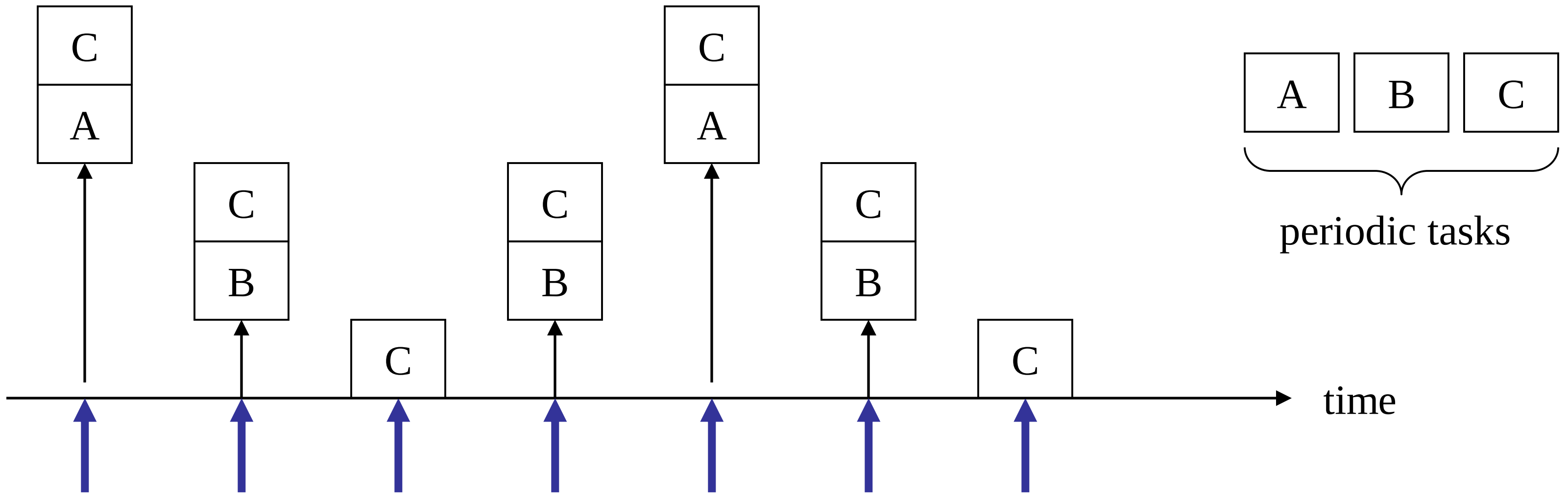
Sound Control

Outline

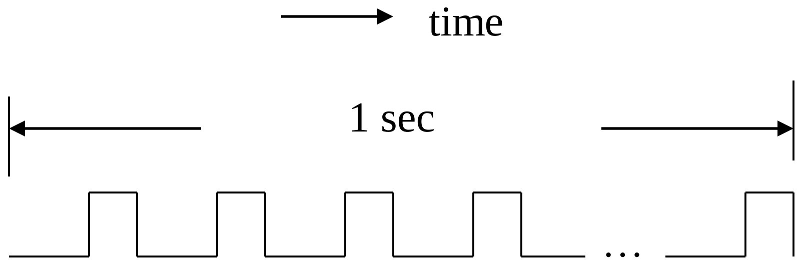
- How to control the buzzer (蜂鳴器) to play required sound?
- How to generate a signal with required frequency?
  - play a sound with fixed frequency
- How to play a song?
  - the frequency changes with time



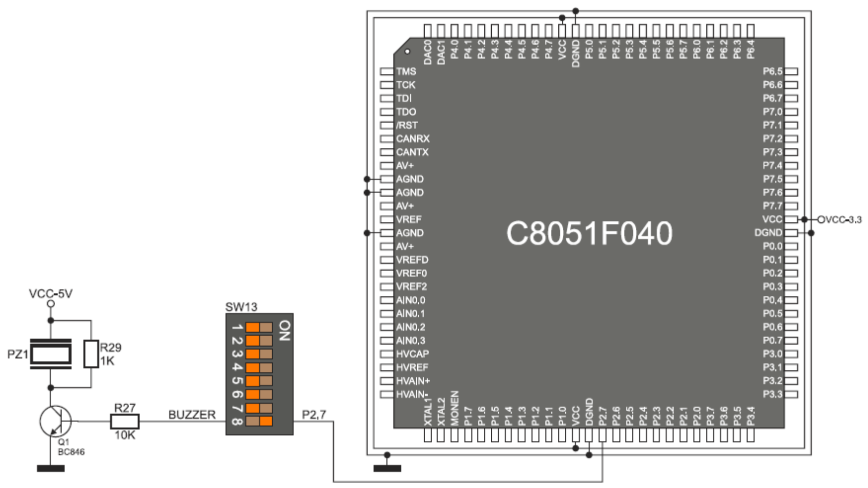
How to control the buzzer

How to control the buzzer

- control the sound by the frequency *f* of the input signal to the buzzer

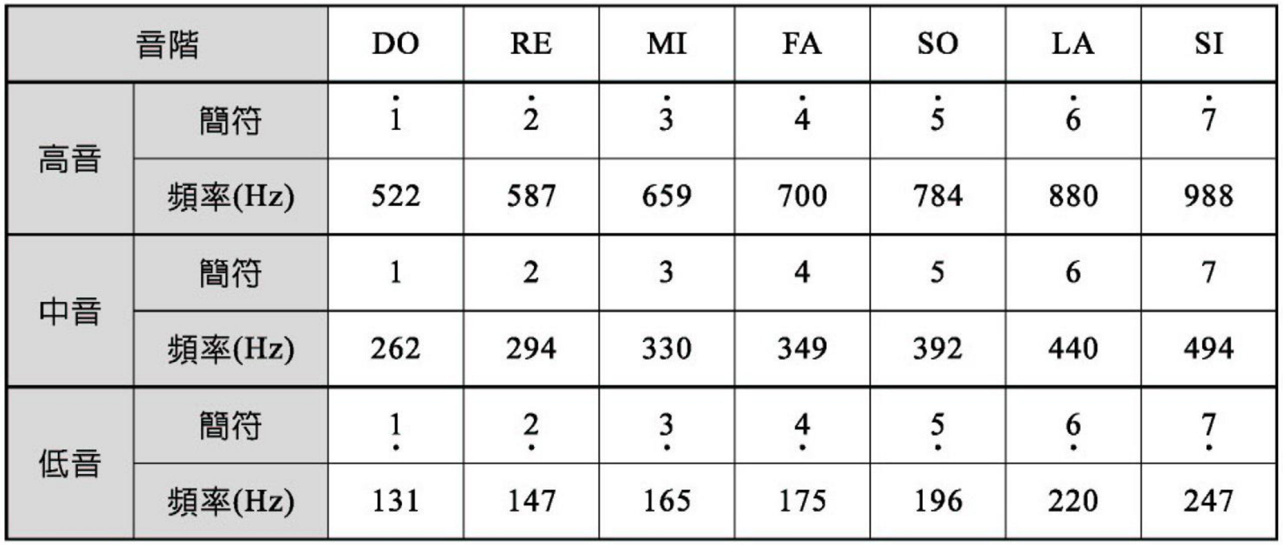


f = number of pulses in one second



Appendix: frequency of tones

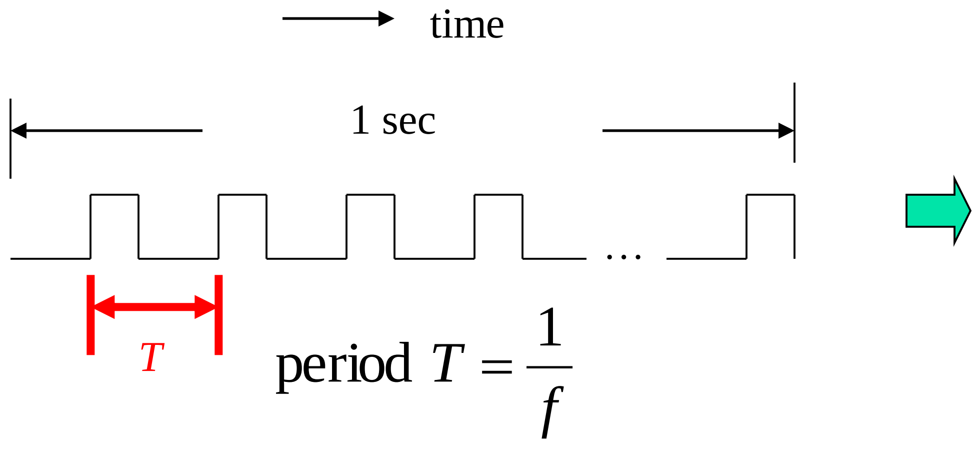
表 26-1　C 調各音階之頻率表



音階		DO	RE	MI	FA	SO	LA	SI
高音	簡符	$\dot{1}$	$\dot{2}$	$\dot{3}$	$\dot{4}$	$\dot{5}$	$\dot{6}$	$\dot{7}$
	頻率(Hz)	522	587	659	700	784	880	988
中音	簡符	1	2	3	4	5	6	7
	頻率(Hz)	262	294	330	349	392	440	494
低音	簡符	$\underset{\cdot}{1}$	$\underset{\cdot}{2}$	$\underset{\cdot}{3}$	$\underset{\cdot}{4}$	$\underset{\cdot}{5}$	$\underset{\cdot}{6}$	$\underset{\cdot}{7}$
	頻率(Hz)	131	147	165	175	196	220	247

Generating a signal with given frequency

How to send out regular pulses with given frequency



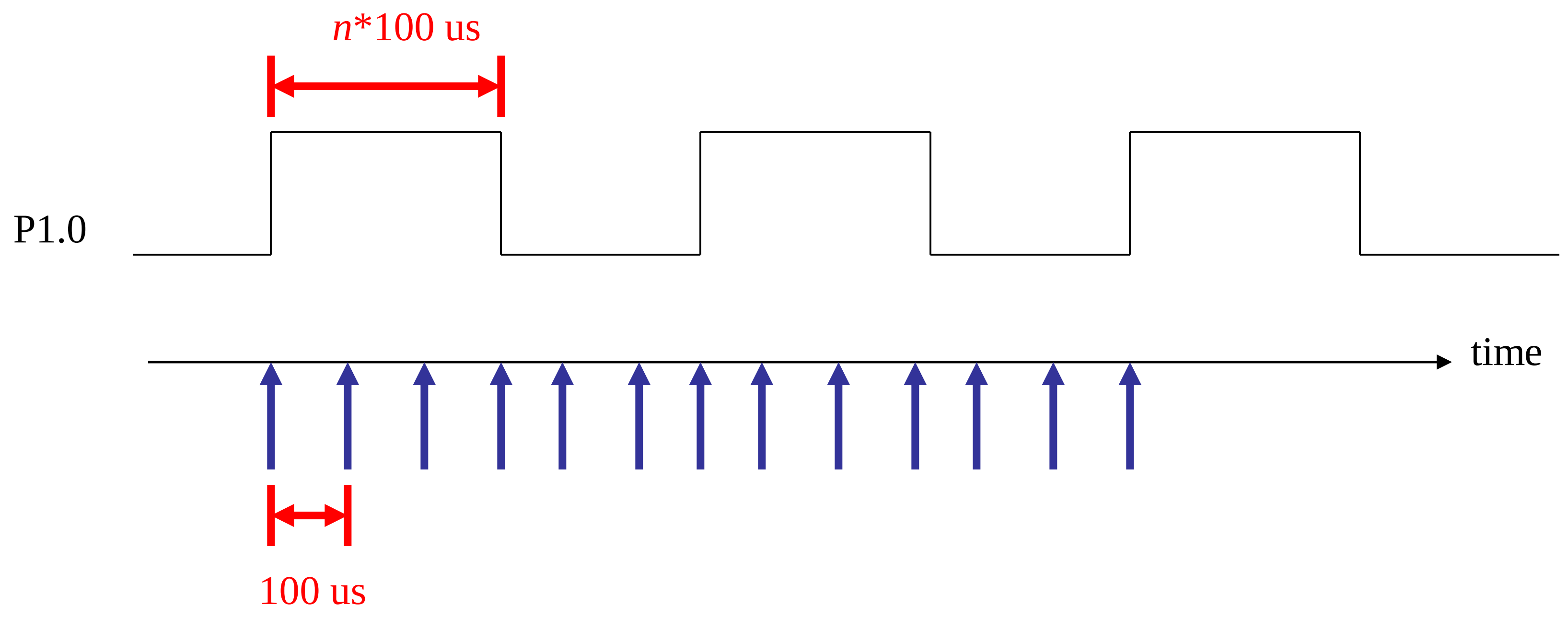
$$\text{period } T = \frac{1}{f}$$

```
main () {
    while (1) {
        status = ~status;
         P2.7 = status;
         delay (N);
    }
}
```

- It’s difficult to fine-tune delay count *N* to match *T/2* (if you use a for-loop)
- This method is not recommended!

The Problem

- Frequency generation using timer interrupt
  - Suppose: the period for timer interrupt is 100us
  - Question: How to generate a signal with half-period *n**100us ?



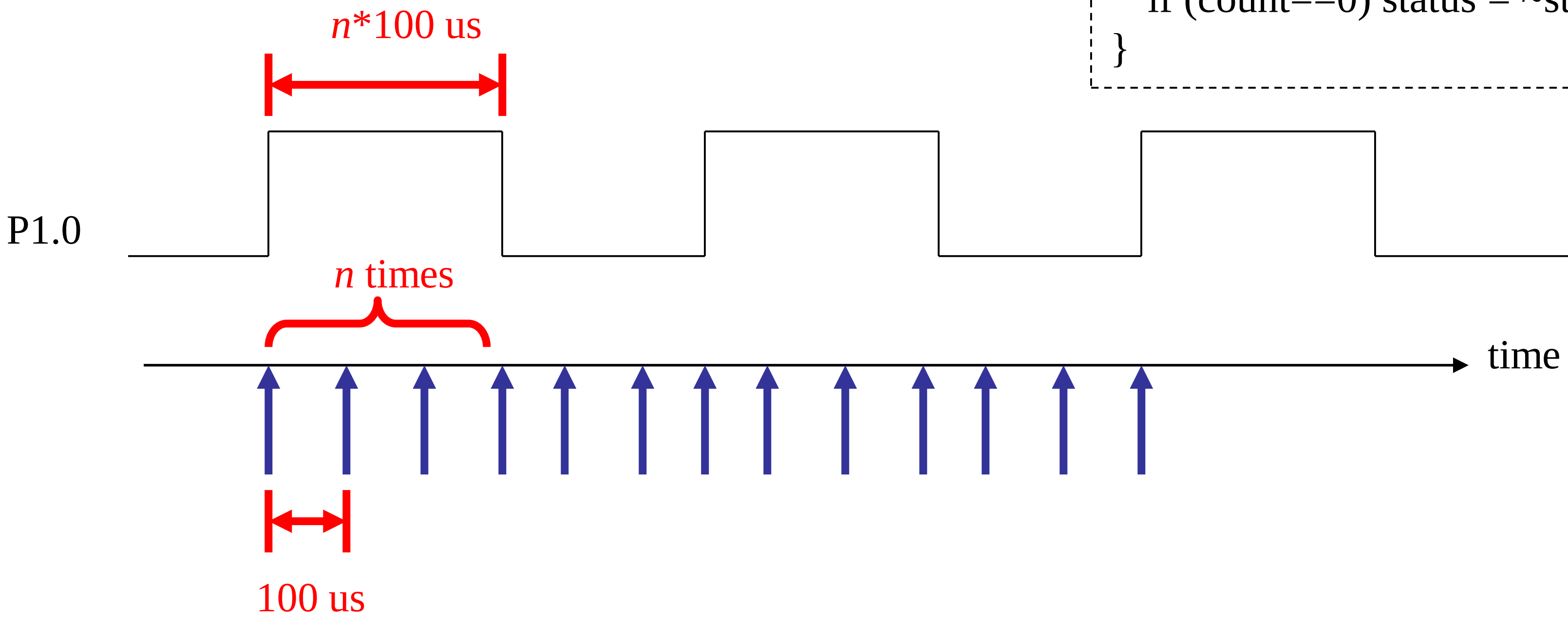
The method

- just reverse the signal every *n* times the timer ISR is called

```
int n;
int count=0;
char status;

main ()
{
    while(1) P2.7 = status;
}

Timer_ISR ()
{
    count = (count+1)%n;
    if (count==0) status = ~status;
}
```



How to play a song?

the frequency changes with time

The method

- Store the 歌譜 as an array of half-period
  - Song_Table[*i*] = the half-period of the *i*-th tone
- Use two timer interrupts
  - Timer0_ISR: to control the signal frequency by half-period *n*
  - Timer1_ISR: change the half-period (*n*) periodically
    - n = Song_Table[i++]

The method

```
int Song_Table[3];

main ()
{
    //setup timer interrupts

   //initialize
   Song_Table [0] = Half_Period (Do);
   Song_Table [1] = Half_Period (Re);
   Song_Table [2] = Half_Period (Mi);
    …
    while (1) P2.7=status;
}
```

```
int n;
int count;
char status;

Timer0_ISR ()  //to control signal frequency
{
    count = (count+1)%n;
    if (count==0) status=~status;
}

int i;

Timer1_ISR ()  //to change the tone
{
    //counting for 1 second…
    n = Song_Table [i];
    i = (i+1)%3;
}
```

The method

```
int Song_Table[3];

main ()
{
   //setup timer interrupts

   //initialize
   Song_Table [0] = Half_Period (Do);
   Song_Table [1] = Half_Period (Re);
   Song_Table [2] = Half_Period (Mi);
   …
   while (1) P2    status;
}
```

Half period of each tone is stored in an array

```
int n;
int count;
char status;

Timer0_ISR ()  //to control signal frequency
{
   count = (count+1)%n;
   if (count==0) status=~status;
}

int i;

Timer1_ISR ()  //to change the tone
{
   //counting for 1 second…
   n = Song_Table [i];
   i = (i+1)%3;
}
```

The method

```
int Song_Table[3];

main ()
{
    //setup timer interrupts

   //initialize
   Song_Table [0] = Half_Period (Do);
   Song_Table [1] = Half_Period (Re);
   Song_Table [2] = Half_Period (Mi);
    …
    while (1) P2.7=status;
}
```

Frequency generator according to half-period *n*

```
int n;
int count;
char status;

Timer0_ISR ()  //to control signal frequency
{
    count = (count+1)%n;
    if (count==0) status=~status;
}

int i;

Timer1_ISR ()  //to change the tone
{
    //counting for 1 second…
    n = Song_Table [i];
    i = (i+1)%3;
}
```

The method

```
int Song_Table[3];

main ()
{
   //setup timer interrupts

  //initialize
  Song_Table [0] = Half_Period (Do);
  Song_Table [1] = Half_Period (Re);
  Song_Table [2] = Half_Period (Mi
   …
   while (1) P2.7=status;
}
```

```
int n;
int count;
char status;

Timer0_ISR ()  //to control signal frequency
{
   count = (count+1)%n;
   if (count==0) status=~status;
}

int i;

Timer1_ISR ()  //to change the tone
{
   //counting for 1 second…
   n = Song_Table [i];
   i = (i+1)%3;
}
```

Frequency generator according to half-period *n*

changes half-period *n* of the generated signal every second

Demo Requirements

- Basic:
  - 正確播放四個小節的音樂
- Bonus 1: (5%)
  - 使用ISR架構而非只是呼叫delay
- Bonus 2: (5%)
  - 加上小幅停頓讓讓歌詞中每個字斷開

Lab06 Study Report

- File name: Bxxxxxxx-MCE-Lab6-Study
- File type: PDF only
- The requirements of report
  - Summarize the content of this slide set
  - Provide your plan for this lab exercise
  - No more than one A4 page
  - Grading: 80 ± 15
- Deadline: 2025/11/26 23:00 (不收遲交)
- Upload to e-learning system

Lab06 Lab Exercise Report

- File name: Bxxxxxxx-MCE-Lab6-Result
- File type: PDF only
- The requirements of report
  - Summarize the problems and results you have in this exercise
  - Some screen shots or some code explanation can be provided
  - No more than two A4 pages
  - Grading: 80 ± 15
- Deadline: 2025/12/3 23:00 (不收遲交)
- Upload to e-learning system