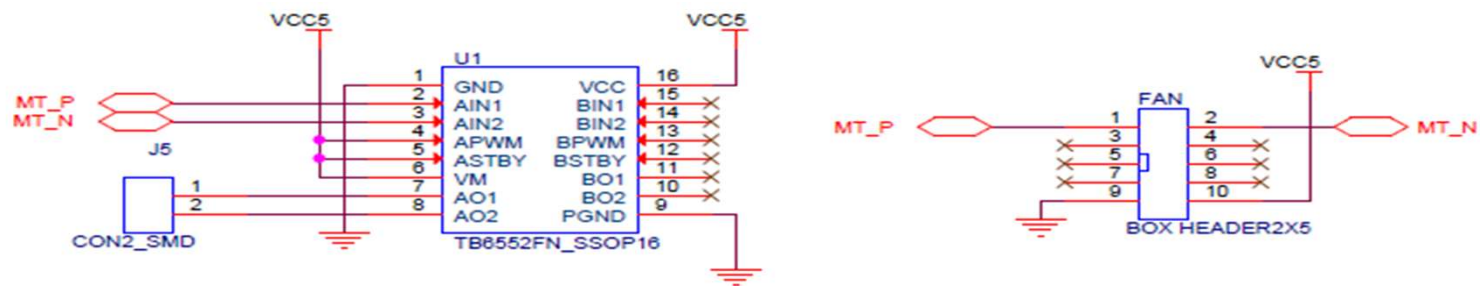


FAN



충북대학교 공동훈련센터

Fan Schematic

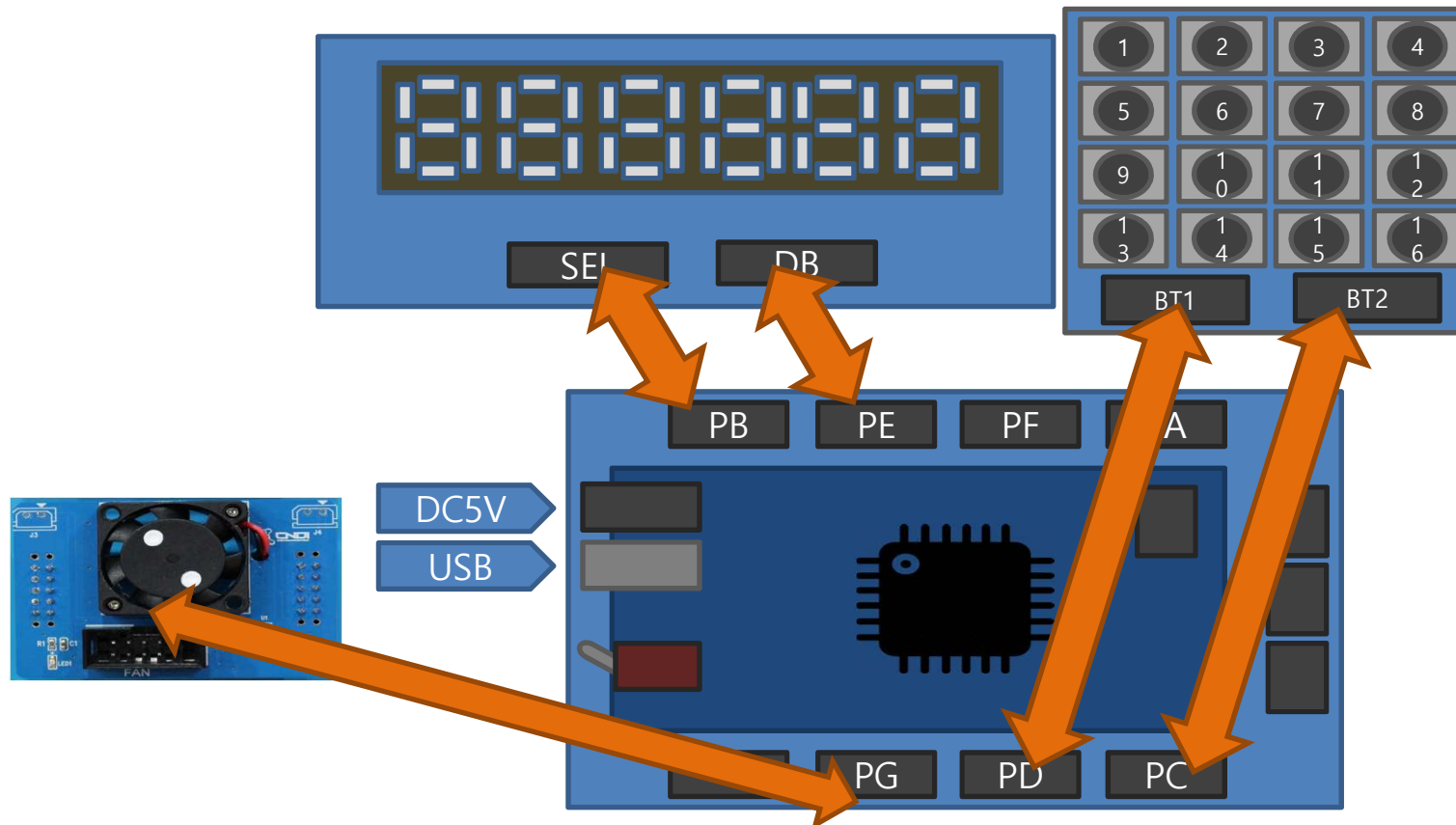


Ex-13 : Pass Word

- Key button을 눌러 10진수 숫자를 입력하자
- 단, 0~9이외의 키는 입력 받지 않는다
- 숫자 6개를 입력하고 A키를 눌러 PW가 맞으면
- FAN을 구동, FND는 '-----'표시
- D키가 입력되면 FAN을 정지하자



Ex-13 : wiring



Ex-13 : Program-define

```
#define F_CPU 14745600UL
#define FND_SEL PORTB
#define FND_DB PORTE
#define SWITCH1 PIND
#define SWITCH2 PINC
#define FAN PORTG
#define dTime 3

#include <avr/io.h>
#include <util/delay.h>

unsigned char FND[17]={0x3f, 0x06, 0x5b, 0x4f, 0x66, 0x6d, 0x7d, 0x27, 0x7f, 0x6f, 0x77,
                      0x7c, 0x58, 0x5e, 0x40, 0x49, 0x08};
unsigned char DGT[6]={0xfe, 0xfd, 0xfb, 0xf7, 0xef, 0xdf};
unsigned char NUM[6]={16, 16, 16, 16, 16, 16};
unsigned char PW[6]={0x01, 0x02, 0x03, 0x04, 0x05, 0x06};
unsigned char NewKey=16;
unsigned char oldKey=16;

void CPU_Setup( ) {
    DDRB=0xff;
    DDRE=0xff;
    DDRC=0x00;
    DDRD=0x00;
    DDRG=0x03;
}
```



Ex-13 : Program

```
FAN=0x01; //Fan On  
FAN=0x00; //Fan Off
```

