# Micro-Controller Experiment

Week7

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TA: 陳大荃 Da-chuan Chen, 陳恩妮 En-ni Chen

# Class Rules

1. No drink besides water.
2. Bring a laptop and breadboard if needed.
3. Ask us TAs to sign and borrow development boards. Do not sign or ask others to sign for you without TAs' permission.
4. Arriving 10 minutes after the bell rings will be regarded as absent.
5. If you damage any borrowed equipment, you have to pay for it.

# Homework Rules

1. Includes: A. Class content, B. Class exercise, C. Homework (screenshot or video)
2. Editing software: MS PowerPoint
3. File format: PDF
4. Filename: "date_group_studentID_name.pdf", like "0916_第1組_11028XXX_陳OO.pdf"
5. The homework deadline is 23:59 of the day before the next class. If you are late, then your grade will be deducted.

# Contact

If you encounter any problems with this class, please get in touch with us with the following

E-mails:

1. Teacher, Prof. Yu-Ping Liao 廖裕評： lyp@cycu.org.tw
2. TA, Da-chuan Chen 陳大荃： dachuan516@gmail.com
3. TA, En-ni Chen 陳恩妮： anna7125867@gmail.com

Or visit 篤信 Lab353 for further questions.

# Outline of the Week

1. PWM introduction
2. PWM Project.
3. Homework 7-1.
4. Homework 7-2.
5. Homework 7-3.
6. Homework 7-4 Bonus.

# PWM Introduction

# PWM

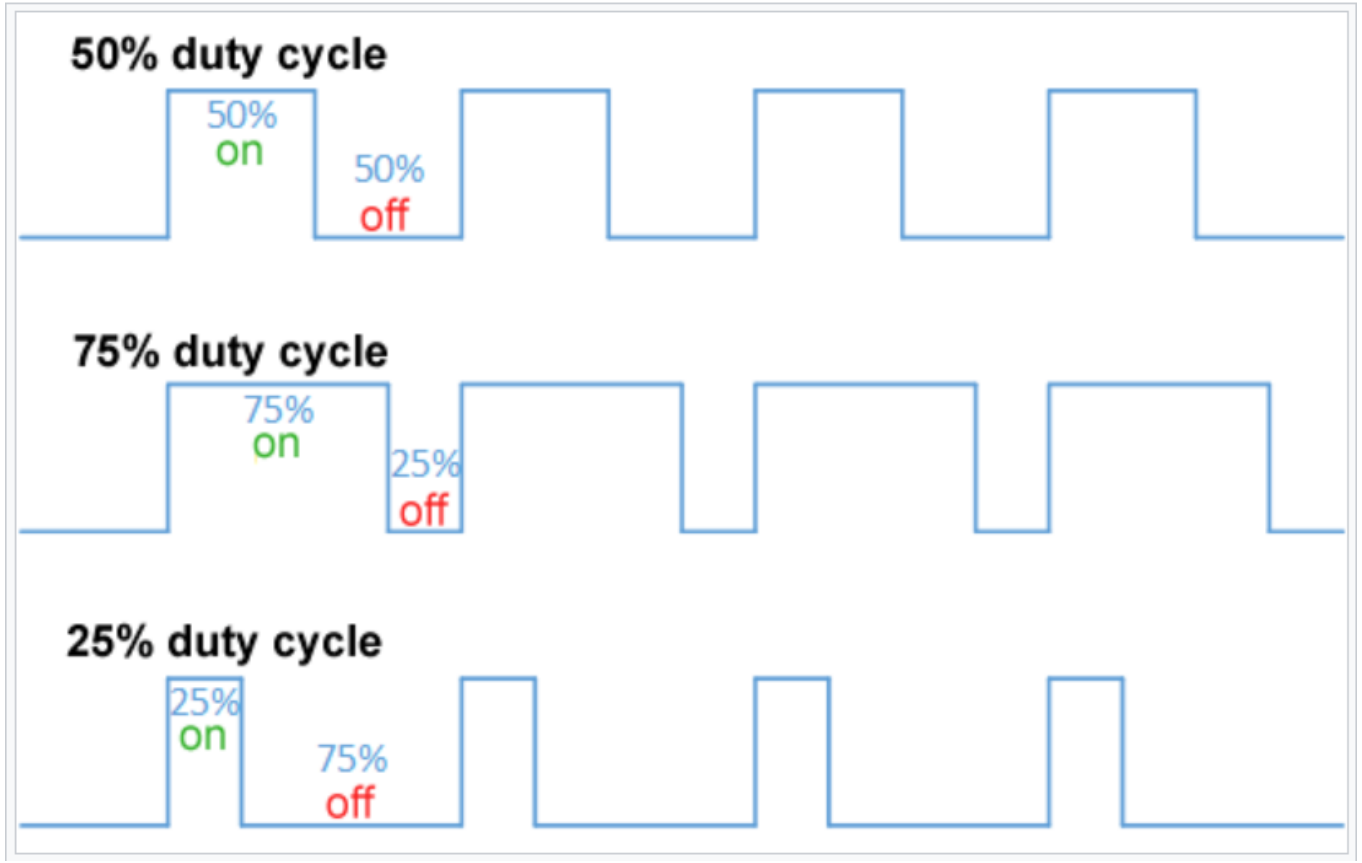
Pulse-width modulation (PWM) is a technique for generating analog signals using pulse waves.

Typically, the converted pulse wave has a fixed period, but the duty cycle of the pulse wave varies depending on the magnitude of the analog signal.

The duty cycle and frequency of a PWM signal determine its behavior.

# Duty Cycle

The term duty cycle describes the proportion of on time to the regular interval or period of time.

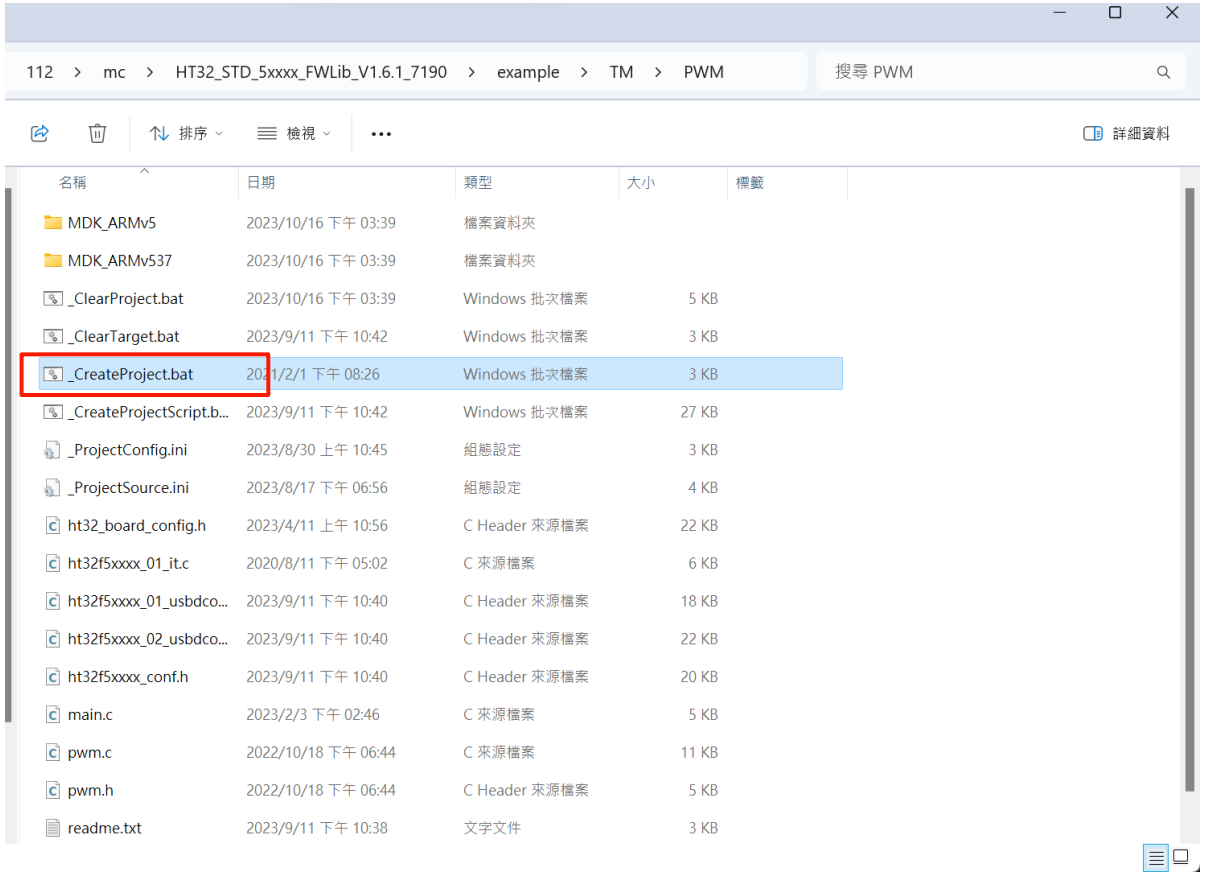


# PWM Project

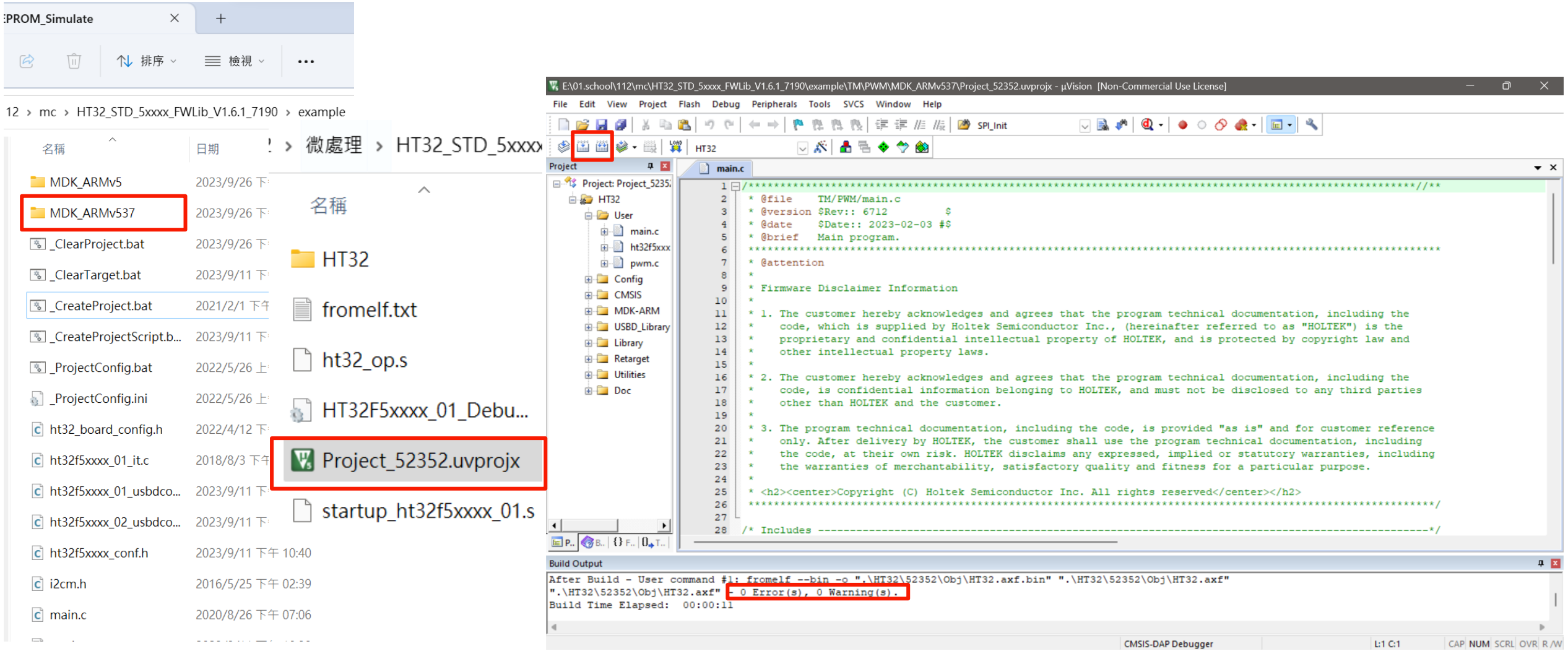
# 1. Execute “_CreatProject”

1. Go to “~/HT32_STD_5xxxx_FWLib_V1.5.1_7084/example/TM/PWM”.

2. Double click “_CreateProject.bat”.



# 2. Launch project



# main

```
54  int main(void)
55  {
56    PWM_Init();
57
58    PWM_UpdateDuty(PWM_CH0, PWM_DUTY_50);
59    PWM_UpdateDuty(PWM_CH1, PWM_DUTY_25);
60    PWM_Cmd(ENABLE);
61
62    Delay(5000);
63
64    PWM_UpdateDuty(PWM_CH0, PWM_DUTY_0);
65    PWM_UpdateDuty(PWM_CH1, PWM_DUTY_75);
66
67    Delay(5000);
68
69    PWM_Cmd(DISABLE);
70
71    Delay(5000);
72
73    PWM_SetFreq(PWM_FREQ_12K);
74    PWM_UpdateDuty(PWM_CH0, PWM_FREQ_12K * 0.25);
75    PWM_UpdateDuty(PWM_CH1, PWM_FREQ_12K * 0.75);
76    PWM_Cmd(ENABLE);
77
78    while (1);
79  }
```

PWM Initialization Setting

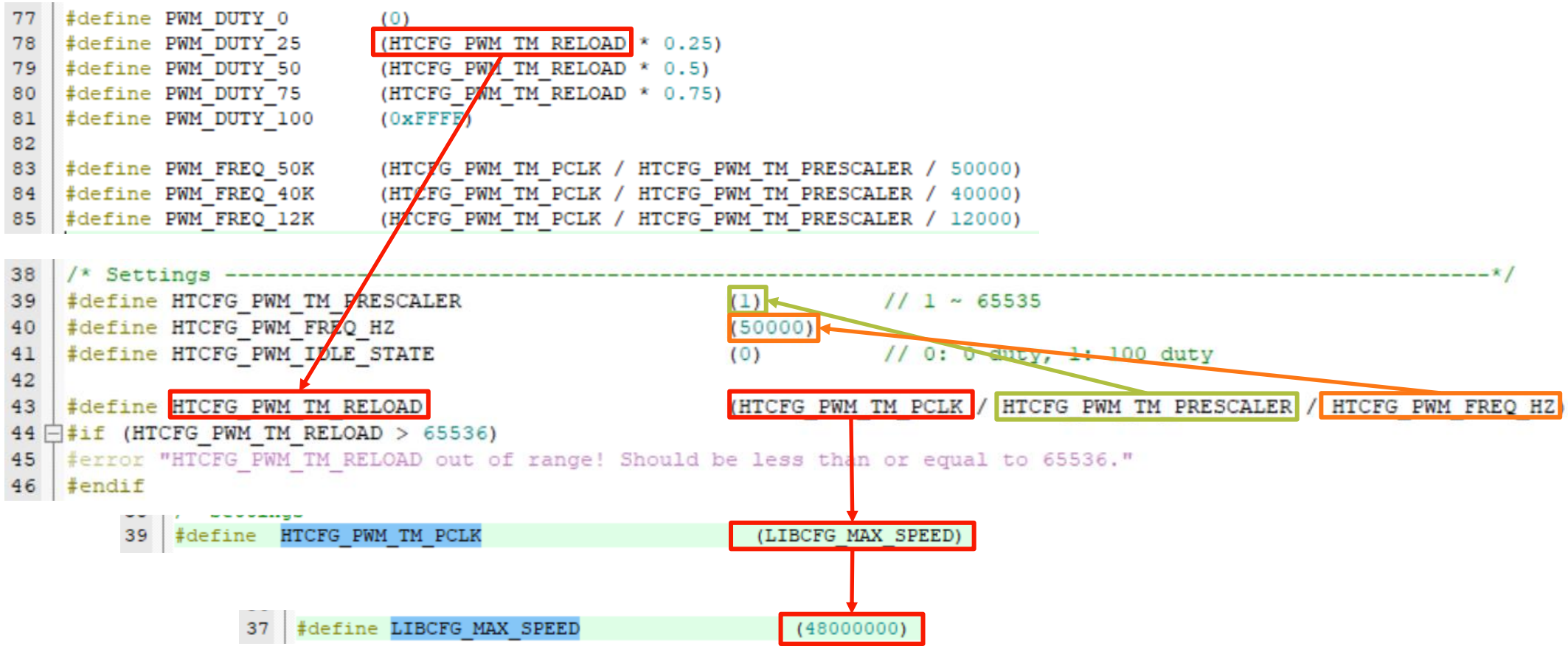
PWM Enable

Set Duty Cycle as X%

PWM Disable

Set CRR value

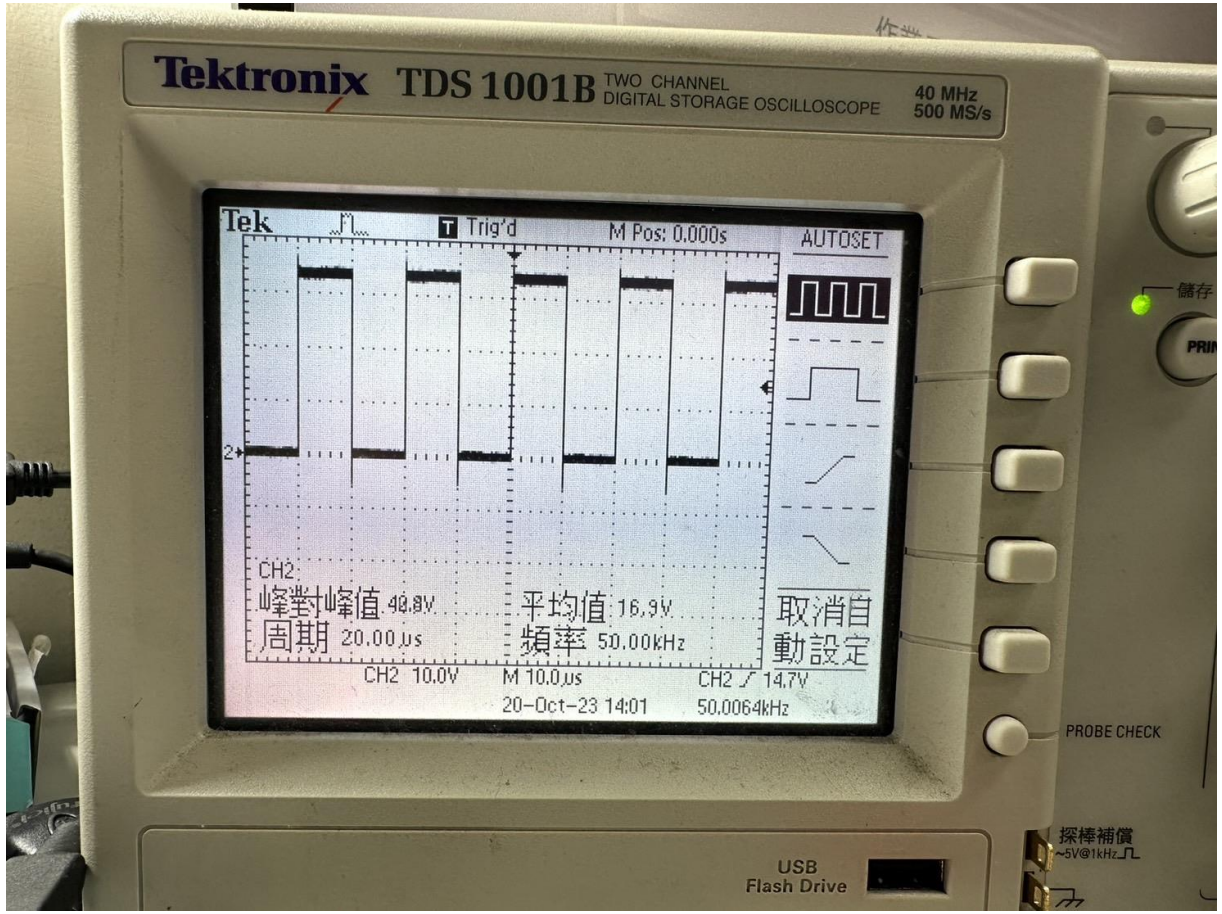
# F12"PWM_FREQ_12K"->PWM.h



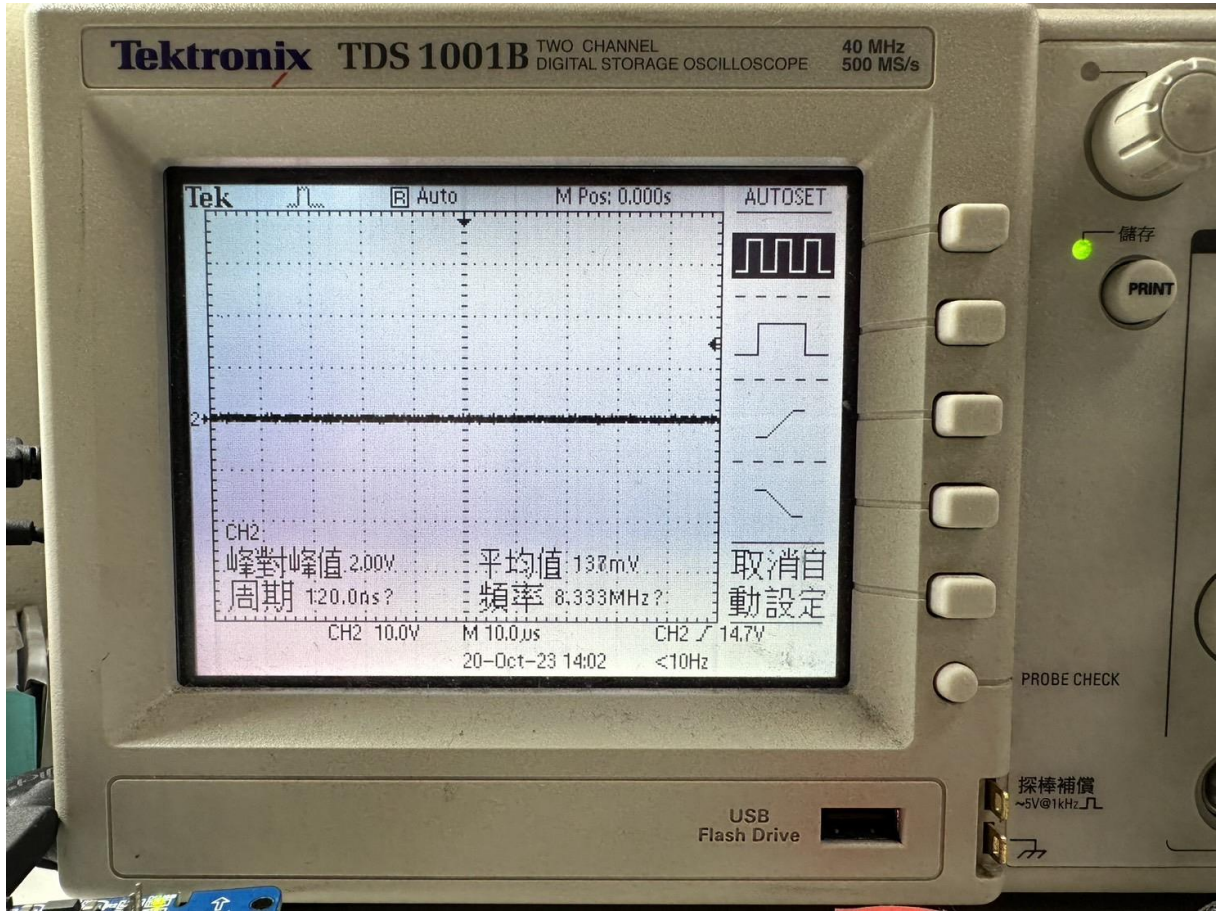

TM_RELOAD=CRR=48000000/1/50000=960<65535
T=1/f=1/50000=0.0002s=20us

PS: Since GPTM is a 16-bit up/down counter, if CRR exceeds 16 bits, it cannot be displayed correctly.

# Show on the oscilloscope

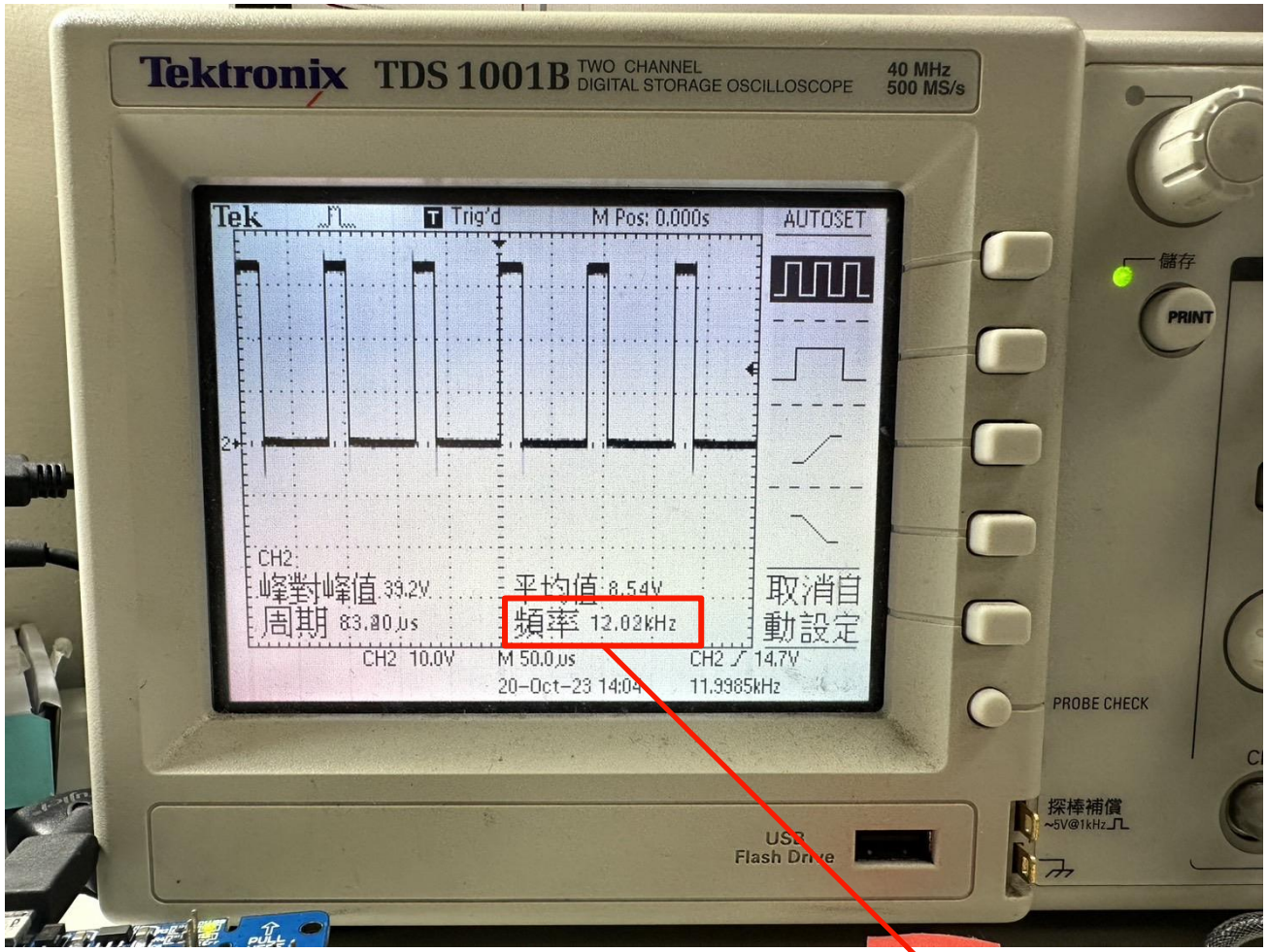



- PWM_UpdateDuty(PWM_CH0, PWM_DUTY_50);




- PWM_UpdateDuty(PWM_CH0, PWM_DUTY_0);

# Show on the oscilloscope




- PWM_UpdateDuty(PWM_CH0, PWM_FREQ_12K * 0.25);

# Homework W7-1.

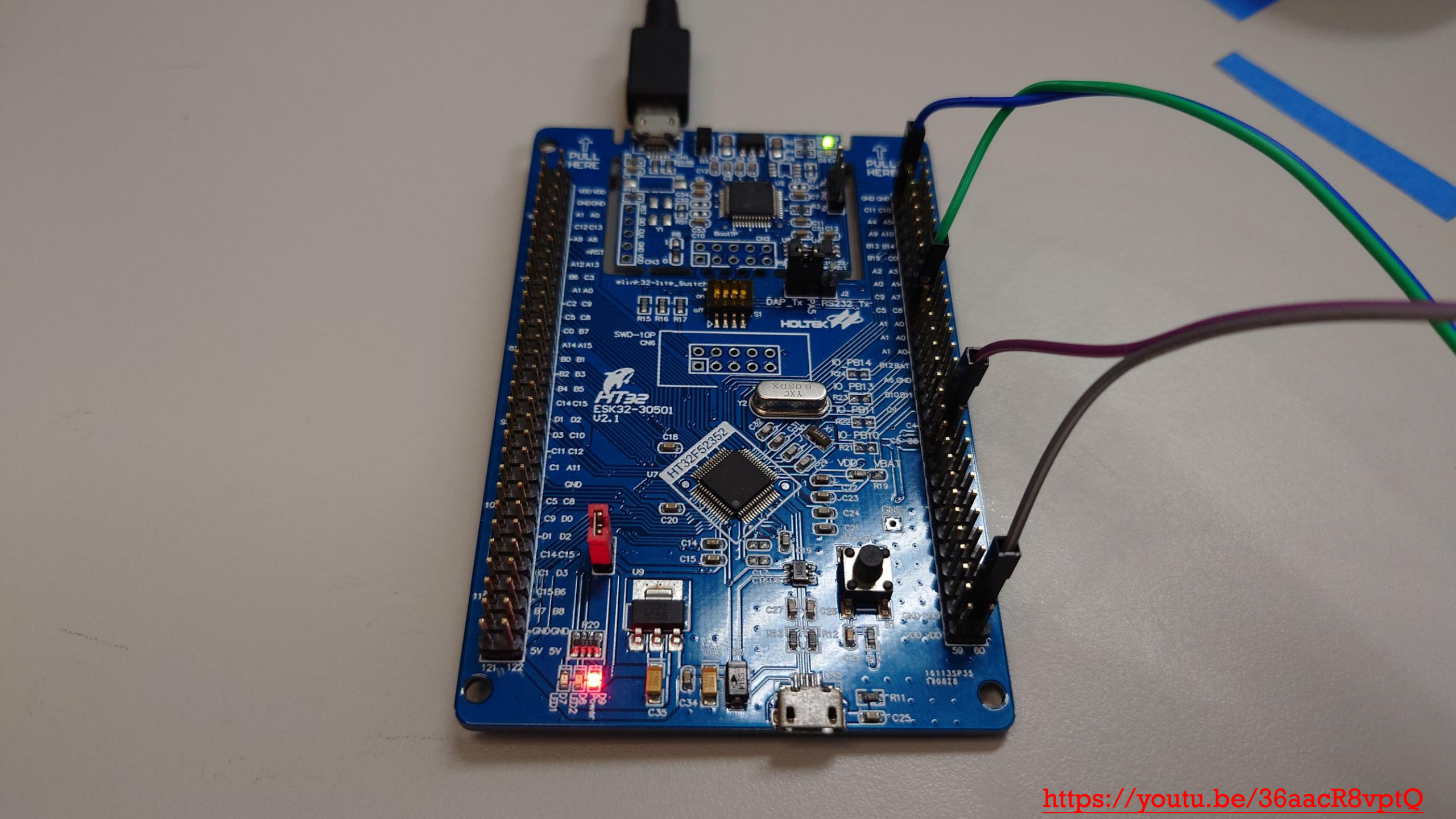
https://github.com/CYCU-AIoT-System-Lab/Microcontroller-Experiment/blob/main/w7/TM-PWM-Experiment_Steps.md

# Execute the example and show on oscilloscope

- Objective: Observe output signal with oscilloscope and explain the code.
- Hint:

1. Use key "F12" to locate specified pins and connect them.
2. Increase the default delay time for result observation.
3. Connect PWM **CH2** and **CH3** to the oscilloscope.

☆ PS. Please record.


PULL HERE
PULL HERE
HT32
ESK32-30501
V2.1
HT32F52352
SWD-10P
CN6
DAP_Tx
RS232_Tx
HOLTEK
IO_PB14
IO_PB13
IO_PB11
IO_PB10
VDD
VBAT
GND
5V
5V
https://youtu.be/36aacR8vptQ

# Homework W7-2

# Control servo motor (SG90)

- Objective: Modify code and connect **CH2** to oscilloscope, and use **CH3** to control SG90.
- Hint:

1. Connect **CH2** to oscilloscope.
2. Connect **CH3** to servo motor SG90, and rotate it to 0, 45, 90, 135, and 180 degrees angle.
3. Edit code in files: main.c & PWM.h.

☆ PS. Please record.

# SG90

Datasheet: https://reurl.cc/6DX3pV

【引線接法】

- 棕色： GND
- 紅色： VCC 3~7.2V (建議5V)
- 橙色： 控制訊號

Feature:

```
38 /* Settings ------------------------------------------------------------------------------------------------*/
39 #define HTCFG_PWM_TM_PRESCALER                  [redacted]          // 1 ~ 65535
40 #define HTCFG_PWM_FREQ_HZ                       (50)
41 #define HTCFG_PWM_IDLE_STATE                    (0)          // 0: 0 duty, 1: 100 duty
42
43 #define HTCFG_PWM_TM_RELOAD                     (HTCFG_PWM_TM_PCLK / HTCFG_PWM_TM_PRESCALER / HTCFG_PWM_FREQ_HZ)
44 #if (HTCFG_PWM_TM_RELOAD > 65536)
45 #error "HTCFG_PWM_TM_RELOAD out of range! Should be less than or equal to 65536."
46 #endif
```

其工作原理是：

控制信號由接收機的通道進入信號調製晶片，獲得直流偏置電壓。它內部有一個基準電路，產生週期為20ms，寬度為1.5ms的基準信號，將獲得的直流偏置電壓與電位器的電壓比較，獲得電壓差輸出。最後，電壓差的正負輸出到電機驅動晶片決定電機的正反轉。當電機轉速一定時，通過級聯減速齒輪帶動電位器旋轉，使得電壓差為0，電機停止轉動。當然我們可以不用去瞭解它的具體工作原理，知道它的控制原理就夠了。就象我們使用電晶體一樣，知道可以拿它來做開關管或放大管就行了，至於管內的電子具體怎麼流動是可以完全不用去考慮的。

舵機的控制：

舵機的控制一般需要一個20ms左右的時基脈衝，該脈衝的高電平部分一般為0.5ms~2.5ms範圍內的角度控制脈衝部分。以180度角度伺服為例，那麼對應的控制關係是這樣的：

0.5ms----------0度；

1.0ms----------45度；

1.5ms----------90度；

2.0ms----------135度；

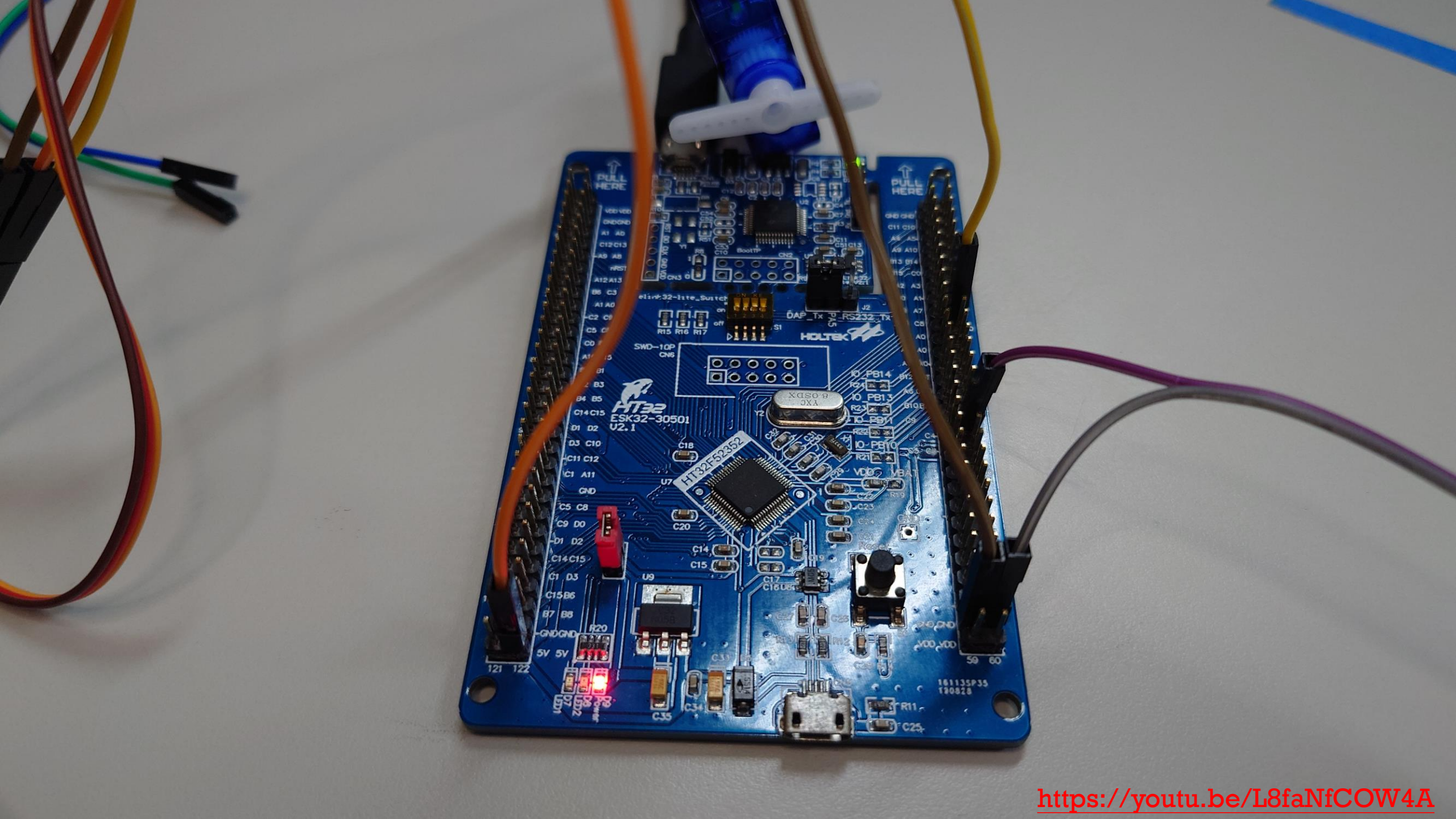
2.5ms----------180度；

這只是一種參考數值，具體的參數，請參見舵機的技術參數。

f=1/T=1/20m=50HZ(=HTCFG_PWM_FREQ_HZ)
TM_RELOAD=CRR=48000000/50/?<65535

0°:0.5/20=0.025
45 ° :1.0/20=0.05
90 ° :1.5/20=0.075
135 ° :2.0/20=0.1
180 ° :2.5/20=0.125

```
#define PWM_DUTY_0      (HTCFG_PWM_TM_RELOAD * 0.025)
#define PWM_DUTY_25     (HTCFG_PWM_TM_RELOAD * [redacted])
#define PWM_DUTY_50     (HTCFG_PWM_TM_RELOAD * [redacted])
#define PWM_DUTY_75     (HTCFG_PWM_TM_RELOAD * [redacted])
#define PWM_DUTY_100    (HTCFG_PWM_TM_RELOAD * [redacted])
```




https://youtu.be/L8faNfCOW4A

# Homework W7-3

# Control the motor angle by input

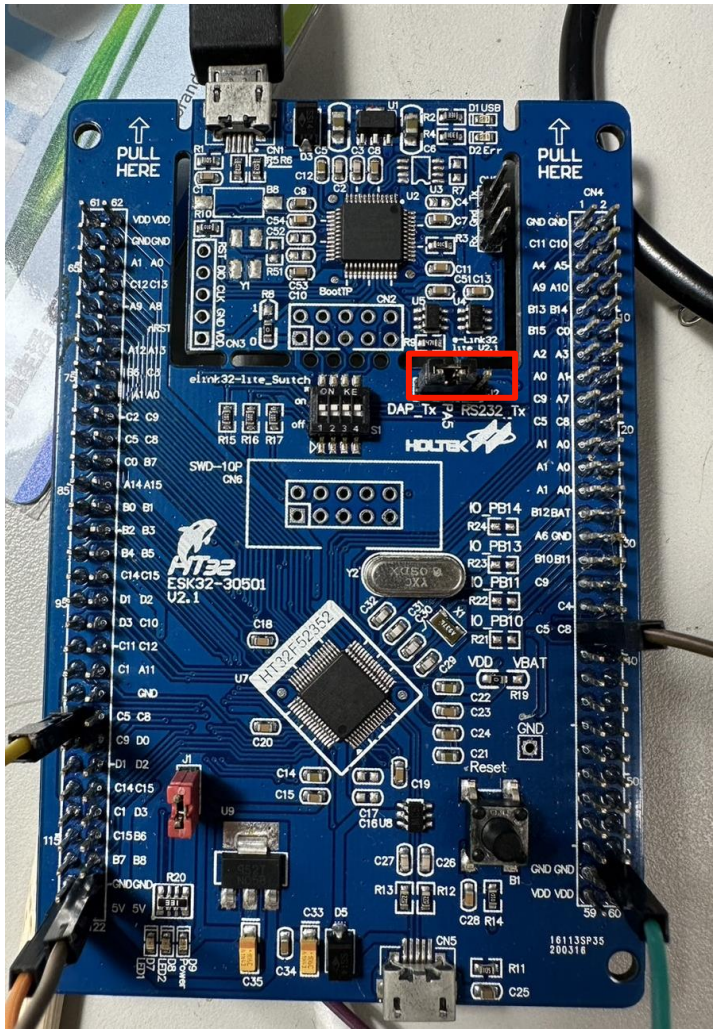
- Objective: Use laptop keyboard (Tera Term) input Duty Cycle to control SG90.
- Hint:

1. Connect **CH2** to oscilloscope.
2. Connect **CH3** to servo motor SG90, and use user input to rotate it to 0, 45, 90, 135, and 180 degrees angle.
3. Edit code.

☆ PS. Please record.

# Step1:

Check if the jumper is connected to DAP_TX and PA5.






Enable local echo in the terminal settings.

# Step2:

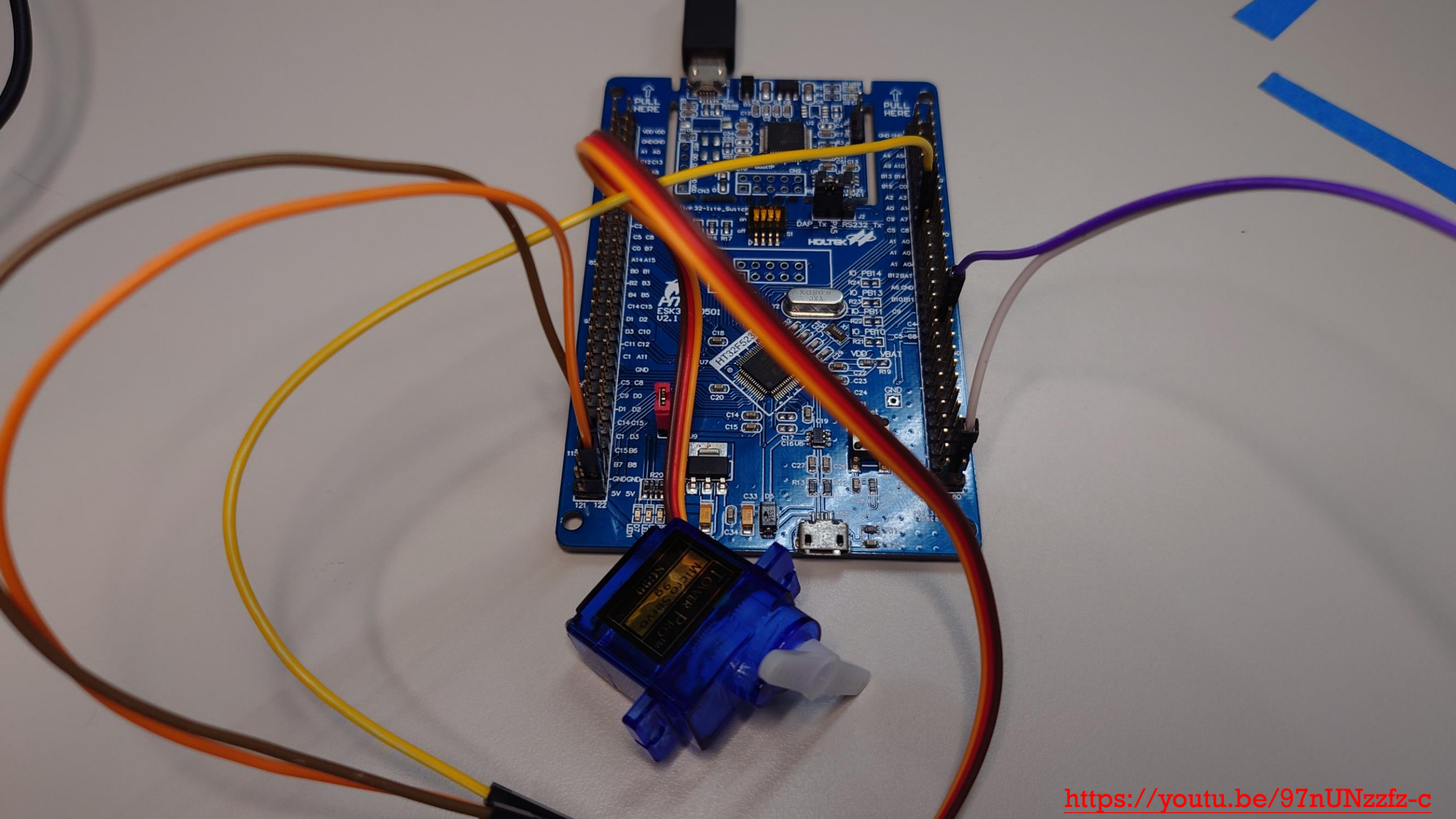
- Add code to the appropriate location and annotate or remove unnecessary code.
- PS. input is floating number

```
float input;
RETARGET_Configuration();
PWM_Init();
```

```
while (1)
{
  printf("Please input ...\n\r");
  scanf("%f", &input);
  printf("the input is %f\r\n", input);

  PWM_UpdateDuty(PWM_CH2, HTCFG_PWM_TM_RELOAD * input);
  PWM_UpdateDuty(PWM_CH3, HTCFG_PWM_TM_RELOAD * input);
  PWM_Cmd(ENABLE);

  Delay(20000000);
}
```




https://youtu.be/97nUNzzfz-c

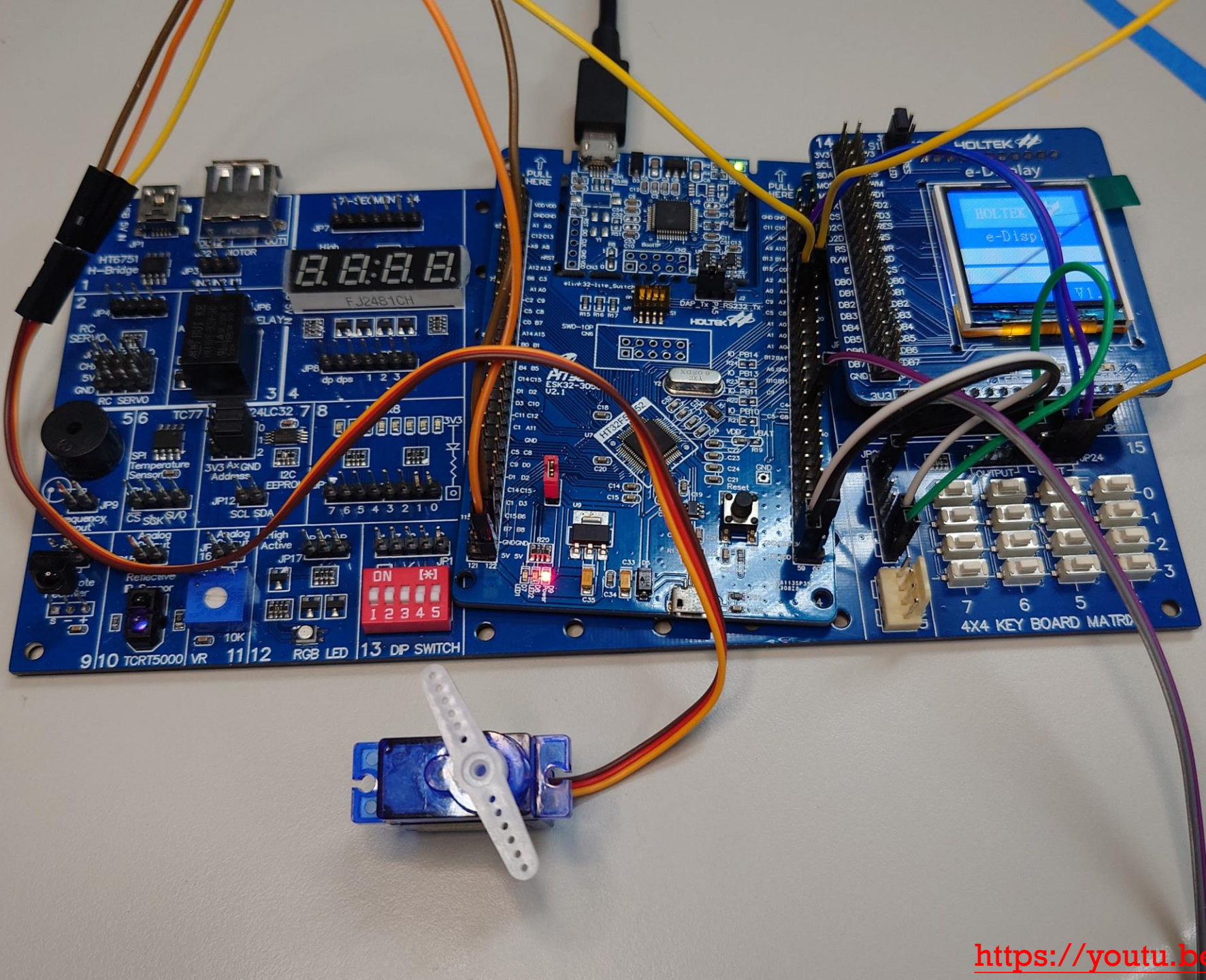
# Homework W7-4 Bonus Question

# Bonus: Use buttons to control the motor.

- Objective:  Use three buttons to control SG90 to rotate to 0, 90, and 180 degrees.
- Hint:

1. Connect **CH2** to oscilloscope.
2. Connect **CH3** to servo motor SG90.
3. Use pin **B1**, **B2**, **B3** to take GPIO input.
4. Refer to week 2 example GPIO/InputOutput.

☆ PS. Please record and explain the code.




https://youtu.be/7Mu6fSOrbyc

# Class Dismissed