

Bonus 1: Spin Stepper Motor When an Alarm is Triggered

This task will add **3 points** to your final grades of this course.

In this task, you need to set an alarm every time the **center button** of joystick is pressed. The alarm should be triggered 10 seconds after the moment when the center button is pressed. When the alarm is triggered, you need to spin the stepper motor 180 degree anticlockwise with full stepping.

*Hint: Since RTC Interrupts are connected to EXTI18 Internally, you need to enable and configure the EXTI line 18 first. By doing this, when an alarm set before is triggered, the processor will respond to this interrupt and execute the RTC_Alarm_IRQHandler. So you are responsible for writing the handler to tell the processor what to do when an alarm is triggered. And do not forget to export RTC_Alarm_IRQHandler. Figure 1 shows how to export a handler for SysTick. You can imitate it to export the handler for RTC alarm. Besides, when you set time for RTC or RTC alarm, the value you pass to the function is in BCD code (refer to the related slides to learn how to set time for RTC). However, the value you read from RTC is in binary form. So you need to convert the value you read from binary form to BCD code. I have provided the function to help you finish this conversion. Call function **BIN2BCD** and pass the value to R0 before you call it. The value in BCD code will be returned and saved in R0.*

```
INCLUDE core_cm4_constants.s      ; Load Cortex-M4 Definitions
INCLUDE stm32l476xx_constants.s  ; Load STM32L4 Definitions
EXPORT SysTick_Handler
```

Figure 1. Exporting handler for systick

Bonus 2: Implement a Clock with Setting Function

This task will add **5 points** to your final grades of this course.

In the regular task, we can display the time on LCD after every second. For a clock, we want to set the time as we like in addition to displaying the time. In this task, we try to implement the setting function by using the buttons of the joystick. The requirement is as follows:

1. The **center button** is used for starting and ending a time setting. When the center button is pressed at the first time, the clock will enter setting mode. And after the time is reset and the center button is pressed for the second time, the clock will exit setting mode. And the clock will keep displaying the time as usual based on the latest time just set.
2. When the clock enters setting mode, the **left/right button** can be used to move the "cursor", which is used for choosing among hours, minutes, and seconds. The cursor is virtual, you don't need to display the cursor. The position of the cursor will

be at the seconds by default when the clock enters setting mode. The cursor will be moved among hours, minutes, and seconds each time you press the left or right button. For example, if the cursor is at the seconds and the left button is pressed, the cursor will move to the minutes. And if the cursor is at the hours and the right button is pressed, the cursor will move to the minutes. However, if the cursor is at the seconds and the right button is pressed, the cursor will not move. If the cursor is at the hours and the left button is pressed, the cursor will not move.

3. When the clock enters setting mode, the **up/down button** can be used to change the value. Every time you press the up button, the value of the chosen part will be increased by one. And the value will be decreased by one each time the down button is pressed. However, if the value you want to change has achieved its upper bound, it should not increase even if you press the up button. For instance, assume you are changing the value of minutes. when the value of minutes has become 59 and you press the up button again, the value should not change. Similarly, when the value achieves its lower bound, the value will not change when you press the down button. **Note** that you should display the latest time on LCD every time you push the up/down button.

I will give you an example to help you learn how the time setting works. Assume the current time is **123456 (12:34:56)** and I want to set the time to **143456(14:34:56)**. First, I need to press the center button to enter the setting mode. Then I press the left button 2 times. By doing this, I move the cursor to hours. And then I press the up button, so the LCD will display **133456 (13:34:56)**. Then I press the up button for the second time. The LCD will display **143456 (14:34:56)**. Since this is the new time I want to set, I press the center button to exit setting mode. So now the LCD should display **143456(14:34:56)** and it keeps displaying the latest time.

Hint: Like Bonus 1, you also need to do the conversion from binary form to BCD code before you set RTC to the new time.