# Timer

**Timer**

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## 1. Learning Objectives

1. Learn the basic use of the MSPM0G3507 motherboard timer.
2. Realize the timed flipping of LED status.

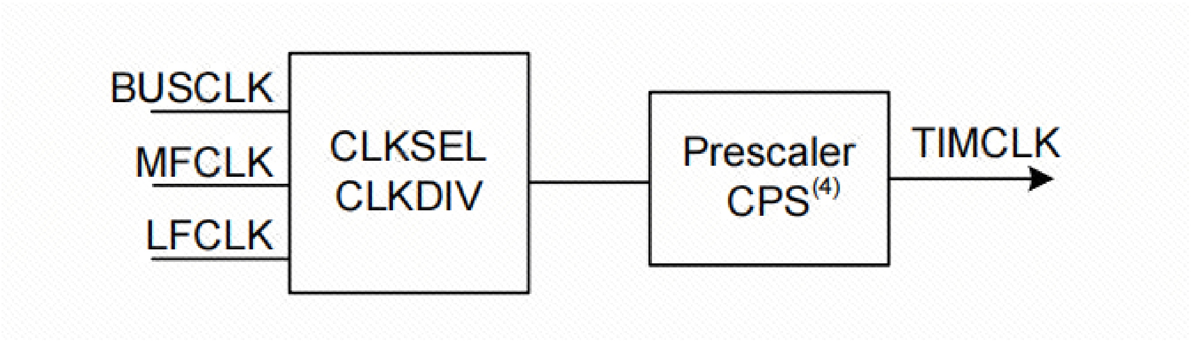
### Timer

The timer is a very important peripheral in the microcontroller, used for timing and generating timed interrupts. The core principle of the timer is to record time through an internal counter. The counter is incremented by one per machine cycle. When the counter reaches a preset value, it triggers an interrupt. The program can perform certain operations in the interrupt service program, such as flipping LEDs, reading sensor data, controlling motors, etc.

### Basic parameters of the timer

1. Prescaler

The prescaler can divide the timer clock (TIMCLK) frequency by any value between 1 and 256 (1 to 256 is based on the 8-bit timer divider). TIMG can choose BUSCLK, MFCLK, LFCLK as the clock source, and can divide the clock by a maximum of 8. After passing through an 8-bit prescaler, it is finally called the timer count clock.



2. Up or down counting mode

Up counting means that the counter starts counting from 0 to the auto-load value. Once the counter counts to the auto-load value, it will start counting from 0 again and generate an overflow event. Down counting means that the counter starts counting from the auto-load value to 0. Once the counter counts to 0, it will start counting from the auto-load value again and generate an underflow event.

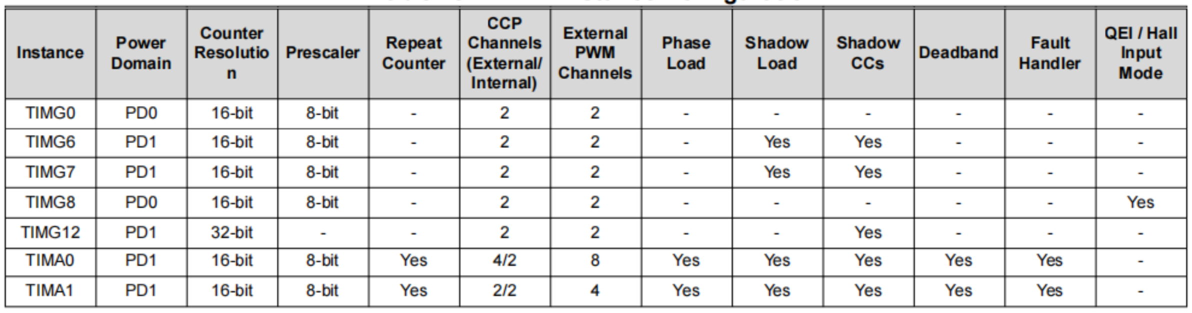
3. Update event

The update event is triggered when the counter overflows or underflows and starts a new counting cycle. The update event can trigger a DMA request to update the timer's operating parameters in time at the beginning of the next counting cycle, which is particularly suitable for real-time control.

## 2. Hardware construction

The MSPM0G series has a total of 7 timers, which can be divided into 2 types, general timers (TIMG) and advanced control timers (TIMA). Different types of timers have different numbers of functions. Generally, advanced timers have the most functions, followed by general timers.

**Table 25-1. TIMx Instance Configuration**



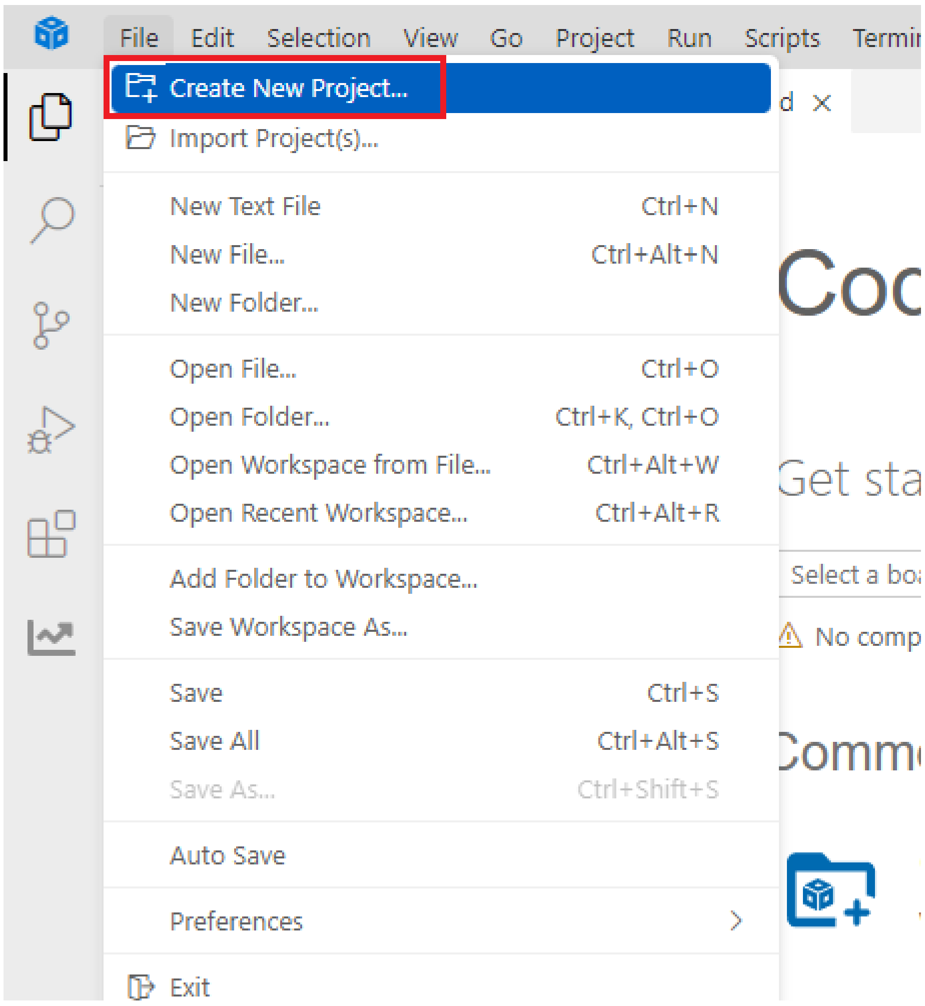
| Instance | Power Domain | Counter Resolution | Prescaler | Repeat Counter | CCP Channels (External/ Internal) | External PWM Channels | Phase Load | Shadow Load | Shadow CCs | Deadband | Fault Handler | QEI / Hall Input Mode |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TIMG0 | PD0 | 16-bit | 8-bit | - | 2 | 2 | - | - | - | - | - | - |
| TIMG6 | PD1 | 16-bit | 8-bit | - | 2 | 2 | - | Yes | Yes | - | - | - |
| TIMG7 | PD1 | 16-bit | 8-bit | - | 2 | 2 | - | Yes | Yes | - | - | - |
| TIMG8 | PD0 | 16-bit | 8-bit | - | 2 | 2 | - | - | - | - | - | Yes |
| TIMG12 | PD1 | 32-bit | - | - | 2 | 2 | - | - | Yes | - | - | - |
| TIMA0 | PD1 | 16-bit | 8-bit | Yes | 4/2 | 8 | Yes | Yes | Yes | Yes | Yes | - |
| TIMA1 | PD1 | 16-bit | 8-bit | Yes | 2/2 | 4 | Yes | Yes | Yes | Yes | Yes | - |

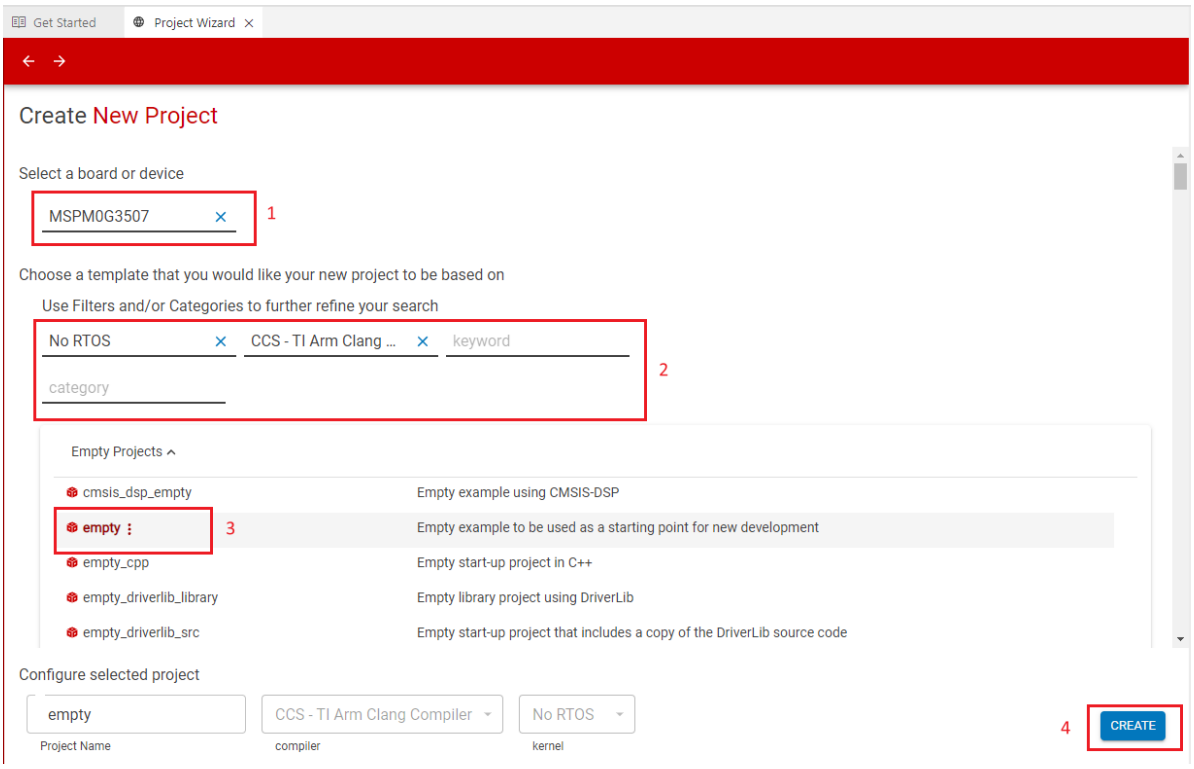
## 3. Experimental steps

If the project needs to execute or repeat a specific task at a fixed time, the configuration of the timer is particularly important. The following will introduce how to set the timer to trigger an interrupt every 1 second, and implement the state flip of the LED in the interrupt service function, so as to achieve the effect of the LED on for 1 second and off for 1 second.

### 1. Open the SYSCONFIG configuration tool

Create a blank project empty in CCS.





Create New Project

Select a board or device

MSPM0G3507 1

Choose a template that you would like your new project to be based on

Use Filters and/or Categories to further refine your search

No RTOS | CCS - TI Arm Clang ... | keyword | category 2

Empty Projects

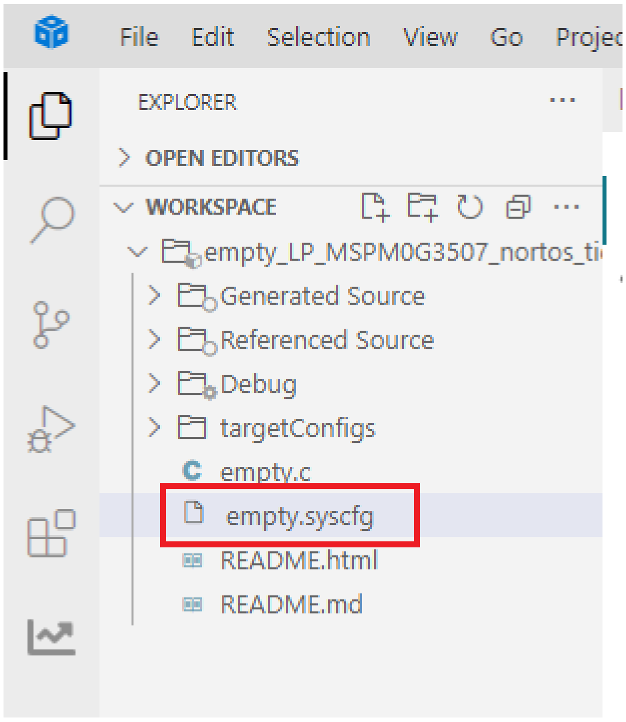
| | |
|---|---|
| cmsis_dsp_empty | Empty example using CMSIS-DSP |
| empty 3 | Empty example to be used as a starting point for new development |
| empty_cpp | Empty start-up project in C++ |
| empty_driverlib_library | Empty library project using DriverLib |
| empty_driverlib_src | Empty start-up project that includes a copy of the DriverLib source code |

Configure selected project

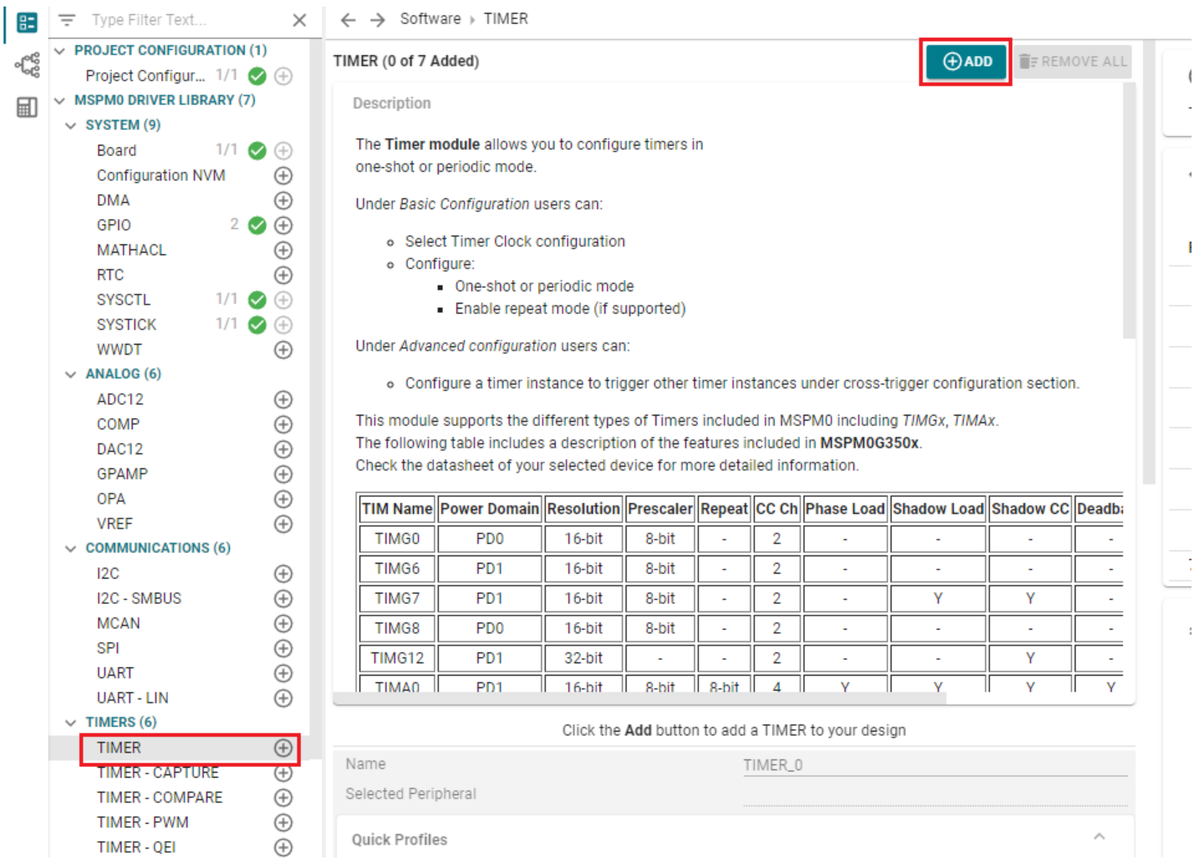
| | | |
|---|---|---|
| empty | CCS - TI Arm Clang Compiler | No RTOS |
| Project Name | compiler | kernel |

4 CREATE

Find and open the empty.syscfg file in the left workspace of CCS.



In SYSCONFIG, select MCU peripherals on the left, find the TIMER option and click to enter. Click ADD in TIMER to add a timer peripheral.



TIMER (0 of 7 Added)

Description

The **Timer module** allows you to configure timers in one-shot or periodic mode.

Under *Basic Configuration* users can:

- Select Timer Clock configuration
- Configure:
  - One-shot or periodic mode
  - Enable repeat mode (if supported)

Under *Advanced configuration* users can:

- Configure a timer instance to trigger other timer instances under cross-trigger configuration section.

This module supports the different types of Timers included in MSPM0 including *TIMGx*, *TIMAx*.
The following table includes a description of the features included in **MSPM0G350x**.
Check the datasheet of your selected device for more detailed information.

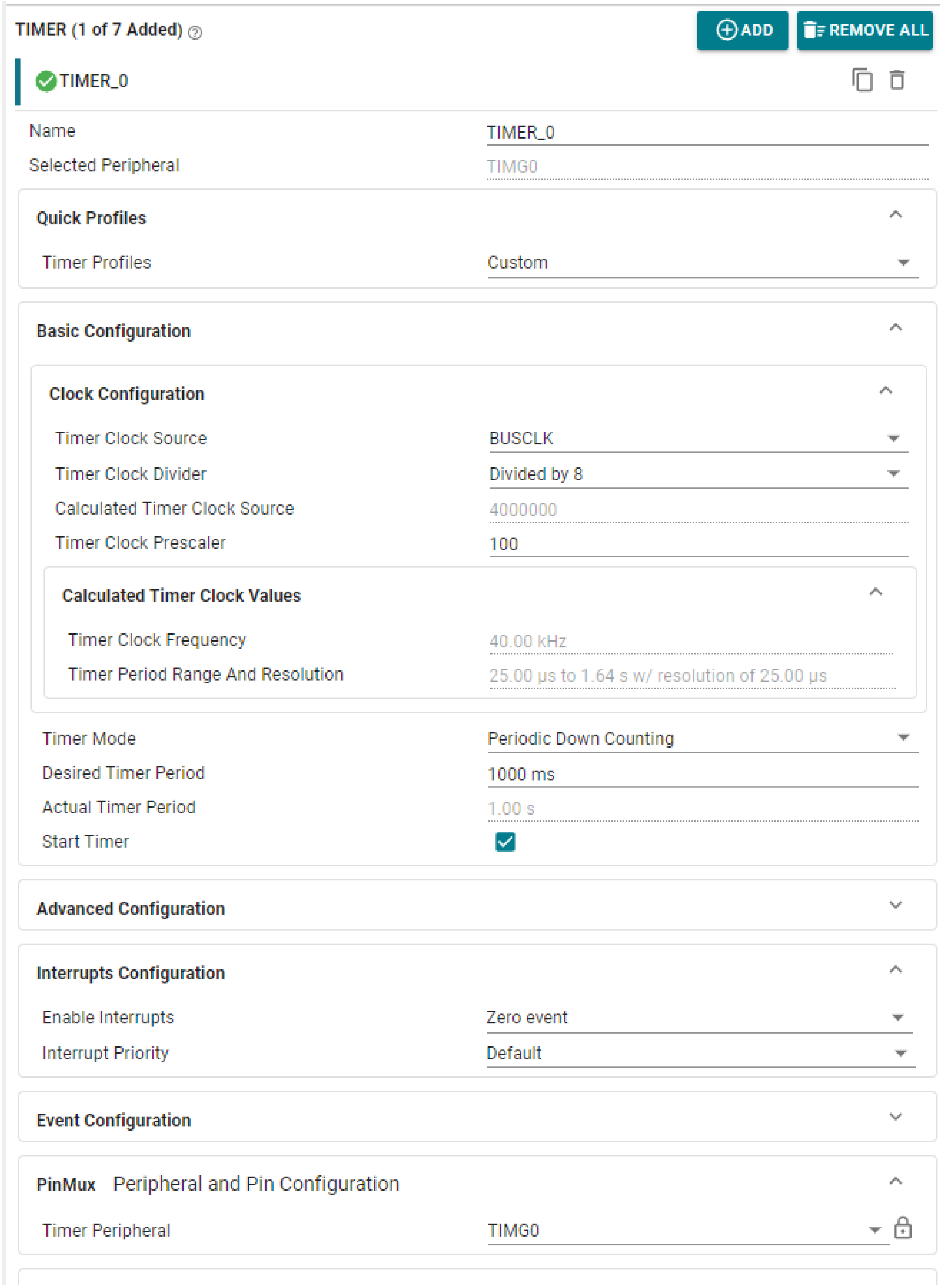
| TIM Name | Power Domain | Resolution | Prescaler | Repeat | CC Ch | Phase Load | Shadow Load | Shadow CC | Deadb |
|---|---|---|---|---|---|---|---|---|---|
| TIMG0 | PD0 | 16-bit | 8-bit | - | 2 | - | - | - | - |
| TIMG6 | PD1 | 16-bit | 8-bit | - | 2 | - | - | - | - |
| TIMG7 | PD1 | 16-bit | 8-bit | - | 2 | - | Y | Y | - |
| TIMG8 | PD0 | 16-bit | 8-bit | - | 2 | - | - | - | - |
| TIMG12 | PD1 | 32-bit | - | - | 2 | - | - | Y | - |
| TIMA0 | PD1 | 16-bit | 8-bit | 8-bit | 4 | Y | Y | Y | Y |

Click the **Add** button to add a TIMER to your design

Name: TIMER_0
Selected Peripheral

## 2. Timer parameter configuration

In this case, select BUSCLK-32MHz for the Timer Clock Source, select 8 for the Timer Clock Divider, and configure 100 for the Timer Clock Prescaler, so the timer frequency is 40KHz. Desired Timer Period sets the timer period to 1S, Timer Mode to period down counting mode, Enable Interrupts turns on 0 overflow interrupt. The GPIO configuration of LED is carried out according to the LED light course.


TIMER (1 of 7 Added)

TIMER_0

| | |
|---|---|
| Name | TIMER_0 |
| Selected Peripheral | TIMG0 |

**Quick Profiles**

| | |
|---|---|
| Timer Profiles | Custom |

**Basic Configuration**

**Clock Configuration**

| | |
|---|---|
| Timer Clock Source | BUSCLK |
| Timer Clock Divider | Divided by 8 |
| Calculated Timer Clock Source | 4000000 |
| Timer Clock Prescaler | 100 |

**Calculated Timer Clock Values**

| | |
|---|---|
| Timer Clock Frequency | 40.00 kHz |
| Timer Period Range And Resolution | 25.00 µs to 1.64 s w/ resolution of 25.00 µs |

| | |
|---|---|
| Timer Mode | Periodic Down Counting |
| Desired Timer Period | 1000 ms |
| Actual Timer Period | 1.00 s |
| Start Timer | ✓ |

**Advanced Configuration**

**Interrupts Configuration**

| | |
|---|---|
| Enable Interrupts | Zero event |
| Interrupt Priority | Default |

**Event Configuration**

**PinMux** Peripheral and Pin Configuration

| | |
|---|---|
| Timer Peripheral | TIMG0 |

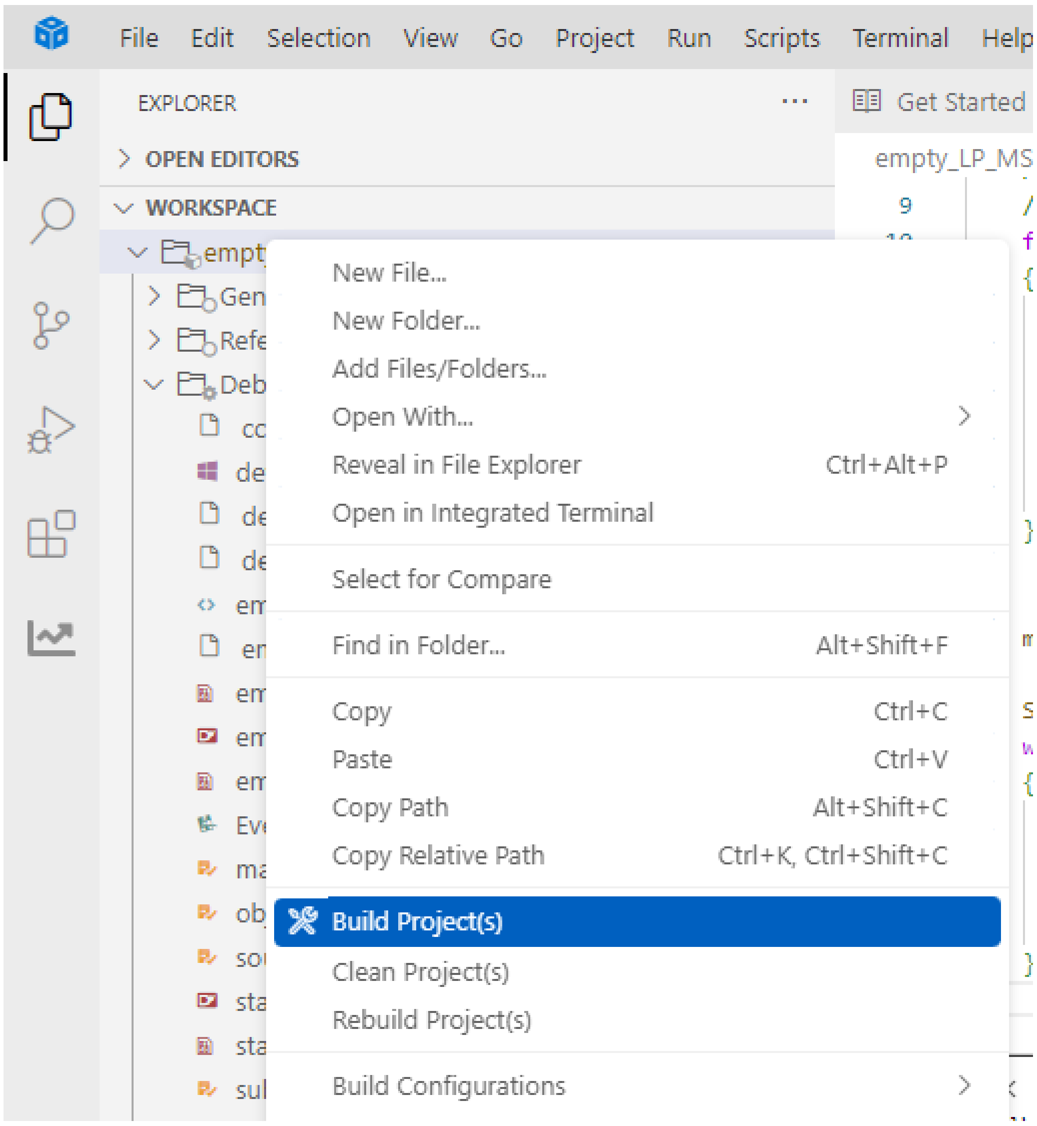
Save the configuration in the .syscfg file using the shortcut key Ctrl+S.

## 3. Write the program

In the empty.c file, write the following code

```
#include "ti_msp_dl_config.h"

int main(void)
{
    SYSCFG_DL_init();
    //清除定时器中断标志 Clear the timer interrupt flag
    NVIC_ClearPendingIRQ(TIMER_0_INST_INT_IRQN);
    //使能定时器中断 Enable timer interrupt
    NVIC_EnableIRQ(TIMER_0_INST_INT_IRQN);

    while (1)
    {

    }
}

//定时器的中断服务函数 已配置为1秒的周期
//The timer interrupt service function has been configured to a period of 1
second
void TIMER_0_INST_IRQHandler(void)
{
    //如果产生了定时器中断 If a timer interrupt occurs
    switch( DL_TimerG_getPendingInterrupt(TIMER_0_INST) )
    {
        case DL_TIMER_IIDX_ZERO://如果是0溢出中断 If it is 0 overflow interrupt
            //将LED灯的状态翻转 Flip the LED status
            DL_GPIO_togglePins(LED1_PORT, LED1_PIN_2_PIN);
            break;

        default://其他的定时器中断 Other timer interrupts
            break;
    }
}
```

## 5. Compile



If the compilation is successful, you can download the program to the development board.

## 4. Program Analysis

- empty.c

```
int main(void)
{
    SYSCFG_DL_init();
    //清除定时器中断标志 Clear the timer interrupt flag
    NVIC_ClearPendingIRQ(TIMER_0_INST_INT_IRQN);
    //使能定时器中断 Enable timer interrupt
    NVIC_EnableIRQ(TIMER_0_INST_INT_IRQN);

    while (1)
    {

    }
}

//定时器的中断服务函数 已配置为1秒的周期
//The timer interrupt service function has been configured to a period of 1 second
void TIMER_0_INST_IRQHandler(void)
{
    //如果产生了定时器中断 If a timer interrupt occurs
    switch( DL_TimerG_getPendingInterrupt(TIMER_0_INST) )
    {
        case DL_TIMER_IIDX_ZERO://如果是0溢出中断 If it is 0 overflow interrupt
            //将LED灯的状态翻转 Flip the LED status
            DL_GPIO_togglePins(LED1_PORT, LED1_PIN_2_PIN);
            break;

        default://其他的定时器中断 Other timer interrupts
            break;
    }
}
```

This is a timer interrupt service program, which is used to handle timer overflow interrupts and perform corresponding operations. Whenever the timer overflows, the state of an LED is flipped.

## 5. Experimental Phenomenon

After the program is downloaded, you can see that the LED light is flashing according to the configuration of a 1-second period.