Outlines

This application note is a reference material for developing products using the clock control and the operation mode (CG) functions of M3H Group (2).
The mode transition is done by an external interrupt.
This document helps the user check operation of the product and develop its program

Target sample program: CGRST_EXINT
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1. Preface

This sample program operates on the evaluation board. The operating mode can be changed from Normal mode to Low power mode by controlling Push SW on the evaluation board. The operation mode state can be checked with the LED.

The operation mode is changed to the Normal mode during the Low power mode by an external interrupt.

Structure diagram of Sample program
2. Reference Document

- Datasheet
  TMPM3H group (2) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Clock Control and Operating Mode (CG-M3H(2)-D) Rev2.0 (Japanese edition)
- Other reference document
  TMPM3H(2) 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>PV0 : (Input Port) PV1 : (Input Port) PV2 : (Input Port)</td>
<td>Input</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PC2 : (INT02)</td>
<td>Interrupt</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PK4 : (Output Port) PK5 : (Output Port) PK6 : (Output Port) PK7 : (Output Port)</td>
<td>Output</td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

<table>
<thead>
<tr>
<th>TMPM3HQFDFG</th>
<th>TMPM3HQFZFG</th>
<th>TMPM3HQFYFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM3HPFDFG</td>
<td>TMPM3HPFZFG</td>
<td>TMPM3HPFYFG</td>
</tr>
<tr>
<td>TMPM3HNFDGF</td>
<td>TMPM3HNFZFG</td>
<td>TMPM3HNFYFG</td>
</tr>
<tr>
<td>TMPM3HNFDFFG</td>
<td>TMPM3HNFDZFG</td>
<td>TMPM3HNFDFDFG</td>
</tr>
<tr>
<td>TMPM3HMFDGF</td>
<td>TMPM3HMFDZFG</td>
<td>TMPM3HMFDYFG</td>
</tr>
</tbody>
</table>

* This sample program operates on the evaluation board of TMPM3HQFDFG.
If other function than the TMPM3HQ 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 (TMPM3HQ). If other function than the TMPM3HQ one is checked, the BSP related file should be changed properly.
5. Operation confirmation condition

<table>
<thead>
<tr>
<th>Used microcontroller</th>
<th>TMPM3HQFDFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used board</td>
<td>TMPM3HQFDFG Evaluation Board (Product of Sensyst)</td>
</tr>
<tr>
<td>Unified development environment</td>
<td>IAR Embedded Workbench for ARM 8.11.2.13606</td>
</tr>
<tr>
<td>Unified development environment</td>
<td>μVision MDK Version 5.24.2.0</td>
</tr>
<tr>
<td>Sample program</td>
<td>V1100</td>
</tr>
</tbody>
</table>

Evaluation board (TMPM3HQFDFG 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>Board function</th>
<th>Through hole No.</th>
<th>Through hole No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED (D10)</td>
<td>33 : PORT_LED0</td>
<td>34 : PK4</td>
<td></td>
</tr>
<tr>
<td>LED (D9)</td>
<td>35 : PORT_LED1</td>
<td>36 : PK5</td>
<td></td>
</tr>
<tr>
<td>LED (D8)</td>
<td>37 : PORT_LED2</td>
<td>38 : PK6</td>
<td></td>
</tr>
<tr>
<td>LED (D7)</td>
<td>39 : PORT_LED3</td>
<td>40 : PK7</td>
<td></td>
</tr>
<tr>
<td>Push SW (S4)</td>
<td>49 : PORT_PSW0</td>
<td>50 : PV0</td>
<td></td>
</tr>
<tr>
<td>Push SW (S5)</td>
<td>51 : PORT_PSW1</td>
<td>52 : PV1</td>
<td></td>
</tr>
<tr>
<td>Push SW (S6)</td>
<td>53 : PORT_PSW2</td>
<td>54 : PV2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CN21</th>
<th>Board function</th>
<th>Through hole No.</th>
<th>Through hole No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Push SW (S9)</td>
<td>15 : I07_STOP2_PC2</td>
<td>16 : PC2</td>
<td></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 blinks on PK4. The mode can be changed to the Low power mode by the Push SW.

- IDLE: S4: PV0
- STOP1: S5: PV1
- STOP2: S6: PV2

The LED’s show the current operation mode.

The LED lighting status depends on an operating mode, shown as follows:

<table>
<thead>
<tr>
<th>Operating Mode</th>
<th>IDLE</th>
<th>STOP1</th>
<th>STOP2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal mode</td>
<td>D10: PK4 (Blink)</td>
<td>D8: PK6 (Lighting)</td>
<td>D7: PK7 (Lighting)</td>
</tr>
<tr>
<td>Low power mode</td>
<td>D9: PK5 (Lighting)</td>
<td>D8: PK6 (Lighting)</td>
<td>D7: PK7 (Lighting)</td>
</tr>
</tbody>
</table>

LED blink frequency

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

Returning to Normal mode by interrupt control

When Push SW S9: PC2 is pushed down, the operation mode is changed from the Low power mode to the Normal mode.

The change among the Low power modes is not supported.
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

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
By pressing Push switch, it switches to low power mode (IDLE/STOP1/STOP2).
A corresponding LED turns on at the transition to the Low power mode.
When an external interrupt is detected, the operation mode returns to the Normal mode.

9.1. Initialization
The following initialization is done after power is supplied.
The PORT setting is done after the initialization of each clock setting and the clock setting.

9.2. Sample program main operation
This sample program executes the reset setting, the LED initialization, and the Push switch setting initialization.
In the main operation, initialize and set the timer, and set the LED and Push switch.

After each initialization completes, the sample program changes the operation mode according to the following procedure.
Operation in the Normal mode (LED: Blink on PK4)
Change to the Low power mode by the Push switch.
LED lighting (PK4 to PK7) shows the operation mode (4 modes).

The current operation mode in the sample program can be checked by using the LED’s.
When the operation mode is changed to the Low power mode by the Push switch, the following operation should be done.
When INT02 interrupt occurs, it returns to Normal mode.
The direct transition among the different Low power modes is not supported by this sample program. The transition to the Low power mode should be done via the Normal mode.

9.3. Operating Mode Switching
The mode switching can be done by setting the GND level selectively to the PORT pins (PV0 to PV2) in this sample program.
After power is supplied or the reset is deasserted, the microcontroller enters the Normal state.
The Normal mode returns after the interrupt (INT02) is generated by the Push switch 9.
9.4. Operating Flow of Sample Program

The operating flows of the sample program are shown in the following;
Normal mode

Normal: Start-up

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

Normal mode procedure

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

ref Timer Application stop

ref Normal: Application end

ref 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 External interrupt.

ref IDLE end

BSP end

System initialization

BSP initialization

RAM initialization
Procedure: Normal start-up

BPS end procedure, if necessary.

Initialization procedure for the Normal mode, if necessary. Watchdog timer, PLL, and so on.
**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**
STOP1 mode

Low power STOP1 mode procedure

START

BSP initialization

STOP1 start-up

WFI instruction

WFI release with external interrupt

STOP1 end

BSP end

BSP initialization

System initialization

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

RAM initialization

Procedure: Normal start-up

BSP initialization procedure for STOP1, if necessary.

BSP end procedure, 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.
- Waiting for internal high-speed oscillator to stop for OFD
- STOP1: Driver initialization
- STOP1: Application initialization
STOP2 mode

Low power STOP2 mode procedure

- BSP initialization
- STOP2 start-up
- WFI instruction
- Reset with external interrupt
STOP2: Start-up

1. LED Application Initialization
2. WDT disable
3. Wait for Flash Ready
4. Port keeping setting
5. STOP2 mode setting
6. PLL stop
7. Internal high speed oscillator starts.
8. External high speed oscillator stops.
9. Internal high speed oscillator for OFD stops.
10. Stop of External high speed oscillator is checked.
11. Wait for Stop of Internal high speed oscillator for OFD
12. STOP2: Driver initialization
13. STOP2: Application initialization

*LED port setting should be done before Port keeping setting.*
External interrupt detection

- Interrupt factor (Rising edge detection)
- INT02_IRQHandler()
- opt
  - Interrupt factor flag clear
  - Status value inversion
- irq_extn(status value)

BSP (Application)
10. Precaution

When using the sample program with CPU other than TMPM3HQ, 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>2018-05-15</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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