CPU Design and Verification
: Vehicle Application

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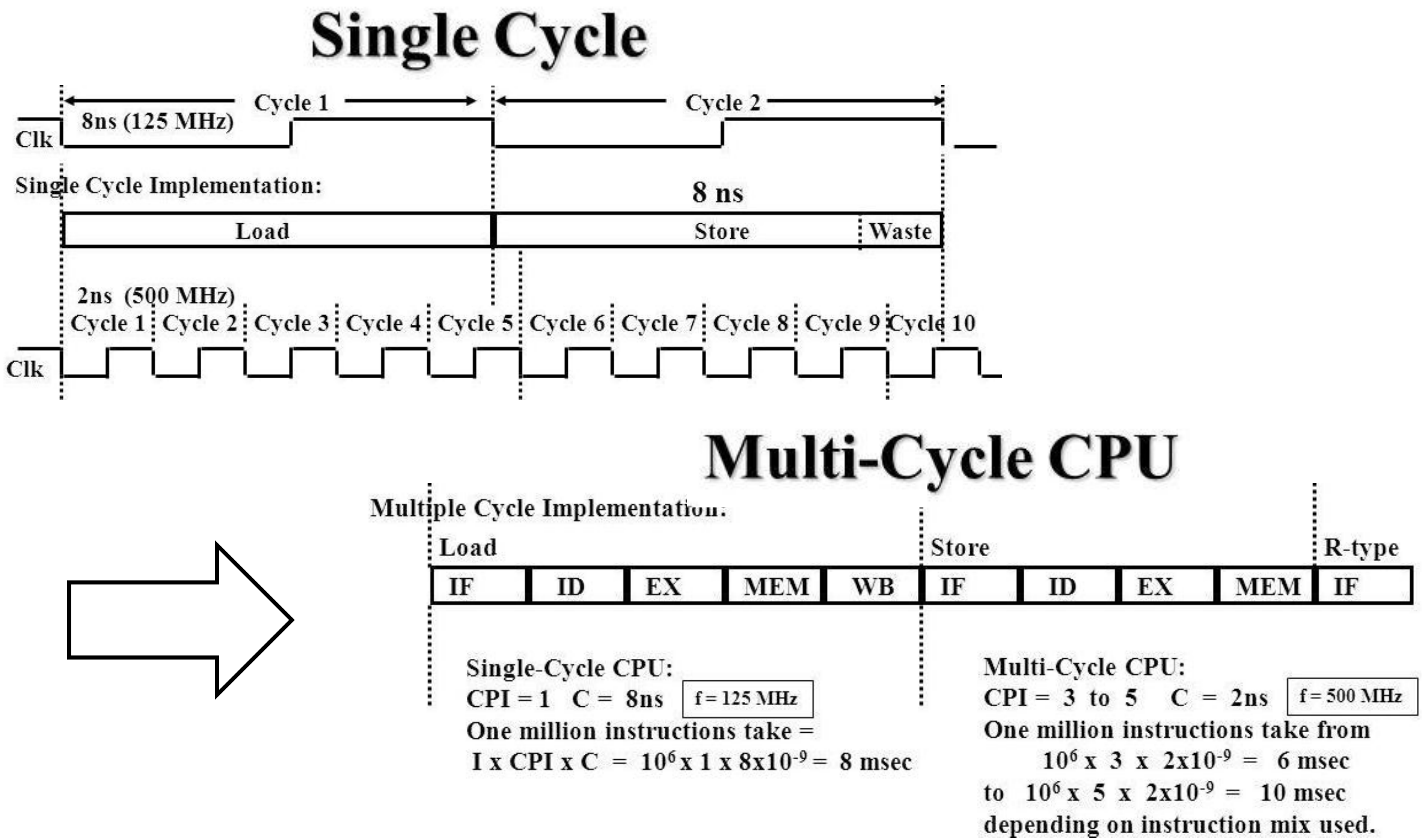
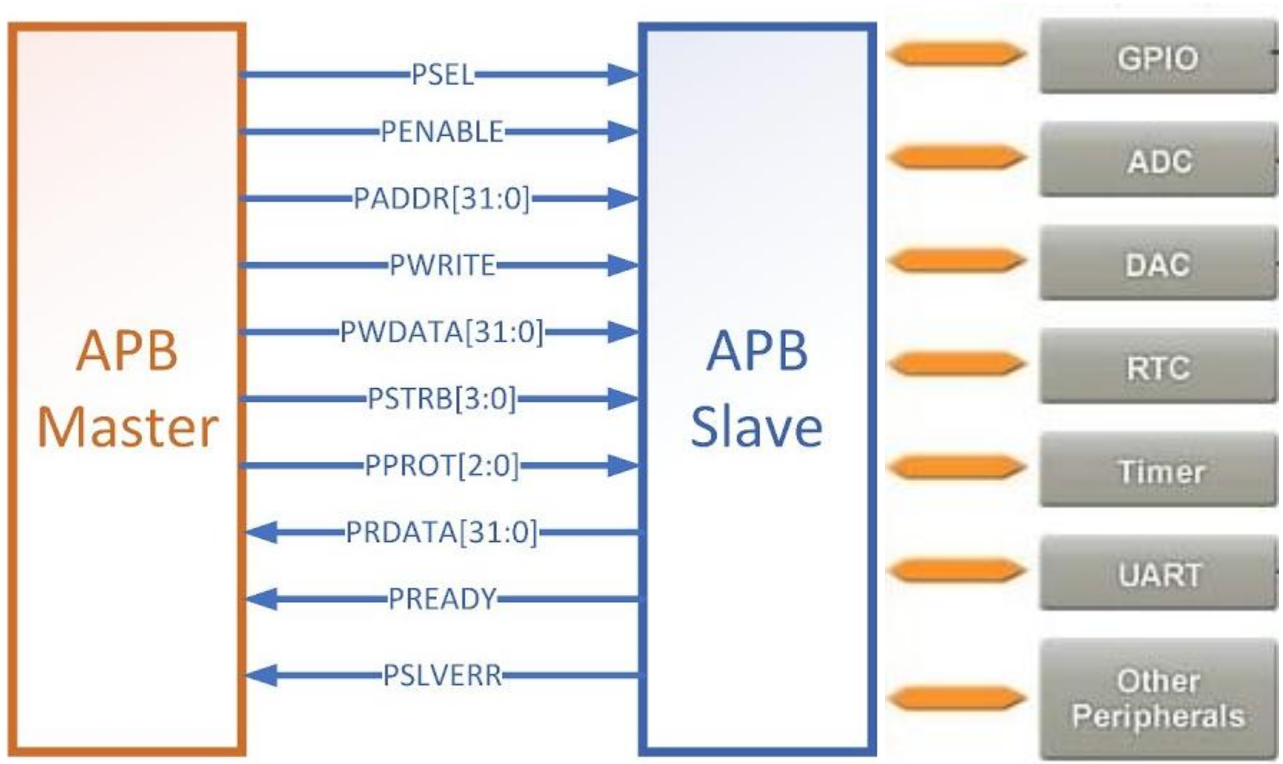


Project Goal



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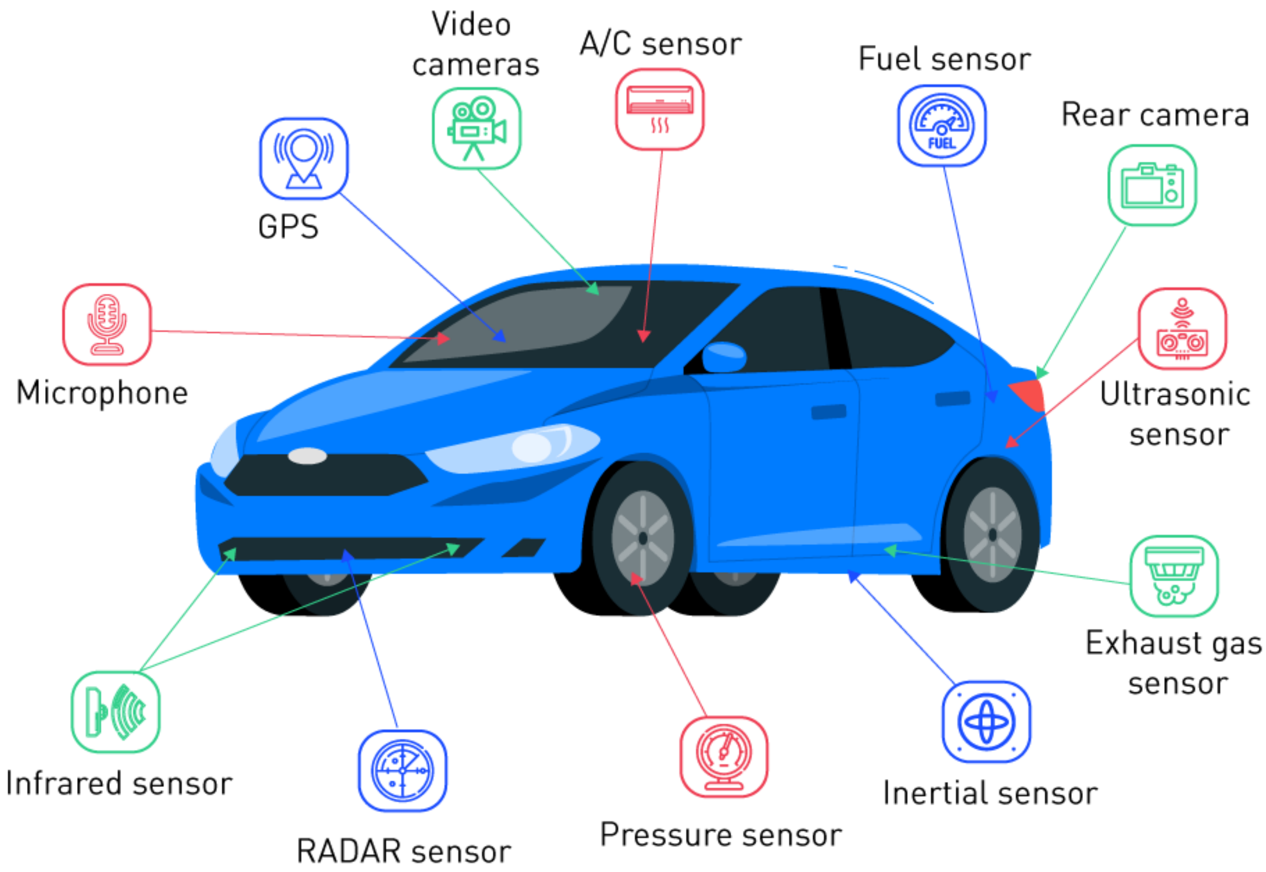
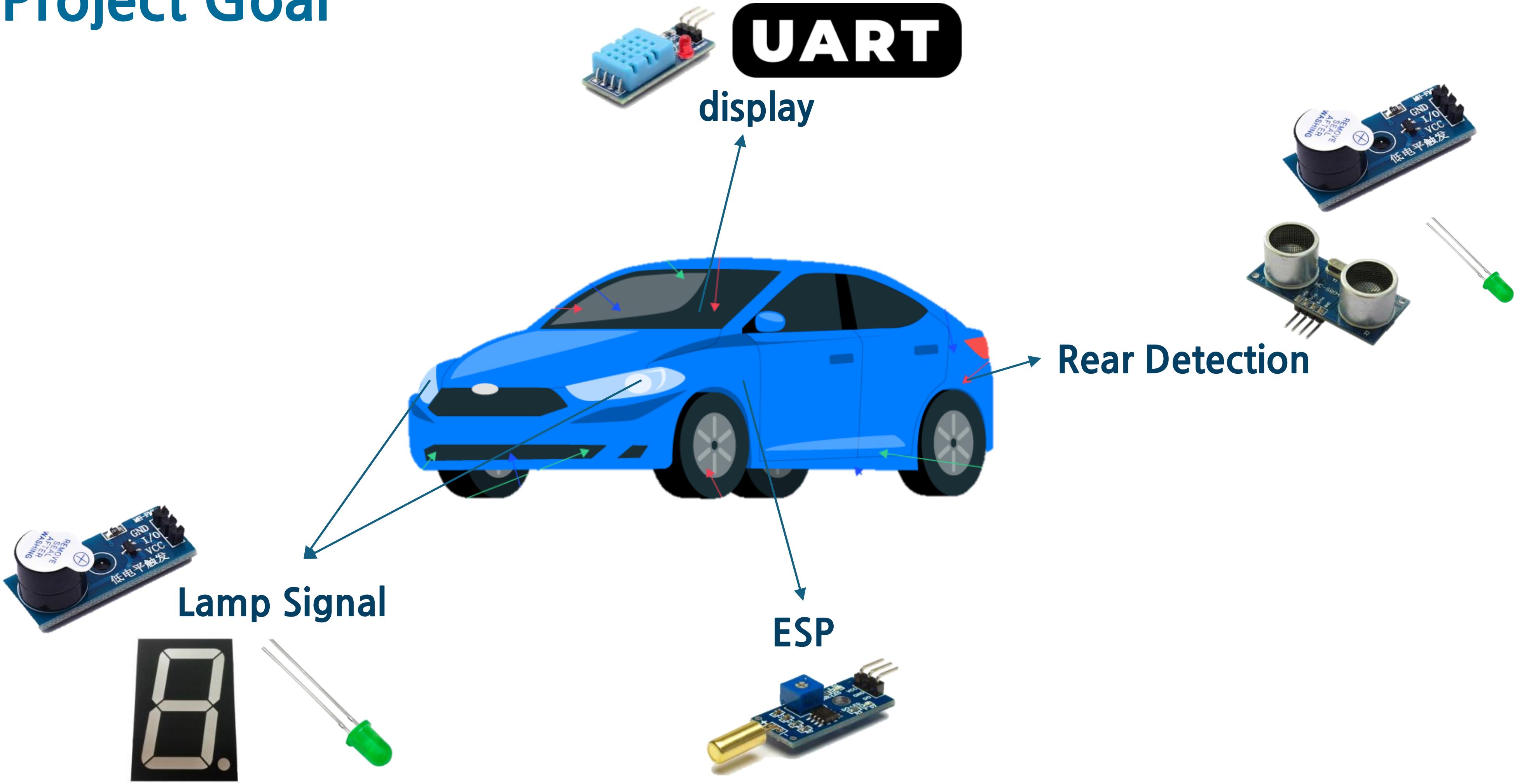
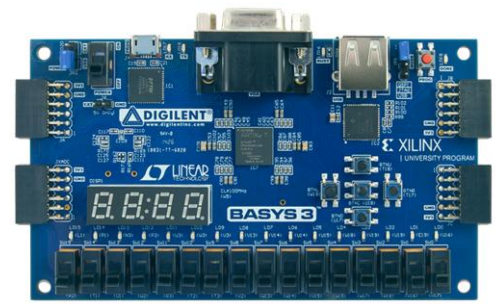


01. Introduction

Project Goal



01. Introduction

Tool	Language	HW
VIVADO HLx Editions	SystemVerilog	
		

02. APB Bus Specification

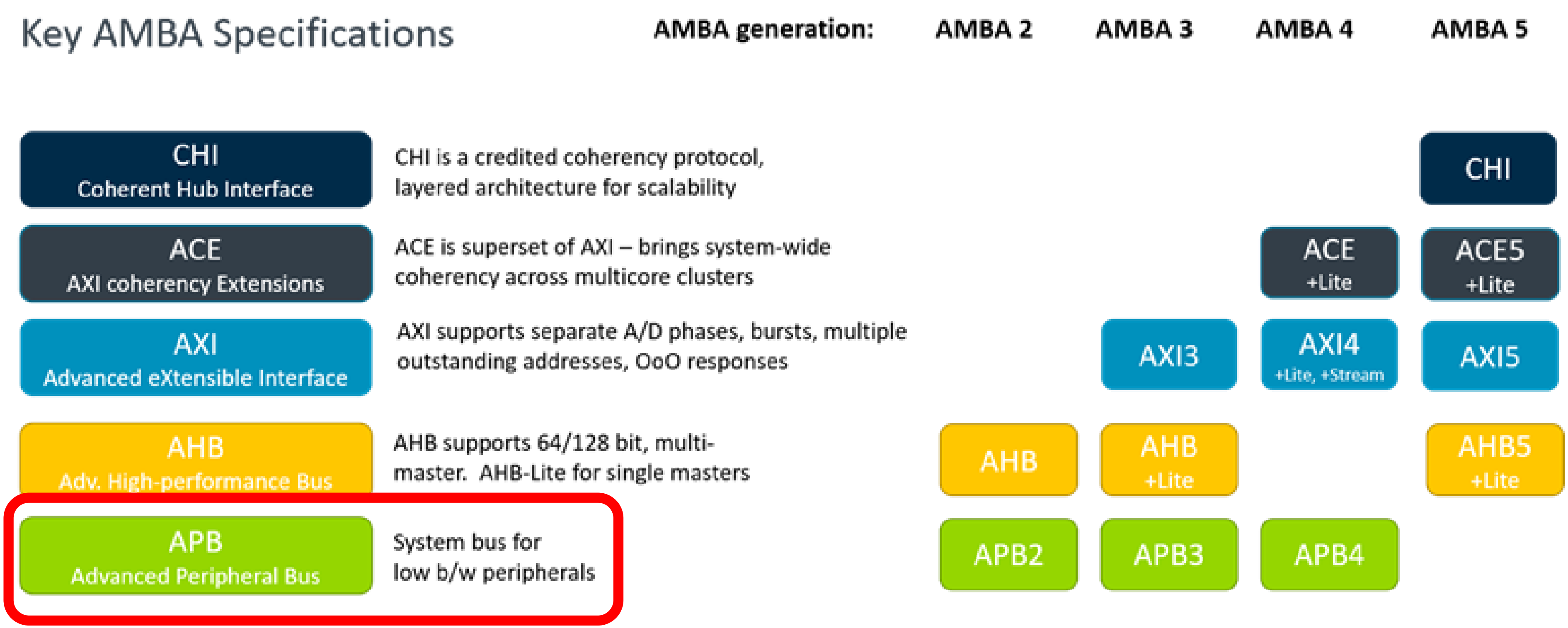
Advanced Peripheral Bus (APB)

ARM® AMBA®

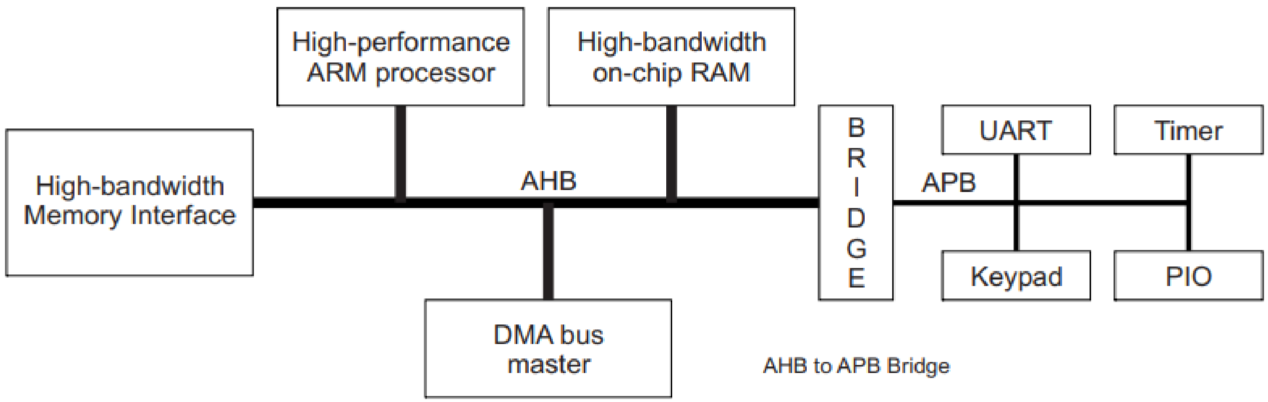
Interconnect Standards

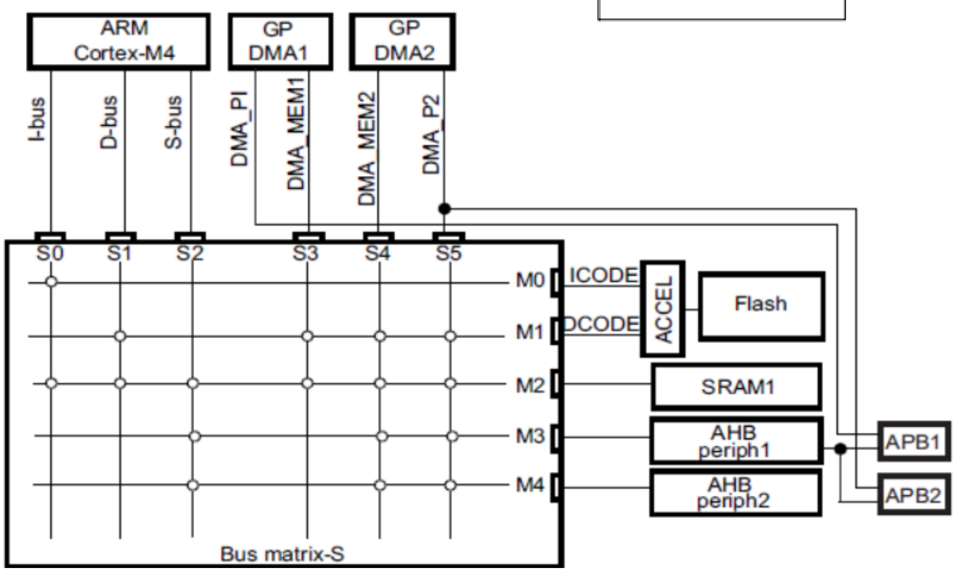
02. APB Bus Specification

Advanced Peripheral Bus (APB)



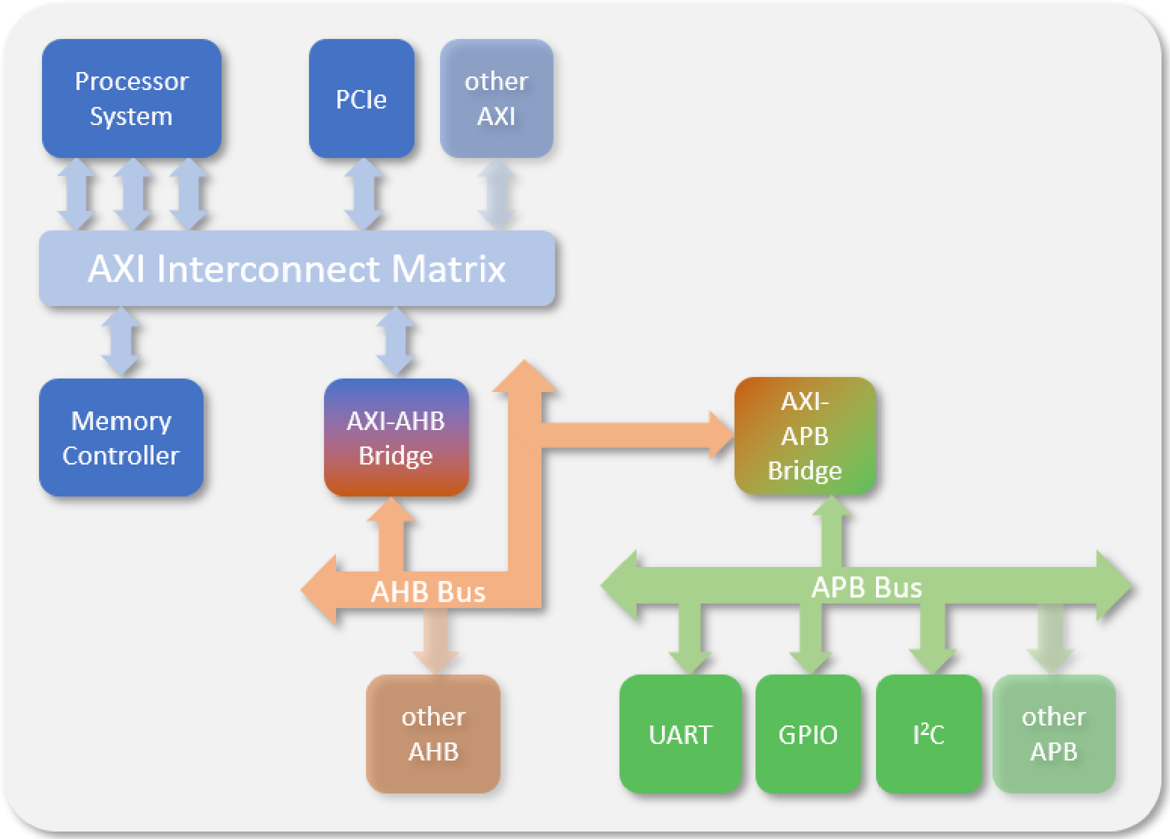
Advanced Peripheral Bus (APB)



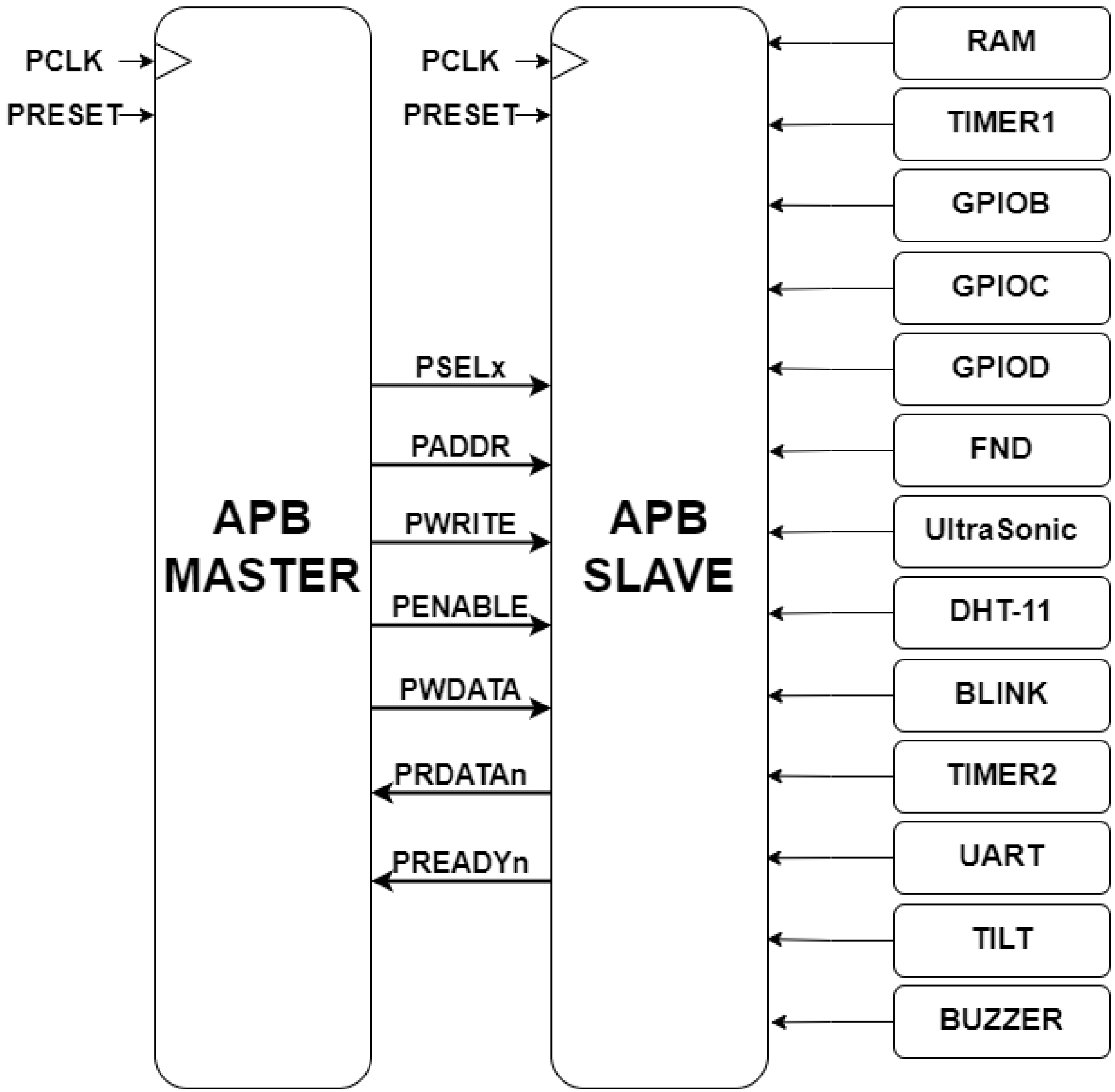


02. APB Bus Specification

Advanced Peripheral Bus (APB)



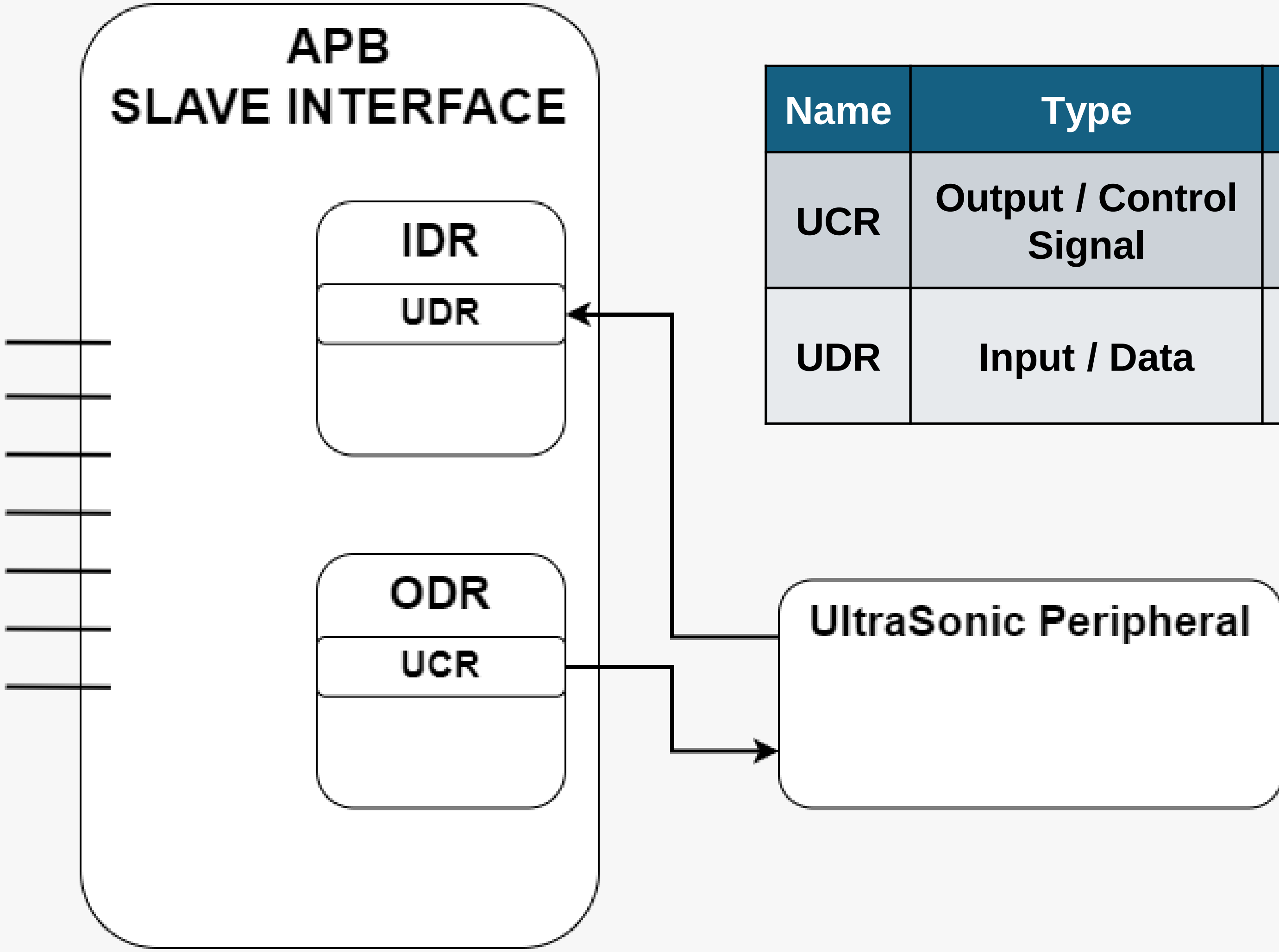
02. APB Bus Specification



02. APB Bus Specification

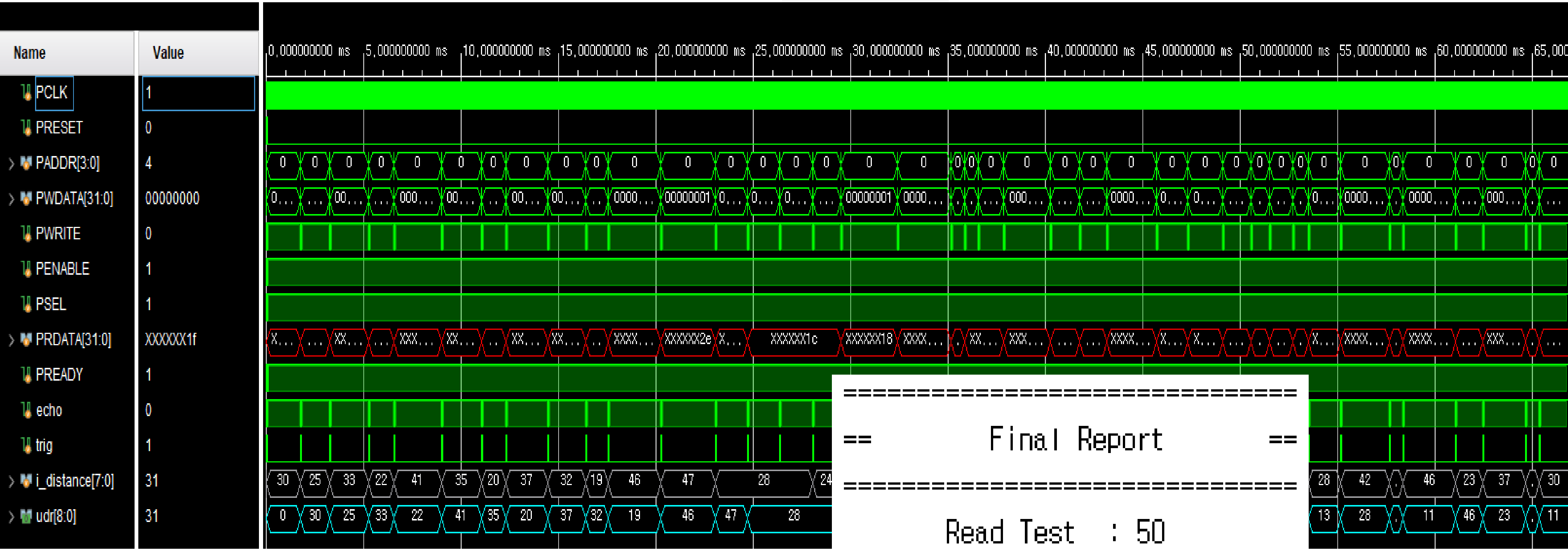
Bus	Boundary address	Peripheral
APB	0x1000 4000 ~ 0x1000 43FF	BUZZER
	0x1000 3C00 ~ 0x1000 3FFF	NOTHING
	0x1000 3800 ~ 0x1000 3BFF	TILT
	0x1000 3400 ~ 0x1000 37FF	UART
	0x1000 3000 ~ 0x1000 33FF	TIMER2
	0x1000 2C00 ~ 0x1000 2FFF	BLINK
	0x1000 2800 ~ 0x1000 2BFF	DHT-11
	0x1000 2400 ~ 0x1000 27FF	ULTRASONIC
	0x1000 2000 ~ 0x1000 23FF	FND
	0x1000 1C00 ~ 0x1000 1FFF	GPIOC
	0x1000 1800 ~ 0x1000 1BFF	GPIOB
	0x1000 1400 ~ 0x1000 17FF	GPIOA
	0x1000 1000 ~ 0x1000 13FF	TIMER1
	0x1000 0000 ~ 0x1000 0FFF	RAM

03. Peripherals - UltraSonic



Name	Type	Offset	Description
UCR	Output / Control Signal	0x00	0 : wait 1 : start
UDR	Input / Data	0x04	Distance value (unit : cm)

03. Peripherals - UltraSonic Simulation

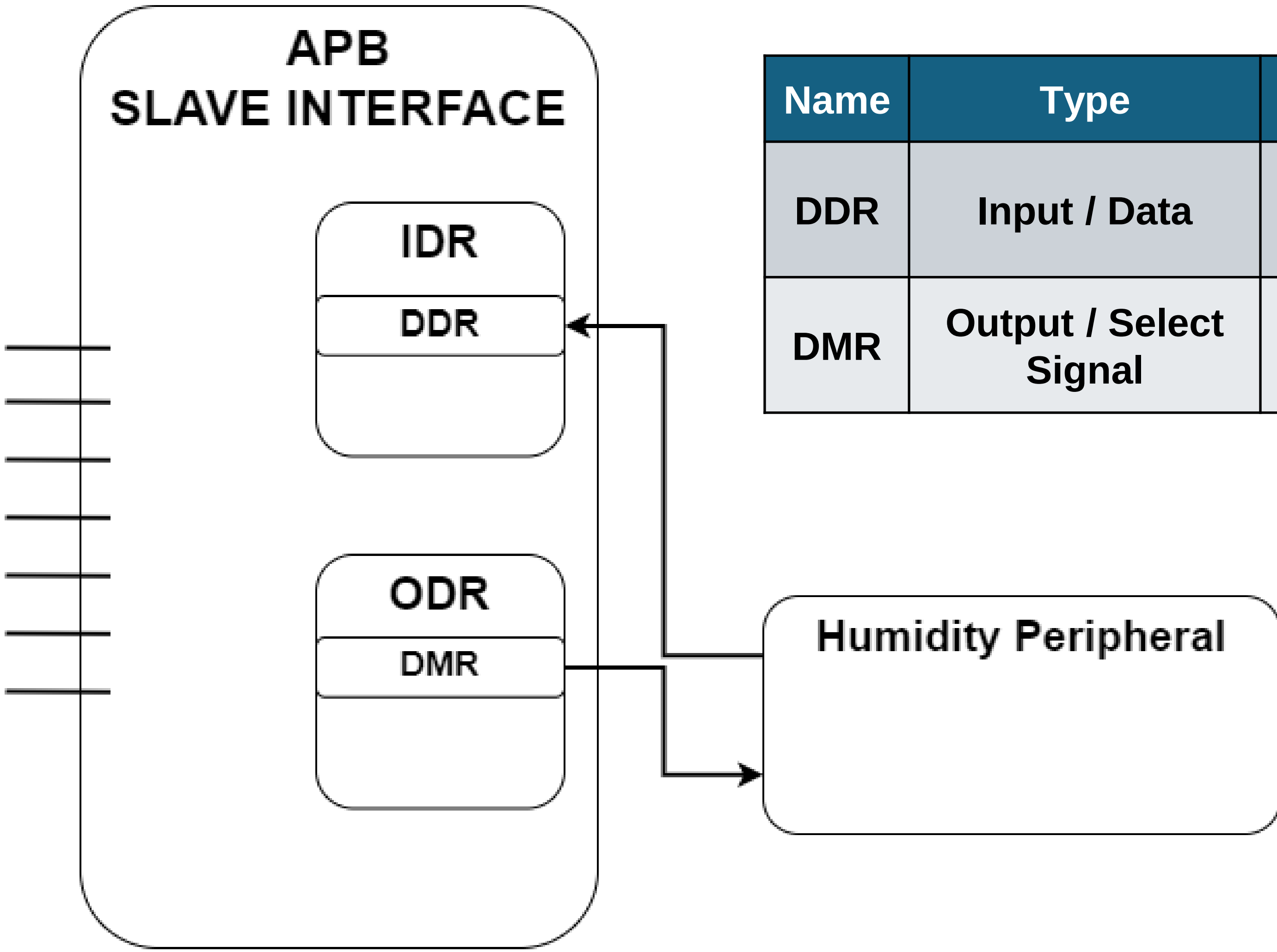



```
==================================
==          Final Report        ==
==================================
          Read Test  : 50
(^-^)b PASS Test  : 50
(;-;)p FAIL Test  : 0
          Total Test : 50
==================================
==================================
```

Gray : Random Vaule

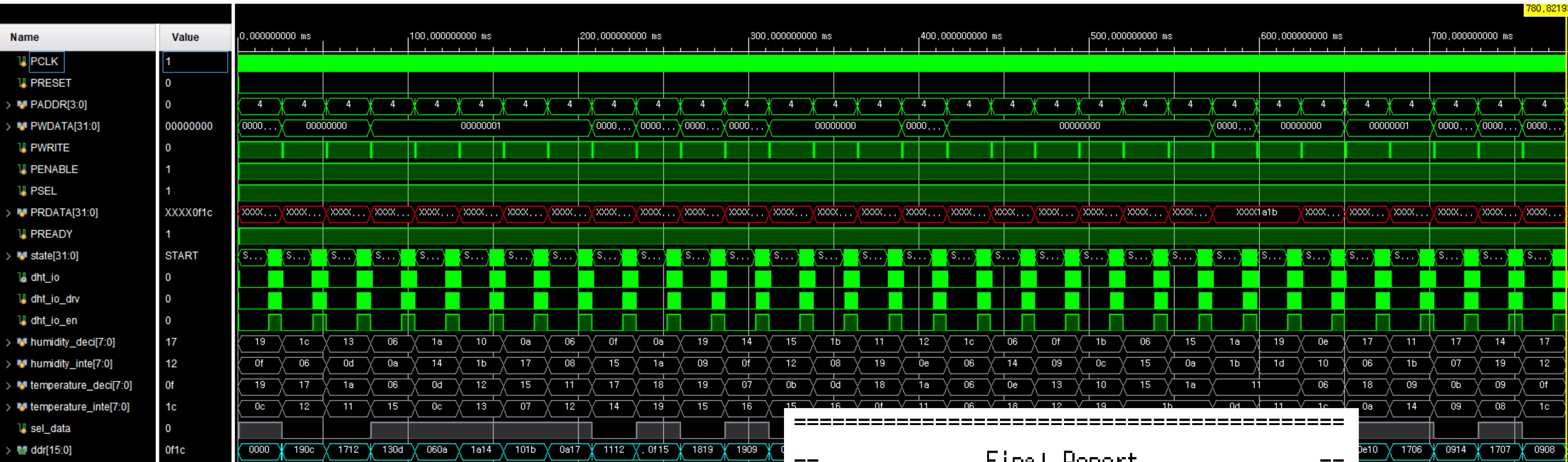
Aqua : DUT UDR Value

03. Peripherals – DHT-11



Name	Type	Offset	Description
DDR	Input / Data	0x00	Value
DMR	Output / Select Signal	0x04	0 : Temperature 1 : Humidity

03. Peripherals - Humidity Simulation




```
==============================================
==                Final Report              ==
==============================================
      Read Test   : 30
(^-^)b PASS Test   : HUMI = 13 / TEMP = 17
(;-;)p FAIL Test   : HUMI = 0 / TEMP = 0
      Total Test  : 30
==============================================
==============================================
```

Gray : Random Vaule

Aqua : DUT DDR Value

03. Peripherals - C Code

definition

```c
typedef struct {
    __IO uint32_t UCR;
    __IO uint32_t UDR;
} ULTRA_TypeDef;

typedef struct {
    __IO uint32_t DDR;
    __IO uint32_t DMR;
} DHT_TypeDef;
```

```c
#define ULTRA_BASEADDR        (APB_BASEADDR + 0x2400)
#define DHT_BASEADDR          (APB_BASEADDR + 0x2800)
#define ULTRA                 ((ULTRA_TypeDef *) ULTRA_BASEADDR)
#define DHT                   ((DHT_TypeDef *) DHT_BASEADDR)
```

function

```c
void Ultra_init(ULTRA_TypeDef *ultra, uint32_t power){
    ultra->UCR = power;
}

uint32_t Ultra_read(ULTRA_TypeDef *ultra){
    return ultra->UDR;
}
void DHT_init(DHT_TypeDef *dht, uint32_t moder){
    dht->DMR = moder;
}

uint32_t DHT_read(DHT_TypeDef *dht){
    return dht->DDR;
}
```

03. Peripherals - C Code

```c
uint32_t sw = Switch_read(GPIOB);

switch (sw) {
```

UltraSonic run code

```c
case (1 << 6):
    delay(500);
    Ultra_init(ULTRA, POWER_ON);
    delay(10);
    distance = Ultra_read(ULTRA);
    Ultra_init(ULTRA, POWER_OFF);
    FND_writeData(FND, distance);
    BLINK_init(BLINK, distance);
    BLINK_init(BUZZER, distance);
    delay(100);
    UART_Send_distance(UART, get_thousands_place(&distance),
    get_hundreds_place(&distance), get_tens_place(&distance),
    get_ones_place(&distance));
    break;
```

DHT-11 run code

```c
case (1 << 5):
    DHT_init(DHT, TEMPERATURE);
    delay(1000);
    temperature = DHT_read(DHT);
    FND_writeData(FND, temperature);
    delay(100);
    UART_Send_Temp(UART, get_thousands_place(&temperature),
    get_hundreds_place(&temperature), get_tens_place(&temperature),
    get_ones_place(&temperature));
    break;
case (1 << 4):
    DHT_init(DHT, HUMIDITY);
    delay(1000);
    humidity = DHT_read(DHT);
    FND_writeData(FND, humidity);
    delay(100);
    UART_Send_Humi(UART, get_thousands_place(&humidity),
    get_hundreds_place(&humidity), get_tens_place(&humidity),
    get_ones_place(&humidity));
    break;
```

Car Blinker run code

```
case (1 << 3): {
    LED_write(GPIOA, led_default);
    FND_init(FND,POWER_OFF);
    while(Switch_read(GPIOB) == (1<<3))
    {
    }

    LED_write(GPIOA, 0);
    FND_init(FND, POWER_ON);
    break;
}
```

Name	Input	Output
Left Signal Lamp	Switch[0]	led[8] FND
Right Signal Lamp	Switch[1]	led[9] FND
Hazard Light	Top Button	led[8], led[9] FND

03. Peripherals - C Code

Car Blinker run code
- State Determination

```c
#define DEFAULT_STATE        0
#define HAZARD_BLINK_STATE   1
#define RIGHT_BLINK_STATE    2
#define LEFT_BLINK_STAT      3
```

Case	Description	State
(1<<0)	Switch[0]	LEFT
(1<<1)	Switch[1]	RIGHT
(1<<4)	Top Button	Hazard

```c
switch(Switch_read(GPIOC))
{
    case (1<<0):
        blinker_state = LEFT_BLINK_STAT;
        break;

    case (1<<1):
        blinker_state = RIGHT_BLINK_STATE;
        break;

    case (1<<4):
        delay(10);
        if((Switch_read(GPIOC) == (1<<4)) && (btn_detect == 0))
        {
            btn_detect = 1;
            blinker_state ^= HAZARD_BLINK_STATE;
        }
        break;

    default:
        btn_detect = 0;
        if(!(blinker_state == 1))
        {
            blinker_state = DEFAULT_STATE;
            led_data = 0b11;
            LED_write(GPIOA, led_default);
            FND_init(FND,POWER_OFF);
            BLINK_init(BUZZER, 1);
        }
}
```

03. Peripherals - C Code

Car Blinker run code
- State-Driven Operation

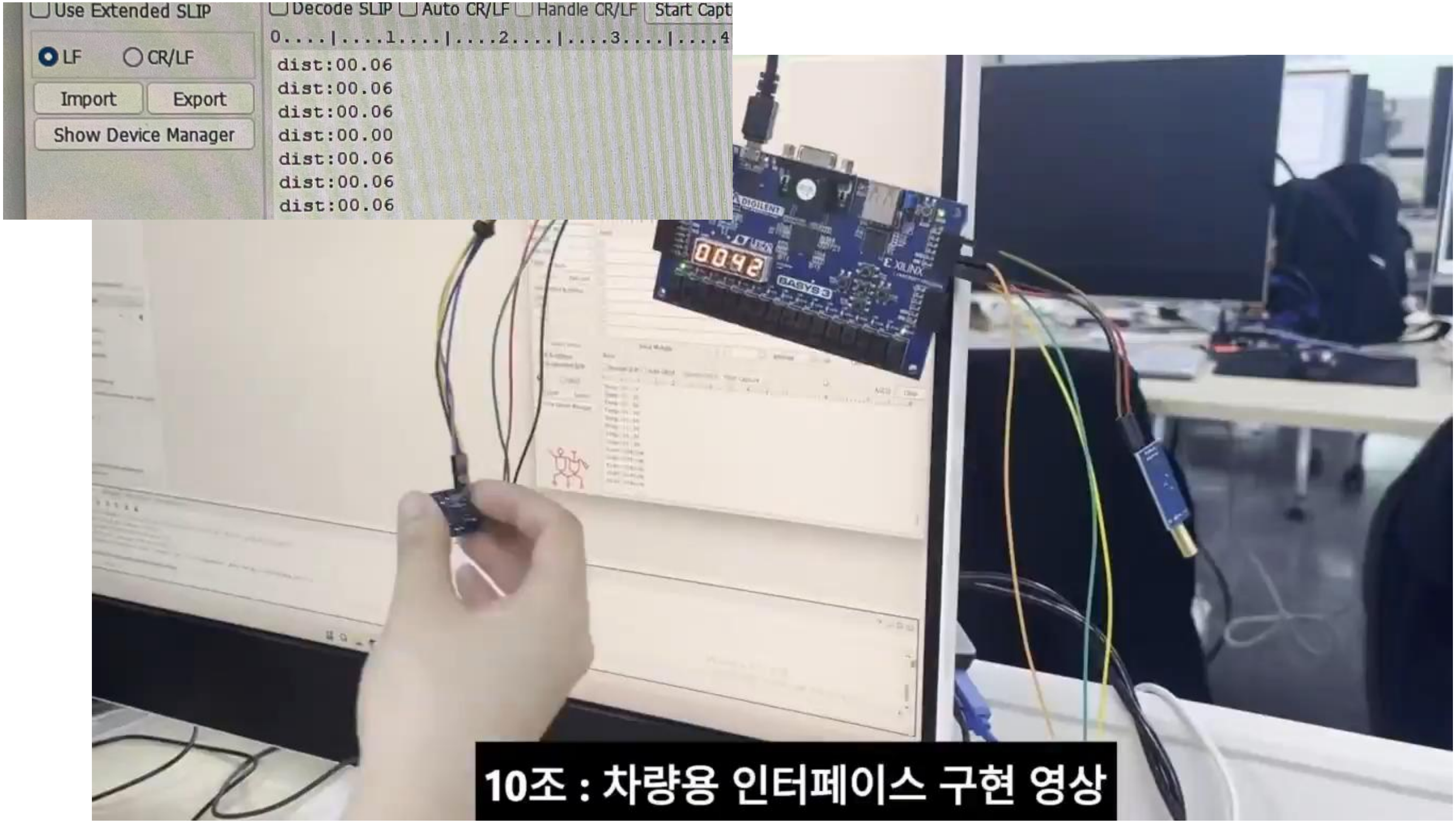
```c
case HAZARD_BLINK_STATE:
    ggambbak = 0b11;
    fnd_shape = HAZARD;
    if(Timer_read(TIMER2) == 0 && blink_flag == 0)
    {
        blink_flag = 1;
        led_data ^= ggambbak;
        fnd_blink = (led_data & ggambbak) == 0 ? POWER_OFF : POWER_ON;
    }
    else if(Timer_read(TIMER2) != 0) blink_flag = 0;

    delay(10);

    BLINK_init(BUZZER, 49);
    LED_write(GPIOA, led_data);
    FND_init(FND,fnd_blink);
    FND_writeData(FND, fnd_shape);
    break;
```

```c
case DEFAULT_STATE: break;
```

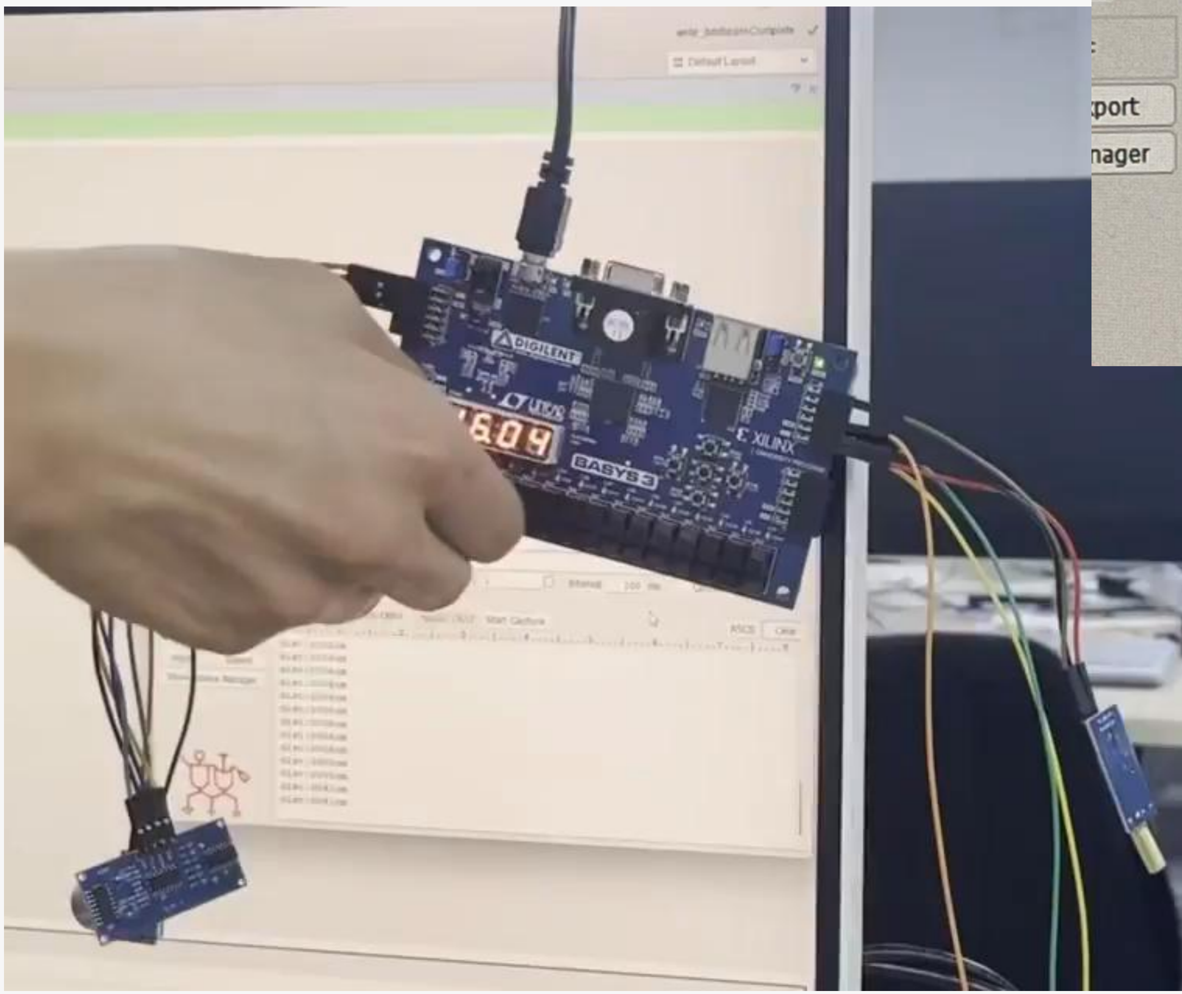
```c
case LEFT_BLINK_STAT:
    ggambbak = 0b10;
    fnd_shape = LEFT;
    if(Timer_read(TIMER2) == 0 && blink_flag == 0)
    {
        blink_flag = 1;
        led_data ^= ggambbak;
        fnd_blink = (led_data & ggambbak) == 0 ? POWER_OFF : POWER_ON;
    }
    else if(Timer_read(TIMER2) != 0) blink_flag = 0;

    delay(10);

    BLINK_init(BUZZER, 49);
    LED_write(GPIOA, led_data);
    FND_init(FND,fnd_blink);
    FND_writeData(FND, fnd_shape);
    break;
```

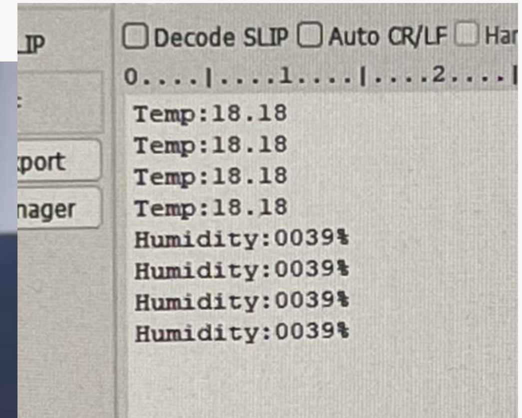
```c
case RIGHT_BLINK_STATE:
    ggambbak = 0b01;
    fnd_shape = RIGHT;
    if(Timer_read(TIMER2) == 0 && blink_flag == 0)
    {
        blink_flag = 1;
        led_data ^= ggambbak;
        fnd_blink = (led_data & ggambbak) == 0 ? POWER_OFF : POWER_ON;
    }
    else if(Timer_read(TIMER2) != 0) blink_flag = 0;

    delay(10);

    BLINK_init(BUZZER, 49);
    LED_write(GPIOA, led_data);
    FND_init(FND,fnd_blink);
    FND_writeData(FND, fnd_shape);
    break;
```

03. Peripherals - Run Video



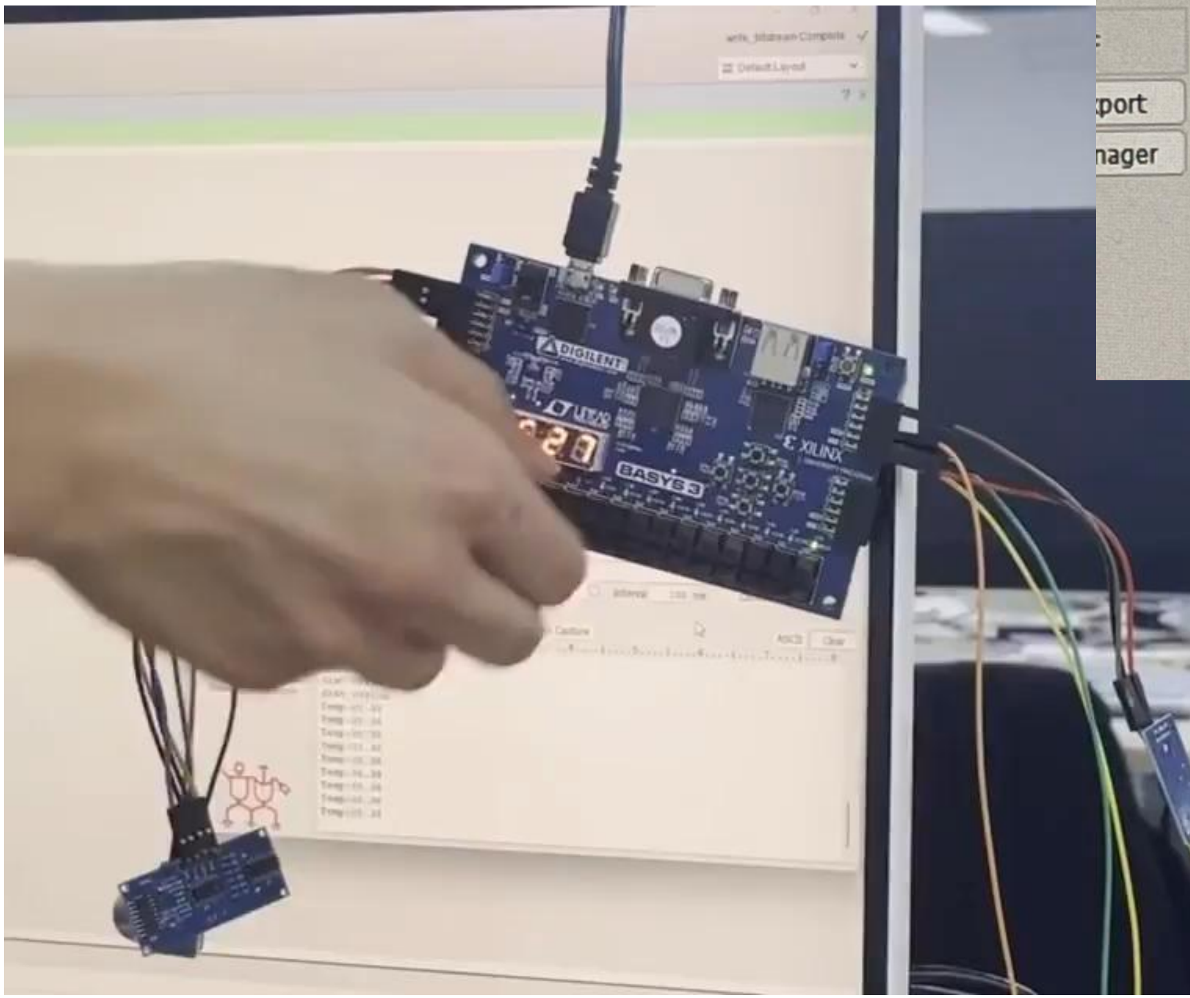
03. Peripherals - Run Video

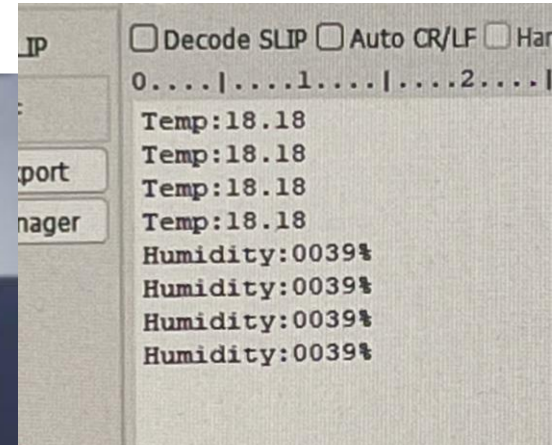




Temp

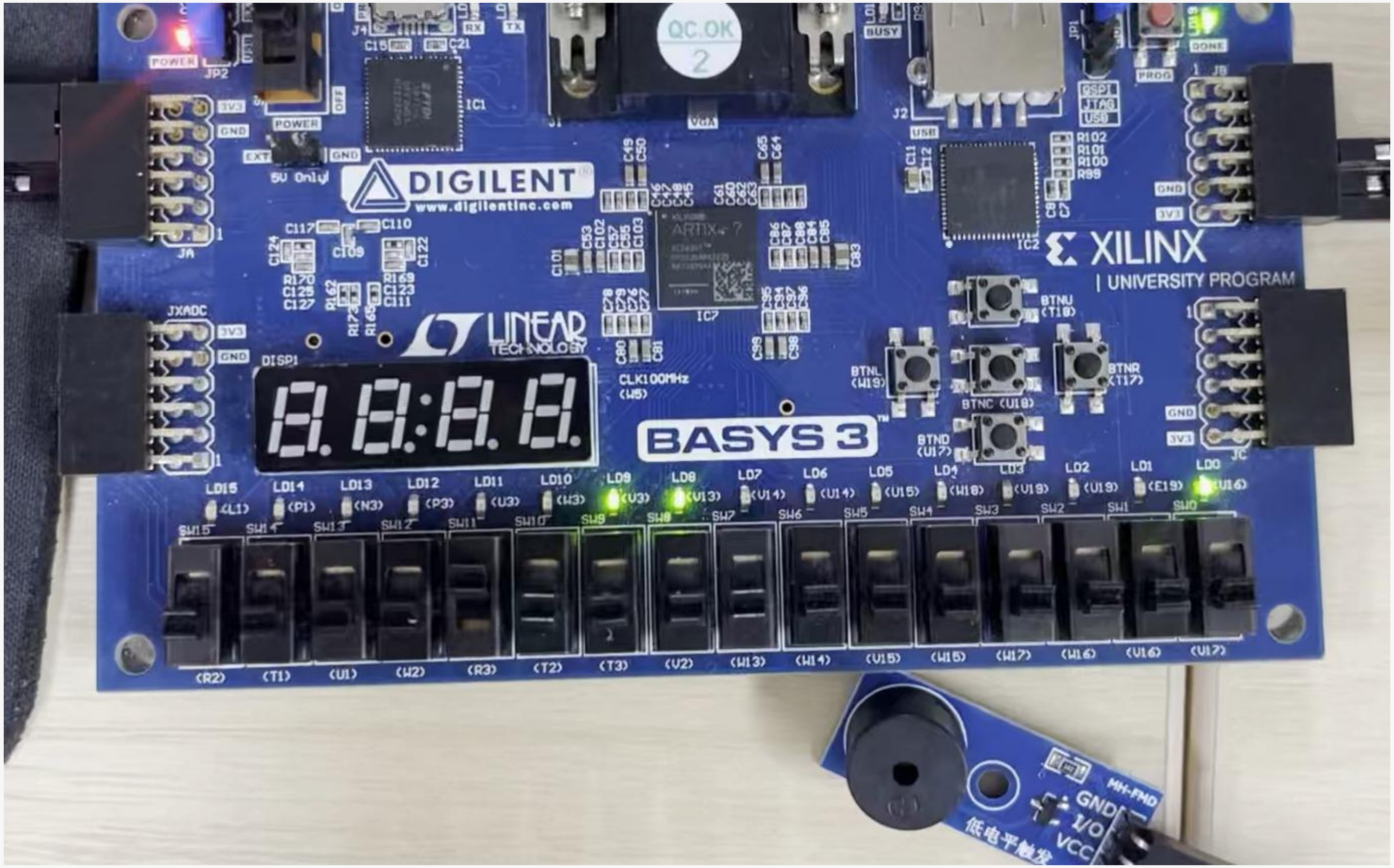
03. Peripherals - Run Video





Humidity

03. Peripherals - Run Video



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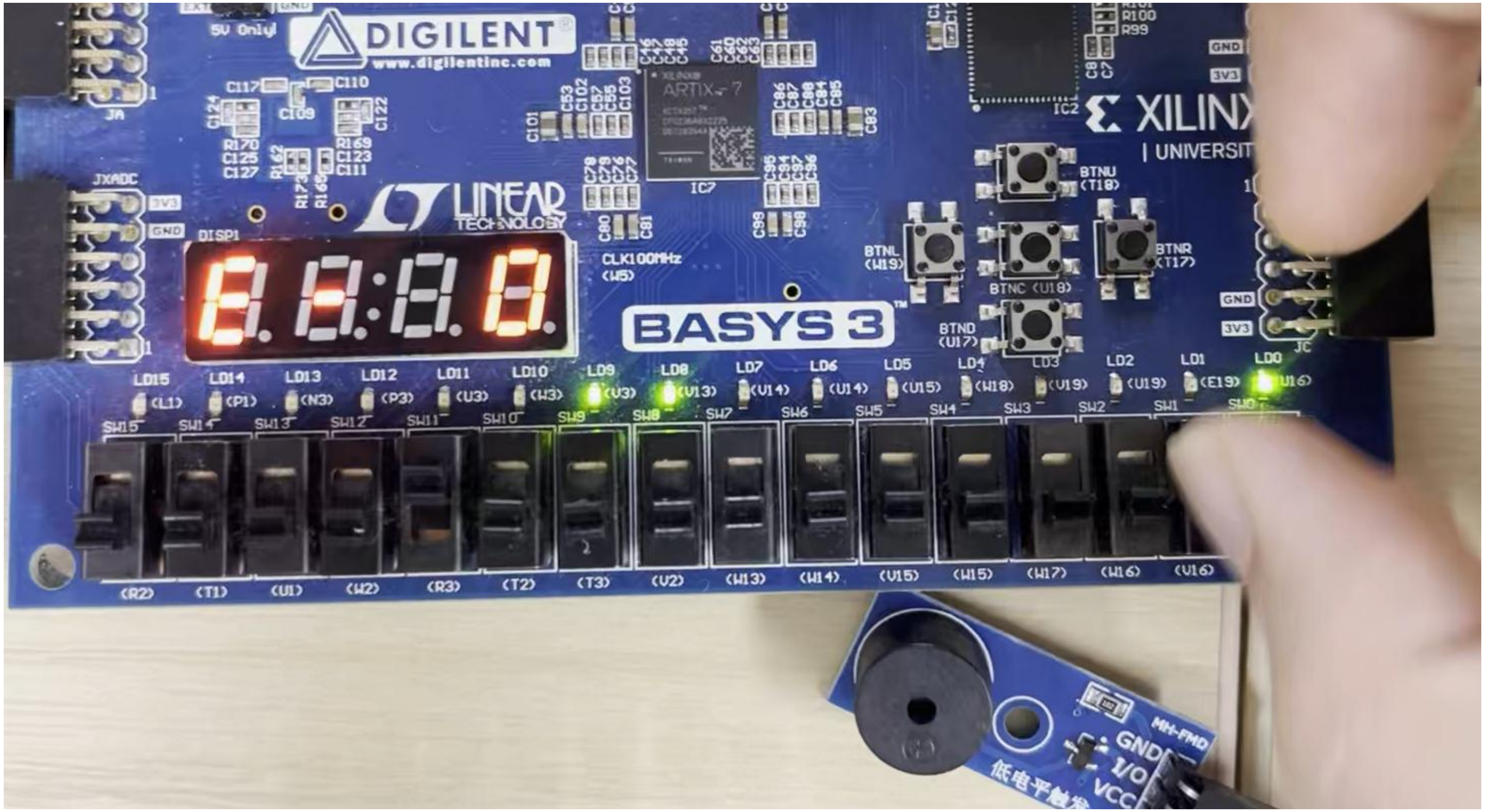
03. Peripherals - Run Video



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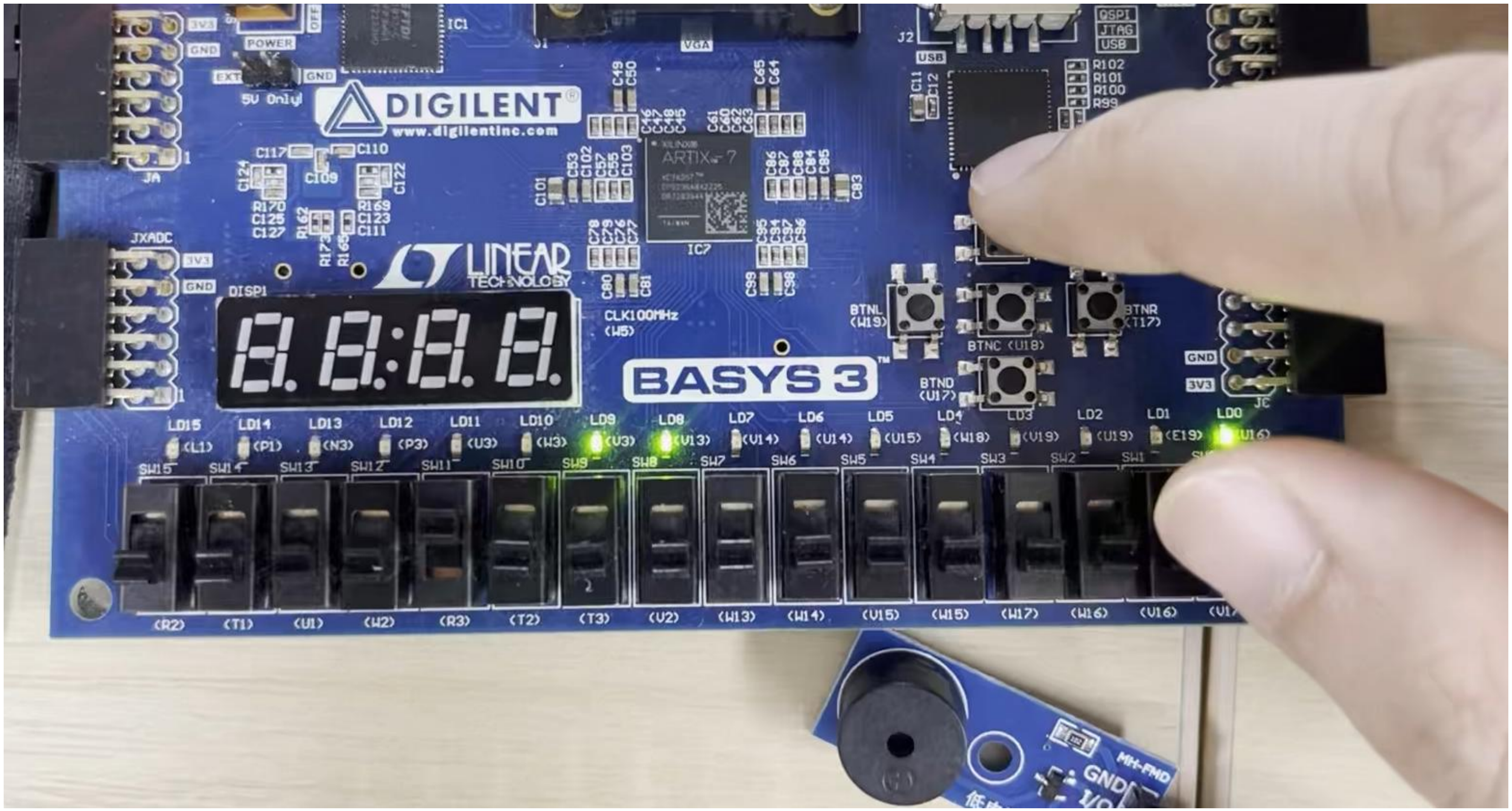
03. Peripherals - Run Video



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04. Conclusion - Trouble Shooting

One Block

State1

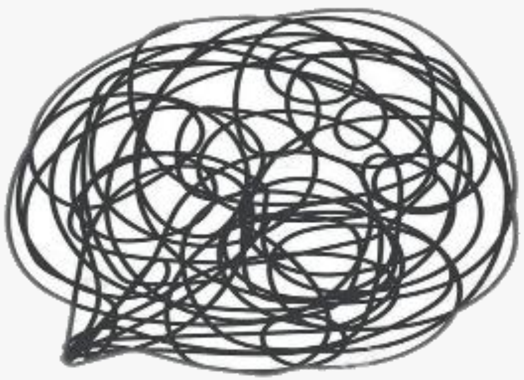
State-Driven Operation

State2

State-Driven Operation

Stat3

State-Driven Operation



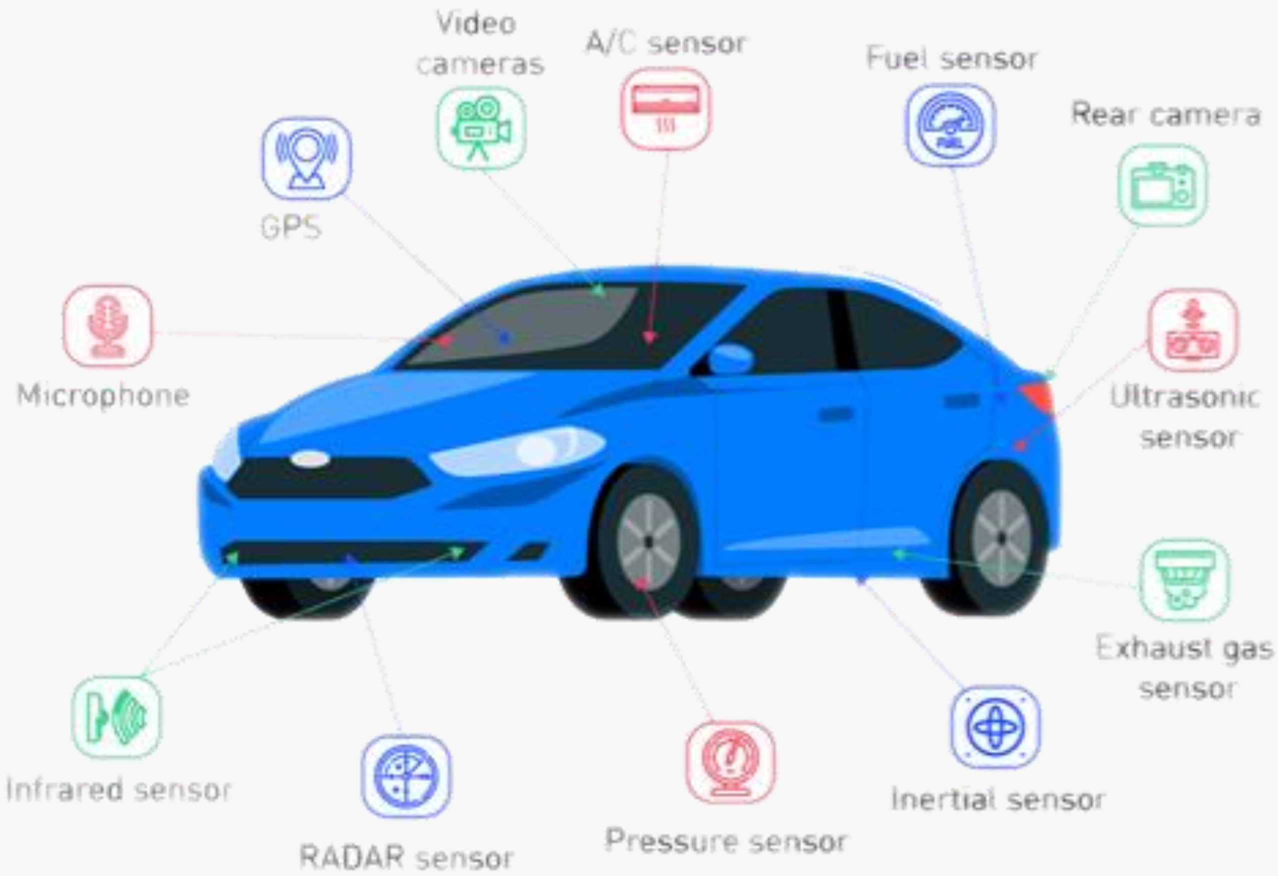
04. Conclusion - Trouble Shooting

Two Block

State-Driven Operation

State Determination

04. Conclusion



Thank you