



HO CHI MINH CITY UNIVERSITY OF TECHNOLOGY
COMPUTER ENGINEERING

Microcontroller



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CHAPTER 1

LED Animations



- 1 Introduction**
- 2 First project on STM32Cube**

3 Simulation on Proteus

For an online training, a simulation on Proteus can be used. The details to create an STM32 project on Proteus are described bellow.

Step 1: Launch Proteus (with administration access) and from menu **File**, select **New Project**.



Figure 1.1: Create a new project on Proteus

Step 2: Provide the name and the location of the project, then click on **Next** button.

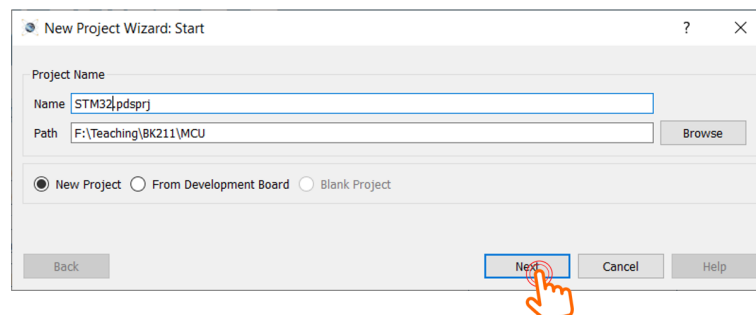


Figure 1.2: Provide project name and location

Step 3: For following dialog, just click on **Next** button as just a schematic is required for the lab.

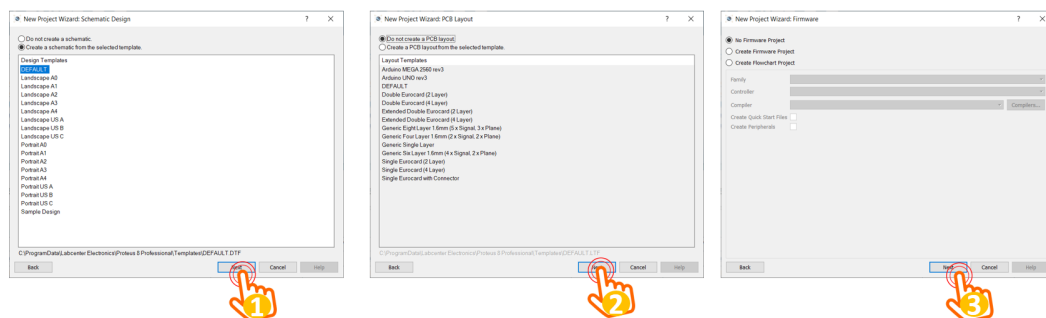


Figure 1.3: Keep the default options by clicking on Next

Step 4: Finally, click on **Finish** button to close the project wizard.

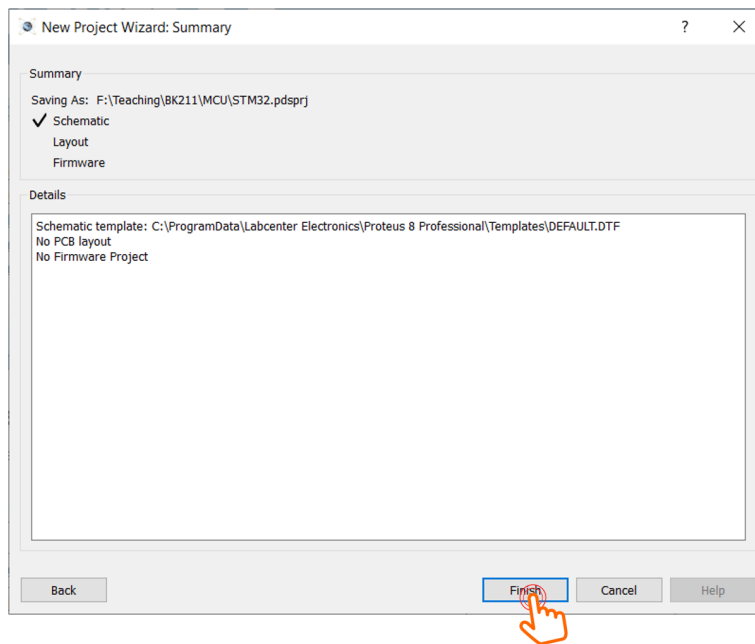


Figure 1.4: Finish the project wizard

Step 5: On the main page of the project, right click to select **Place, Components, From Libraries**, as follows:

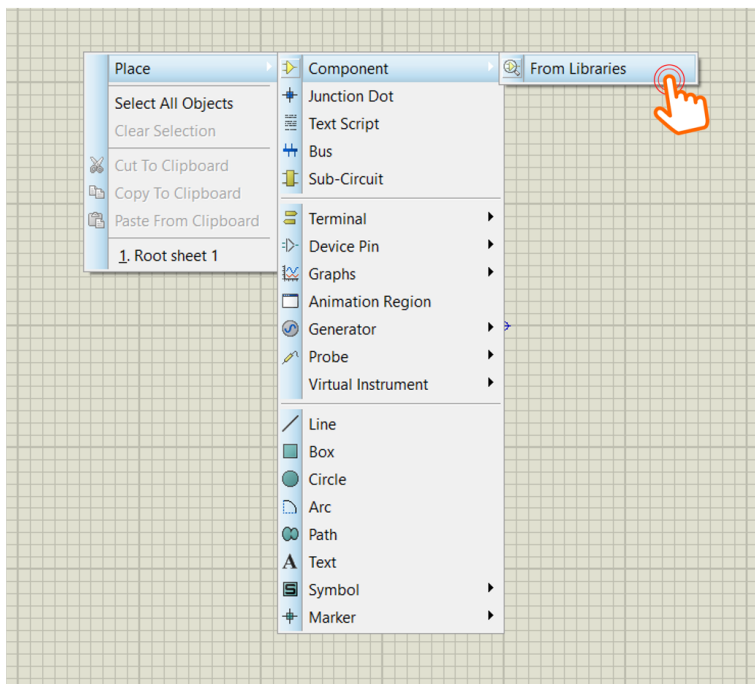


Figure 1.5: Select a component from the library

If there is an error with no library found, please restart the Proteus software with Run as administrator option.

Step 6: From the list of components in the library, select STM32F103C6, as follows:

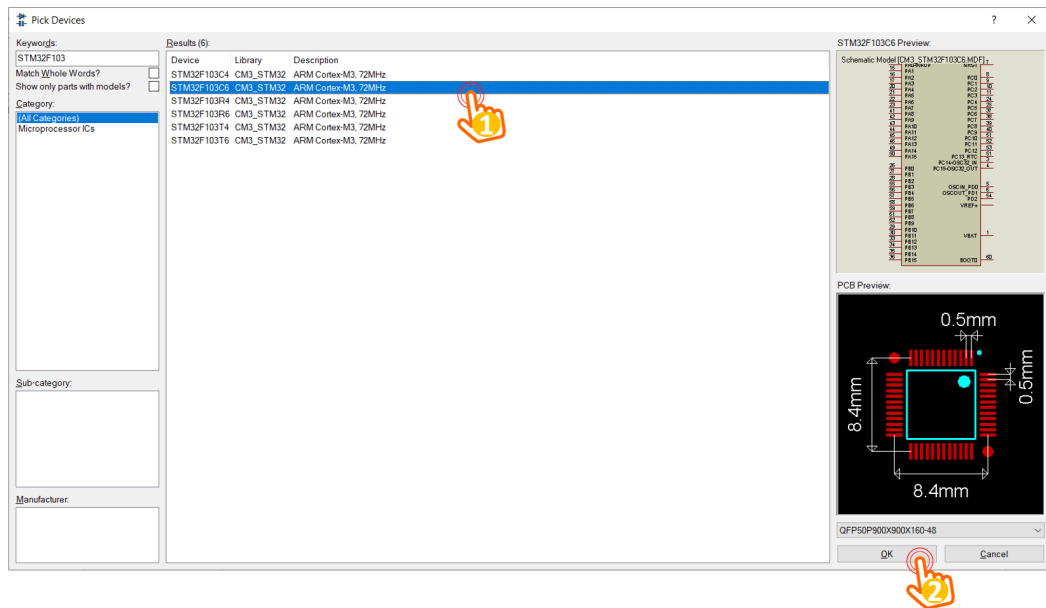


Figure 1.6: Select STM32F103C6

Repeat step 5 and 6 to select an LED, named **LED-RED** in Proteus. Finally, these components are appeared on the DEVICES windows, which is on left hand side as follows:

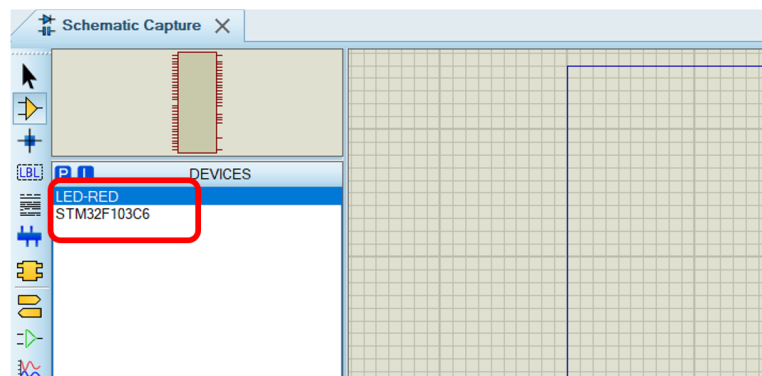


Figure 1.7: STM32 and an LED in the project

Step 7: Place the STM32 to the project: right

4 Exercise and Report

4.1 Exercise 1

From the simulation on Proteus, one more LED is connected to pin **PA6** of the STM32 (negative pin of the LED is connected to PA6). The component suggested in this exercise is **LED-YELLOW**, which can be found from the device list.

In this exercise, the status of two LEDs are switched every 2 seconds, as demonstrated in the figure bellow.

Report 1: Depict the schematic from Proteus simulation in this report. The caption of the figure is a downloadable link to the Proteus project file (e.g. a github link).

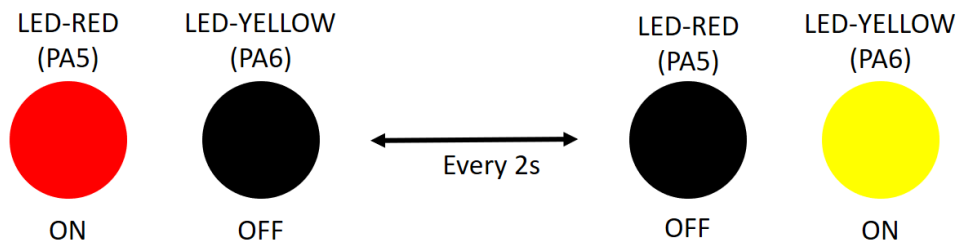


Figure 1.8: State transitions for 2 LEDs

Report 2: Present the source code in the infinite loop while of your project. If a user-defined functions is used, it is required to present in this part. A brief description can be added for this function (e.g. using comments). A template to present your source code is presented bellow.

```
1 while (1){
2     HAL_GPIO_TogglePin(GPIOA , GPIO_PIN_5);
3     HAL_Delay(1000);
4 }
```

Program 1.1: An example for your source code

4.2 Exercise 2

Extend the first exercise to simulate the behavior of a traffic light. A third LED, named **LED-GREEN** is added to the system, which is connected to **PA7**. A cycle in this traffic light is 5 seconds for the RED, 2 seconds for the YELLOW and 3 seconds for the GREEN. The LED-GREEN is also controlled by its negative pin.

Similarly, the report in this exercise includes the schematic of your circuit and a your source code in the while loop.

Report 1: Present the schematic.

Report 2: Present the source code in while.

4.3 Exercise 3

Extend to the 4-way traffic light. Arrange 12 LEDs in a nice shape to simulate the behaviors of a traffic light. A reference design can be found in the figure bellow.

4.4 Exercise 4

Add **only one 7 led segment** to the schematic in Exercise 3. This component can be found in Proteus by the keyword **7SEG-COM-ANODE**. For this device, the common pin should be connected to the power supply and other pins are supposed to connected to PB0 to PB6. Therefore, to turn-on a segment in this 7SEG, the STM32 pin should be in logic 0 (0V).

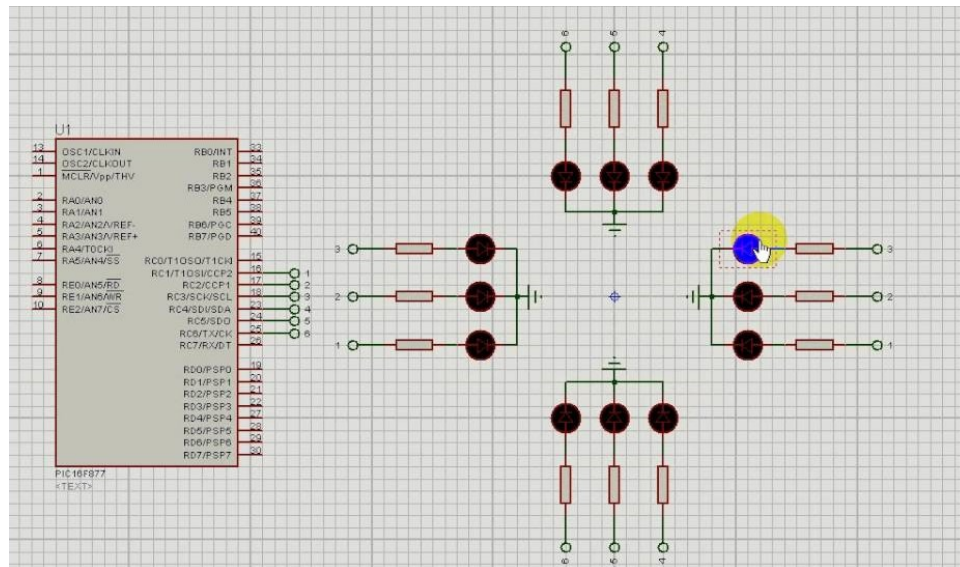


Figure 1.9: Reference design for a 4 way traffic light

Implement a function named **display7SEG(int num)**. The input for this function is from 0 to 9 and the outputs are listed as following:

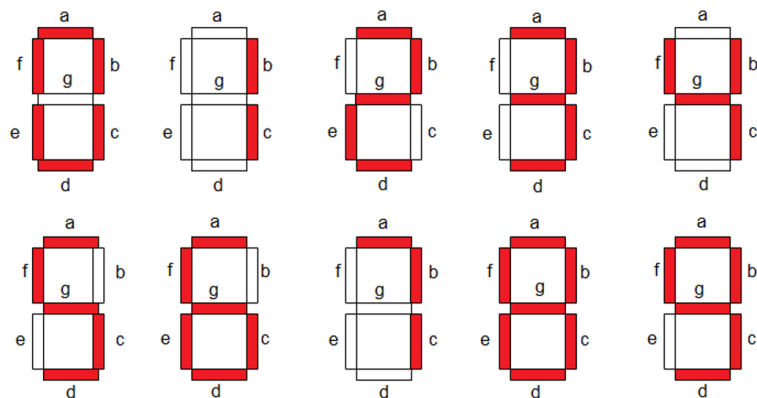


Figure 1.10: Display a number on 7 segment LED

This function is invoked in the while loop for testing as following:

```
1 int counter = 0;
2 while (1){
3     if(counter >= 10) counter = 0;
4     display7SEG(counter++);
5     HAL_Delay(1000);
6
7 }
```

Program 1.2: An example for your source code

Report 1: Present the schematic.

Report 2: Present the source code for display7SEG function.

4.5 Exercise 5

Integrate the 7SEG-LED to the 4 way traffic light. In this case, the 7SEG-LED is used to display countdown value.

In this exercise, only source code is required to present. The function display7SEG in previous exercise can be re-used.

4.6 Exercise 6

In this exercise, a new Proteus schematic is designed to simulate an analog clock, with 12 different number. The connections for 12 LEDs are supposed from PA4 to PA15 of the STM32. The arrangement of 12 LEDs is depicted as follows.

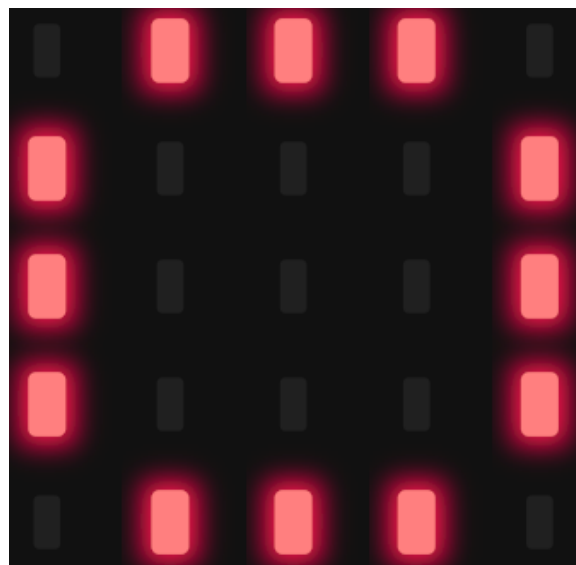


Figure 1.11: 12 LEDs for an analog clock

Report 1: Present the schematic. Report 2: Implement a simple program to test the connection of every single LED. This testing program should turn every LED in a sequence.

4.7 Exercise 7

Implement a function named **clearAllClock()** to turn off all 12 LEDs. Present the source code of this function.

```
1 void clearAllClock() {  
2     //TODO  
3 }
```

Program 1.3: Function Implementation

4.8 Exercise 8

Implement a function named **setNumberOnClock(int num)**. The input for this function is from **0 to 11** and an appropriate LED is turn on. Present the source code of this function.

4.9 Exercise 9

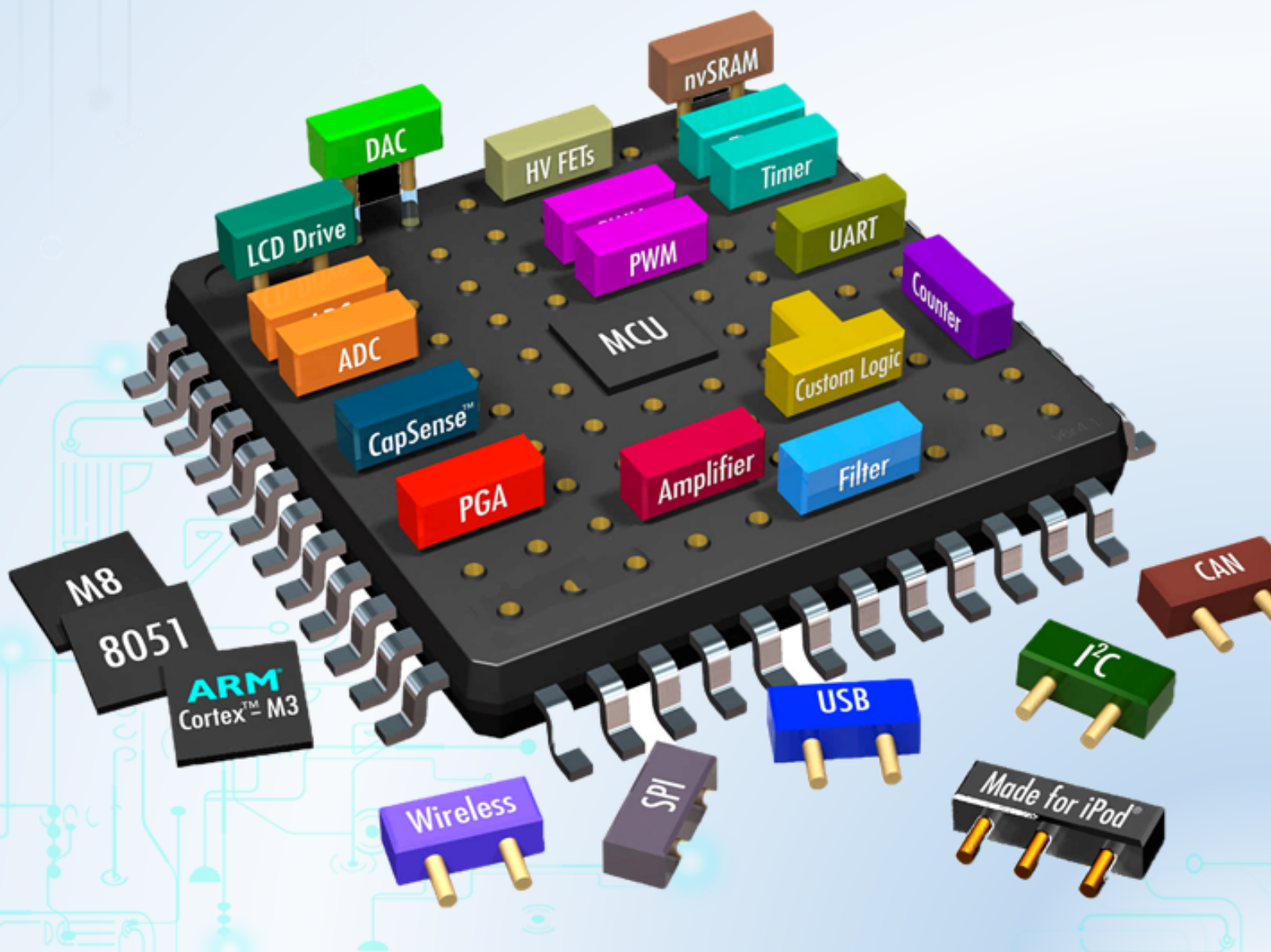
Implement a function named **clearNumberOnClock(int num)**. The input for this function is from **0 to 11** and an appropriate LED is turn off.

4.10 Exercise 10

Integrate the whole system and use 12 LEDs to display a clock. At a given time, there are only 3 LEDs are turn on for hour, minute and second information.

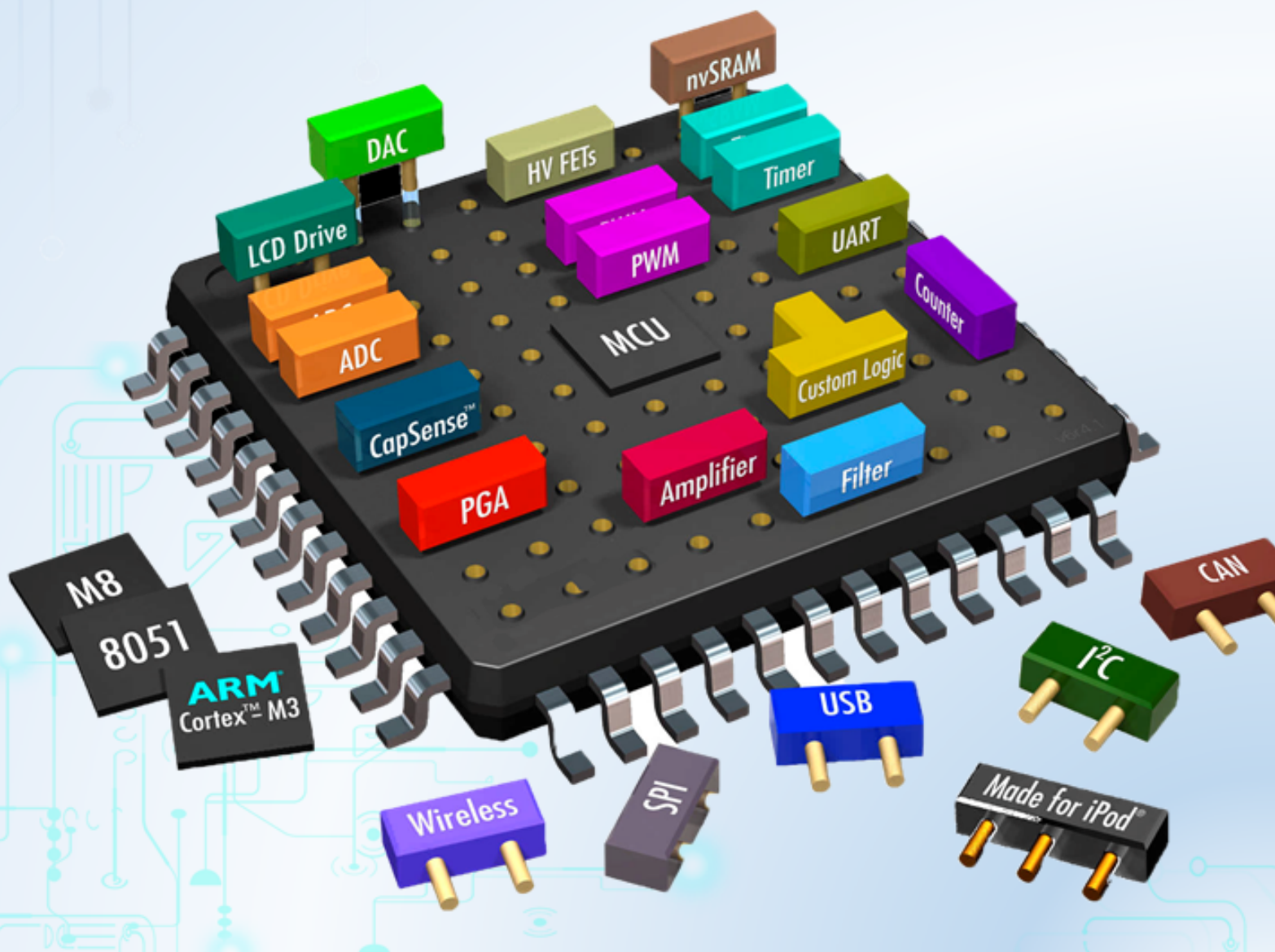
CHAPTER 2

LED Scanning and Timer Interrupt



CHAPTER 3

Buttons



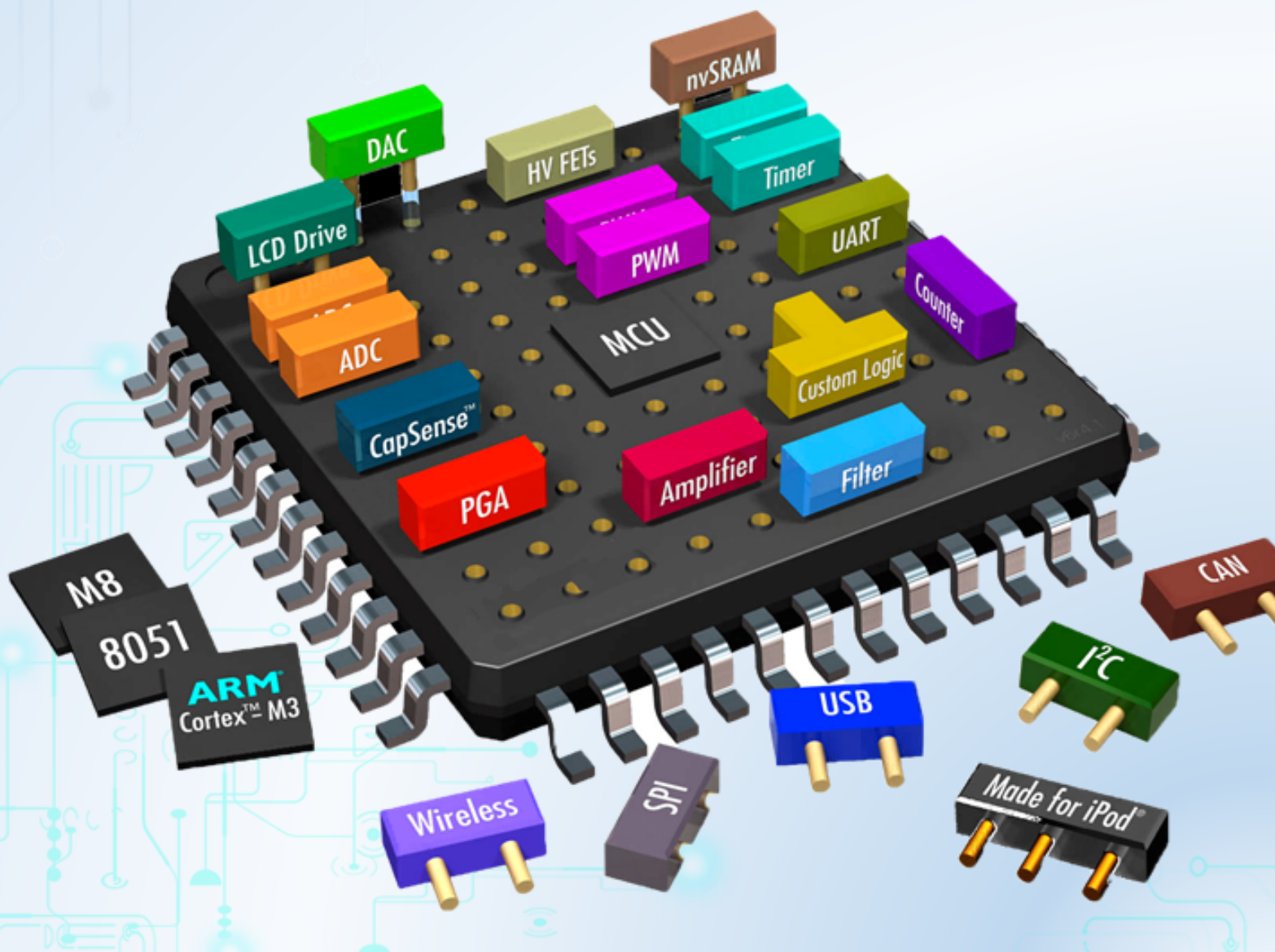
CHAPTER 4

Smart Watch Project



CHAPTER 5

Internet of Things Project



1 Introduction

2 Reading sensor

analogRead

3 Control actuators

analogWrite PWM

4 Communications based UART

CHAPTER 6

Real Time Operating System

