Outlines
This application note is a reference material for developing products using the digital noise filter circuit (DNF) function of H3M Group(2).
This document helps the user check operation of the product and develop its program

Target sample program: DNF_LED
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1. Preface

This sample program is used to check the operation of the digital noise filter circuit function.

Structure diagram of Sample program
2. Reference Document

- Datasheet
  TMPM3H group (2) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Digital noise filter circuit (DNF-A) Rev2.0 (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>Digital noise filter</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Input and Output ports</td>
<td>-</td>
<td>PV3 (INT18)</td>
<td>External interrupt</td>
</tr>
<tr>
<td></td>
<td>-</td>
<td>PK7 (Output Port)</td>
<td>Output</td>
</tr>
</tbody>
</table>

4. Target Device

The target devices of application note are as follows.

<table>
<thead>
<tr>
<th>TMPM3HQFDFG</th>
<th>TMPM3HQFZFG</th>
<th>TMPM3HQFYFG</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMPM3HPFDFG</td>
<td>TMPM3HPFZFG</td>
<td>TMPM3HPFYFG</td>
</tr>
<tr>
<td>TMPM3HNFDFG</td>
<td>TMPM3HNFZFG</td>
<td>TMPM3HNFYFG</td>
</tr>
<tr>
<td>TMPM3HNFDDFG</td>
<td>TMPM3HNFZDFG</td>
<td>TMPM3HNFYDFG</td>
</tr>
<tr>
<td>TMPM3HMDFDG</td>
<td>TMPM3HMDFZFG</td>
<td>TMPM3HMDFYG</td>
</tr>
</tbody>
</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

<table>
<thead>
<tr>
<th>Used microcontroller</th>
<th>TMPM3HQFDGF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Used board</td>
<td>TMPM3HQFDGF 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>Unified development environment</td>
<td>μVision MDK Version 5.24.2.0</td>
</tr>
<tr>
<td>Sample program</td>
<td>V1100</td>
</tr>
</tbody>
</table>

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>Through hole No.</th>
<th>Through hole No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LED (D7)</td>
<td>PORT_LED3</td>
<td>PK7</td>
</tr>
<tr>
<td>Push SW (S7)</td>
<td>PORT_PSW3</td>
<td>PV3</td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board

When Push switch (S7) is pushed down, LED (D7) lights on and off alternately. When the Push switch is pushed down, the external interrupt request is generated. The interrupt request is detected through the DNF. When the interrupt request is detected, the LED lighting and lights-off are controlled by Port K7.
8. Outline of Digital Noise Filter Circuit Function

The digital noise filter circuit can remove the noise of a predetermined width from the external interrupt pin input.
9. Sample Program

It detects the external interrupt signal generated by the Push switch via the digital noise filter and switches turning on and off the LED.

9.1. Initialization

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

9.2. Sample program main operation

After the initialization, the “main” function executes. And the following initializations are done.
1. BSP (Board Support Package) initialization
2. Timer driver initialization
3. Application initialization
4. The timer starts to operate.
5. Clock setting of [DNFxCKCR] (noise filter control register)
6. Enable interrupt of external interruption (INT17_18) for DNF operation check (Interrupt control register B)
7. Noise filter permission setting of [DNFxENCR] (noise filter enable register)
8. Enable interrupt of external interruption (INT17_18) for DNF operation check (NVIC controller)

When LED (D7) is off: When push switch (S7) is pressed, the LED (D7) lights on.
When LED (D7) is on: When push switch (S7) is pressed, the LED (D7) Lights off.

The lighting and lights-off of the LED (D7) are controlled by Push switch (S7).
9.3. Output Example of Sample Program

Activating the sample program turns the LED (D7) on and off each time the Push switch (S7) is pressed.

LED lit / off
9.4. Operating Flow of Sample Program

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

![Operating Flow Diagram]

- BSP initialization
- RAM initialization
  Procedure = Normal start-up
- Start-up
Start-up

- Driver initialization
- Application initialization
- DNF setting
- Timer Application start-up

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.
Application initialization

- Timer Application initialization
- LED Application initialization

[loop]
[1, Count of used LED's]

SW Application initialization

- SW Generation of SW initial setting
  - sw_initialize(LED instance address)

SW (Application)
LED Application initialization

LED
Generation of LED initial setting

led_initialize (LED instance address)

GPIO (Application)

gpio_write_bit (GPIO instance address, Group, Number, DATA, LED initial setting value)

led_initialize(-)
LED lighting and lights-off are controlled by Status value.

Main processing:
- led_task(LED instance address)

Driver:
- gpio_read_bit (GPIO instance address, Group, Number, DATA)
- gpio_write_bit (GPIO instance address, Group, Number, DATA, LED initial setting value)

Application:
- led_task(LED instance address)

BSP (Application):
- bsp_irq_extint_enable();
- External interrupt is enabled

INTer_IRQHandler:
- irq_extint(Status value)
External interrupt detection

Interrupt factor (Rising edge detection)

BSP (Application)

INT18_IRQHandler()

Interrupt factor flag clear
Reversed status value

irq_extint(Status value)
DNF setting

REG_NFCKCR_set
(Set register address, Clock setting value)

REG_NFENCR_enable
(Set register address, Interrupt number)
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>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>2018-05-11</td>
<td>-</td>
<td>First release</td>
</tr>
</tbody>
</table>
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