Outlines

This application note is a reference material for developing products using clock control and operation mode (CG) functions of M3H Group(1).
This document helps the user check operation of the product and develop its program.

Target sample program: CGRST
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1. Preface

CG function sets the clock gear, the prescaler clock selection, the warm-up interval of the oscillator, and others. This sample program operates on the evaluation board. The operation mode can be changed from Normal mode to Low power mode by controlling Push switch on the evaluation board. The operation mode state can be checked with the LED.

Structure diagram of Sample program

2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Clock Control and Operating Mode (CG-M3H(1)-D) Rev2.0 (Japanese edition)
- Other reference document
  TMPM3H 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>Clock control</td>
<td>–</td>
<td>–</td>
<td>System clock control/Mode switching</td>
</tr>
<tr>
<td>Input and output port</td>
<td>–</td>
<td>PN1 (Input Port)</td>
<td>Mode switching</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PN2 (Input Port)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PN3 (Input Port)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>PB4 (Output Port)</td>
<td>LED lighting control terminal</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>Real time clock</td>
<td>–</td>
<td>–</td>
<td>Low Power Mode Timeout</td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

```
| TMPM3H6FWFG       | TMPM3H6FUFG       | TMPM3H6FSFG       |
| TMPM3H6FWDFG      | TMPM3H6FUDFG      | TMPM3H6FSDFG      |
| TMPM3H5FWFG       | TMPM3H5FUFG       | TMPM3H5FSFG       |
| TMPM3H5FWDFG      | TMPM3H5FUDFG      | TMPM3H5FSDFG      |
| TMPM3H4FWUG       | TMPM3H4FUUG       | TMPM3H4FSUG       |
| TMPM3H4FWFG       | TMPM3H4FUFG       | TMPM3H4FSFG       |
| TMPM3H3FWUG       | TMPM3H3FUUG       | TMPM3H3FSUG       |
| TMPM3H2FWDUG      | TMPM3H2FUDUG      | TMPM3H2FSDUG      |
| TMPM3H2FWQG       | TMPM3H2FUQG       | TMPM3H2FSQG       |
| TMPM3H1FWUG       | TMPM3H1FUUG       | TMPM3H1FSUG       |
| TMPM3H1FPUG       | TMPM3H0FSDUG      | TMPM3H0FMDUG      |
```

* 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.

This sample program uses the RTC function.
Because TMPM3H1 and TMPM3H0 are not supported with RTC, operation check with this sample program can not be executed.
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
Sample program: V1100

Evaluation board (TMPM3H6FWFG Evaluation Board) (Top view)

For purchasing the board, refer to the following homepage. (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></td>
<td>LED (D10)</td>
<td>27-28</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>LED (D9)</td>
<td>29-30</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>LED (D8)</td>
<td>31-32</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>LED (D7)</td>
<td>33-34</td>
<td>Connection</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></td>
<td>Push SW (S4)</td>
<td>19-20</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>Push SW (S5)</td>
<td>21-22</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>Push SW (S6)</td>
<td>23-24</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>Push SW (S7)</td>
<td>25-26</td>
<td>Connection</td>
</tr>
</tbody>
</table>
7. Operation of Evaluation Board

The initial mode is the Normal mode. After the reset is deasserted, the controller operates in the Normal mode. The LED on PB4 blinks. The mode can be changed to one of the Low power modes by the Push switch.

- **IDLE** S7: Port N1
- **STOP1** S6: Port N2
- **STOP2** S5: Port N3

The LED's show the current operating mode. The LED blinking pattern depends on an operating mode, shown as follows:

- **Normal mode**: Port B4 (Blink)
- **Low power mode**
  - **IDLE**: Port B5 (LED On)
  - **STOP1**: Port B6 (LED On)
  - **STOP2**: Port B7 (LED On)

**LED blink frequency**

- **Normal mode**: LED On for 1 second -> LED Off for 1 second, and it repeats.
- **Low power mode**
  - **IDLE**: LED On
  - **STOP1**: LED On
  - **STOP2**: LED On

The controller enters one of the Low power modes. Then, the operation mode changes to the Normal mode after the following RTC setting interval elapses.

- **RTC setting interval**: 1 minute
8. Outline of clock control function

The operation mode consists of the Normal mode and the Low power modes. The power consumption can be saved by transition of the operation modes according to the application.

The clock control available are shown as follows:
  • System clock control
    As the source of the system clock, the internal high speed oscillation clock and the external high speed oscillation clock (connection of a crystal oscillator or a clock input) can be used.
  • Prescaler clock control
    Each peripheral function has a prescaler to divide the clock \( \phi T_0 \).

The clock function has the following operation modes.
  • Normal mode
  • Low power mode (3 modes)
    IDLE/STOP1/STOP2

<table>
<thead>
<tr>
<th>Operating mode</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal mode</td>
<td>Normal</td>
<td>Normal operation.</td>
</tr>
<tr>
<td>Low power mode</td>
<td>IDLE</td>
<td>CPU stops. Peripheral functions can operate.</td>
</tr>
<tr>
<td></td>
<td>STOP1</td>
<td>System clock stops. Low frequency clock can operate.</td>
</tr>
<tr>
<td></td>
<td>STOP2</td>
<td>System clock stops. Power supply for the internal circuits is shut down.</td>
</tr>
</tbody>
</table>

The operation mode can be changed by the Push switch in this sample program. And the operation mode is shown by the LED blinking pattern.
9. Sample Program

The port input signal from the Push switch is a trigger to change to the Low power mode (IDLE/STOP1/STOP2). A corresponding LED turns on at the transition to the Low power mode. The operation mode of the CPU shift to normal mode by RTC interrupt.

9.1. Initialization

The following initialization is done after power is supplied. The port setting is executed after the initialization of clock setting.

9.2. Sample program main operation

This sample program executes the reset setting, the timer initialization, the LED initialization, and the Push switch setting initialization. After each initialization completes, CG function changes the operating mode according to the following conditions.

- Operation in the Normal mode (LED: Blink on PB4)
- Change to a Low power mode by the Push switch.
- LED On (PB4 to PB7) shows the operating mode (4 modes). The operating mode in the sample program can be checked by using the LED’s.

When the operating mode is changed to a Low power mode by the Push switch, the following operations are executed.

- The mode timeout is set according to RTC alarm setting condition (1 minute in this sampling program).
- After the alarm setting interval elapses, the operating mode is changed to the Normal mode by the alarm interrupt.
- The direct transition between Low power modes is invalid in this sample program. The transition should be done via the Normal mode.

* The RTC function executes the calendar initialization (Sunday, January 01, 2017 00:00:00) and sets the alarm time.

The alarm time can be set for a day, a date, an hour, and a minute.

9.3. Operating Mode Switching

The mode switching can be done by setting the GND level selectively to the PORT pins (PN1 to PN3) in this sample program.

After power is supplied or the reset is deasserted, the microcontroller enters the Normal state. The low power mode is switched to the Normal mode after the RTC alarm setting interrupt is executed. The interval of the RTC alarm interrupt has been set to 1 minute in this sample program.
9.4. Operating Flow of Sample Program

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

```
ref BSP initialization

ref Port keeping release

RAM initialization
Procedure: Normal start-up

loop

alt

[Procedure: Normal start-up]

ref Normal: Start-up

Procedure: Normal

[Procedure: Normal]

Normal mode procedure

[Procedure: Normal mode end]

ref Normal: End

Procedure: Low power mode is set.

Go to IDLE mode.

[Procedure: Normal start-up]

ref Low power IDLE mode procedure

Procedure: Low power IDLE mode procedure

[Procedure: Low power STOP1 mode procedure]

ref Low power STOP1 mode procedure

Procedure: Low power STOP1 mode procedure

[Procedure: STOP2]

ref Low power STOP2 mode procedure

Procedure: Low power STOP2 mode procedure
```
Normal mode

- Normal: Start-up
- Normal: Driver initialization
- Normal: Application initialization
- Timer Application start-up

Normal mode procedure

- loop [1, used SW count]
  - ref SW detection
- loop [1, used LED count]
  - ref LED control
Normal: End

Timer Application stop

Normal: Application end

Normal: Driver end

BSP end

BPS end procedure, if necessary.
IDLE mode

Low power IDLE mode procedure

BSP initialization

ref
IDLE start-up

WFI instruction

WFI is cleared by RTC interrupt.

ref
IDLE end

BSP end

BPS initialization procedure for the IDLE mode, if necessary.

BPS end procedure, if necessary.

Initialization procedure for the Normal mode, if necessary. Watchdog timer, PLL, and so on.

System initialization

BSP initialization

RAM initialization

Procedure: Normal start-up

Normal mode, if necessary.
IDLE: Start-up

- WDT disable
- IDLE mode setting
- PLL stop
- Internal high speed oscillator starts.
- External high speed oscillator stops.
- Internal high speed oscillator for OFD stops
- Stop of External high speed oscillator is checked.
- Wait for Stop of Internal high speed oscillator for OFD.
- IDLE: Driver initialization
- IDLE: Application initialization
- RTC start-up
STOP1 mode

Low power STOP1 mode procedure

BSP initialization

STOP1 start-up

WFI instruction

WFI is cleared by RTC interrupt.

STOP1 end

BSP end

Initialization procedure for the Normal mode, if necessary. Watchdog timer, PLL, and so on.

BSP initialization

RAM initialization

Procedure: Normal start-up

BSP initialization procedure for STOP1, if necessary.
STOP1: Start-up

- WDT disable
- Wait for Flash Ready
- Wait for Warm-up of High speed oscillator
- Warm-up setting of Internal high speed oscillator
- STOP1 mode setting
- PLL stop
- Internal high speed oscillator starts.
- External high speed oscillator stops.
- Internal high speed oscillator for OFD stops.
- Stop of External high speed oscillator is checked.
- Wait for Stop of internal high speed oscillator
- STOP1: Driver initialization
- STOP1: Application initialization
- RTC start-up
STOP2 mode

Low power STOP2 mode procedure

- BSP initialization
  - STOP2 start-up
  - WFI instruction

BSP initialization procedure for STOP2, if necessary.

Reset by RTC interrupt.
STOP2: Start-up

- LED Application initialization
- WDT disable
- Wait for Flash Ready
- Port keeping setting
- STOP2 mode setting
- PLL stop
- Internal high speed oscillator starts.
- External high speed oscillator stops.
- Internal high speed oscillator for OFD stops.
- Stop of External high speed oscillator is checked.
- Wait for Stop of Internal high speed oscillator for OFD
- STOP2: Driver initialization
- STOP2: Application initialization
- RTC start-up

LED port setting should be done before Port keeping setting.
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>2018-03-22</td>
<td>–</td>
<td>First release</td>
</tr>
</tbody>
</table>
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