Outlines

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

Target sample program: UART_Echo
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1. Preface

This sample program is used to check the operation of UART communication function. It executes command input and echo back from the terminal software on the PC via the USB - UART interface.

Structure diagram of Sample program

![Structure diagram of Sample program](image-url)
2. Reference Document

- Datasheet
  TMPM3H group (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Asynchronous serial communication circuit (UART-C) 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</td>
<td>ch0</td>
<td>PA1 (UT0TXDA)</td>
<td>UART mode</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>TMPM3H5FSGF</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>TMPM3H4FSGF</td>
</tr>
<tr>
<td>TMPM3H3FWUG</td>
<td>TMPM3H3FUUG</td>
<td>TMPM3H3FSUG</td>
</tr>
<tr>
<td>TMPM3H2FWUG</td>
<td>TMPM3H2FUUG</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. 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
  - 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/](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. Operation of Evaluation Board

PC should be connected to the USB_UART pin on the evaluation board with a USB cable.

After start-up the terminal software (Tera Term), performs communication setting on the terminal software.

Push the reset button on the evaluation board.

The following operations should be done on the terminal software (Tera Term) on PC.

1. Initial display
   "Input =" requires a user inputting proper information on the display
2. Character input
   The user should input proper characters. Then, "Enter" should be done.
3. Echo-back output
   The input characters are displayed after "Echo =".
4. When the count of the characters exceeds the maximum value;
   "Input Error!!" is displayed.

<table>
<thead>
<tr>
<th>Port</th>
<th>TXD:PA1, RXD:PA2</th>
</tr>
</thead>
</table>
8. Outline of UART interface function

The asynchronous serial communication circuit (UART) can operate as a transmission / reception circuit of 1 channel (UTxTXDA / UTxTXDB / UTxRXD) per unit. The following is a list of functions.

<table>
<thead>
<tr>
<th>Function classification</th>
<th>Function</th>
<th>Operation explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baud rate control</td>
<td>Frequency dividing of prescaler</td>
<td>Selectable from 1/1 to 1/512 of the ΦT0 frequency.</td>
</tr>
<tr>
<td></td>
<td>Baud rate generator</td>
<td>N dividing or N + (64 - K) / 64 (N = 1 to 65535 and K = 0 to 63) dividing of the source clock frequency are possible.</td>
</tr>
<tr>
<td>Data format</td>
<td>Data length</td>
<td>Selectable 7, 8, or 9-bit.</td>
</tr>
<tr>
<td></td>
<td>Parity</td>
<td>Parity control: Enable or disable selection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parity type: Even or odd parity is selectable</td>
</tr>
<tr>
<td></td>
<td>Stop bit length</td>
<td>Selectable 1-bit or 2-bit.</td>
</tr>
<tr>
<td></td>
<td>Data transfer order</td>
<td>Selectable LSB first or MSB first.</td>
</tr>
<tr>
<td></td>
<td>Data signal inversion</td>
<td>Inversion control of the input and output data signal. Selectable disabled or enabled.</td>
</tr>
</tbody>
</table>
| Transmission / reception control | FIFO storage stages | Reception: 8 stages  
Transmission: 8 stages                                                                 |
|                         | Noise cancelling function                  | Reception: Noise cancelling function is enabled or disabled for UTxRXD.               |
|                         | Error detection                            | Reception: Parity error, Framing error, Break error, Overrun error  
Transmission: Break error, Trigger transmission error               |
|                         | Handshake function                        | Transmission / reception control by handshake with UTxCTS_N / UTxRTS_N signal is possible. |
|                         | Wake-up function                           | Serial link operation using the wakeup function in the 9-bit mode is possible.        |
| Interlocking control    | Interrupt                                  | Reception interrupt, Transmission interrupt, and Error interrupt.                   |
|                         | DMA request                                | Reception DMA request: Burst transfer or Single transfer  
Transmission DMA request: Burst transfer or Single transfer                  |
| Special control         | Half clock mode (Transmission / reception) | Transmission and reception with half width of "0" width of the normal UART waveform is possible. |
|                         | Loopback function (Test function)         | The transmission data is connected to the reception data and the loopback test is possible. |
|                         | Software reset                             | Initialization can be done by software.                                               |

UTxTXDA can be exchanged for UTxRXD and UTxCTS_N can be exchanged for UTxRTS_N, too. This is done by a port setting. Refer to "Input/Output Ports" of the reference manual.

8.1. Clock Supply

When you use UART, please set an applicable clock enable bit to "1" (clock supply) in fsys supply stop register A ([CGFSYSENA]), fsys supply stop register B ([CGFSYSENB]), and fc supply stop registers ([CGFCEN]).

Please refer to "Clock Control and Operation Mode" of the reference manual for the details.

When attempting to stop supplying the clock, make sure to check whether the UART is stopping. Note that when the MCU enters STOP mode, make sure to check whether the UART is stopping as well.
9. Sample Program

The data transferred from the terminal software is echoed back.

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 operation, shift to the main function and perform the following initialization.
1. Initialization of BSP (Board Support Package)
2. Initialization of variables
3. Initialize the driver
4. Initialize the application

After performing the above processing, start the timer and clear the data.
It waits for input at “Input =” indication on the PC terminal software.
After inputting, the input character is displayed following “Echo =” display as the echo back output.
9.3. Output Example of Sample Program

After the sample program starts to operate, the command results are displayed as shown in the following.
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 as follows.

```
Main

ref Creation and Initialization

ref Start-up

loop [No procedure errors]

ref Output

"Input =" Display data output

ref Input

Wait for Data input until "line feed" code is received.

ref Output

Echo-back data output

ref Stop

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

```
T32A Driver initialization

bsp_get_timer_ch(BSPTimer) → Channel number = bsp_get_timer_ch()

ref t32a_mode_init(Instance address)

ref timer_initialize(Timer Instance address)

result = timer_initialize(-):success

ref t32a_timer_init(Instance address)

result = t32a_timer_init(-):success

result = t32a_mode_init(-):success

Acquisition of Timer channel for 1-ms timer

BSP (Application)

T32A (Driver)

Application initialization

ref Timer Application initialization

ref UART Application initialization
```
UART Application initialization

BSP (Application)

bsp_get_usb_uart_tx_ch

Acquisition of Channel for USB UART

UART IO Initial setting creation

uart_io_initialize (Storage destination of UART IO initial setting)

uart_io (Application)

UART IO instance address = uart_io_initialize (-)

Assignment of Address to Specified UART CH register

UART (Driver)

Create UART Driver initial setting
- uart_initial_setting_t

Registration of UART driver event handler
- Transmission event handler
- Reception event handler

uart_init(UART instance address)

uart_receiveit (UART instance address, Storage destination of Reception buffer information)

Exception enable
- INTUARTxTX
- INTUARTxRX
- INTUARTxERR

UART IO instance address = uart_io_initialize (-)
End and Deletion

ref Application end

ref Driver end

ref BSP end

Driver end

ref T32A Driver end

T32A Driver end

Release of assignment of Register address to Channel for 1-ms timer
UART Application end

• Exception disable
  - INTUARTxTX
  - INTUARTxRX
  - INTUARTxERR

Release of assignment of Address to Specified UART CH register

uart_deinit
(UART IO instance address)

uart_io_finalize
(UART IO instance address)

uart_io_finalizer()
"print" is retargeted to "fputc", and the characters are output one by one.

Create transmission information

uart_transmitIt
(UART instance address, Storage destination of Transmission buffer information)

loop

opt
[Transmission result = Successful]

uart_get_status
(UART instance address, Storage destination of Status)

break
[Status = Transmission stop]

break
[Transmission result = Failure]

"printf" is retargeted to "fputc", and the characters are output one by one.
"getchar" is retargeted to "getc", and the characters are input one by one.

[Reception result! = Failure]

[Reception information = Reception data is present.]

Pick up Reception data.
uart_io_tx_irq_handler (UART IO instance address)

uart_transmit_irq_handler (UART instance address)

Transmission

Transmission result is stored.

Transmission result is stored.

Registration transmission handler (-)

Registration transmission handler (-)

uart_transmit_irq_handler (-)

uart_io_tx_irq_handler (-)

uart_io_tx_irq_handler (-)

UART(IO instance address)

UART (Driver)

uart_transmit_irq_handler (UART instance address)

uart_transmit_irq_handler (UART instance address)

uart_io (Application)

Transmission completes.

OPT

Transmission completes.
Reception

uart_io_rx_irq_handler
(UART IO instance address)

UART
(Driver)

uart_receive_irq_handler
(UART instance address)

[Data reception]

OPT
Registration reception handler
(UART instance handle, Reception result, Storage destination of Reception information)

Reception result and Reception information are stored.

Registration transmission handler(-)

uart_receive_irq_handler(-)

uart_io_rx_irq_handler(-)
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>2018-03-15</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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