

KYAMBOGO



UNIVERSITY

Tet la'ngech

Embedded Systems Technology

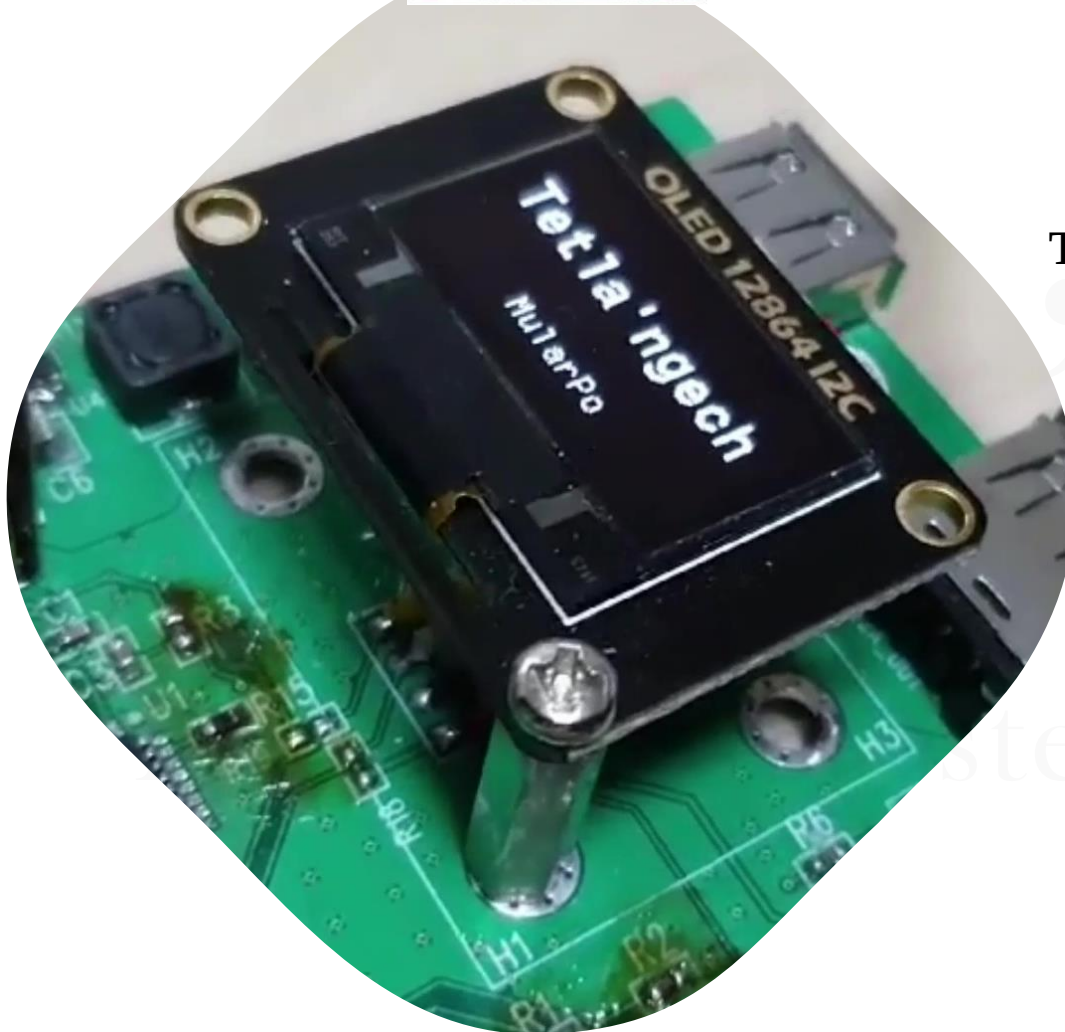
Third session – 03/09/2024

TETE 3102 MICROCONTROLLERS AND APPLICATIONS

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Embedded Systems

STM32 General Purpose Input Output (GPIO) Peripheral

“Innovating for progress with embedded systems”

GPIO: GPIO Basics

- ❑ GPIO pins serve as the interface between the microcontroller and the external world. They can be configured as either input or output.

Key attributes of GPIO:

- ❑ Direction – Input (reading signal) or Output (driving external device)
- ❑ Mode – Input/Output, Analog or Alternate function
- ❑ Speed – How fast the voltage changes
- ❑ Pull-up/pull-down – Optional resistors that affect the default state of the pin

GPIO: GPIO Registers

STM32 MCUs provide several registers to configure and control GPIO pins

- ❑ GPIOx_MODER: Sets the pin mode (input, output, alternate function, or analog).**
- ❑ GPIOx_OTYPER: Configures the output type (push-pull or open-drain).**
- ❑ GPIOx_OSPEEDR: Sets the output speed.**
- ❑ GPIOx_PUPDR: Configures pull-up and pull-down resistors.**
- ❑ GPIOx_IDR: Reads the input data register (for reading input pins).**
- ❑ GPIOx_ODR: Writes to the output data register (for setting output pins).**
- ❑ GPIOx_BSRR: Sets or clears individual bits in the output data register.**
- ❑ GPIOx_AFRL and GPIOx_AFRH: Configure alternate function mappings.**

GPIO: Operating modes

- ❑ Each port bit of the general-purpose I/O (GPIO) ports can be individually configured by software in several modes:

**Output mode: push-pull
or open drain + pull-
up/down**

**Input mode: floating,
pull-up/down, analog**

**General
Purpose
Input
Output**

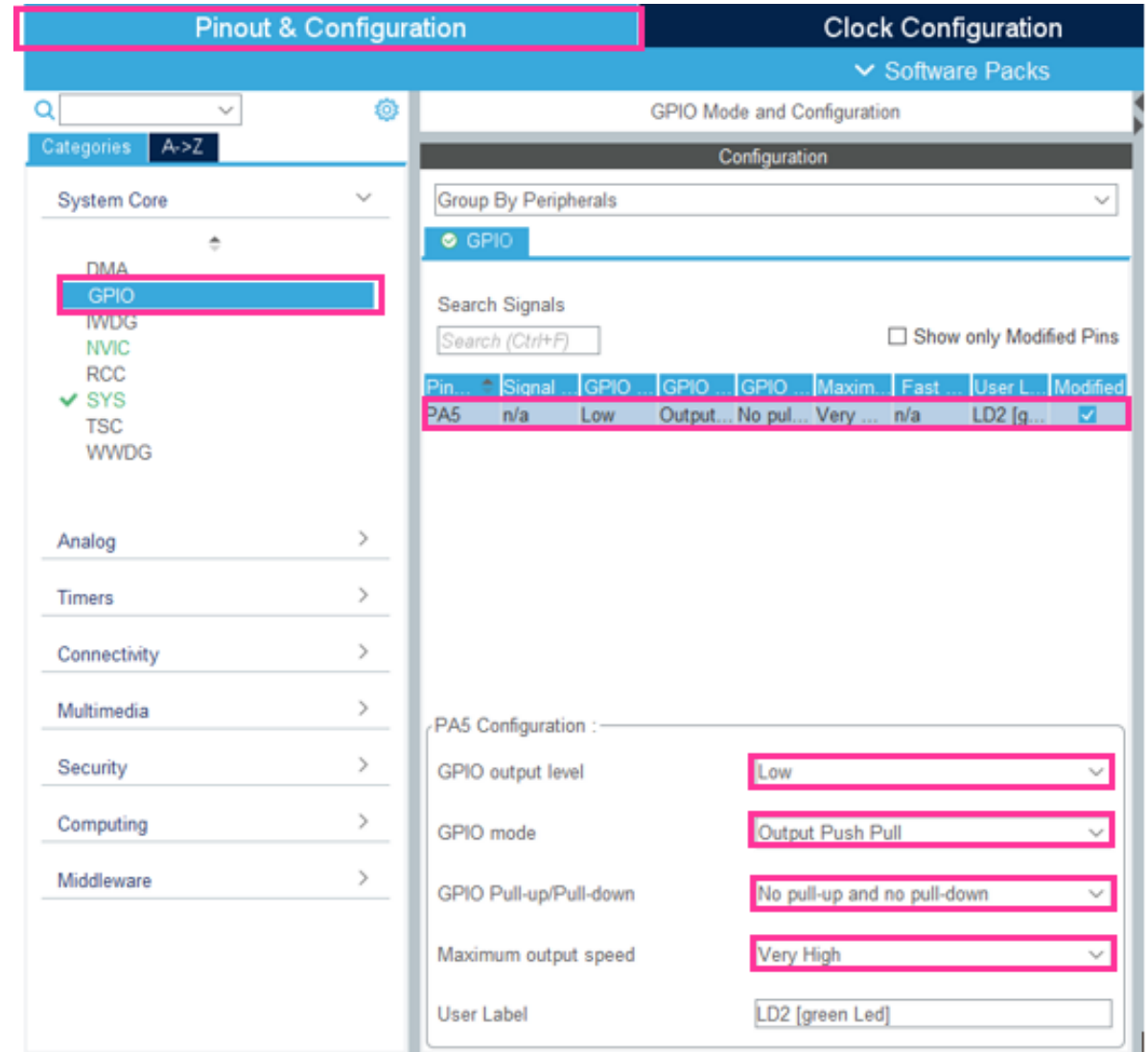
Alternate functions:

- ❑ USART/UART
- ❑ SPI
- ❑ I2C
- ❑ TIMERS/PWM
- ❑ External Interrupts

Analog (ADC)

GPIO: Pin Configuration

- ❑ Configure the Pin Mode:
input/output
- ❑ Set Output Type and Speed (if output).
- ❑ Configure Pull-up/Pull-down (if needed).
- ❑ Set the pull-up/pull-down resistors
- ❑ Read/Write/Toggle.



GPIO: Basic Functionalities

- ❑ Write – Set the status of a GPIO pin

`HAL_GPIO_WritePin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin, GPIO_PinState PinState)`

`HAL_GPIO_WritePin(Port Number, Pin Number, Pin State)`

- ❑ GPIO – General Purpose Input Output

- ❑ GPIO_TypeDef*, uint16_t & GPIO_PinState are data types

- ❑ GPIOx – Port Number

- ❑ GPIO_Pin – Pin Number

- ❑ PinState – State of GPIO pin

- ❑ PinState; GPIO_PIN_RESET (0), GPIO_PIN_SET (1)

- ❑ Sample application: Turn LED on or off



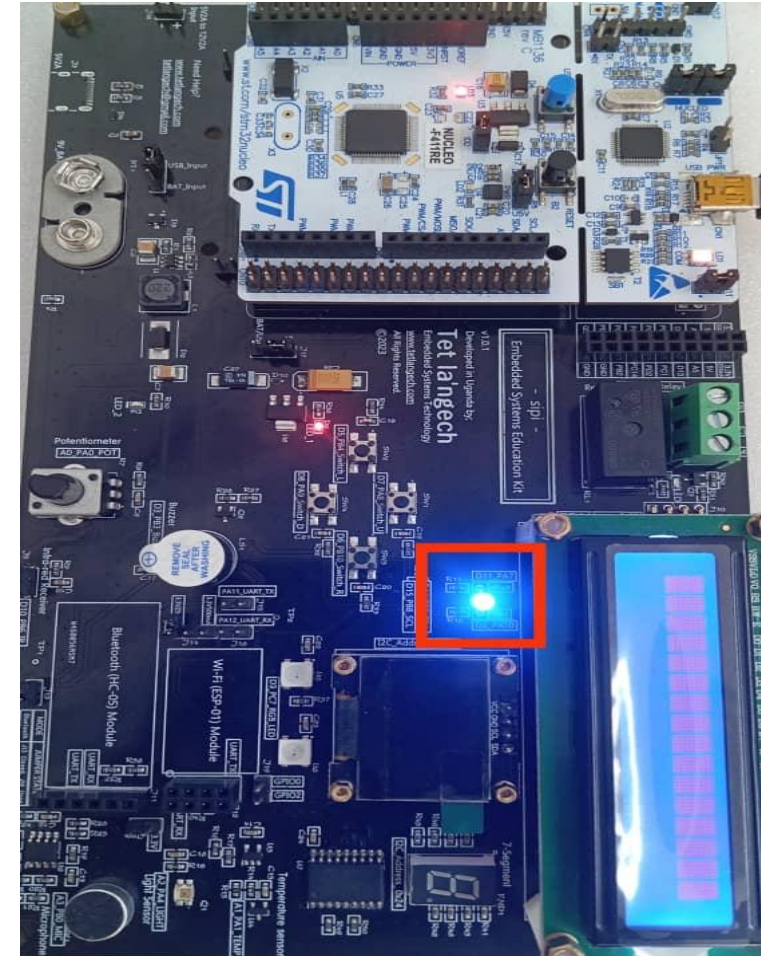
GPIO: Basic Functionalities

❑ Toggle (Blink) – Change the status of a GPIO pin

HAL_GPIO_TogglePin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin)

HAL_GPIO_TogglePin(Port Number, Pin Number)

❑ Sample application: Blink LED (Turn LED on & off)



Task 1: Students

- ❑ Blink the BLUE_LED for five times every second and then turn on the RED_LED for five seconds.

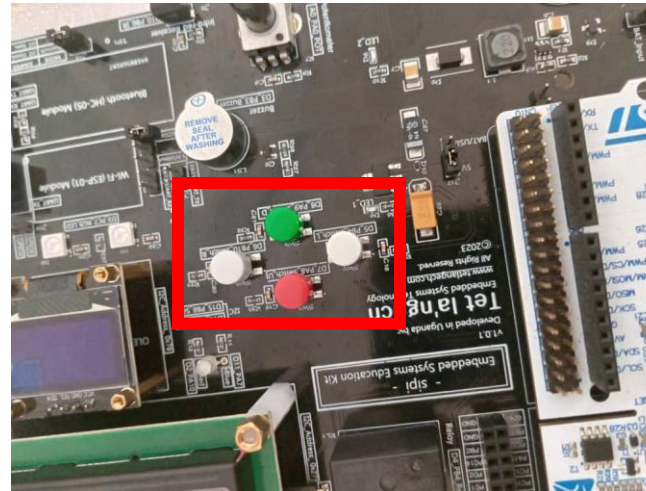
GPIO: Basic Functionalities

❑ Read – Get the status of a GPIO pin

`HAL_GPIO_ReadPin(GPIO_TypeDef* GPIOx, uint16_t GPIO_Pin)`

`HAL_GPIO_ReadPin(Port Number, Pin Number)`

❑ Sample application: Read input from Tactile switch on Sipi education kit



GPIO: Basic Functionalities

External Interrupt – Rising, Falling, Rising or Falling

- ❑ Rising – Rise in Voltage

- ❑ Falling – Fall in Voltage

- ❑ Rising or Falling – Rise or Fall in Voltage

```
void HAL_GPIO_EXTI_Callback(uint16_t GPIO_Pin)
```

```
void HAL_GPIO_EXTI_Callback(Pin Number)
```

Sample application:

- ❑ Programming almost all sensors,

- ❑ Using sipi tactile switches to perform a certain task e.g. blink
an BLUE_LED

