CRC Calculation Circuit
(CRC-A)

Outlines
This application note is a reference material for developing products using the CRC calculation circuit (CRC) function of M3H Group (2). This document helps the user check operation of the product and develop its program.

Target sample program: CRC_TSPI
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1. Preface

This sample program is used to check the operation of the CRC calculation circuit function.

Structure diagram of Sample program
2. Reference Document
- Datasheet
  TMPM3H group (2) datasheet Rev2.0 (Japanese edition)
- Reference manual
  CRC calculation circuit (CRC-A) Rev1.0 (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>CRC</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Asynchronous communication</td>
<td>ch0</td>
<td>PA1 (UT0TXDA)</td>
<td>UART mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PA2 (UT0RXD)</td>
<td></td>
</tr>
<tr>
<td>Serial peripheral interface</td>
<td>ch2</td>
<td>PT3 (TSPI2TXD)</td>
<td>SPI mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT2 (TSPI2SCK)</td>
<td>Master operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PT1 (TSPI2CS0)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ch1</td>
<td>PB4 (TSPI1RXD)</td>
<td>SPI mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PB2 (TSPI1SCK)</td>
<td>Slave operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PB5 (TSPI1CS0)</td>
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</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

<table>
<thead>
<tr>
<th>Target Device</th>
<th>Target Device</th>
<th>Target Device</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM3HQFDFG</td>
<td>TMPM3HQFZFG</td>
<td>TMPM3HQFYFG</td>
</tr>
<tr>
<td>TMPM3HPFDFG</td>
<td>TMPM3HPFZFG</td>
<td>TMPM3HPFYFG</td>
</tr>
<tr>
<td>TMPM3HNFDFG</td>
<td>TMPM3HNFZFG</td>
<td>TMPM3HNFYDFG</td>
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<td>TMPM3HNFDDFG</td>
<td>TMPM3HNFZDFG</td>
<td>TMPM3HNFYDFG</td>
</tr>
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<td>TMPM3HMFDGF</td>
<td>TMPM3HMFZFG</td>
<td>TMPM3HMFYFG</td>
</tr>
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</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

- **Used microcontroller**: TMPM3HQFDFG
- **Used board**: TMPM3HQFDFG 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/](http://www.chip1stop.com/)
6. Evaluation Board Setting

The following pin connections should be done on the evaluation board.

<table>
<thead>
<tr>
<th>CN12</th>
<th>Board function</th>
<th>Through hole No.</th>
<th>Through hole No.</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>USB UART conversion</td>
<td>53 : PA1</td>
<td>54 : USB_TXD</td>
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<tr>
<td></td>
<td>USB UART conversion</td>
<td>55 : PA2</td>
<td>56 : USB_RXD</td>
</tr>
<tr>
<td></td>
<td>SPI communication (Inter-channel)</td>
<td>7 : PT1</td>
<td>31 : PB5</td>
</tr>
<tr>
<td></td>
<td>SPI communication (Inter-channel)</td>
<td>9 : PT2</td>
<td>37 : PB2</td>
</tr>
<tr>
<td></td>
<td>SPI communication (Inter-channel)</td>
<td>11 : PT3</td>
<td>33 : PB4</td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board

The USB_UART connecter on the evaluation board should be connected to a PC with a USB cable. The terminal software (Tera Term) is started up on the PC, and the communication setting should be done. The reset button should be pushed down on the evaluation board. The communication starts according to the command input. For the details of the command operation, refer to “Sample program main operation”.

USB_UART connecter
8. Outline of CRC Calculation Circuit Function

CRC (Cyclic Redundancy Check) is used to detect an error for memory data and communication data. CRC calculation circuit is a hardware calculator of CRC.
9. Sample Program

The character string “TOSHIBA” and its CRC code are transmitted and received using the TSPI on the two channel. The reception data is displayed on the terminal software (Tera Term).

9.1. Initialization

The following initialization is done after power is supplied. The port settings are done 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. Variable value initialization
3. Application initialization
4. Initialization of TSPI input and output
5. Command procedure starts.

“command >” is displayed on the Tera Term “send” should be input to transmit data. When “send” command is input, the character string “TOSHIBA” and its CRC code are transmitted. The CRC value and its check result are displayed on the Tera Term. And at last, the received character string is displayed. Then, “command >” is displayed again.
9.3. Output Example of Sample Program

When the sample program operates, the command results are shown as follows;

![Command Results]

- command > send
- CRC Code > 0xfd0d8
- CRC Check: OK
- read data > TOSHIBA
- command >
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

Creation and Initialization

Start-up

loop
[No processing error]

Wait for Input command

Command procedure

Data transmission
```
Creation and Initialization

- RAM initialization
- Application initialization
- BSP initialization

Application initialization

- UART Application initialization
- TSPI transmission channel initialization
- TSPI reception channel initialization
**TSPI transmission channel initialization**

- BSP (Application)
- TSPI (Driver)

```
bsp_get_tspi_tx_ch
```

Get TSPI transmission channel

```
tsri_init
```

**TSPI reception channel initialization**

- BSP (Application)
- TSPI (Driver)

```
bsp_get_tspi_rx_ch
```

Get TSPI reception channel

```
tsri_init
```
“getchar” is retargeted to “getc”, and the characters are input one by one.

Reception data is picked up.
**Command procedure**

- **Input data == "send"?**
  - NO: Command error message display
  - YES: CRC setting/Calculation
    - CRC calculation result is added to Transmission data.
    - Data transmission
      - Reception data buffer setting
        - tsip_master_read (TSPI reception instance address, Reception data storage address, Re-try count)
      - CRC check
        - Reception data display
TSPI (Driver)

Data transmission

```
# Registered transmission handler
(tSPI transmission instance address, Transmission result)
```

```
# Transmission completion
```

```
# Transmission result is stored.
```

```
# Registered transmission handler(-)
```

```
# tspi_irq_handler Transmit(TSPI transmission instance address)
```

```
# tspl_master_transfer(-)
```

```
# tspl_master_transfer
(TSPI transmission instance address, Transmission data storage address)
```

```
# tspi_irq_handler Transmit(-)
```

```
# irq_sflsh_tx
```

```
# OPT
```

```
# Registered transmission handler
(TSPI transmission instance address, Transmission result)
```

```
# Transmission result is stored.
```

```
# Registered transmission handler(-)
```

```
# tspi_irq_handler Transmit(-)
```
CRC setting/Calculation

REG_CRCDIN_set(Register base address, Transmission data)

REG_CRCCLC_get(Register base address)

CRC calculation result: REG_CRCCLC_get(-)
CRC check

REG_CRCTYP_set(Register base address, Parameter)
REG_CRCDIN_set(Register base address, Data)
REG_CRCCLC_get(Register base address, Data)

CRC calculation result = 0?

CRC check result is displayed.
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>
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</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2018-05-17</td>
<td>-</td>
<td>First release</td>
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