

HOMework 1

Due date:

Sunday, September 22, 14:30

1- Answer the following question, using NUCLEO manual and datasheet:

- a. If you need information about the connection within the NUCLEO board (e.g. at which microcontroller pin is LD2 connected?) which document would you use?

We are going to read the Nucleo Schematic.pdf

- b. At which page of the NUCLEO manual do you find the correspondence of extension connectors pins and microcontroller pins?

It start on page 33 on 135.

- c. Which is the meaning of different blinking speed and colors of LD1 in the NUCLEO board?

Color / State	Meaning
Red Slow Blink	Standby mode / No communication
Red fast Blink	Active communication or Debug mode
Red Solid	Error in communication with the target MCU
Green Blinking	Firmware update in progress
Green Solid	Connected and ready
Off	ST-LINK not powered / No USB connection

- d. What is the Jumper J6 used for?

It is used to measure the MCU current consumption

- e. What is a solder bridge?

It's a connection of two or more pads by an excessive application of solder that creates a "bridge" between them

- f. What do you have to do if you want to use PH0 and PH1 as normal GPIO ?

We need to disable their default functionality as the high-speed external oscillator (HSE) input and output. For that we need to open SB54 and SB55 solder bridges.

- g. On your NUCLEO board how is the LSE clock configured? Can you use PC14 and PC15 as normal GPIO?

The LSE is configured like an oscillator working at a maximum of 32.768 kHz. It is connected to PC14 and PC15 so we can't use these PINs as normal GPIO.

- h. If you want to send/receive data with a virtual serial port (to communicate with a computer), which pins do you select and which solder bridge should be connected/disconnected?

We are going to use USART with the PINs PA2(TX) and PA3(RX). We need to connect SB13 and SB14.

- i. In the NUCLEO board schematics which is the component name of the F401RE microcontroller and of the ST-Link microcontroller?

For the ST-Link microcontroller, the name is STM32F103CBT6. For the F401RE microcontroller, the name is MCU_LQFP64.

- j. Which pin of the morpho connector can be connected to PA6?

It can be connected to the PIN 28 of the morpho connector, but we need to connect the solder bridge SB39.

2- Look at the STM32F401RE data-sheet and answer the following questions:

- a. Which is the meaning of each part of the name STM32F401RE?

- **STM32:** STM32 family (32-bit ARM Cortex-M microcontroller)
- **F:** STM32F series (General-purpose, performance-focused)
- **4:** STM32F4 subfamily (ARM Cortex-M4 core)
- **01:** Specific model (STM32F401)
- **R:** LQFP64 package (64 pins)
- **E:** 512 KB Flash memory

- b. Which is the package of the STM32F401RE?

It's an LQFP64 package

- c. What voltages are allowed as Vdd power supply? Which is the maximum acceptable variations between different pins of Vdd? What is and how is Vbat used?

Vdd is between 1,6V and 3,6V. The maximum acceptable variations between different pins of Vd should be less than 50mV

Vbat is between 1,6V and 3,6V and supply power to the RTC and backup registers when the main Vdd supply is turned off.

- d. Which is the typical current consumption (order of magnitude)?

It depends of the mode of the microcontroller

- Run Mode : 21,8 mA
- Sleep Mode 16,6 mA
- Stop Mode : 111 uA
- Standby Mode : 2,8 uA

- e. Which peripherals are connected to AHB1, APB1 and APB2?
- AHB1 = GPIO, CRC, DMA
 - APB1 = TIM, PWR, USART, I2C, SPI, I2S, WWDG
 - APB2 = TIM, ADC, SPI, USART, SDIO, SYSCFG
- f. Which is the difference in terms of clock frequency between APB1 and APB2?
The clock frequency is different between APB1 and APB2. For APB1, it's 42MHz and for APB2 it's 84MHz.
- g. How many channels does the ADC have? How many bits? Which is the maximum sampling frequency (and how is it affected by Vdda)?
The STM32F401RE has 16 ADC for the ADC, with a resolution of 12 bits and a maximum sampling frequency of 30MHz. The more the voltage of Vdda increase, the more the frequency of the ADC increase too.
- h. What is the Analog Watchdog?
It's a feature of the STM32F401RE which permit to monitor the analog input levels of the ADC and to ensure that the monitored voltage levels remain within specified limits.
- i. Which are the values of the S&H resistance and capacitance?
S&H (Sample and Hold) resistance has a value of 6k Ω and the capacitance has a value of 4 pF
- j. Which is the maximum CPU clock frequency?
The maximum frequency of the CPU is 84 MHz.
- k. Which is the range of operating frequencies of HSE and LSE clocks?
HSE as a range of operating frequencies of 4 to 26MHz.
LES has a frequency of 32.768 kHz.
- l. List all the communication interfaces (and also how many of them).
- I²C \rightarrow 3x
 - USART \rightarrow 3x
 - SPI \rightarrow 4x
 - SDIO \rightarrow 1x
 - USB 2.0 \rightarrow 1x
- m. Which are the typical clock frequencies for the I2C and SPI interfaces?
The I²C interfaces can work up to 100kHz for the standard mode and up to 400kHz for the fast mode
The SPI interfaces can work up to 42MHz

- n. What is the NVIC? How many priority levels can it manage?

It manages all the interrupt requests and provides a mechanism for handling them efficiently. It can manage up to 16 priority levels.

- o. How large is the embedded flash memory? And the SRAM memory?

There is a 512kB of flash memory and 96kB of SRAM memory.

- p. What is the DMA? Which peripherals can use the DMA? How many streams are supported at maximum? What is the circular buffer management?

DMA (Direct Memory Access) allows peripherals to directly transfer data to and from memory without involving the CPU.

The peripherals which can use the DMA are :

- ADC
- SPI
- I²C
- USART
- TIMERS
- DAC
- SDIO

The microcontroller can support up to 8 DMA stream.

Circular buffer management in DMA allows continuous data streaming.

- q. What is the RTC?

The real-time clock (RTC) is an independent BCD timer/counter. Dedicated registers contain the second, minute, hour (in 12/24 hour), week day, date, month, year,

- r. What is PIN60 in the STM32F401RE?

PIN60 = PA0

We can use it like :

- GPIO
- ADC Channel
- TIM2_CH1 (PWM Generation)
- EXTI0

- s. What is an alternate function? Make some examples.

An alternate function is a PIN of the microcontroller which work for a specific interface rather than a GPIO like PA2 for the USART TX.

- t. Which is the maximum source/sink source current of the GPIOs? What are the output voltage levels of GPIOs?

The maximum source/sink source current of the GPIO is up to 25mA per PIN.

The output voltage levels of GPIO is 3,3V when on high level and 0V at low level.

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- u. Which is the value of the internal reference voltage?

V_{ref} needs to be between 1,7V and 3,6V