Outlines

This application note is a reference material for developing products using the real-time clock (RTC) function of M3H Group(1). This document helps the user check operation of the product and develop its program.

Target sample program: RTC_UART
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1. Preface

This sample program is a sample program for checking the operation of the RTC’s clock function. The time values is displayed on the terminal software on the host PC via USB-UART.

Structure diagram of Sample program

2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Real time clock (RTC-A) 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>Real time clock</td>
<td>-</td>
<td>-</td>
<td>Clock function</td>
</tr>
<tr>
<td>Asynchronous serial</td>
<td>ch0</td>
<td>PA1 (UT0TXDA)</td>
<td>Asynchronous communication with PC</td>
</tr>
<tr>
<td>communication</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>TMPM3H4FWFG</td>
<td>TMPM3H4FUFG</td>
<td>TMPM3H4FSFG</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>
</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 IO 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

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>UART (RXD)</td>
<td>9-10</td>
<td>Connection</td>
</tr>
<tr>
<td></td>
<td>UART (TXD)</td>
<td>11-12</td>
<td>Connection</td>
</tr>
</tbody>
</table>

7. Outline of RTC function

RTC function is the clock function which can count a leap year in the calendar.
It operates with 1Hz clock which is generated by counting the low speed clock (fs).
A clock correction function corrects the gaining or losing of the time caused by the frequency error of the low speed oscillator.
The alarm function issues an interrupt request or outputs a pulse on ALARM_N pin when the preset time values match the clock time values.
The main RTC function is as follows:
   - Clock function
   - Alarm function
This sample program can check the operation of the clock function.
8. Sample Program

The sample program displays year / month / date / time and day of the week in terminal software. RTC uses 1Hz interrupt and the clock function. Time information is displayed on the terminal software via USB-UART.

8.1. 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.

8.2. Sample program main operation

It initializes UART, System Clock, the UART SW reset, and others. The time setting is done by this sample program. Year/Month/Date/Day/Time/ are set (initialized). After the settings complete, this program starts the clock. The date and time are acquired from the clock register at the timing of the 1Hz periodic interrupt. The time values are transferred via UART ch0 to PA1/2 pins (UTOTXDA/UTORXD) and displayed by the terminal software. For the details of the register setting, refer to an appropriate reference manual.

![Diagram](Initialization: Clock, UART)
8.3. Output Example of Sample Program

When this sample program operates, the content in the clock register is displayed, as shown in the following figure.
The followings are the output of the default value of the sample program.

8.3.1. Setting Example of Terminal Software

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

The operating flows of the sample program are shown as follows.
Creation and Initialization flow

- Creation and Initialization
- BSP initialization
- RAM initialization
- Driver initialization
- Application initialization

Driver initialization

- Driver initialization
- T32A Driver initialization
T32A (Timer) Driver initialization

Although initialization setting of 32-bit timer event counter of TMPM3H is done, it is not used in actual operation of this sample program.

Application initialization
**Time setting initialization**

**Horologe Application initialization**

Horologe instance handle = horol initialize()

Horologe initial setting starts.

1. horol_initialize (Storage of Horologe initial setting)

2. Assignment of RTC register address
   - rtc_init(RTC instance address)

3. Horologe initial setting starts.

   - rtc_clock_set_leap (RTC instance handle: Leap year setting)
   - rtc_set_hour_notation (RTC instance handle: 12/24-hour display)
   - rtc_clock_set_year (RTC instance handle: Year)
   - rtc_clock_set_month (RTC instance handle: Month)
   - rtc_clock_set_date (RTC instance handle: Date)
   - rtc_clock_set_day (RTC instance handle: Day)
   - rtc_set_hour_24 (RTC instance handle: Hour)
   - rtc_set_hour_12 (RTC instance handle: AM/PM and Hour)

   - rtc_clock_set_min (RTC instance handle: Minute)
   - rtc_clock_set_sec (RTC instance handle: Second)
   - rtc_set_int_source (RTC instance handle: 1Hz interrupt)

**Clock initial setting**

RTC (Application)
start-up

Timer Application start-up

Horologe Application start-up

Time Application start-up

Horologe (Application)

RTC (Application)

BSP (Application)

horol_start (Horologe instance address)

rtc_clock_enable (RTC instance address)

rtc_enable_int (RTC instance address)

bsp_irq_rtc_enable()

EXCEPTION acceptance
INTRTC_IRQn

horol_start(·)
Setting and output of Time information

Horologe (Application)
- horol_irq_handler (Horologe instance address)
-rtc_clock_get_year (RTC instance handle: Storage of Year)

RTC (Application)
- rtc_get_hour_notation (RTC instance handle: Storage of 12/24-hour display)
-rtc_clock_get_hour_24 (RTC instance handle: Storage of Hour)
-rtc_clock_get_hour_12 (RTC instance handle: Storage of AM/PM and Hour)
-rtc_clock_get_day (RTC instance handle: Storage of Day)
-rtc_clock_get_month (RTC instance handle: Storage of Month)
-rtc_clock_get_date (RTC instance handle: Storage of Date)
-rtc_clock_get_min (RTC instance handle: Storage of Minute)
-rtc_clock_get_sec (RTC instance handle: Storage of Second)

Write Layer
- Decision of Time information
- Time update

Read Layer
- Switch of Time information
- Update flag OFF
- Update flag ON
- horol_get_current_clock (Horologe instance address: Storage of Time information)
- Current time information acquisition

UART IO (Application)
- printf (Time display data)

Storage of the information of Time information Read Layer
- horol_get_current_clock(-)
- Current time information acquisition

User ID
- Handler of Time information update notification (-)
- Handler of Time information update notification
- horol_irq_handler

Update flag ON
- opt

Update flag OFF
- opt

Century value increment
- opt

Century value change
- opt

Century value increment
- opt

Century value change
Application stop procedure

Time setting and Stop of the timer operation
RTC end procedure

End and Deletion

Driver end

BSP end

End of Time setting application procedure

Application end

Horologe Application end

UART Application end

Timer Application end
End of Time setting application procedure

Horologe Application end

horol_finalize (Horologe instance address)

horol_finalize(-)

reference

Horologe Application stop

rtc_deinit(RTC instance address)

Release of RTC register address assignment

Timer driver end procedure

T32A Driver end

Release of Register address assignment for 1-ms timer channel
8.5. Setting Modification of Displayed Time Information

When the time information is changed, change the setting value in RTC: main.c

<table>
<thead>
<tr>
<th>Item</th>
<th>Modified location</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>CFG_HOROL_HOUR_NOTATION</td>
<td>(RTC_HOUR_NOTATION_24)</td>
<td>24-hour display setting</td>
</tr>
<tr>
<td>CFG_HOROL_CENTURY</td>
<td>((uint8_t)21)</td>
<td>Year setting</td>
</tr>
<tr>
<td>CFG_HOROL_YEAR</td>
<td>((uint8_t)17)</td>
<td>Setting of 2 least significant digits of the year</td>
</tr>
<tr>
<td>CFG_HOROL_MONTH</td>
<td>(RTC_MONTH_JAN)</td>
<td>Month setting</td>
</tr>
<tr>
<td>CFG_HOROL_DATE</td>
<td>((uint8_t)1)</td>
<td>Date setting</td>
</tr>
<tr>
<td>CFG_HOROL_DAY</td>
<td>(RTC_DAY_SUNDAY)</td>
<td>Day setting</td>
</tr>
<tr>
<td>CFG_HOROL_MERIDIEM</td>
<td>(RTC_MERIDIEM_AM)</td>
<td>AM/PM setting</td>
</tr>
<tr>
<td>CFG_HOROL_HOUR</td>
<td>((uint8_t)0)</td>
<td>Hour setting</td>
</tr>
<tr>
<td>CFG_HOROL_MIN</td>
<td>((uint8_t)0)</td>
<td>Minute setting</td>
</tr>
<tr>
<td>CFG_HOROL_SEC</td>
<td>((uint8_t)0)</td>
<td>Second setting</td>
</tr>
</tbody>
</table>

The initial values of the time has been set to “Sunday, January 01, 2017 00:00:00” in this sample program. Any time values can be set by modifying each item value.

For the modification conditions and the range of each item value, refer to “rtd.h file” in ¥Project¥Examples¥utilities¥rtc. The modification range of each item is set there.
9. Precaution

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

10. 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>2018-03-07</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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