



Sunbeam Institute of Information Technology
Pune and Karad

Module - Micro controller Programming and Interfacing

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12-15

regx: 0x0000hA00

0000	0000	0000	0000	0100	1010	0000	0000
0000	0000	0000	0000	1111	0000	0000	0000
<hr/>							
0000	0000	0000	0000	1111	1010	0000	0000
<hr/>							
0000	0000	0000	0000	0001	0000	0000	0000
0000	0000	0000	0000	0010	0000	0000	0000
0000	0000	0000	0000	0100	0000	0000	0000
0000	0000	0000	0000	1000	0000	0000	0000
<hr/>							
0000	0000	0000	0000	1111	0000	0000	0000

regx = regx | BV(12) | BV(13) | BV(14) | BV(15)
 or
 regx |= BV(12) | BV(13) | BV(14) | BV(15)

17-20

0x000hA000

0000	0000	0000	0100	1010	0000	0000	0000
1111	1111	1110	0001	1111	1111	1111	1111
<hr/>							
0000	0000	0000	0000	1010	0000	0000	0000
<hr/>							
0000	0000	0000	0010	0000	0000	0000	0000
0000	0000	0000	0100	0000	0000	0000	0000
0000	0000	0000	1000	0000	0000	0000	0000
0000	0000	0001	0000	0000	0000	0000	0000
<hr/>							
0000	0000	0001	1110	0000	0000	0000	0000
<hr/>							
1111	1111	1110	0001	1111	1111	1111	1111

regx = regx & ~ (BV(17) | BV(18) | BV(19) | BV(20))
 or
 regx &= ~ (BV(17) | BV(18) | BV(19) | BV(20))

19-24

0x10hA0000

24 23 22 21 20 19

0001 0000 0100 1010 0000 0000 0000 0000

>>19

0000 0000 0000 0000 0000 0010 0000 1001

0000 0000 0000 0000 0000 0000 0011 1111

⊕

0000 0000 0000 0000 0000 0000 0000 1001

value = (reg >> 19) ⊕ 0x0000003F

0001 0000 0100 1010 0000 0000 0000 0000

0001 0001 1111 1000 0000 0000 0000 0000

0000 0000 0100 1000 0000 0000 0000 0000

>>19

0000 0000 0000 0000 0000 0000 0000 1001

8-15

0x52

0x100hA000

15 14 13 12 11 10 9 8

0001 0000 0000 0100 1010 0000 0000 0000

0001 0000 0000 0100 0000 0000 0000 0000

0000 0000 0000 0000 0101 0010 0000 0000

|

0001 0000 0000 0100 0101 0010 0000 0000

reg &= ~(BV(8) | BV(9) | BV(10) | BV(11) |
BV(12) | BV(13) | BV(14) | BV(15))

reg | = (value << 8)

value = 0x52

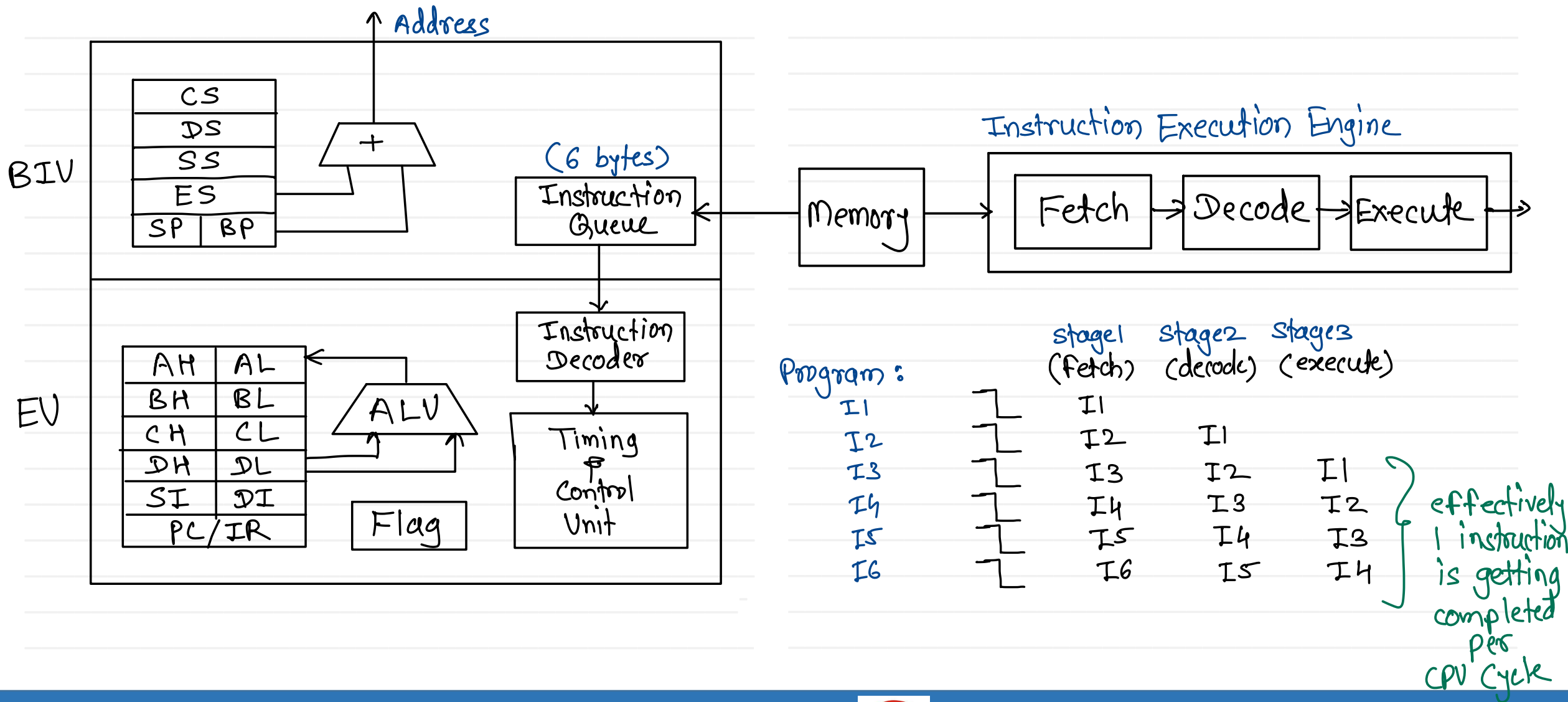
value = 0000 0000 0000 0000 0000 0000 0101 0010

value << 8 = 0000 0000 0000 0000 0101 0010 0000 0000

reg8 =	0001	0000	0000	0100	1010	0000	0000	0000
	0000	0000	0000	0000	0101	0010	0000	0000
<hr/>								
	0001	0000	0000	0100	1111	0010	0000	0000

reg8 =	0001	0000	0000	0100	0000	0000	0000	0000
	0000	0000	0000	0000	0101	0010	0000	0000
<hr/>								
	0001	0000	0000	0100	0101	0010	0000	0000

Instruction queue vs Instruction pipeline



Instruction pipeline hazards

Control Hazard

```

1  MOV A, 10
2  MOV B, 20
3  CMP
4  Branch → T
5  B is greater
6  JUMP E
7  T : A is greater
8  E :
  
```

	F	D	E
1	1		
2	2	1	
3	3	2	1
4	4	3	2
5	5	4	3
6	6	5	4
7	7		-
8	8	7	-
		8	7
			8

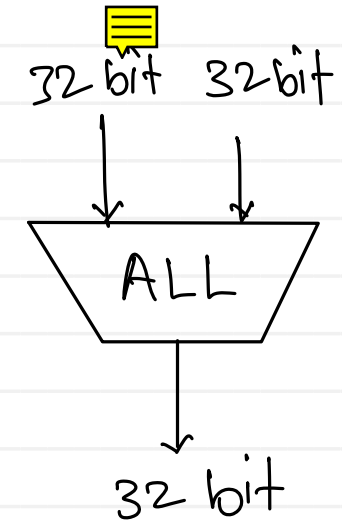
Data Hazard

```

1  MOV A, 10
2  MOV B, 20
3  MUL A, B
4  STA 0x12345678
5  .....
  
```

	F	D	E
1	1		
2	2	1	
3	3	2	1
4	4	3	2
5	5	4	3
			3
			3
		5	4
			5

Pipeline is
halted



MODER	OTYPER	OSPEEDR	PUPDR	IDR	ODR	BSRR	LCKR	AFRL	AFRH
00	04	08	0C	10	14	18	1C	20	24

start: $0x4002\ 0C00$ end: $0x4002\ 0FFF$ (struct GPIO *) $0x4002\ 0C00 \rightarrow \dots$

```
struct GPIO {
    uint32_t MODER;
    uint32_t OTYPER;
    uint32_t OSPEEDR;
    uint32_t PUPDR;
    uint32_t IDR;
    uint32_t ODR;
    uint32_t BSRR;
    uint32_t LCKR;
    uint32_t AFRL;
    uint32_t AFRH;
};
```

};

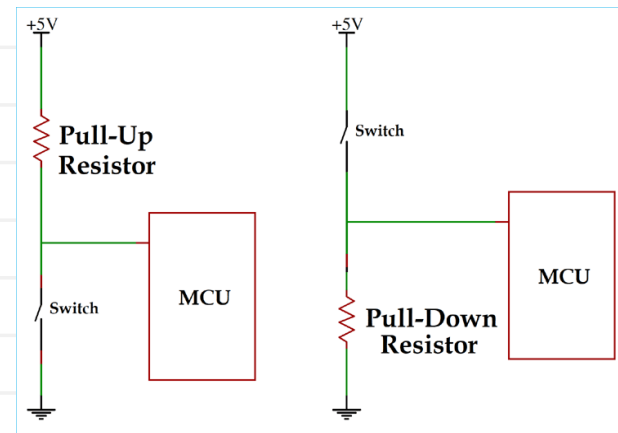
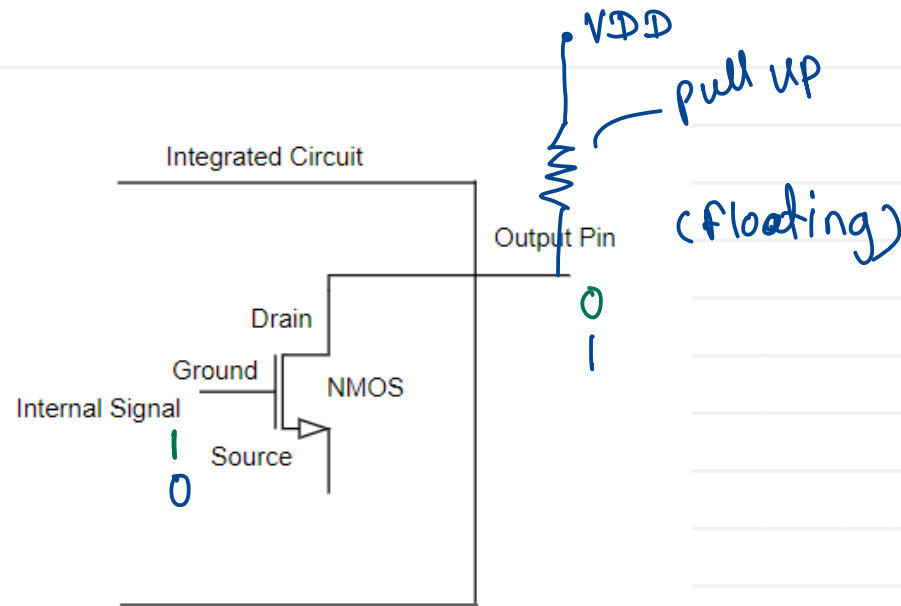
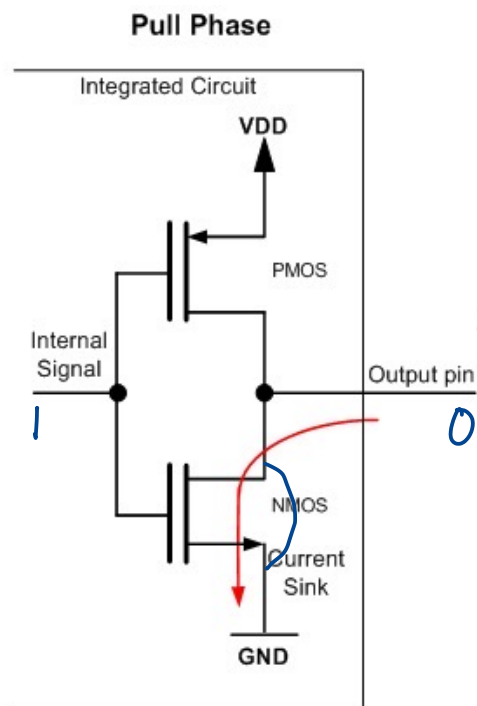
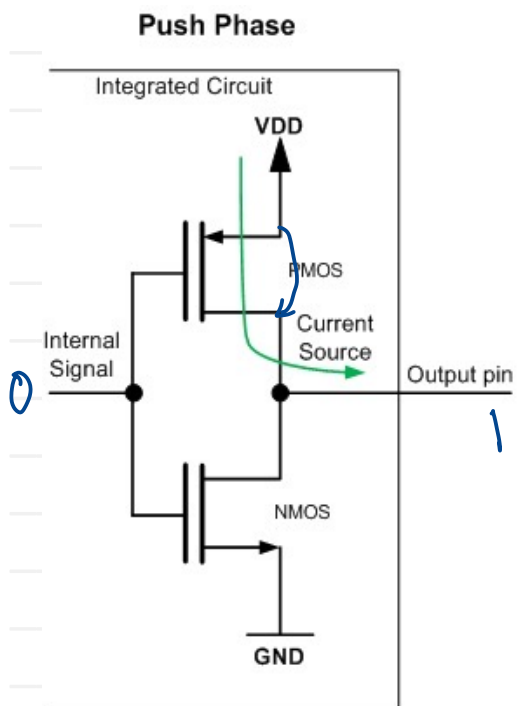
#define GPIOD_Base $0x4002\ 0C00$

(struct GPIO *) GPIOD_Base $\rightarrow \dots$

#define (struct GPIO *) GPIOD_Base GPIOD

GPIOD $\rightarrow \dots$

Push-pull vs Open drain configuration





Thank you!!!

Devendra Dhande

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