Outlines

This application note is a reference material for developing products using the trimming circuit (TRM) function of M3H Group (1).
This document helps the user check operation of the product and develop its program.

Target sample program: TRMOSC
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1. Preface

This sample program is used to check the operation of the trimming function. This sample program executes the calculation of the frequency error of the internal oscillator, and sets a corresponding adjustment value to the internal oscillation adjustment register.

Structure diagram of Sample program
2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Trimming circuit (TRM-A) Rev2.0 (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>Asynchronous communication</td>
<td>ch0</td>
<td>PA1 (UT0TXDA) PA2 (UT0RXD)</td>
<td>UART mode</td>
</tr>
<tr>
<td>Trimming circuit</td>
<td>ch0</td>
<td>PA0 (T32A00OUTA)</td>
<td>Pulse wave output</td>
</tr>
<tr>
<td></td>
<td>ch4</td>
<td>-</td>
<td>Interval timer and Capture</td>
</tr>
<tr>
<td>32-bit timer event counter</td>
<td>ch2</td>
<td>PR1 (T32A02INA0)</td>
<td>External clock input</td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of this application note are as follows.

<table>
<thead>
<tr>
<th>TMPM3H6FWFG</th>
<th>TMPM3H6FUFG</th>
<th>TMPM3H6FSFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM3H6FDWG</td>
<td>TMPM3H6FUDFG</td>
<td>TMPM3H6FSDFG</td>
</tr>
<tr>
<td>TMPM3H5FWFG</td>
<td>TMPM3H5FUFG</td>
<td>TMPM3H5FSFG</td>
</tr>
<tr>
<td>TMPM3H5FDWG</td>
<td>TMPM3H5FUDFG</td>
<td>TMPM3H5FSDFG</td>
</tr>
<tr>
<td>TMPM3H4FWUG</td>
<td>TMPM3H4FUUG</td>
<td>TMPM3H4FSUG</td>
</tr>
<tr>
<td>TMPM3H4FWFG</td>
<td>TMPM3H4FUFG</td>
<td>TMPM3H4FSFG</td>
</tr>
<tr>
<td>TMPM3H3FWUG</td>
<td>TMPM3H3FUUG</td>
<td>TMPM3H3FSUG</td>
</tr>
<tr>
<td>TMPM3H2FDUG</td>
<td>TMPM3H2FUDUG</td>
<td>TMPM3H2FSUG</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. Conditions for Correct Operation

- 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/)
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></td>
<td>Connection</td>
</tr>
<tr>
<td>UART(TXD)</td>
<td>11-12</td>
<td></td>
<td>Connection</td>
</tr>
<tr>
<td>PORT(Output)</td>
<td>7</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

When an external clock is input, the following connector should be used.

<table>
<thead>
<tr>
<th>CN9</th>
<th>Use</th>
<th>Through-hole No.</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>PORT(Input)</td>
<td>16</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board

The USB_UART pins on the evaluation board should be connected to the PC with a USB cable. The PC executes the communication setting after start-up of the terminal software (Tera Term). The reset button should be pushed down on the evaluation board.

After the completion of the trimming procedure, it should be checked that a 5-MHz pulse wave outputs on the PA0 port.
8. Outline of Trimming Circuit Function

The trimming circuit (TRM) can adjust the frequency for an internal oscillator. The lists of functions are as follows.

<table>
<thead>
<tr>
<th>Function Classification</th>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency adjustment of</td>
<td>Target oscillator</td>
<td>Internal High Speed Oscillator 1 (IHOSC1)</td>
</tr>
<tr>
<td>the internal oscillator</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Adjustment range</td>
<td>Coarse trimming -18.8 to +30.4 % (Average 0.8 % step)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fine trimming -0.8 to +0.7 % (0.1 % step)</td>
</tr>
<tr>
<td></td>
<td>Monitor function</td>
<td>The reading of the initial trimming level is possible</td>
</tr>
<tr>
<td></td>
<td>Protection function</td>
<td>Incorrect writing is prevented</td>
</tr>
</tbody>
</table>

8.1. Clock Supply

When you use TRM, please set an applicable clock enable bit to “1” (clock supply) in fsys supply stop register A ([CGFSYSENAA]), fsys supply stop register B ([CGFSYSENB]), and fc supply stop register ([CGFCEN]).

For the details, refer to “Clock control and operation mode” in Reference manual.
9. Sample Program

This sample program executes adjustment of the frequency of the internal oscillator using the trimming circuit (TRM) in TMPM3H6FWFG.
The low-speed clock (32.768 kHz) or an external clock are available as the reference clock.

The reference clock is selected by "TRMOSC_LOSC" in the macro “txz_sample_def.h”.
Low-speed clock (32.768 kHz): TRMOSC_LOSC should be enabled.
External clock: TRMOSC_LOSC should be disabled.

9.1. Initialization

The following initialization is done after power is supplied.
The PORT setting is executed after the initialization of each clock setting, the watchdog timer setting, and the clock setting.

9.2. Sample Program Main Operation

After the initialization, the “main” function is executed, and the following initialization is done.
1. BSP (Board Support Package) initialization
2. Initialization of the external low-speed oscillator
3. Trigger selector initialization
4. Application initialization
5. T32A initialization (Interval timer output setting)
6. T32A initialization (Capture setting)
7. Initialization of the trimming control register (for debugging)
8. Trimming procedure starts.

The adjustment procedure for the internal oscillator starts. The adjustment value is set to the register and the result of the procedure is issued. Then the infinite loop procedure executes.

The adjustment procedure completes when TRMOSC_DONE is issued to the terminal software. When Initial trimming value is issued to the terminal software, the adjustment procedure completes and the adjustment value is the same one at shipment.
9.3. Output Example of Sample Program

When the sample program operates, the command results are shown as follows;
9.3.1. Setting Example of Terminal Software

The operation of the terminal software (Tera Term) has been checked with the following settings.
9.4. Operating Flow of Sample Program

The operating flows of the sample program are shown in the following:

- **main**
  - Port initialization `initGpio()`
  - Clock supply to peripheral devices
  - T32A0 interval timer output setting `initT32A0()`
  - T32A2 capture setting `initT32A2()`
  - TRM initialization `initTRM()`
  - Software timer
    ```
    for(i=0; i<0x00400000; i++);
    ```
  - Loop count: 10
  - Adjustment procedure for the internal oscillator `IOSCadjustment()`
  - Adjustment is successful?
    - Y: Successful (TRMOSC_DONE) Coarse trimming value output Fine trimming value output
    - N: Run the adjustment?
      - Y: Run (TRMOSC_RUN) Coarse trimming value output Fine trimming value output
      - N: Failure (TRMOSC_ERROR)
  - No conditions

TRM register is initialized only by Power-on reset. Here, the register is set to the initial value by software procedure to check the pre-adjusted waveform on the debugger.

In order to check the waveform before adjustment, wait is inserted.
Internal oscillator adjustment procedure
IOSCAdjustment()

Waveform measurement
MeasureWave()

Error calculation
CalcDiff()

Error is present?
Y
N

Adjustment value calculation
CalcAdjVal()

Within the set range?
Y
N

Trimming value setting
SetTrmOsc()

Run the adjustment
(TRMOSC_RUN)

Adjustment is successful
(TRMOSC_DONE)

Failure (TRMOSC_ERROR)
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>2018-03-29</td>
<td>-</td>
<td>First release</td>
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</tbody>
</table>
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