Outlines

This application note is a reference material for developing products using the interval timer function in the 32-bit timer event counter(T32A) function of M3H Group(1). This document helps the user check operation of the product and develop its program.

Target sample program: Timer_LED
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1. Preface

This sample program uses Timer A to control LEDs’ lighting. Lighting and lights-off of an LED can be switched by Push switch.

Structure diagram of Sample program

2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  32-bit timer/event counter (T32A-B) Rev2.1 (Japanese edition)
- Other reference document
  TMPM3H(1) Group Peripheral Driver User Manual (Doxygen)
3. Function to Use

<table>
<thead>
<tr>
<th>IP</th>
<th>Channel</th>
<th>Port</th>
<th>Function/Operation mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>32-bit timer event counter</td>
<td>Timer A ch0</td>
<td>-</td>
<td>Interval timer</td>
</tr>
<tr>
<td>Input or output port</td>
<td>-</td>
<td>PN1 (Input Port)</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PN2 (Input Port)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PB4 (Output Port)</td>
<td>Output</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PB5 (Output Port)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PB6 (Output Port)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PB7 (Output Port)</td>
<td></td>
</tr>
<tr>
<td>Asynchronous serial</td>
<td>ch0</td>
<td>PA1 (UT0TXDA)</td>
<td>Asynchronous communication with PC</td>
</tr>
<tr>
<td>communication circuit</td>
<td></td>
<td>PA2 (UT0RXD)</td>
<td></td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

<table>
<thead>
<tr>
<th>TMPM3H6FWFG</th>
<th>TMPM3H6FUFG</th>
<th>TMPM3H6FSFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM3H6FWDFG</td>
<td>TMPM3H6FUDFG</td>
<td>TMPM3H6FSDFG</td>
</tr>
<tr>
<td>TMPM3H5FWFG</td>
<td>TMPM3H5FUFG</td>
<td>TMPM3H5FSFG</td>
</tr>
<tr>
<td>TMPM3H5FWDFG</td>
<td>TMPM3H5FUDFG</td>
<td>TMPM3H5FSDFG</td>
</tr>
<tr>
<td>TMPM3H4FWUG</td>
<td>TMPM3H4FUUG</td>
<td>TMPM3H4FSUG</td>
</tr>
<tr>
<td>TMPM3H4FWDFG</td>
<td>TMPM3H4FUDFG</td>
<td>TMPM3H4FSDFG</td>
</tr>
<tr>
<td>TMPM3H3FWUG</td>
<td>TMPM3H3FUUG</td>
<td>TMPM3H3FSUG</td>
</tr>
<tr>
<td>TMPM3H2FWDUG</td>
<td>TMPM3H2FUDUG</td>
<td>TMPM3H2FSDUG</td>
</tr>
<tr>
<td>TMPM3H2FWQG</td>
<td>TMPM3H2FUQG</td>
<td>TMPM3H2FSQG</td>
</tr>
<tr>
<td>TMPM3H1FWUG</td>
<td>TMPM3H1FUUG</td>
<td>TMPM3H1FSUG</td>
</tr>
<tr>
<td>TMPM3H1FPUG</td>
<td>TMPM3H0FSDUG</td>
<td>TMPM3H0FMDUG</td>
</tr>
</tbody>
</table>

* This sample program operates on the evaluation board of TMPM3H6FWFG.

If other function than the TMPM3H6 one is checked, it is necessary that CMSIS Core related files (C startup file and I/O header file) should be changed properly.

The BSP related file is dedicated to the evaluation board (TMPM3H6). If other function than the TMPM3H6 one is checked, the BSP related file should be changed properly.
5. Operation confirmation condition

- **Used microcontroller**: TMPM3H6FWFG
- **Used board**: TMPM3H6FWFG Evaluation Board (Product of Sensyst)
- **Unified development environment**: IAR Embedded Workbench for ARM 8.11.2.13606
- **Unified development environment**: μVision MDK Version 5.24.2.0
- **Terminal software**: Tera Term V4.96
- **Sample program**: V1100

For purchasing the board, refer to the following homepage. ([http://www.chip1stop.com/](http://www.chip1stop.com/))
6. Evaluation Board Setting
The following pin connections should be done on the evaluation board.

<table>
<thead>
<tr>
<th>CN5</th>
<th>Use</th>
<th>Through-hole No.</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>UART (RXD)</td>
<td>9-10</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>UART (TXD)</td>
<td>11-12</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>LED (D10)</td>
<td>27-28</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>LED (D9)</td>
<td>29-30</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>LED (D8)</td>
<td>31-32</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>LED (D7)</td>
<td>33-34</td>
<td>Connection</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CN9</th>
<th>Use</th>
<th>Through-hole No.</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push SW (S6)</td>
<td>23-24</td>
<td>Connection</td>
<td></td>
</tr>
<tr>
<td>Push SW (S7)</td>
<td>25-26</td>
<td>Connection</td>
<td></td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board
Push Switch can switch the lighting and the lights-off.

<table>
<thead>
<tr>
<th>Key</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>PN1 (S7) SW</td>
<td>LED blink stop</td>
</tr>
<tr>
<td>PN2 (S6) SW</td>
<td>LED blink re-start</td>
</tr>
</tbody>
</table>
8. Outline of Timer Event Counter (T32A) function

T32A is composed two 16-bit timer that can be used Timer A and Timer B. Also it can use Timer C that is connected Timer A and Timer B as 32-bit timer. When use Timer C, Timer A and Timer B cannot be used.

The T32A have an interval timer, event counter, input capture, 2-phase counter input, PPG output, Synchronous Start, and Trigger start/stop functions.

The timer has the following functions;
16-bit timer: Timer A and Timer B
32-bit timer: Timer C
9. Sample Program

The sample program uses a timer to cycle on and off the LED every second. The stop and re-start of the function are controlled by the Push Switch.

9.1. Initialization

The following initialization is done after power is supplied. The PORT setting is executed after the initialization of each clock setting and the clock setting. The main operation of the sample program is done after every initialization completes.

9.2. Sample program main operation

The timer settings in this sample program should be done. The ch0 of Timer A is used. UART ch0 setting and LED setting should be done. The corresponding port of a used LED should be set, and the lighting time is set to the timer. This sample program assigns PB4 to PB7 to OUTPUT for LED lighting. The setting value in the timer for the lighting and lights-off times are predetermined as 1-ms, respectively, which is defined as the following;

\[
p_{\text{timer}}->\text{init.interval} = 1000
\]

The lighting time has been set precisely as the followings; Timer A generates 1-ms interval. After 1000 times of the 1-ms interval are counted, the LED is lit. In this manner, 1-second intervals for the lighting and the lights-off are generated, respectively. The timer operation starts after every setting completes.
9.3. Output Example of Sample Program

After the sample program starts to operate, LED blink interval and the definition of the Push Switch functions are displayed.

```plaintext
General Timer Period : 1sec
Push SW1 => Timer STOP
Push SW2 => Timer RESTART
```

The displayed image has been specified by "printf". If "General Timer Period" is changed, the real setting time is different from the displayed data.

9.3.1. Setting Example of Terminal Software

The operation of the terminal software (Tera Term) has been checked with the following settings.

![Terminal setup](image_url)
9.4. Timer setting change

The change of the timer setting time can be done as the followings.

Timer data change

Count-up count change

Timer data change

"static TXZ_Result driver_initialize(void)" in "main" function is used to set.

p_timer->init.interval = 1000

The above sets 1 ms.
If “1000 (1 μs*1000)” is changed, the blink time is modified.

Count-up count change

"static void timer_interval_handler(uint32_t id)" in "main" function is used to set.

if(count < 1000) {   /* 1ms * 1000 = 1sec LED on */
    count++;
    on = 1;
}else if((count >= 1000) && (count < 2000)){  /* 1ms * 1000 = 1sec LED off */
    count++;
    on = 0;

If the count value above is changed, the blink time is modified.
9.5. Operating Flow of Sample Program

The operating flows of the sample program are shown as follows.
Driver initialization

**T32A Driver initialization**

1. **BSP** (Application)
   - `bsp_get_timer_ch(BSPTimer)`
     - Channel number = `bsp_get_timer_ch(-)`
   - `t32a_mode_init(Instance address)`
   - `timer_initialize(Timer Instance address)`
   - `t32a_timer_init(Instance address)`
   - `result = t32a_mode_init(-):success`
   - `result = t32a_timer_init(-):success`
   - `result = timer_initialize(-):success`
**Application initialization**

1. **UART Application initialization**
2. **LED Application initialization**
3. **SW Application initialization**

- **SW Application initialization**
  - `sw_initialize(SW Instance address)`
  - **SW Initial setting creation**

- **loop**
  - `[1, used LED count]`
  - **ref** LED Application initialization

- **loop**
  - `[1, used SW count]`
  - **ref** SW Application initialization
LED Application initialization

- LED Initial setting creation
  - led_initialize (LED Instance address)
  - GPIO Instance address, Group, Number, DATA, LED initial setting value

- LED (Application)
  - gpio_write_bit (GPIO Instance address, Group, Number, DATA, LED initial setting value)
  - led_initialize(-)
Timer interrupt

Procedure result:
Count less than 1000
led_turn_on(Instant handle)

Procedure result:
Count 1000 or more and less than 2000
led_turn_off(Instant handle)

Count reset
SW detection

- **sw_task(SW instance address)**
- **gpio_read_bit**
  - (Port instance address, group, run, DATA)

**Registration handler for notification of SW status change**
- (SW instance address, Port status)
- **Port state changed**
- **Port status=Push**
- **Assigned to Push SW**
- **Processing = Stop / Start**

**Registration handler for notification of SW status change(-)**
10. Precaution

When using the sample program with CPU other than TMPM3H6, please check operation sufficiently.

11. Revision History

<table>
<thead>
<tr>
<th>Rev</th>
<th>Date</th>
<th>Page</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2018-03-08</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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