2.0 LPC1768 INTERFACING WITH PERIPHERALS

2.1 INTERFACING LEDS WITH LPC1768 MICROCONTROLLER

Learning Outcomes:

- Configure GPIO pins of the LPC1768 microcontroller for output to control external devices such as LEDs.
- Demonstrate the ability to use registers (FIODIR, FIOSET, FIOCLR, and FIOPIN) to manipulate and control GPIO operations effectively.
- Write, compile, and execute embedded C programs to turn ON, turn OFF, and blink LEDs connected to GPIO pins.

2.1.1 INTERFACING DIAGRAM

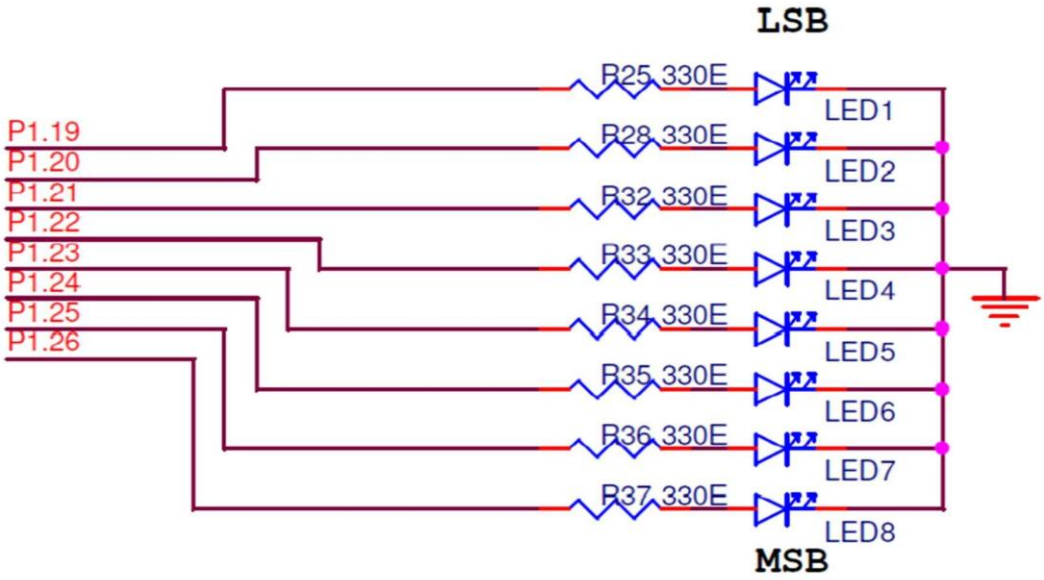

Fig.: Interfacing LEDs with LPC1768 Microcontroller

The LEDs are connected to pins P1.19 to P1.26 of the LPC1768 microcontroller. These pins act as General Purpose Input/Output (GPIO) lines.

Each pin can source or sink current, allowing control of the connected devices such as LEDs.

The LEDs are connected with their cathodes grounded, while the anodes connected to resistors and then to the microcontroller pins. This configuration is commonly called active high since the LEDs light up when the corresponding pin is driven high.

Resistors labeled R25 to R37 (all 330 ohms) are placed in series with each LED. The purpose of these resistors is to limit the current flowing through the LEDs, protecting them from damage and ensuring proper operation. The resistance value is calculated based on the supply voltage, forward voltage of the LEDs (usually around 2V), and the desired current (typically around 4-20 mA for standard LEDs).

Here,

V = 3.3 V V = 2V I = 4 mA

$$\therefore R = \frac{V_{CC} - V_F}{I_F} = \frac{3.3 - 2}{4x10^{-3}} = 325 \text{ Ohm}$$

Selecting Standard Value of Resistance **R = 330 Ohm**

The power dissipation in each resistor is calculated as

P = I R = (4x10) x 330 = 0.00528W < 0.25 W of Standard Resistor

2.1.2 EXAMPLE CODES

1a) Write a program in C to switch ON the LED connected to port pin P1.19 Solution:

FIODIR Register Configuration:

P1.19 should be configured as an output pin by setting its corresponding bit in the FIODIR register to 1.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIODIR = 0x0008 0000

FIOSET Register Configuration:

To Switch ON the LED, Logic '1' should be written to bit 19 of FIOSET Register.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIOSET = 0x0008 0000

Code:

```
#include <lpc17xx.h>   int main()
{
  // Configure P1.19 as output
```

```
    LPC_GPIO1->FIODIR = 0x00080000;

    // Switch ON LED
    LPC_GPIO1->FIOSET = 0x00080000;     while(1);
  }
```

1b) Write a program in C to switch ON the LED connected to port pin P1.19 and P1.20

Solution:

```
#include <lpc17xx.h>   int main()
{
   // Configure P1.19 and P1.20 as output pins
   LPC_GPIO1->FIODIR |= (1<<19) | (1<<20);

   // Switch ON LED
   LPC_GPIO1->FIOSET |= (1<<19) | (1<<20);
    while(1);
}
```

1c) Write a program in C to blink the LEDs connected to P1 using FIOSET and FIOCLR registers.

Solution:

FIODIR Register Configuration:

Configure all the pins connected to LEDs as output pins by writing '1'.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIODIR = 0x07F8 0000

FIOSET Register Configuration:

Write '1' to Switch ON all the LED's

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIOSET = 0x07F8 0000

FIOCLR Register Configuration:

Write '1' to Switch OFF all the LED's

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIOCLR = 0x07F8 0000

Code:

```
#include <lpc17xx.h>   void delay(unsigned
int count)
{
        unsigned int i,j;          for(i=0;
i<count; i++)              for(j=0; j<1275; j++);
} int main()
{
      // Configure as output pins  LPC_GPIO1->FIODIR =
      0x07F80000; while(1)
      {
        // Switch ON LEDs
        LPC_GPIO1->FIOSET = 0x07F80000;
        // Delay delay(2000);
            // Switch OFF LEDs
        LPC_GPIO1->FIOCLR = 0x07F80000;
        // Delay delay(2000);
      }
}
```

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Solution:

FIODIR Register Configuration:

Configure all the pins connected to LEDs as output pins by writing ‘1’.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIODIR = 0x07F8 0000

FIOPIN Register Configuration to Switch ON LEDs:

Write ‘1’ to Switch ON all the LED’s.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIOPIN = 0x07F8 0000

FIOPIN Register Configuration to Switch OFF LEDs:

Write ‘0’ to Switch OFF all the LED’s.

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Therefore, FIOPIN = 0x0000 0000

Code:

```
#include <lpc17xx.h>
 void delay(unsigned int count)
{
        unsigned int i,j;          for(i=0;
i<count; i++)              for(j=0; j<1275; j++);
} int main()
{
            // Configure as output pins
        LPC_GPIO1->FIODIR = 0x07F80000;

            while(1)
      {
        // Switch ON LEDs
        LPC_GPIO1->FIOPIN |=
      0x07F80000;
            // Delay
            delay(2000);
            // Switch OFF LEDs
        LPC_GPIO1->FIOPIN &=
      0xF807FFFF;
        // Delay delay(2000);
      }
}
```

The OR operation preserves the values of the other bits.

The AND operation preserves the values of the other bits.

Difference Between FIOPIN, FIOSET, and FIOCLR Registers

Register	Purpose	Operation	Bit State Behaviour
FIOPIN	Pin Value Register	Reads or writes the current state of GPIO pins	Writing directly affects the pin output (1: High, 0: Low)

FIOSET	Set Pin Register	Sets specified GPIO pins to logic High (1)	Writing 1 to a bit sets it, writing 0 has no effect
FIOCLR	Clear Pin Register	Clears specified GPIO pins to logic Low (0)	Writing 1 to a bit clears it, writing 0 has no effect

Did you notice the LEDs on the PCB board

SMD LEDs

SMD LEDs are a type of LED designed for mounting directly onto the surface of a PCB (Printed Circuit Board) without the need for through-hole soldering. They are compact, efficient, and widely used in various electronic applications.