

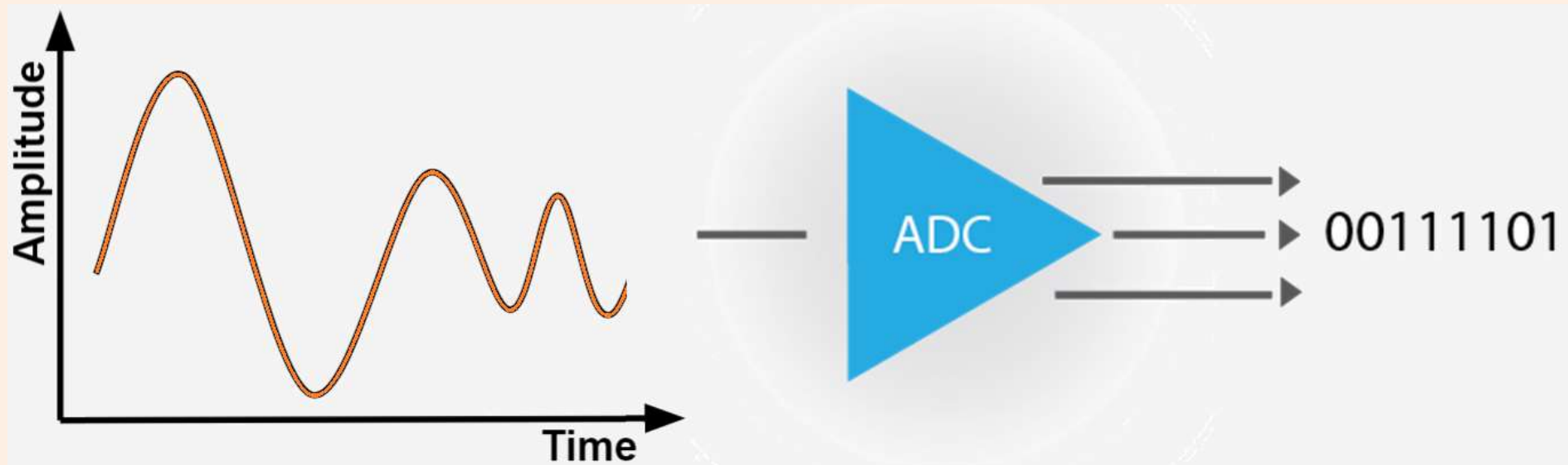
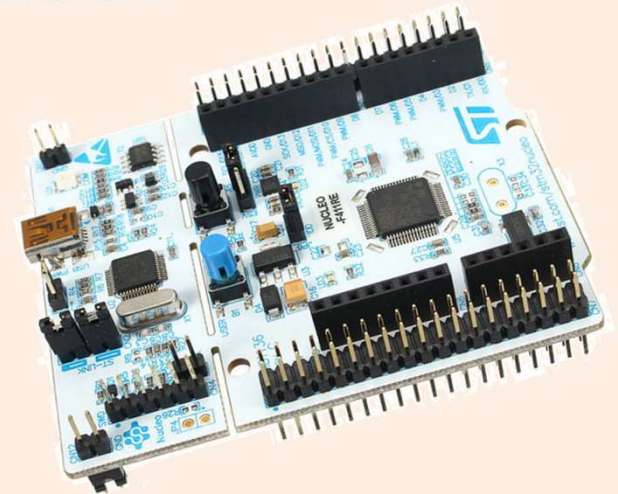
Competências Transferíveis

Microcontroladores e Interação com Sensores e Atuadores

2021-2022

Rui Escadas Martins

ADC – Analog to Digital Converters

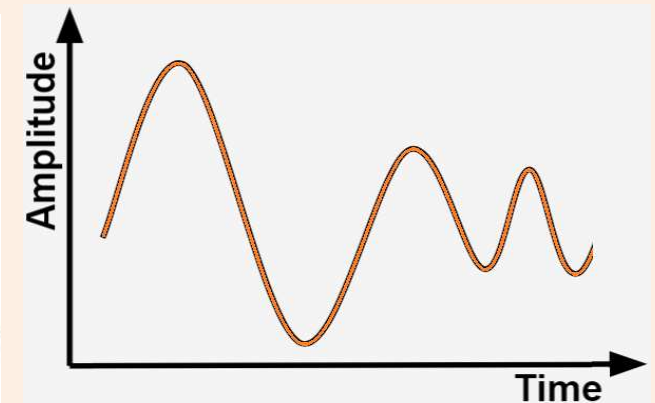
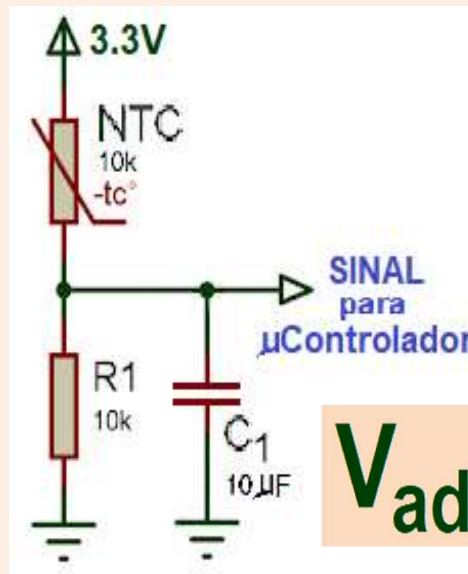
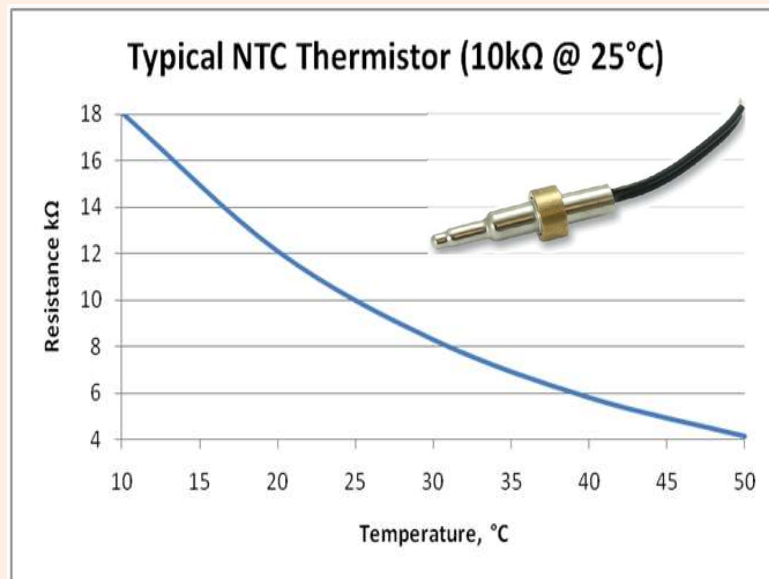


Analog Digital converters

O que são:

São componentes que convertem uma grandeza analógica, geralmente uma tensão, na sua representação binária.

Tipicamente, a tensão é gerada através do condicionamento (amplificação, filtragem, etc) do sinal gerado por um sensor.

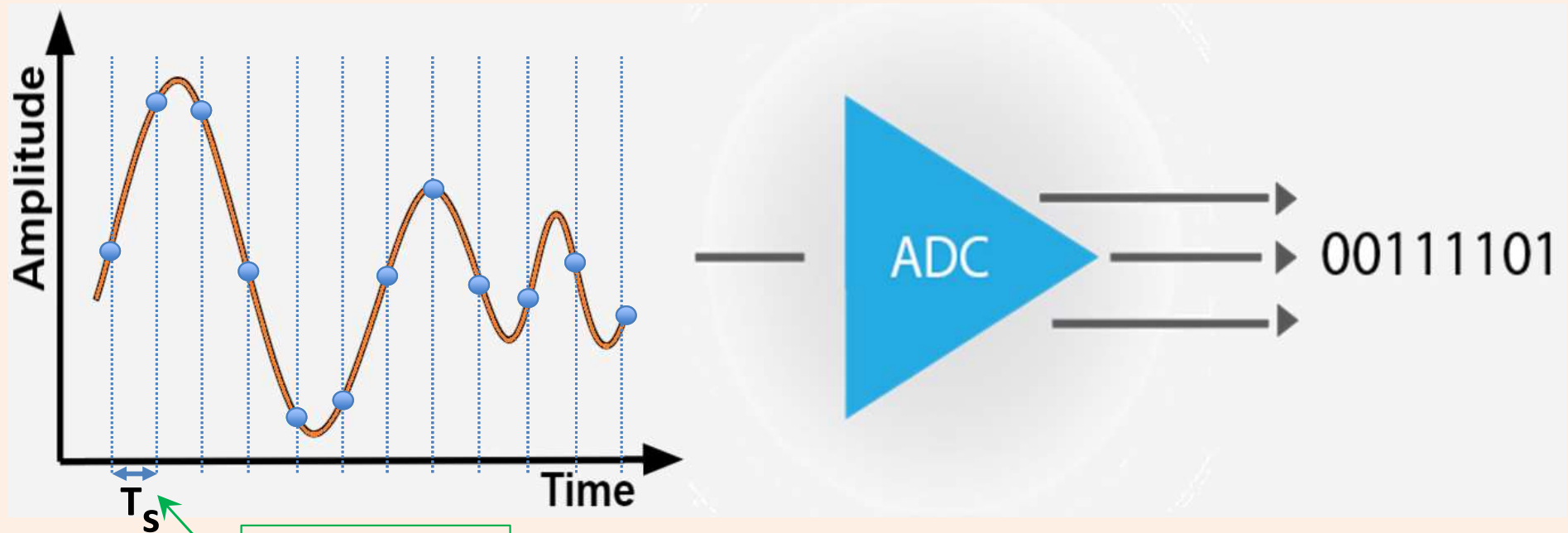


$$V_{adc} = R_1 / (R_1 + R_{NTC})$$

Analog Digital converters

O que são:

São componentes que convertem uma grandeza analógica, geralmente uma tensão, na sua representação binária.

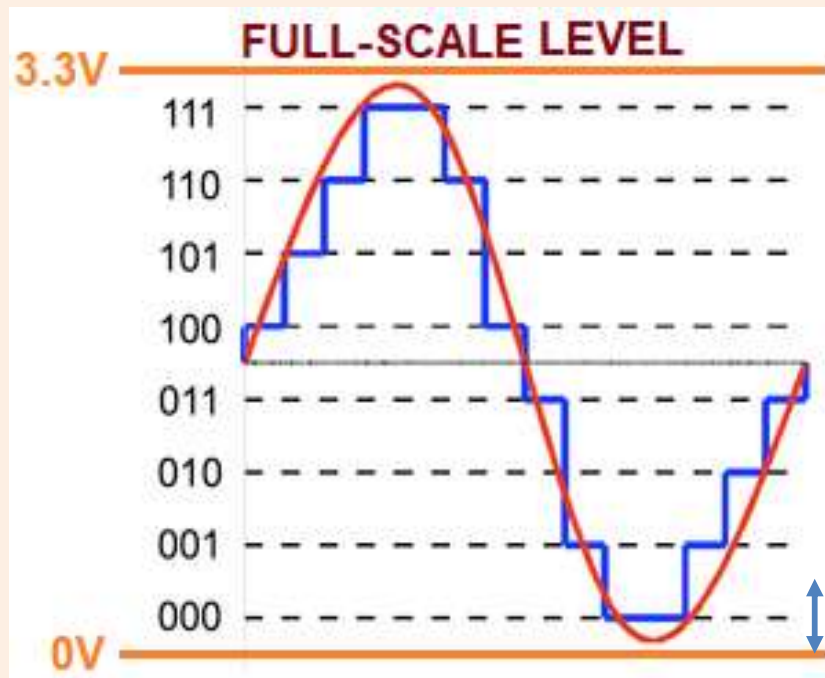


Normalmente especifica-se a **frequência de amostragem**: $F_s = 1/T_s$ (amostras/s)

Analog Digital converters

O que são:

São componentes que convertem uma grandeza analógica, geralmente uma tensão, na sua representação binária.



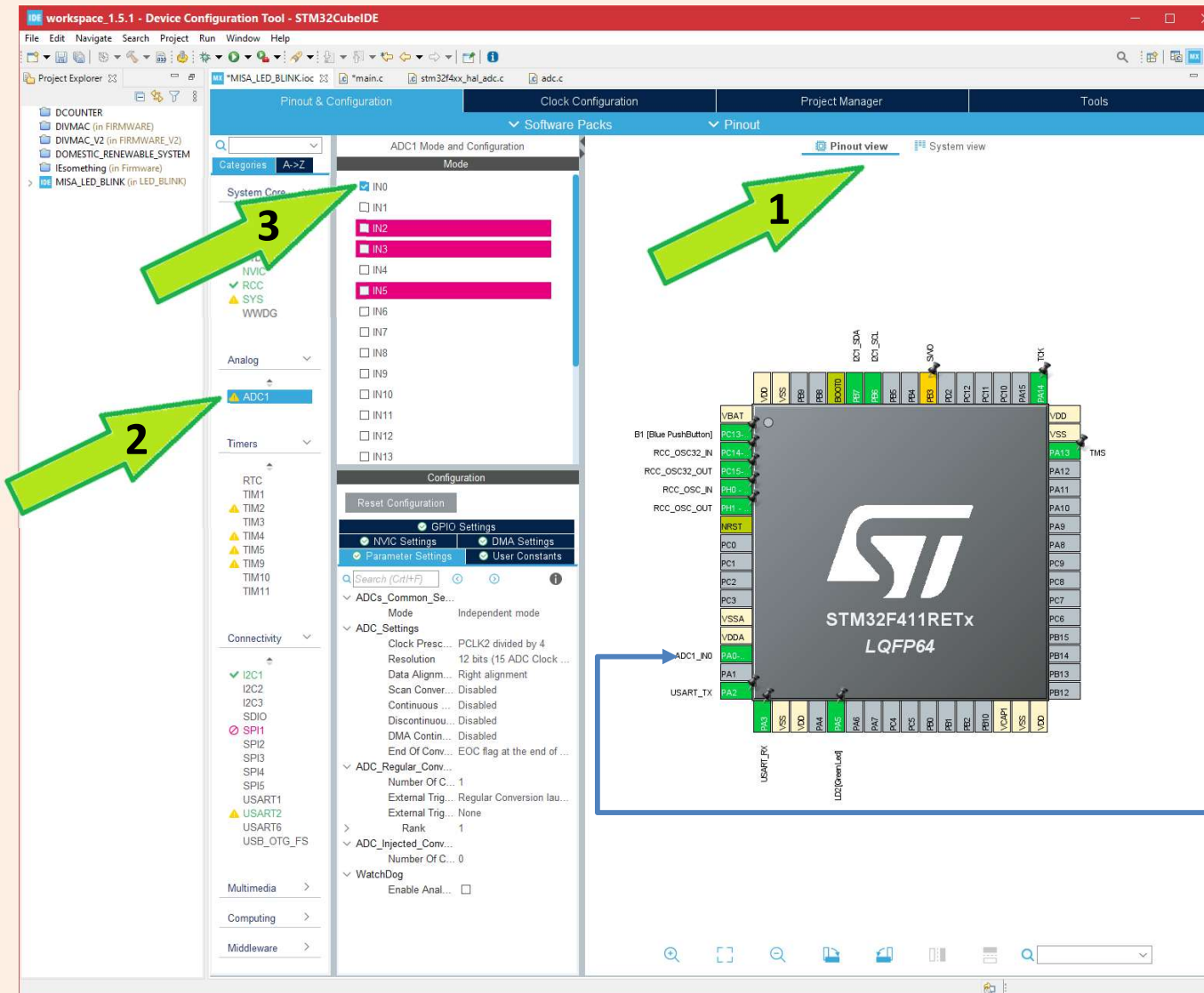
Todos os valores (sinal contínuo) que estão compreendidos neste intervalo são codificados com o mesmo Código Binário!

A **Resolução** de uma ADC é o valor mínimo do intervalo de tensão que causa a mudança da saída digital.

Normalmente especifica-se em **Número de bits** – por exemplo, uma ADC de 3-bits (como na figura) tem $2^3 = 8$ níveis possíveis. Para se conseguir uma representação mais “fiel” na prática são usadas resoluções muito superiores. A ADC usada tem 12-bits (ou seja $2^{12} = 4096$ níveis).

Analog Digital converters

Procedimento: em **Pinout View** (Seta1) seleccionar **ADC1** (Seta2), depois **IN0** (Seta3),



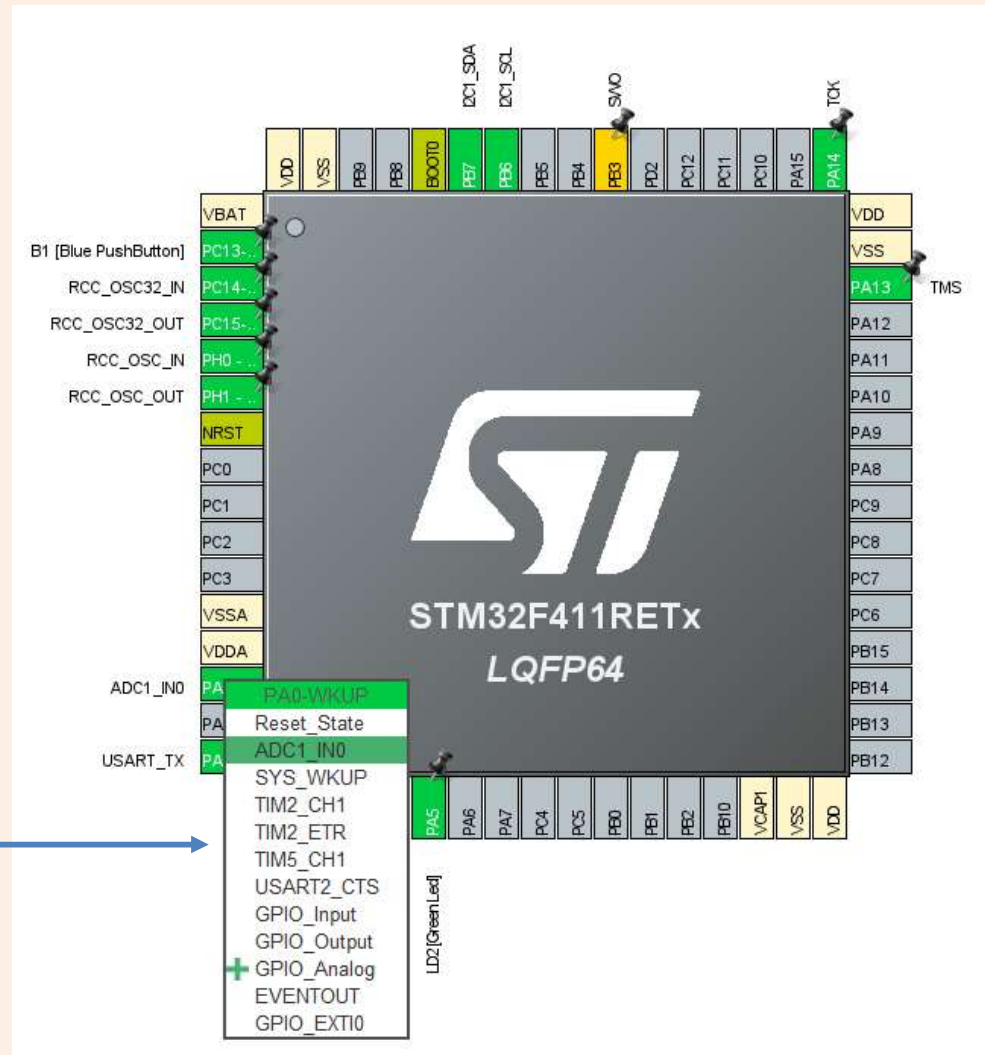
Reparar que este pino fica verde (significa que está a ser usado).

Analog Digital converters

Procedimento: seleccionar o pino **ADC1_IN0** com o botão esquerdo

Pode-se ver o tipo de funcionalidades possíveis para um dado pino. Neste caso está como ADC1_IN0 + GPIO_Analog

NOTA: Caso se queira fazer regressar o pino a um estado “Não utilizado” seleccionar: **Reset_State**

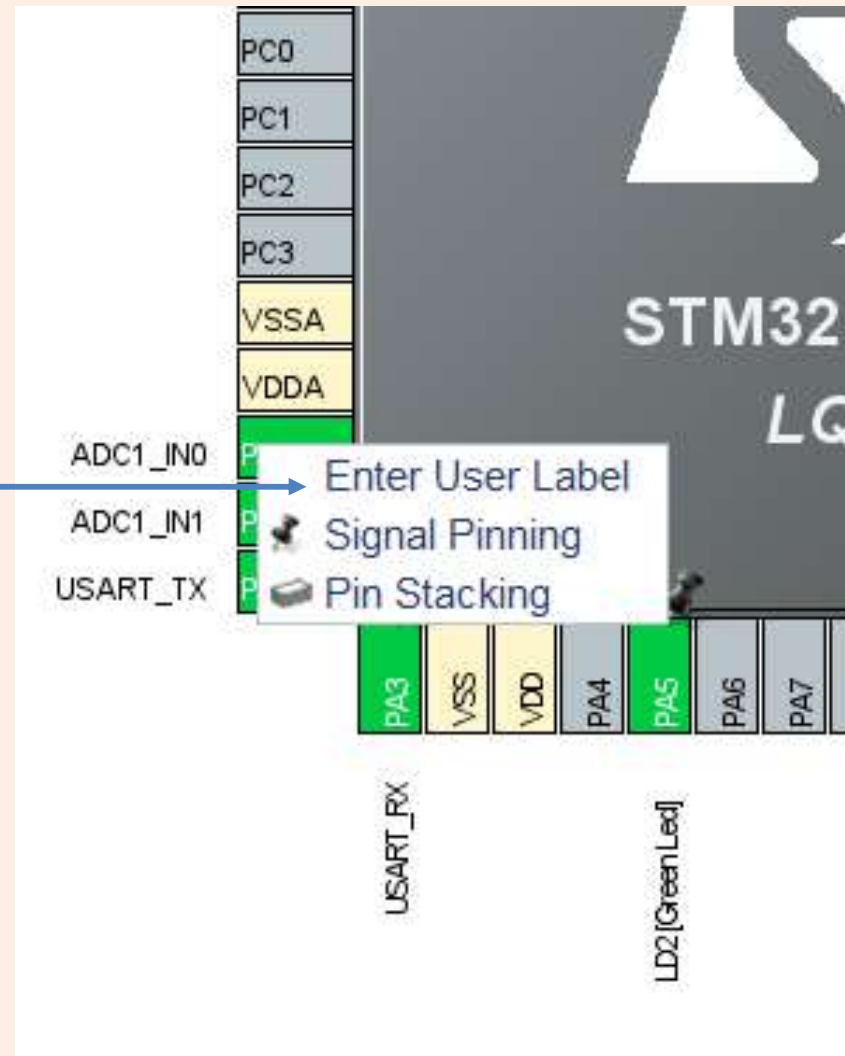


Analog Digital converters

Procedimento: seleccionar o pino **ADC1_IN0** com o botão direito

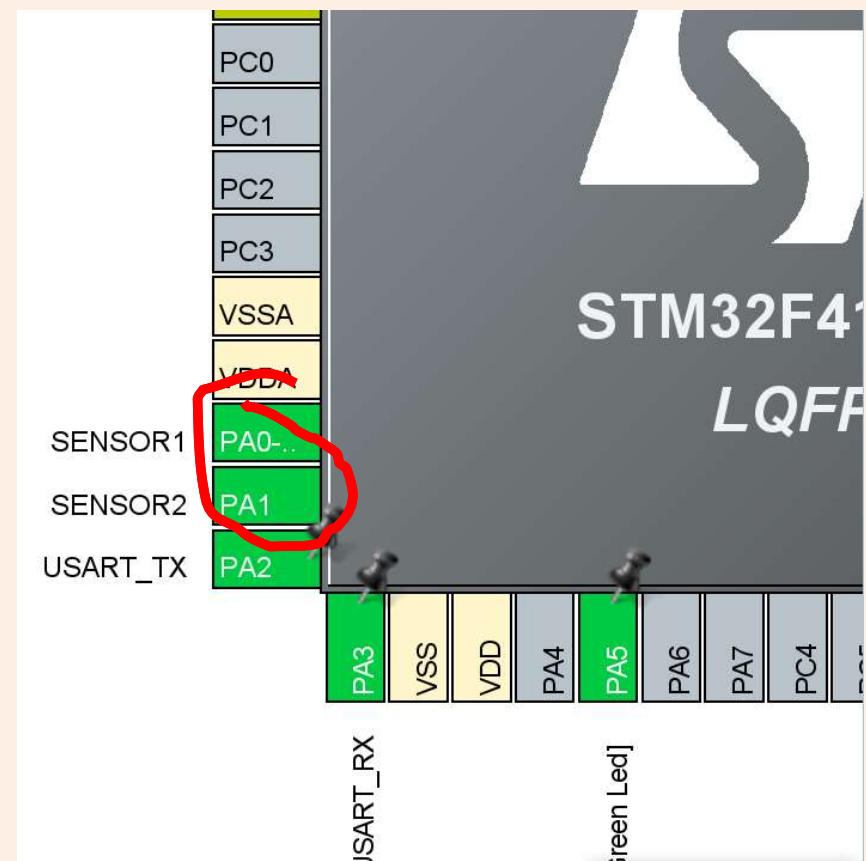
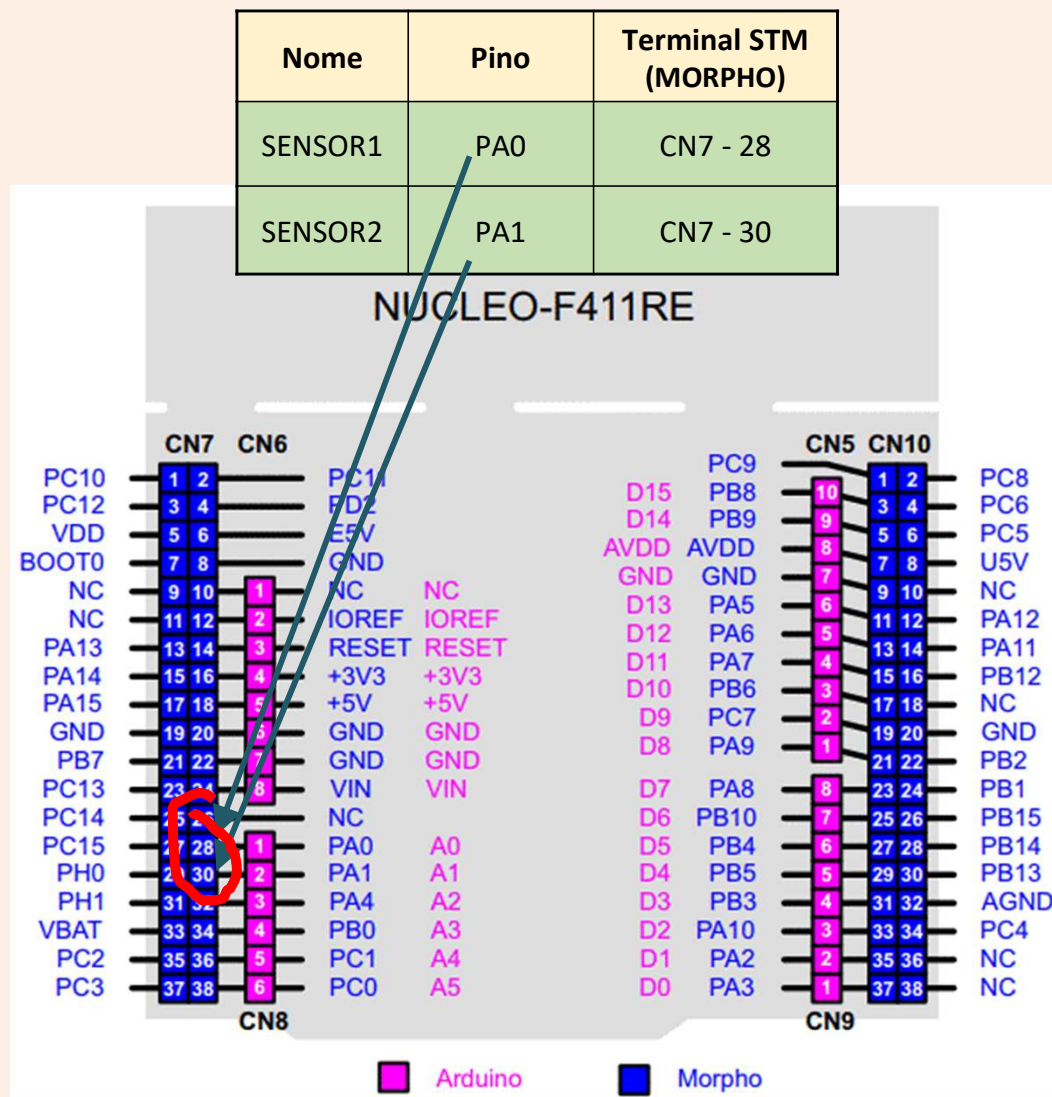
Pode-se alterar o nome do pino para ser mais fácil entender a sua função...

Este nome vai ter correspondência no Código Gerado, para também facilitar a sua identificação



Analog Digital converters

Procedimento: identificar os pinos e relacioná-los com os terminais físicos.



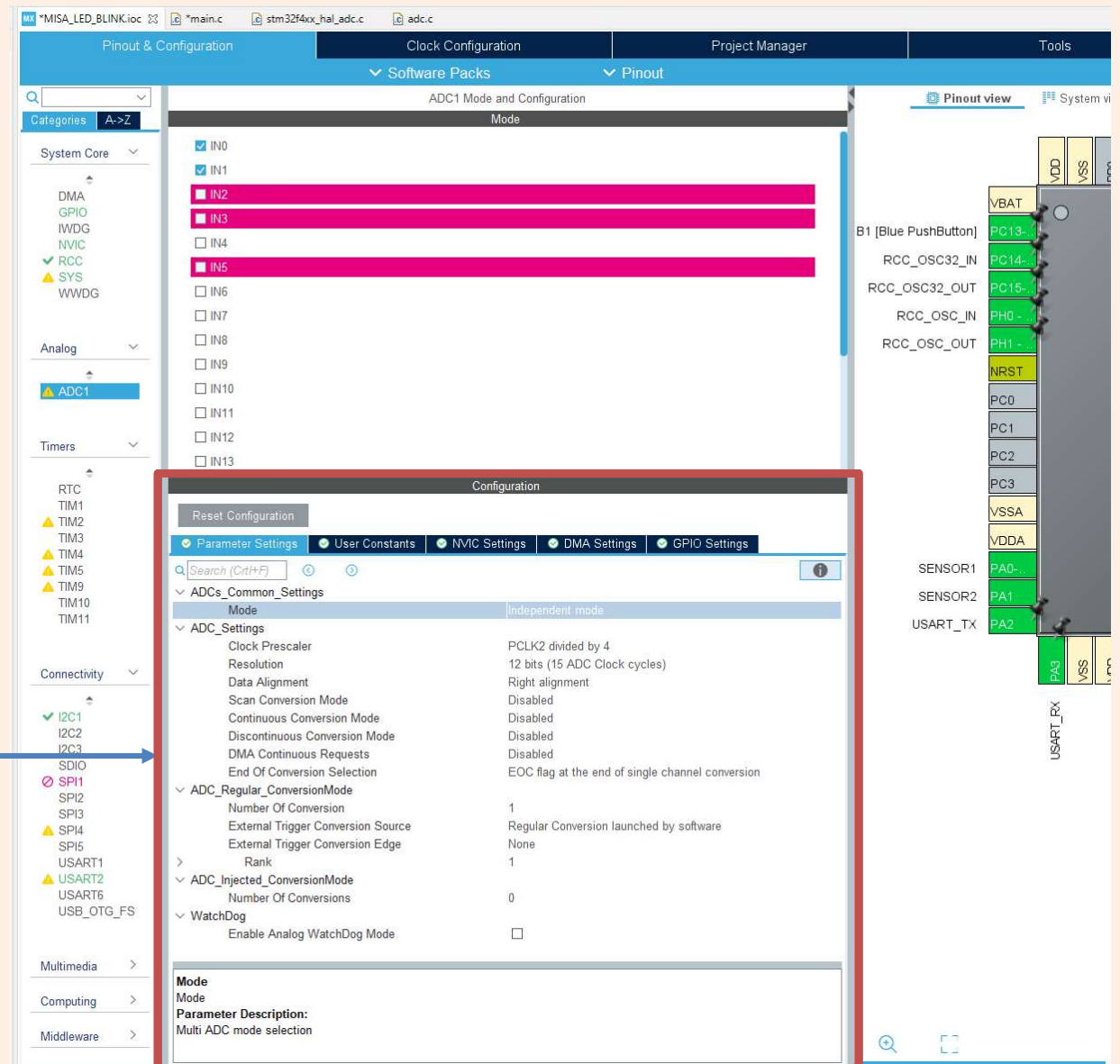
O procedimento é idêntico usando o ambiente de desenvolvimento baseado em Arduino!

Analog Digital converters

Nota extra:

Na zona das configurações dos periféricos é possível aceder a um conjunto de parâmetros que se podem configurar.

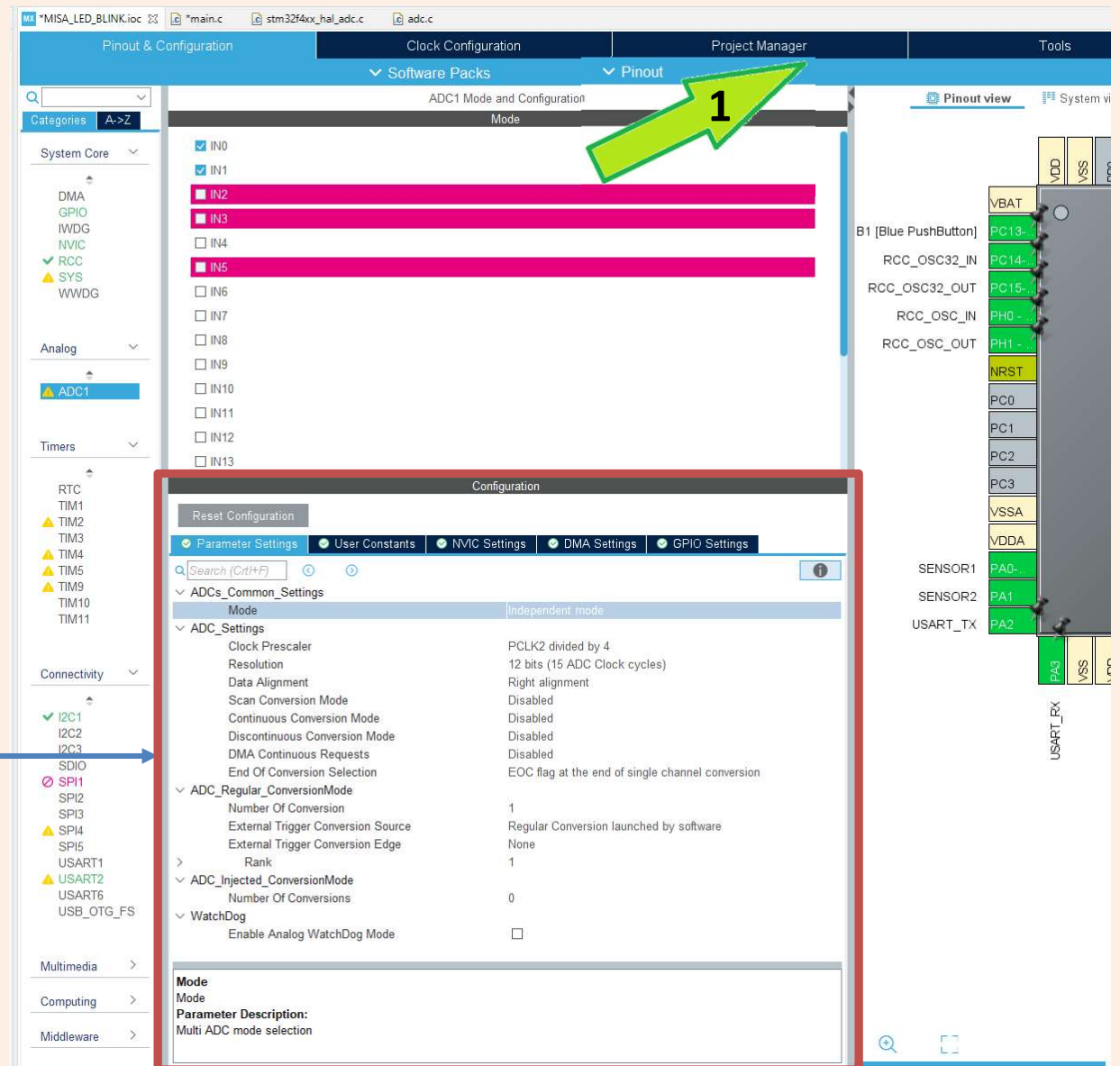
Para este curso recomendo que se não alterem as configurações standard.



Analog Digital converters

Nota extra:

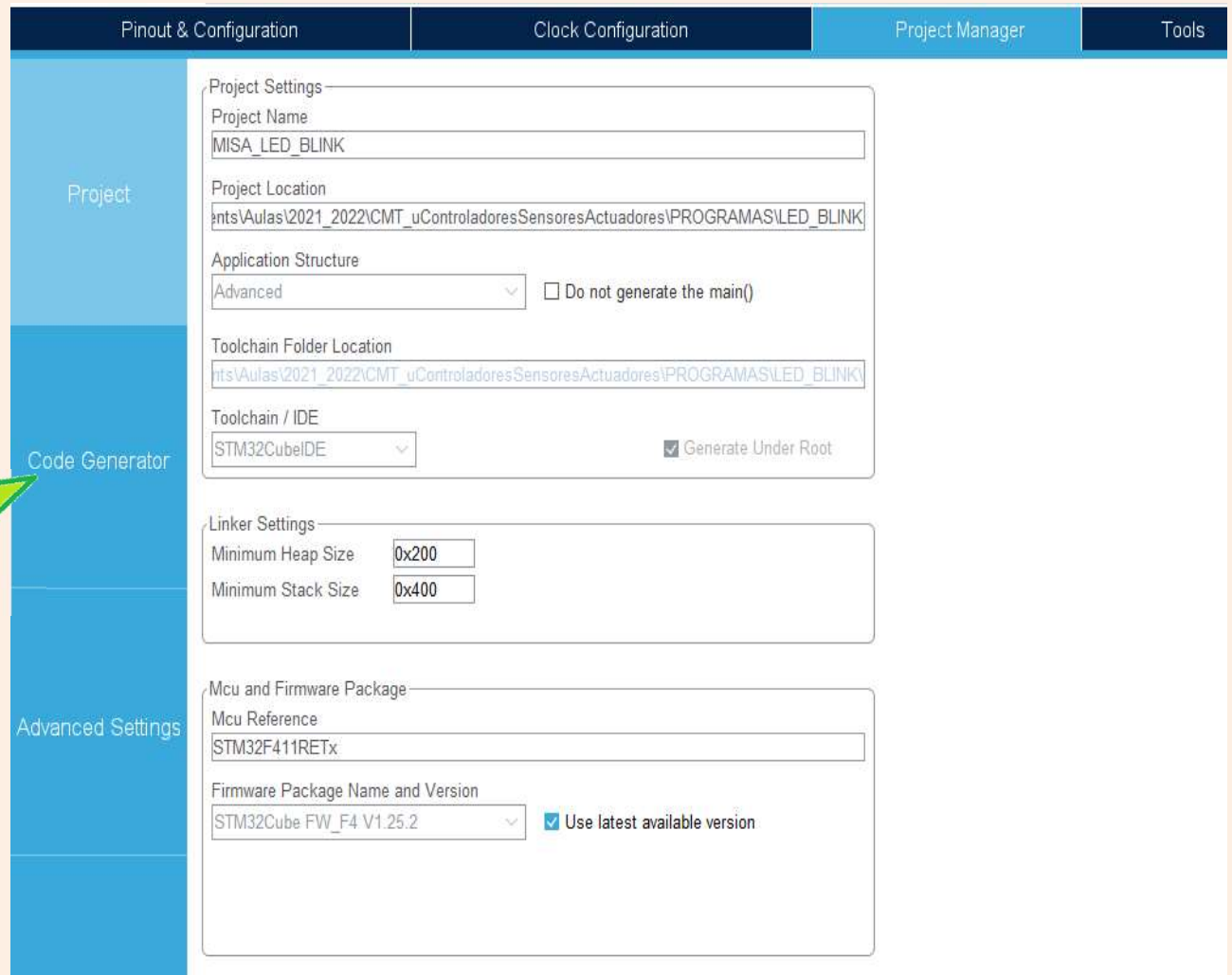
Selecionando o **Project Manager** é possível aceder a um menu sobre o projecto.



Analog Digital converters

Nota extra:

Selecionando **Code Generator**
pode-se fazer algumas
configurações interessantes



The screenshot shows the STM32CubeIDE Project Manager window. The left sidebar has four tabs: 'Project', 'Code Generator', 'Advanced Settings', and 'Tools'. The 'Code Generator' tab is selected and highlighted in blue. A green arrow with the number '1' points to this tab. The main area displays the 'Code Generator' settings, which are organized into sections: 'Project Settings', 'Linker Settings', and 'Mcu and Firmware Package'. The 'Project Settings' section includes fields for 'Project Name' (MISA_LED_BLINK), 'Project Location' (a long file path), 'Application Structure' (Advanced), and 'Toolchain Folder Location' (another long file path). There is a checkbox for 'Do not generate the main()' and a 'Generate Under Root' checkbox. The 'Linker Settings' section includes 'Minimum Heap Size' (0x200) and 'Minimum Stack Size' (0x400). The 'Mcu and Firmware Package' section includes 'Mcu Reference' (STM32F411RETx) and 'Firmware Package Name and Version' (STM32Cube FW_F4 V1.25.2), with a 'Use latest available version' checkbox.

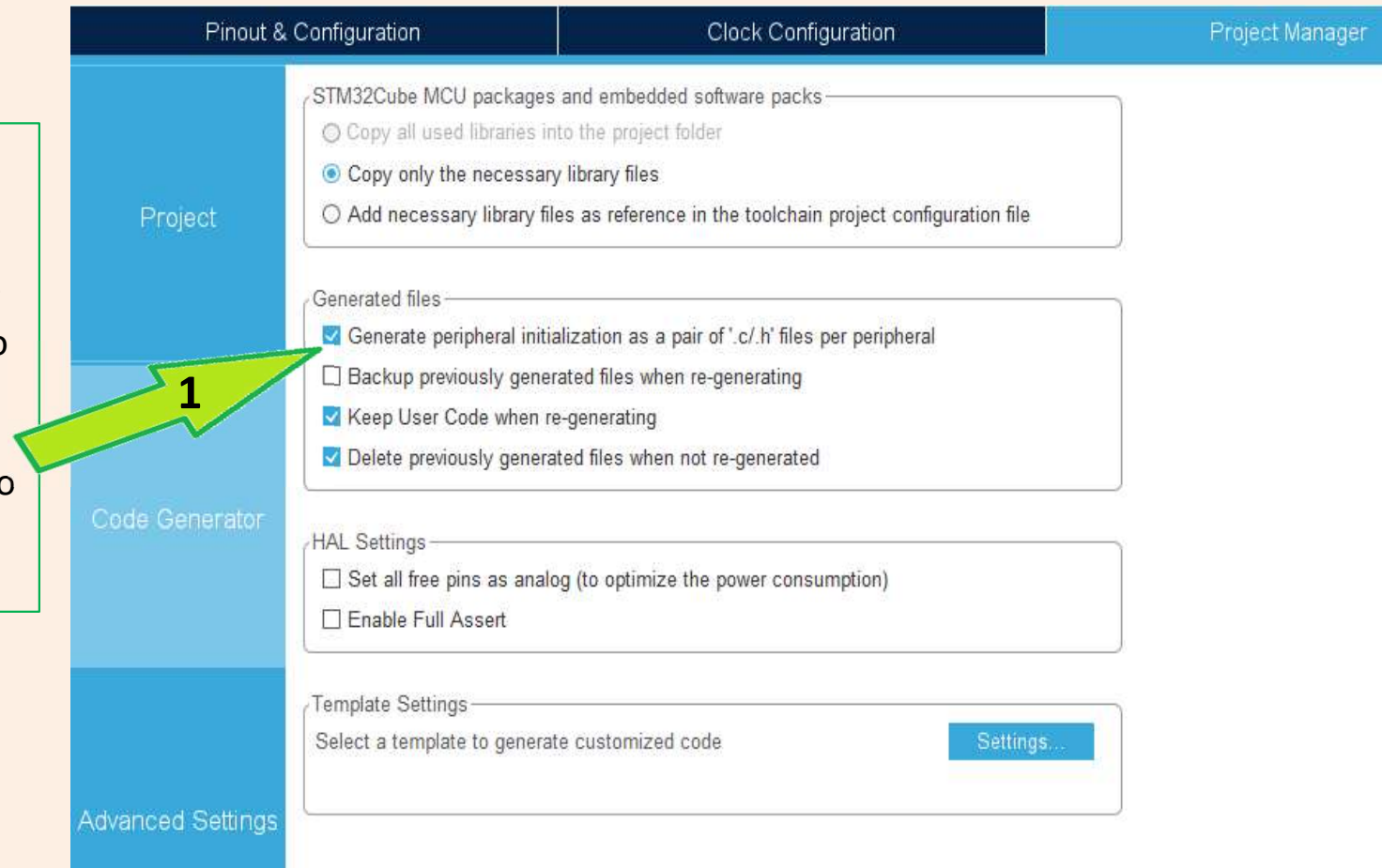
Pinout & Configuration	Clock Configuration	Project Manager	Tools
Project Settings			
Project Name MISA_LED_BLINK			
Project Location nts\Aulas\2021_2022\ICMT_uControladoresSensoresAtuadores\PROGRAMAS\LED_BLINK			
Application Structure Advanced <input type="checkbox"/> Do not generate the main()			
Toolchain Folder Location nts\Aulas\2021_2022\ICMT_uControladoresSensoresAtuadores\PROGRAMAS\LED_BLINK			
Toolchain / IDE STM32CubeIDE <input checked="" type="checkbox"/> Generate Under Root			
Linker Settings			
Minimum Heap Size 0x200			
Minimum Stack Size 0x400			
Mcu and Firmware Package			
Mcu Reference STM32F411RETx			
Firmware Package Name and Version STM32Cube FW_F4 V1.25.2 <input checked="" type="checkbox"/> Use latest available version			

Analog Digital converters

Nota extra:

Em vez de ficar tudo concentrado em “main.c” seleccionando esta opção, gera-se um par de “.c/.h” por cada periférico, o que torna o código mais leve.

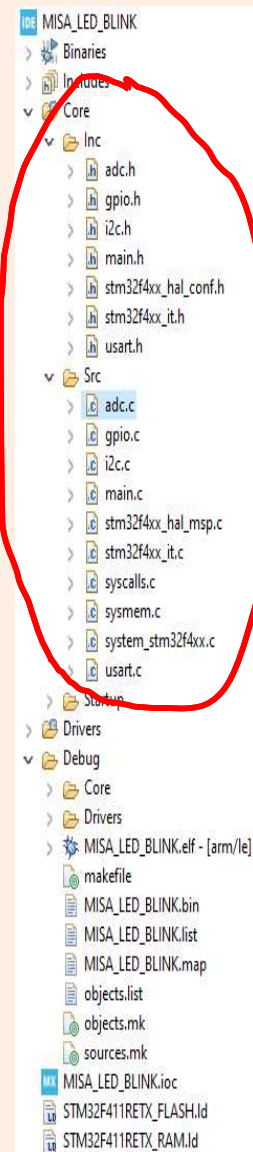
As outras opções também são fáceis de entender, mas em caso de dúvida não mexer!



Por último: “Salvar” as configurações e gerar Código automaticamente!

Analog Digital converters

Reparar que foram adicionados, entre outros, os ficheiros: **adc.c** e **adc.h**

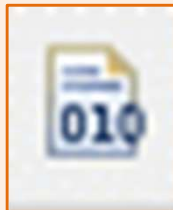


```
1  /* USER CODE BEGIN Header */
2  #ifndef __MAIN__
3  #define __MAIN__
4  #endif
5  /* USER CODE END Header */
6  #include "main.h"
7  #include "adc.h"
8  #include "i2c.h"
9  #include "usart.h"
10 #include "gpio.h"
11
12 /* Private includes */
13 #include "stm32f4xx_hal.h"
14 #include "stm32f4xx_it.h"
15 #include "syscalls.h"
16 #include "system.h"
17 #include "system_stm32f4xx.h"
18 #include "usart.h"
19 #include "gpio.h"
20
21 /* Private typedef */
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23 /* Private define */
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25 /* Private macro */
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27 /* USER CODE BEGIN PD */
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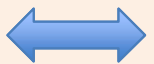
Analog Digital converters

Fazer como já apresentado:

- Escrever o Código.
- Compilar/criar executável: **Project > Build-All**
- e para enviar o ficheiro executável para a placa fazer: **Run > Debug!**
- Em alternativa, também podem seleccionar os icons correspondents:



Build-All



Debug!