Outlines

This application note is a reference material for developing products using remote control signal processor (RMC) function of M3H Group(1).
This document helps the user check operation of the product and develop its program.

Target sample program: RMC_UART
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1. Preface

This sample program receives the remote control signal whose carrier wave is removed, using the remote control signal preprocessor (RMC). The received signal is displayed on the terminal software.

Structure diagram of Sample program

Application Layer

Driver Layer

H/W

Board Support Package (bsp.c/.h)

Remote Control (rcm.c/.h)

RMC (rcm.c/.h)

Exception

Interrupt
callback

Main (main.c)

Uart ID (bsp_uartio.c/.h)

Timer (bsp_timer.c/.h)
2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Remote Control Signal Preprocessor (RMC-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>Remote Control Signal Preprocessor</td>
<td>-</td>
<td>PB1 (RXIN0)</td>
<td>Circuit to receive the remote control signal</td>
</tr>
<tr>
<td>Asynchronous serial communication circuit</td>
<td>ch0</td>
<td>PA1 (UT0TXDA) PA2 (UT0RXD)</td>
<td>Asynchronous communication with PC</td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

| TMPM3H6FWFG | TMPM3H6FUDFG | TMPM3H6FSDFG |
| TMPM3H6FWDFG | TMPM3H6FUDFG | TMPM3H6FSDFG |
| TMPM3H5FWFG  | TMPM3H5FUDFG | TMPM3H5FSDFG |
| TMPM3H5FWDFG | TMPM3H5FUDFG | TMPM3H5FSDFG |
| TMPM3H4FWUG  | TMPM3H4FUUG  | TMPM3H4FUG    |
| TMPM3H4FWUG  | TMPM3H4FUUG  | TMPM3H4FUG    |
| TMPM3H3FWUG  | TMPM3H3FUUG  | TMPM3H3FUG    |
| TMPM3H2FWUG  | TMPM3H2FUUG  | TMPM3H2FUG    |
| TMPM3H1FWUG  | TMPM3H1FUUG  | TMPM3H1FUG    |
| 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 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

<table>
<thead>
<tr>
<th>Used microcontroller</th>
<th>TMPM3H6FWFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used board</td>
<td>TMPM3H6FWFG 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>Terminal software</td>
<td>Tera Term V4.96</td>
</tr>
<tr>
<td>Sample program</td>
<td>V1100</td>
</tr>
</tbody>
</table>

Evaluation board (TMPM3H6FWFG Evaluation Board) (Top view)

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></td>
<td>Connection</td>
</tr>
<tr>
<td>UART (TXD)</td>
<td>11-12</td>
<td></td>
<td>Connection</td>
</tr>
<tr>
<td>RMC input (IC16)</td>
<td>21-22</td>
<td></td>
<td>Connection</td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board

RMC: The remote control signal should be input to PB1.
The input signal is output to the terminal software (Tera Term).

The reception format is compatible with NEC format or AEHA (Association for Electric Home Appliances) format.
8. Outline of RMC function

Remote control signal preprocessor (hereafter referred to as RMC) receives a remote control signal of which carrier is removed. Please refer to a bottom for the list of functions.

<table>
<thead>
<tr>
<th>Function category</th>
<th>Function</th>
<th>Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>The reception</td>
<td>Sampling clock</td>
<td>A sampling clock can be selected from either low frequency clock (32.768kHz) or Timer output.</td>
</tr>
<tr>
<td>of the remote</td>
<td>Noise filter</td>
<td>Noise canceling time can be adjusted. (15 phases)</td>
</tr>
<tr>
<td>control signal</td>
<td>Leader detection</td>
<td>Detection is possible at the cycle of a reader, and a setup of Low width.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Without the leader in a state of the leader waiting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Begin in leaders only for Low width.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Fixed phase method in a period.</td>
</tr>
<tr>
<td></td>
<td>Data reception</td>
<td>A maximum of 72 bits of reception are possible.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Two kinds of data bit 0/1 judgments allow.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1) Judgment by the threshold setting.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2) Judgment by the falling edge interrupt.</td>
</tr>
<tr>
<td></td>
<td>Interrupt</td>
<td>Generating of each remote control interruption(INTRMCx) is controllable.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Leader detection interrupt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Falling edge interrupt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Maximum data bit cycle interrupt.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>&gt; Low width detection interrupt.</td>
</tr>
</tbody>
</table>

8.1. Reception of Remote Control Signal

The sampling of remote control signal is performed by the low speed clock (fs: 32.768 kHz.) or timer output (TBxOUT).
As for the signal input by RXINx, a signal performed noise reduction of through a noise filter circuit is input into a reception control circuit.
9. Sample Program

The 16-bit custom code, the 8-bit data code, and the reversed 8-bit data code which are received by RMC are transferred to the terminal software through USB-UART interface. This sample program will receive in NEC format and AEHA (Association for Electric Home Appliances) format.

9.1. Initialization

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

9.2. Sample program main operation

The driver is initialized.
UART settings are done.
The remote controller settings are done. The low-speed clock is used in this sample program.
The main procedure is executed after every setting completes.
The remote control circuit starts to operate. It receives remote control signals and transfers the reception result to the terminal software.
In this sample program, the format of the reception result is as follows;
Custom Code (16 bits) + Data Code (16 bits)

<table>
<thead>
<tr>
<th>Remote control receiver</th>
<th>RPM7138-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port of TMPM3H6</td>
<td>PB1:RXIN</td>
</tr>
</tbody>
</table>
9.3. Output Example of Sample Program
The following example is that the result of the data reception from the remote controller is transferred to the terminal software.
Custom Code (Customer Code) and Data Code are displayed

![Image](https://via.placeholder.com/150)

9.3.1. Setting Example of Terminal Software
The operation of the terminal software (Tera Term) has been checked with the following settings.

![Image](https://via.placeholder.com/150)
9.4. Operating Flow of Sample Program

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

- **Main**
  - **Creation and Initialization**
  - **Start-up**
  - **Reception code output**
  - **Stop**
  - **End and Deletion**

[Diagram showing the operating flow with the mentioned steps]
Initialization

Creation and Initialization

- BSP initialization

RAM initialization

- Driver initialization

- Application initialization

Driver initialization

- T32A Driver initialization
T32A 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.

```
bsp_get_timer_ch(BSPTimer)

Channel number = bsp_get_timer_ch(-)

t32a_mode_init(Instance address)

timer_initialize(Timer Instance address)

result = timer_initialize(-): success

t32a_timer_init(Instance address)

result = t32a_mode_init(-): success

result = t32a_timer_init(-): success
```
ref Timer Application Start-up

ref Remote Control Application Start-up

Application start-up

Remote Control Application start-up

remote_start (Remote Control Instance address)

rmc_rx_enable (RMC Instance address)

bsp_irq_rmc_enable()
Reception code output

Remote control (Application)

Remote control (Application)

UART IO (Application)

remote irq_handler (Remote control instance address)

rmc_get_status (RMC instance handle, status storage destination)

rmc_get_data (RMC instance handle, reception data storage destination)

remote irq_handler (-)

rmc_get_status (-)

rmc_get_data (-)

remote_irq_handler(-)

remote_get_list_data (Remote control instance address, Storage destination of Data information)

Data reception handler (-)

Data reception handler (User ID)

Procedure result=remote_get_list_data(-)

[Procedure result=success]

printf(Reception data)

Reception list update
- Storage count of the lists
- Read pointer

Data reception handler (User ID)

Data reception handler(-)

remote_irq_handler(-)

remote_irq_handler (Remote control instance address)

rmc_get_status (RMC instance handle, status storage destination)

rmc_get_data (RMC instance handle, reception data storage destination)

remote_irq_handler (Application)

Remote Control (Application)

UART IO (Application)

RMC (Application)
Application stop

Remote Control Application Stop

remote_stop (Remote control instance address)

remote_stop(-)

remote_stop

EXCEPTION disable
INTRMC_IRQn

rmc_rx_disable (RMC instance address)

bsp_irq_rmc_disable()
Remote control application end

Remote Control Application End

remote_finalize (Remote Control instance address)

ref
Remote Control Application Stop

rmc_deinit (RMC instance address)

Release of RMC register address assignment

driver_finalize(-)

Release of RMC register address assignment

Driver end

Driver End

ref
T32A Driver End
T32A Driver end

T32A Driver End

T32A (Driver)

Release of Register address assignment for 1-ms timer channel
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>2018-03-09</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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