Microcontroller Engineering
TMIK13
Lecture 9

ADC

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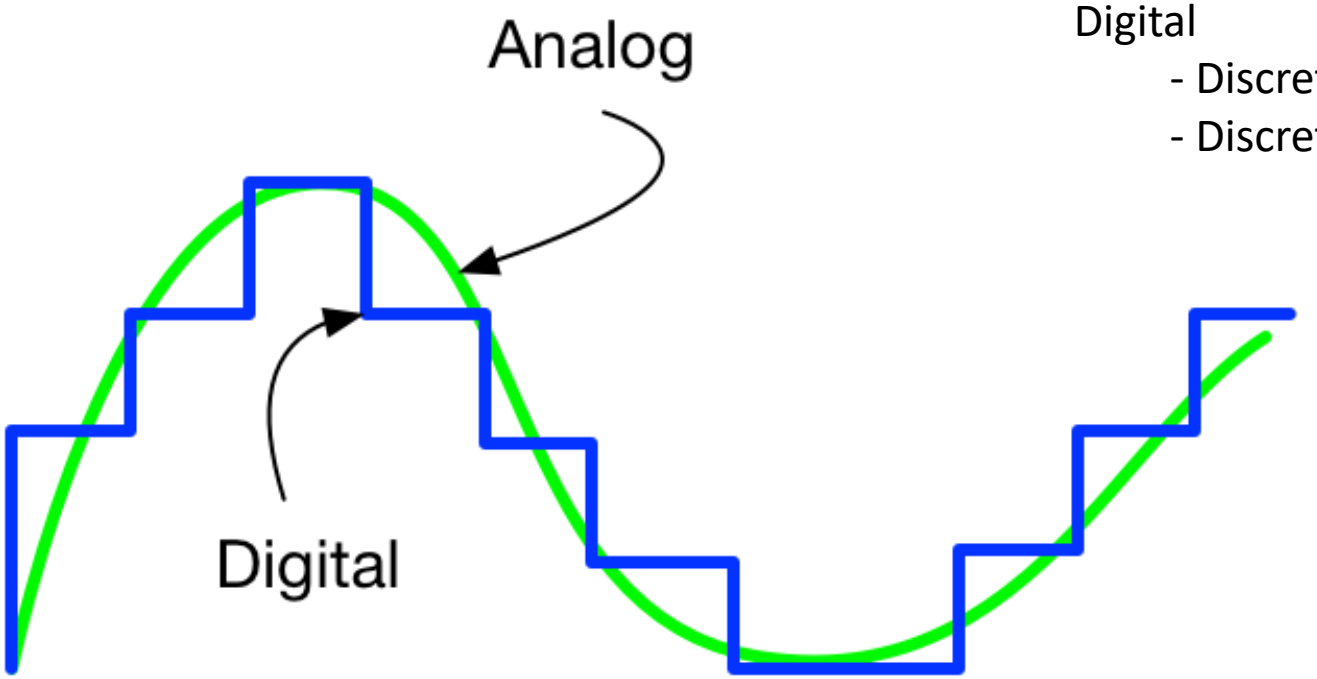
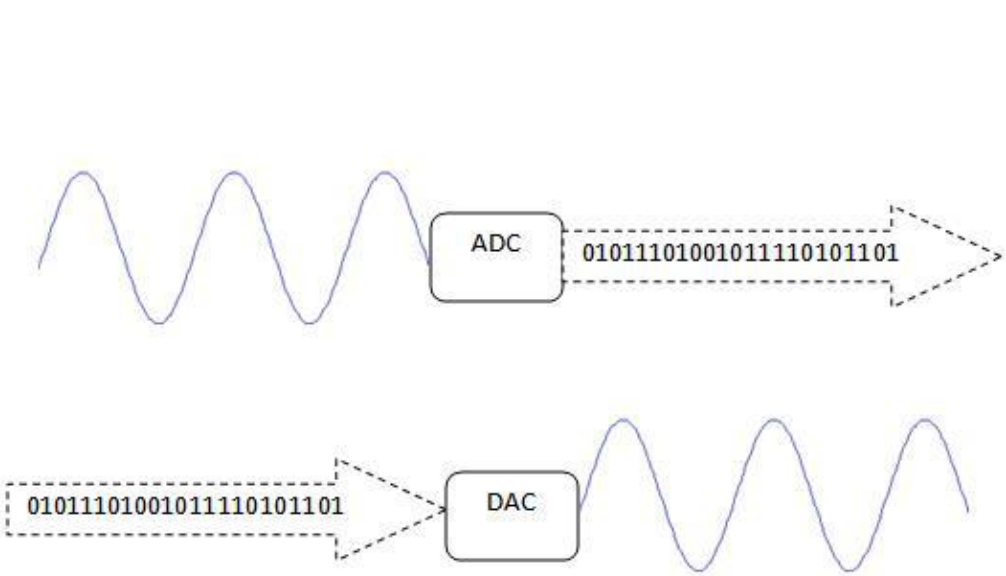
Analog/Digital Signals

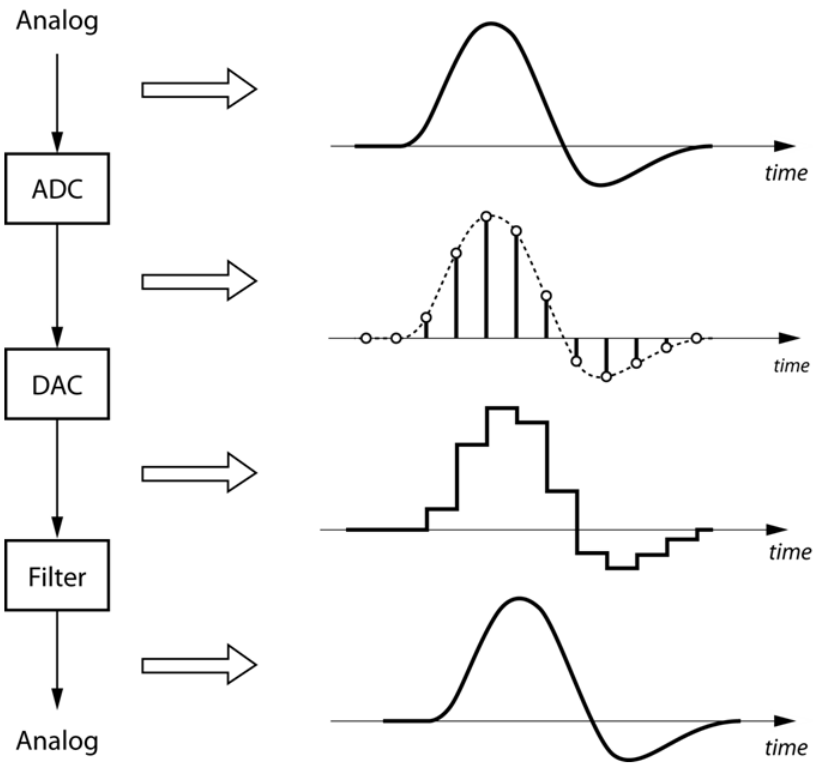
Analog
- Continuous in Time
- Continuous in Amplitude

Digital
- Discrete in Time
- Discrete in Amplitude

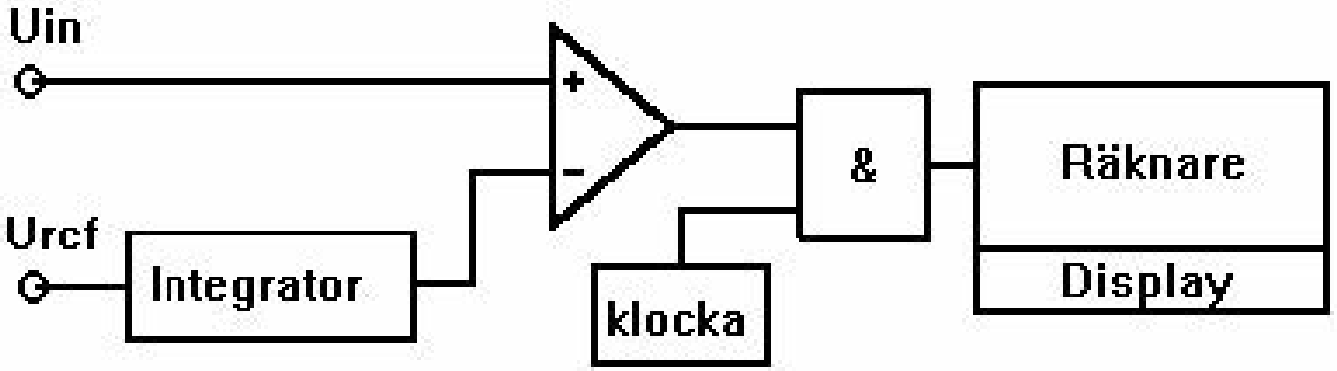


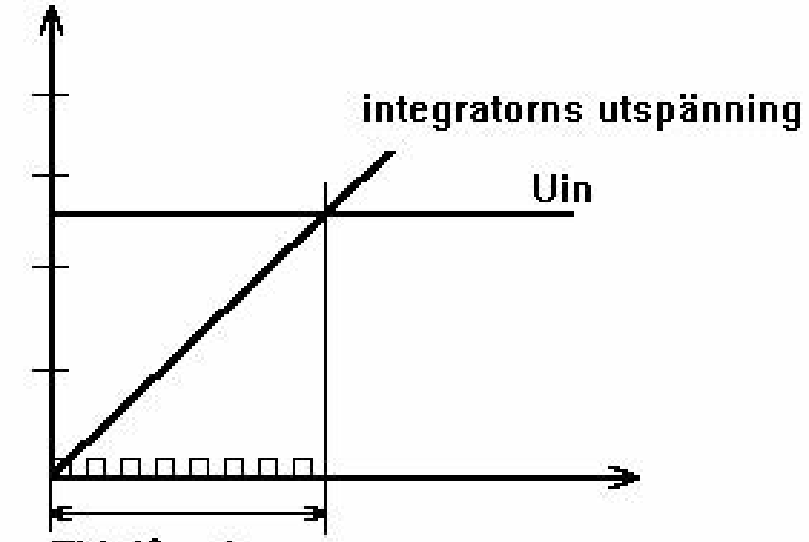
Analog/Digital Signals



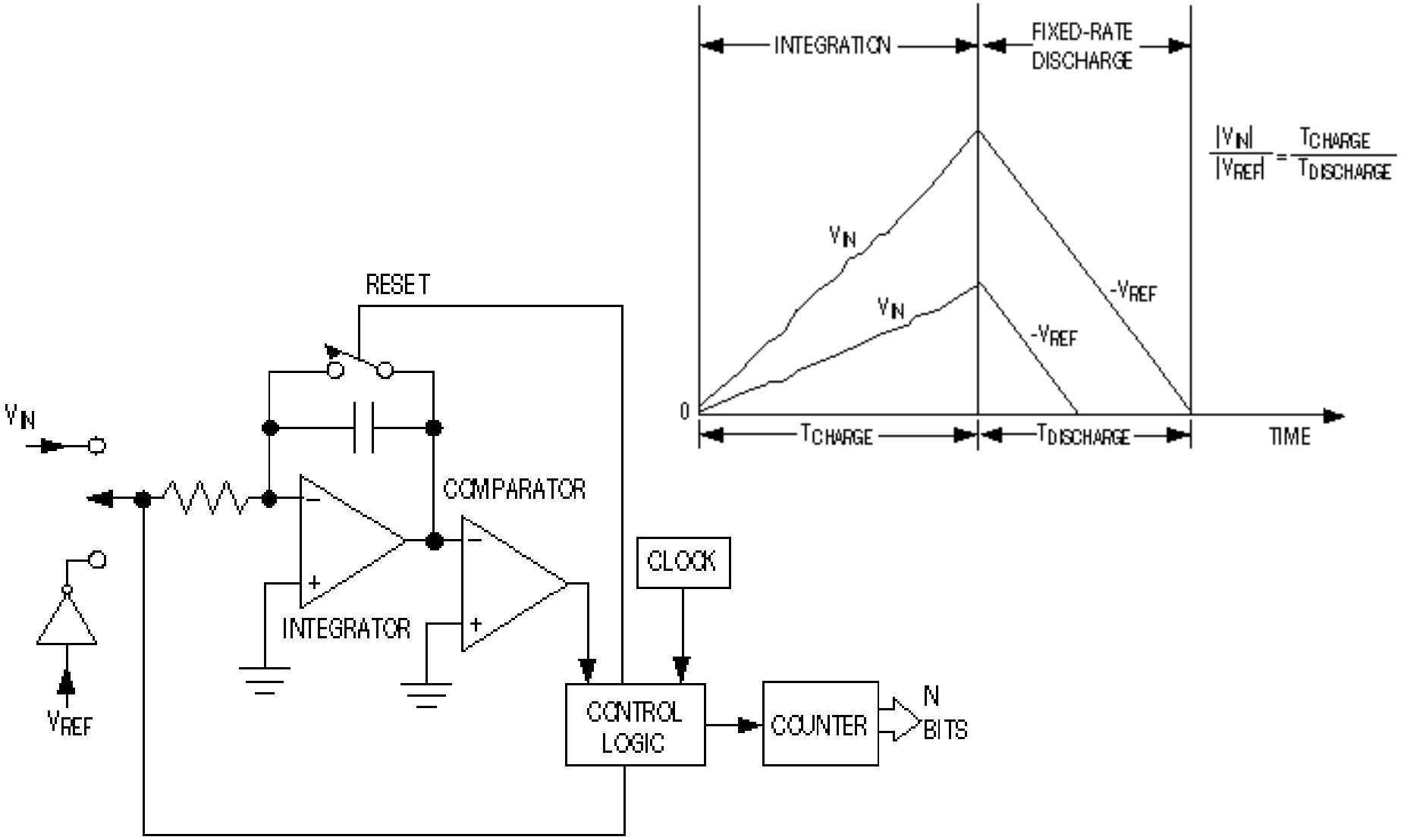


ADC – Integrating Converter

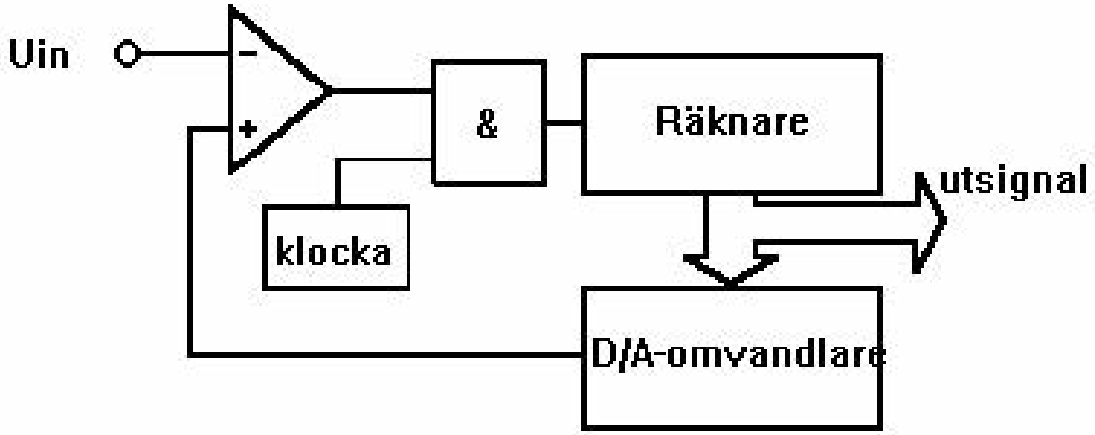


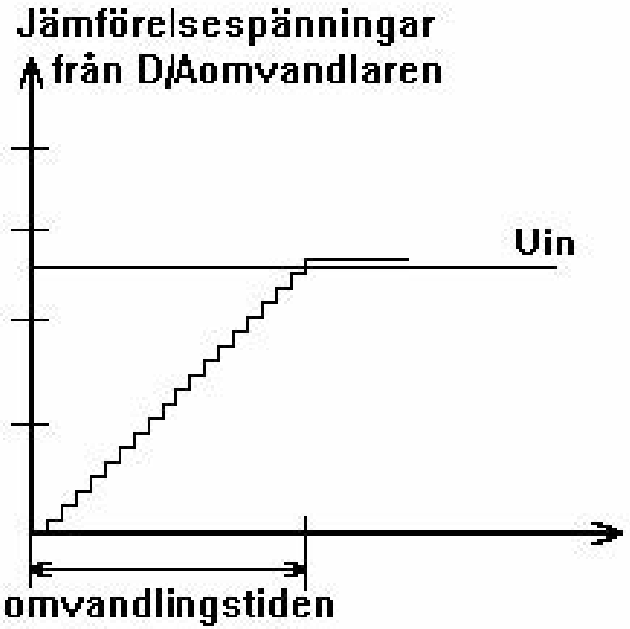


ADC – Integrating Converter

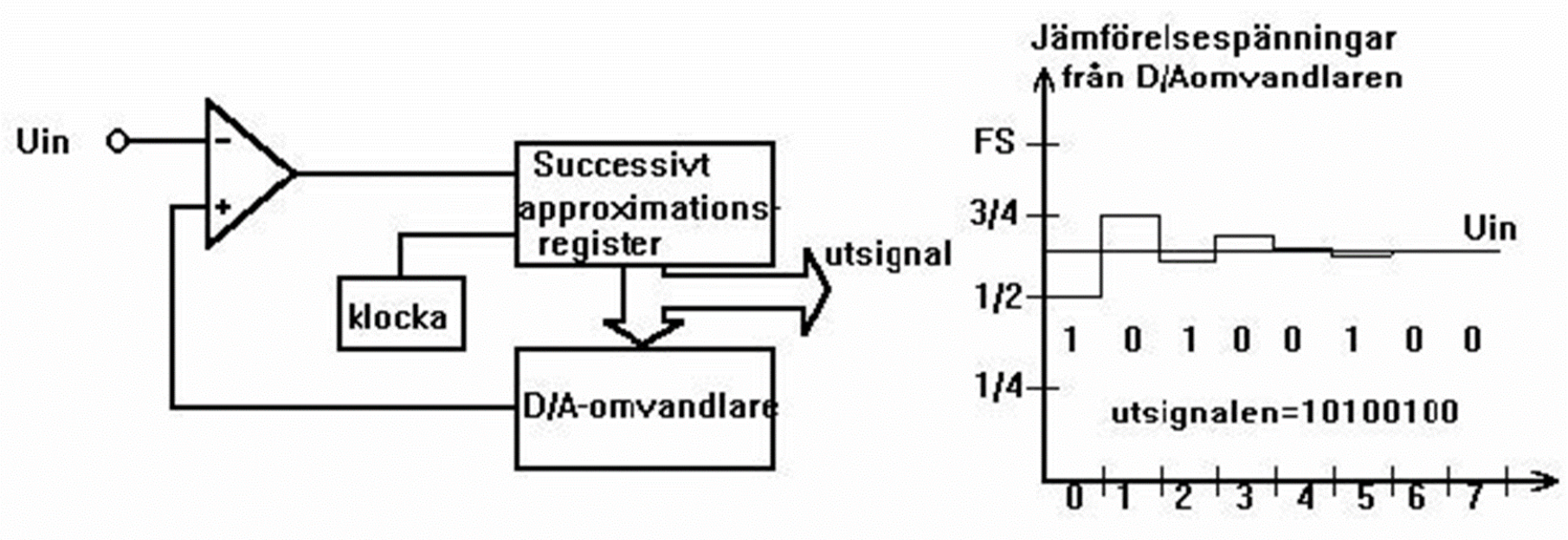


ADC – Digital Ramp Converter

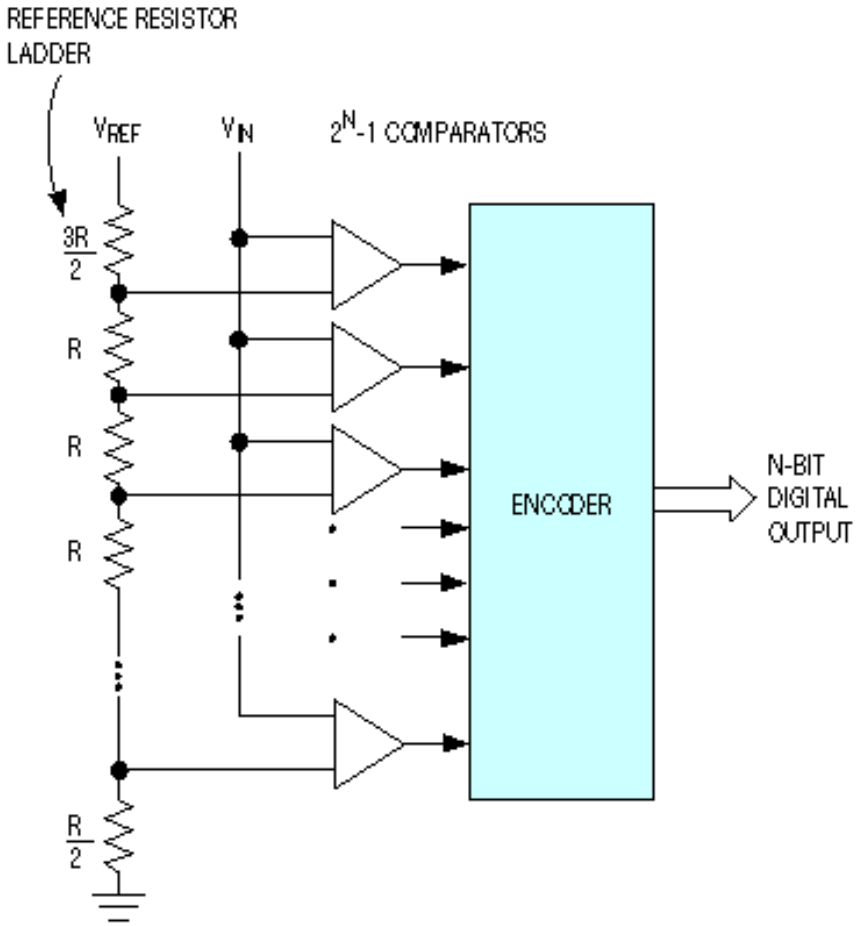




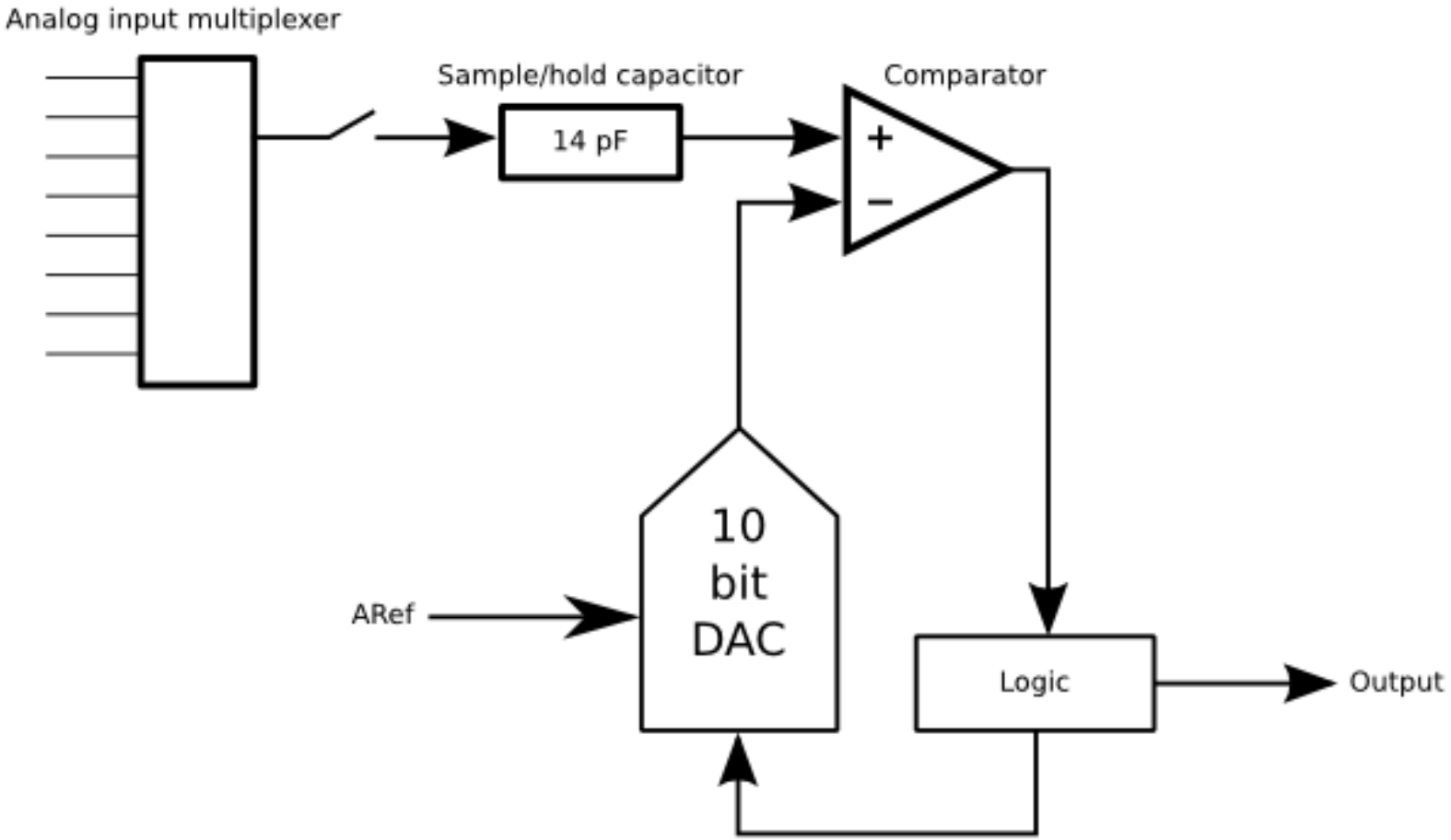
ADC – Successive Approximation



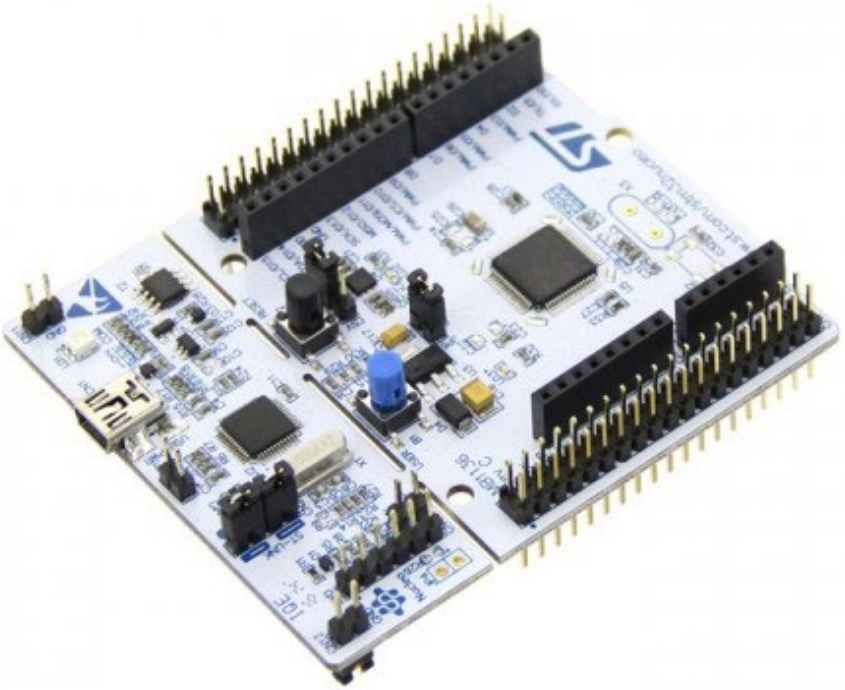
ADC – Parallel Converter (Flash)

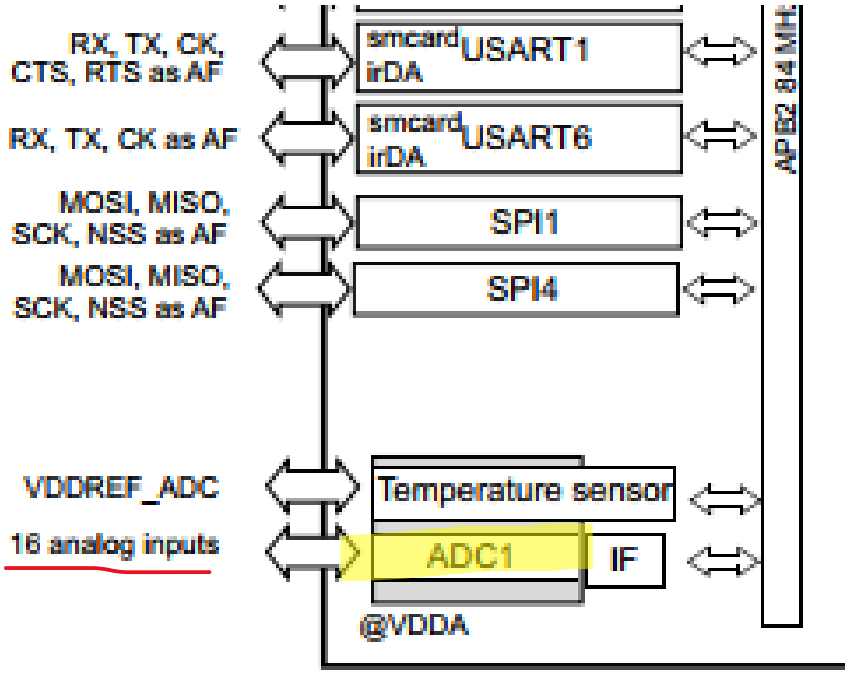


ADC – Analog Multiplexer

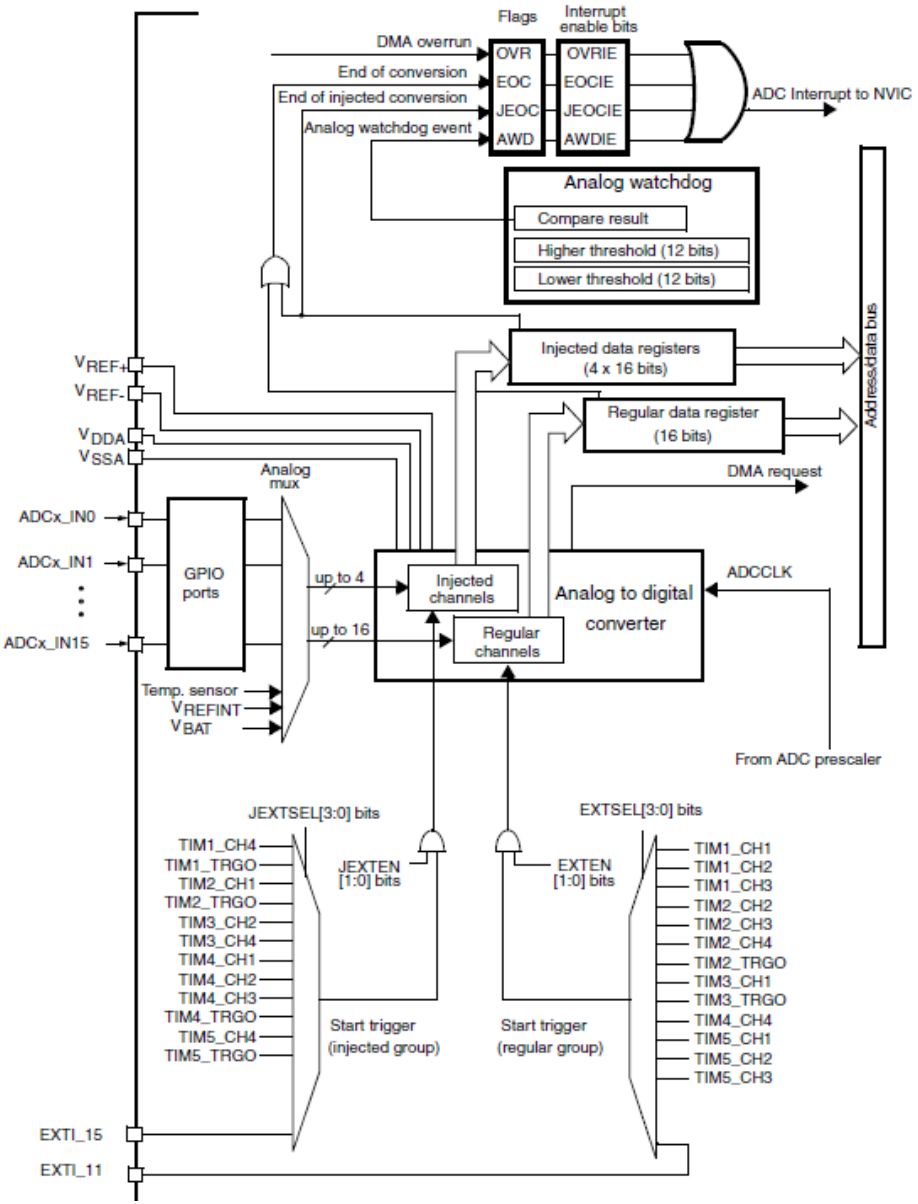


Nucleo-64 STM32F401RE

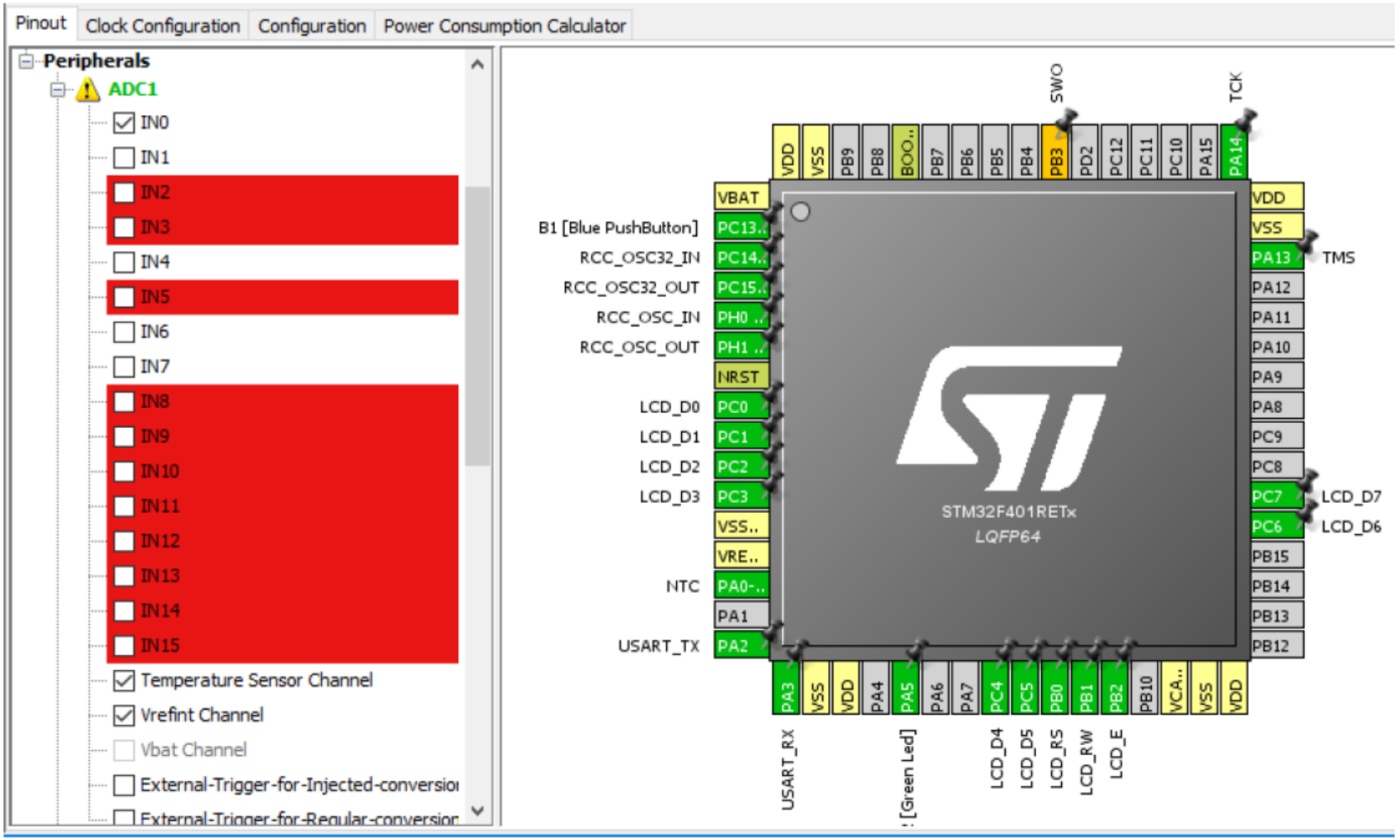




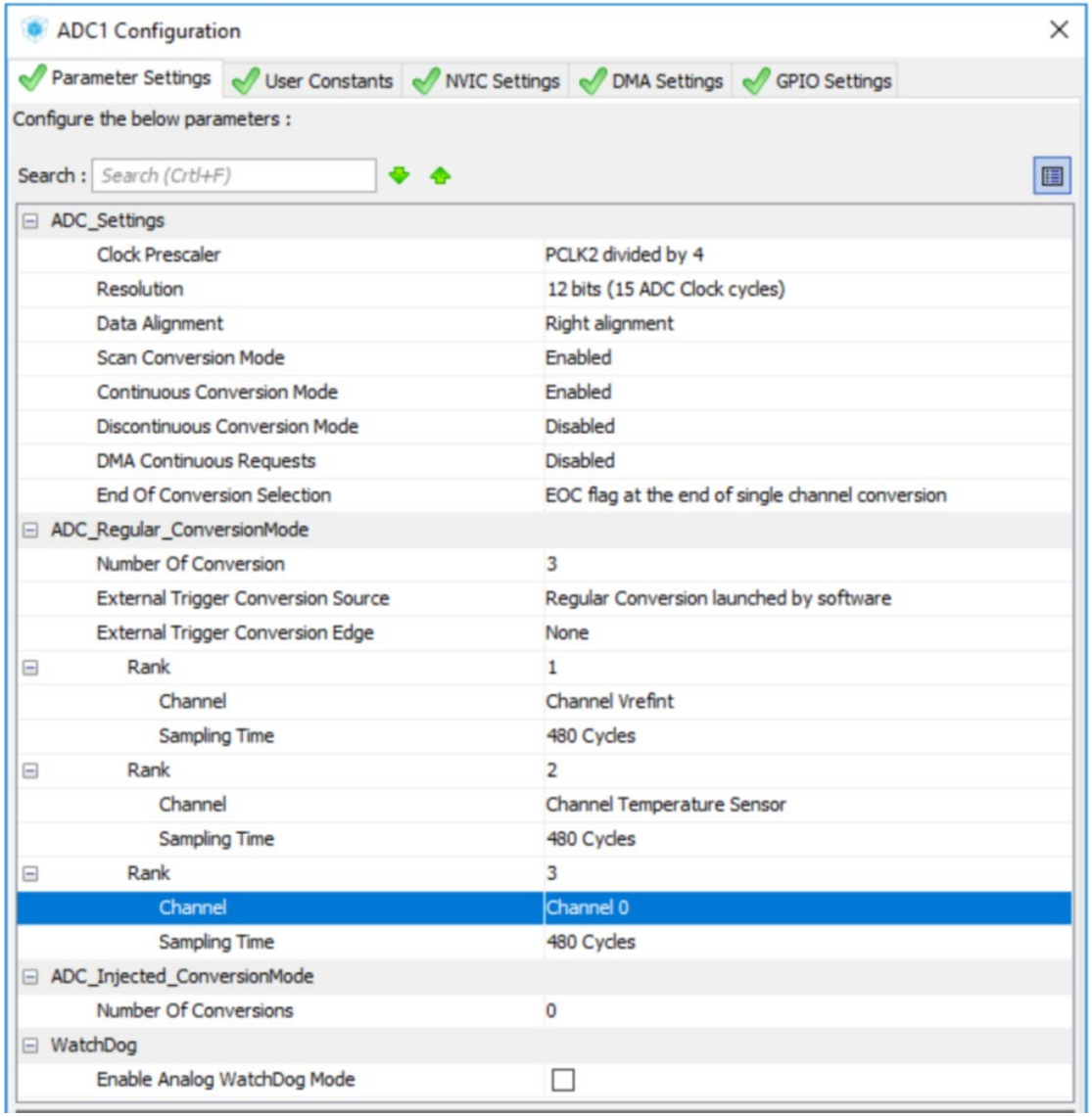
ADC – STM32F401RE



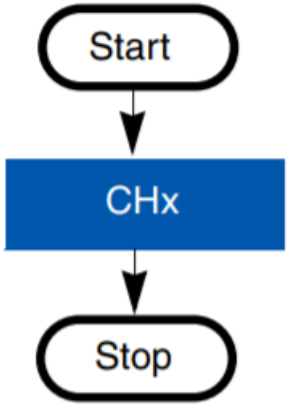
STM32CubeMX



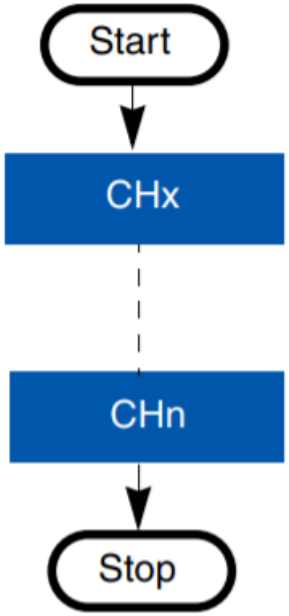
STM32CubeMX



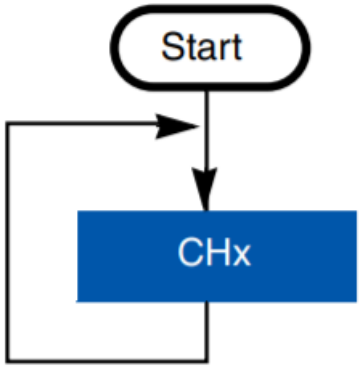
ADC – Conversion Modes



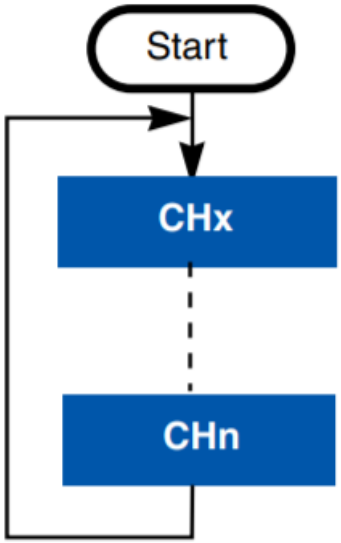
Single Channel
Single Conversion



Multiple Channels
Single Conversion



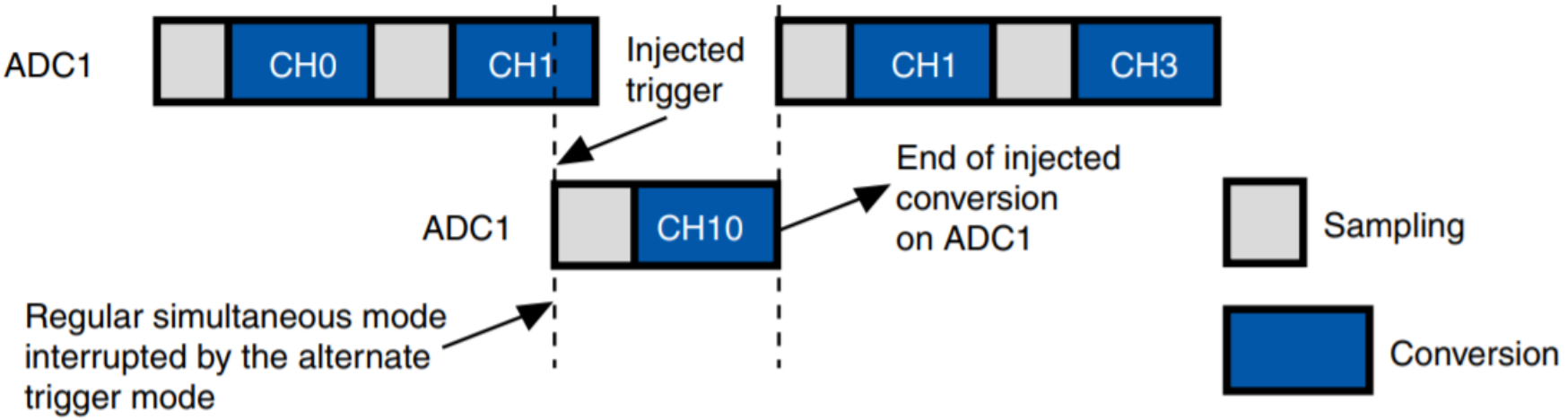
Single Channel
Continuous
Conversion



Multiple Channels
Continuous
Conversion

https://www.st.com/resource/en/application_note/cd00258017-stm32s-adc-modes-and-their-applications-stmicroelectronics.pdf

ADC – Regular vs Injected Conv



Injected conversion has higher priority and interrupts the regular conversion if needed

ADC – VRef and Temperature

$$V_{\mathrm{DDA}} = 3.3\,V * \frac{VREFINT\_CAL}{VREFINT\_DATA}$$

$$Temperature\ in\ degC = \frac{110\ degC - 30\ degC}{TS\_CAL2 - TS\_CAL1} * (TS\_DATA - TS\_CAL1) + 30\ degC$$

ADC – VRef and Temperature Calib

Table 73. Temperature sensor calibration values

Symbol	Parameter	Memory address
TS_CAL1	TS ADC raw data acquired at temperature of 30 °C, V_{DDA}= 3.3 V	0x1FFF 7A2C - 0x1FFF 7A2D
TS_CAL2	TS ADC raw data acquired at temperature of 110 °C, V_{DDA}= 3.3 V	0x1FFF 7A2E - 0x1FFF 7A2F

Table 76. Internal reference voltage calibration values

Symbol	Parameter	Memory address
V_{REFIN_CAL}	Raw data acquired at temperature of 30 °C V_{DDA} = 3.3 V	0x1FFF 7A2A - 0x1FFF 7A2B

```
#define VREFIN_CAL *((uint16_t*)((uint32_t) 0x1FFF7A2A))
#define TS_CAL30   *((uint16_t*)((uint32_t) 0x1FFF7A2C))
#define TS_CAL110  *((uint16_t*)((uint32_t) 0x1FFF7A2E))
```

ADC – HAL Driver Usage

Polling mode IO operation

- Start the ADC peripheral using HAL_ADC_Start()
- Wait for end of conversion using HAL_ADC_PollForConversion(), at this stage user can specify the value of timeout according to his end application
- To read the ADC converted values, use the HAL_ADC_GetValue() function.
- Stop the ADC peripheral using HAL_ADC_Stop()

Interrupt mode IO operation

- Start the ADC peripheral using HAL_ADC_Start_IT()
- Use HAL_ADC_IRQHandler() called under ADC_IRQHandler() Interrupt subroutine
- At ADC end of conversion HAL_ADC_ConvCpltCallback() function is executed and user can add his own code by customization of function pointer HAL_ADC_ConvCpltCallback
- In case of ADC Error, HAL_ADC_ErrorCallback() function is executed and user can add his own code by customization of function pointer HAL_ADC_ErrorCallback
- Stop the ADC peripheral using HAL_ADC_Stop_IT()

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- Stop the ADC peripheral using HAL_ADC_Stop_IT()

```
/* Check End of conversion flag */
__HAL_ADC_GET_FLAG(&hadc1, ADC_FLAG_EOC);
```

ADC – STM32CubeIDE Demo

Lets go!!!

Microcontroller Engineering

Questions?

Contact information

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