M3H Group(1)
Application Note
Digital Noise Filter Circuit
(DNF-A)

Outlines
This application note is a reference material for developing products using the digital noise filter circuit (DNF) function of H3M Group(1).
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 (1) datasheet Rev2.0 (Japanese edition)
- Reference manual
  Digital noise filter circuit (DNF-A) Rev2.0 (Japanese edition)
- Other reference document
  TMPM3H 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>Noise reduction</td>
</tr>
<tr>
<td>Input and Output ports</td>
<td>–</td>
<td>PN3 (INT10)</td>
<td>External interrupt</td>
</tr>
<tr>
<td></td>
<td>–</td>
<td>PB7 (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>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>
<tr>
<td>TMPM3H1FWUG</td>
<td>TMPM3H1FUUG</td>
<td>TMPM3H1FSUG</td>
</tr>
<tr>
<td>TMPM3H1FPUG</td>
<td>TMPM3H0FSDUG</td>
<td>TMPM3H0FMDUG</td>
</tr>
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</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
- **Unified development environment**: μVision MDK Version 5.24.2.0
- **Sample program**: V1100

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></td>
<td>LED (D7)</td>
<td>33-34</td>
<td>Connection</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CN9</th>
<th>Use</th>
<th>Through-hole No.</th>
<th>Setting</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Push SW (S5)</td>
<td>21-22</td>
<td>Connection</td>
</tr>
</tbody>
</table>

7. Operation of Evaluation Board

When Push switch (S5) 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 B7.
8. Outline of Digital Noise Filter Circuit Function

The digital noise filter circuit consists of a clock control circuit, noise removal circuits and interrupt request selectors.
9. Sample Program

It repeats the turning on and off of the LED by the external interrupt signal passed through the digital noise filter.

9.1. Initialization

The following initialization is done after power is supplied.
The PORT setting is executed after the initialization of each clock setting and the clock setting.

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. DNF setting

The lighting and lights-off of the LED are controlled by Push SW (S5).
9.3. Operating Flow of Sample Program

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

---

**T32A Driver initialization**

**BSP (Application)**

- `bsp_get_timer_ch(BSPTimer)`
  - Channel number = `bsp_get_timer_ch(-)`

- `t32a_mode_init(Instance address)`
  - `result = t32a_mode_init(-):Successful`

- `t32a_timer_init(Instance address)`
  - `result = t32a_timer_init(-):Successful`

- `timer_initialize(Timer instance address)`
  - `result = timer_initialize(-):Successful`

**Acquisition of Timer channel for 1-ms timer**
Application initialization

ref Timer Application initialization

loop [1. Count of used LED's]

ref LED Application initialization

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)

LED
(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)

Optional:
- led_task(-)

Optional:
- [Port state = LED status]

Optional:
- irq_extn(-)

Optional:
- External interrupt is enabled

Optional:
- bsp_irq_extn_enable(-)

Optional:
- bsp_irq_extn_enable(-)

Optional:
- irq_extn(Status value)

Optional:
- INTfor_IRQHandler

Application:
- gpio_task(GPIO instance address, Group, Number, DATA)

Optional:
- gpio_write_bit(GPIO instance address, Group, Number, DATA, LED initial setting value)
External interrupt detection

Interrupt factor
(Rising edge detection)

INT09_IRQHandler()

BSP
(Application)

opt

Interrupt factor flag clear
Reversed status value

irq_exint(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 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>2018-03-22</td>
<td>-</td>
<td>First release</td>
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