TOSHIBA

TX03 Peripheral Driver Usage Example (TMPM380)

Ver 1

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TOSHIBA ELECTRONIC DEVICES & STORAGE CORPORATION

CMDR-M380UE-01E

RESTRICTIONS ON PRODUCT USE

- DO NOT USE THIS SOFTWARE WITHOUT THE SOFTWARE LISENCE AGREEMENT.

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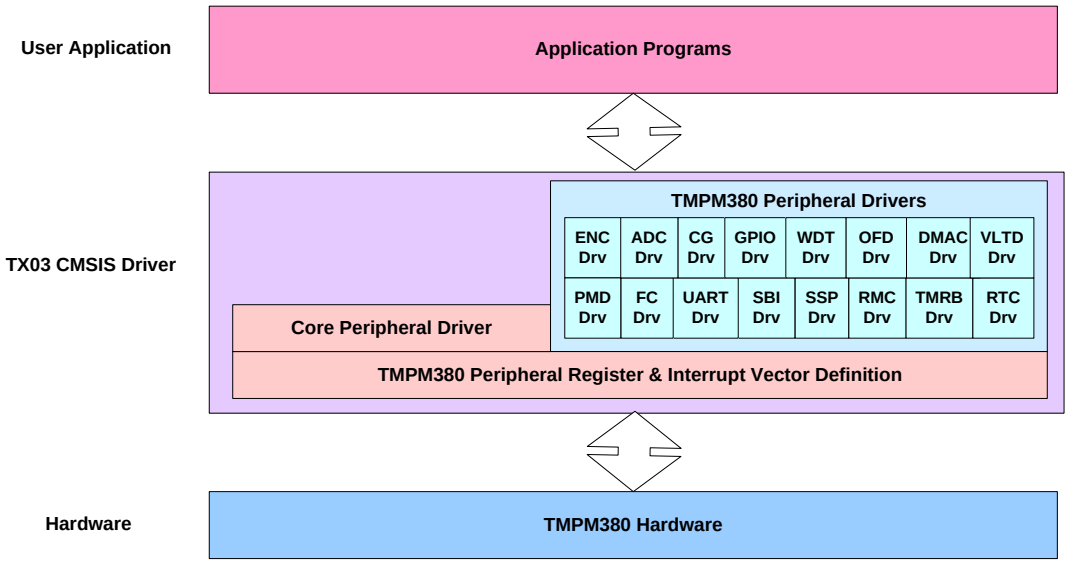
1 General description

The example programs described hereafter are specially designed for TOSHIBA TMPM380 MCU. The programs can be executed individually each to show the main MCU functions. Users can utilize some portions of the programs and integrate them into users' own programs to perform customized functions.

2 Overview

User application utilizes TX03 peripherial driver as following.



3 Build-in hardware usage

Hardware	Channel	Use presence, use
CG	Clock Gear	Used for CG demo
	PLL	PLL on (4x)
Standby mode	-	Use SLEEP mode
SysTick	-	Unused
Watch dog timer (WDT)	-	Used for WDT and OFD demo
External interrupt (INT)	INT0	Unused
	INT1	Unused
	INT2	Unused
	INT3	Unused

Hardware	Channel	Use presence, use
	INT4	Unused
	INT5	Unused
	INT6	Unused
	INT7	Unused
	INT8	Unused
	INT9	Unused
	INTA	Unused
	INTB	Unused
	INTC	Unused
	INTD	Unused
	INTE	Unused
	INTF	Unused
SIO	SIO0	Used for UART & DMAC demo Tx
	SIO1	Used for UART & DMAC demo Rx
	SIO2	Used for UART retarget demo
	SIO3	Unused
	SIO4	Unused
Synchronous serial port (SSP)	SSP0	Used for SSP transfer demo Tx
	SSP1	Used for SSP transfer demo Rx
Serial bus (SBI)	SBI0	Used for Master Tx
	SBI1	Used for Slave Rx
Remote control signal processor (RMC)	RMC0	Used for RMC signal receive
16-bit timer	TMRB0	Used for TMRB: General Timer
	TMRB1	Unused
	TMRB2	Unused
	TMRB3	Unused
	TMRB4	Unused
	TMRB5	Unused
	TMRB6	Unused
	TMRB7	Used for TMRB: PPG Output
16-bit multi-purpose timer	MPT0	Unused
	MPT1	Used for PMD demo: Phase Output
	MPT2	Unused
RTC	-	Used for RTC demo
OFD	-	Used for Startup demo
VLTD	-	Used for low voltage detection
Encoder input function	ENC0	Used for ENC Roller demo
	ENC1	Unused
10-bit A/D converter	AIN0	Used for ADC data read

Hardware	Channel	Use presence, use
	AIN1	Unused
	AIN2	Unused
	AIN3	Unused
	AIN4	Unused
	AIN5	Unused
	AIN6	Unused
	AIN7	Unused
	AIN8	Unused
	AIN9	Unused
	AIN10	Unused
	AIN11	Unused
	AIN12	Unused
	AIN13	Unused
	AIN14	Unused
	AIN15	Unused
	AIN16	Unused
	AIN17	Unused

4 Pin Usage

The example programs are tested on the IAR TMPM380-SK Evaluation Board except SBI & SSP that are tested on TOSHIBA TMPM380 Evaluation Board.
Following is pin usage for example programs on IAR TMPM380-SK Evaluation Board.

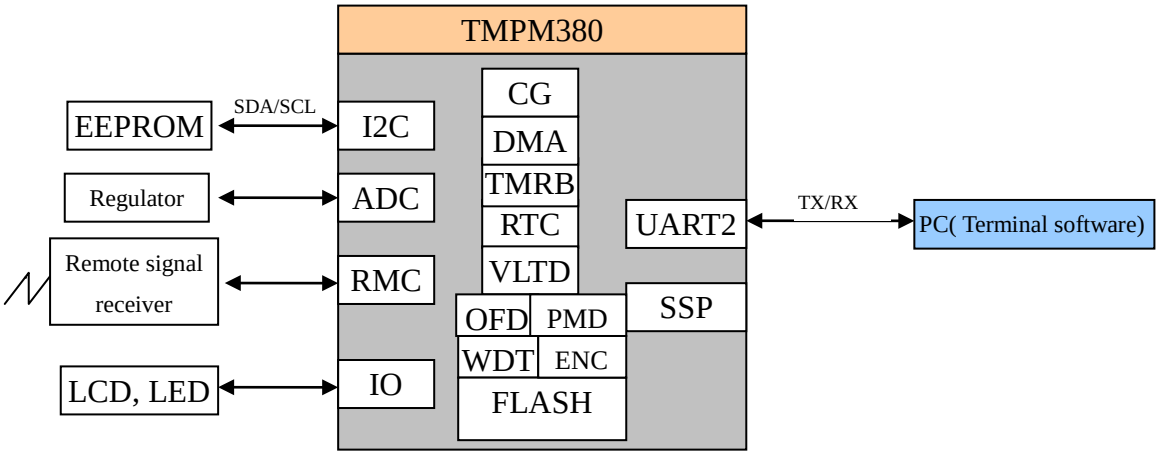
No	Name	Usage
1	PD4, SCLK2, CTS2	Unused
2	PD3, INT9	Unused
3	PD2, ENCZ0, INTD	Toggle switch 3
4	PD1, ENCB0, TB5OUT	Toggle switch 2 / ENCB0
5	PD0, ENCA0, TB5IN, INTC	Toggle switch 1 / ENCA0
6	DVSS	GND
7	PC7, MT0IN, RX4	Unused
8	PC6, EMG0	Unused
9	PC5, ZO0, MTOUT10, MTTB0IN, SCLK4, CTS4	Unused
10	PC4, WO0, MTOUT00, MTTB0OUT	Unused
11	PC3, YO0, SP0FSS	Unused
12	PC2, VO0, SP0CLK	Unused
13	PC1, XO0, SP0DI, SCL0 / SI0	Unused
14	PC0, UO0, SP0DO, SDA0 / SO0	Unused
15	DVDD5	+5V
16	PP1, XT2	Connect 32.768kHz oscillator
17	PP0, XT1	Connect 32.768kHz oscillator
18	PM1, X2	Connect 10MHz oscillator
19	CVSS	GND
20	PM0, X1	Connect 10MHz oscillator
21	DVSS	GND
22	PG0, UO1, SDA1 / SO1	PMD UO1 output
23	PG1, XO1, SCL1 / SI1	PMD XO1 output
24	PG2, VO1, SCK1	PMD VO1 output
25	PG3, YO1	PMD YO1 output
26	PG4, WO1, MTOUT01, MTTB1OUT	LED digit select / PMD WO1 output
27	PG5, ZO1, MTOUT11, MTTB1IN	LED digit select / PMD ZO1 output
28	PG6, EMG1, GEMG1	LED digit select / PMD EMG1 input
29	PG7, MT1IN	LED digit select
30	PA0, TB0IN, INT3	LED data
31	PA1, TB0OUT, SCOUT	LED data
32	PA2, TB1IN, INT4	LED data

No	Name	Usage
33	PA3, TB1OUT, RXIN	LED data
34	PA4, SCLK1, CTS1	LED data/ UART1
35	PA5, TXD1, TB6OUT	LED data/ UART1
36	PA6, RXD1, TB6IN	LED data/ UART1
37	PA7, TB4IN, INT8	LED data
38	PE0, TX0	UART0
39	PE1, RX0	UART0
40	PE2, SCLK0, CTS0	UART0
41	PE3, TB4OUT	Unused
42	DVDD5	+5V
43	PE4, TB2IN, INT5	Unused
44	PE5, TB2OUT	Unused
45	DVSS	GND
46	PE6, TB3IN, INT6	Unused
47	PE7, TB3OUT, INT7	Unused
48	PN0, SP1DO	Unused
49	PN1, SP1DI	Unused
50	PN2, SPICLK	Unused
51	PN3, SPIFSS	Unused
52	PN4, MTOUT02, MTTB2OUT	Unused
53	PN5, MTOUT12, MTTB2IN	Unused
54	PN6, GEMG2	Unused
55	PN7, MT2IN, INTE	Unused
56	PL2, INTF	Unused
57	DVSS	GND
58	MODE	GND
59	RVDD5	+5V
60	RESET	RESET
61	VOUT3	Unused
62	PH0, AIN0, INT0	AIN0
63	PH1, AIN1, INT1	Unused
64	PH2, AIN2, INT2	Unused
65	PH3, AIN3	Unused
66	PH4, AIN4	Unused
67	PH5, AIN5	Unused
68	PH6, AIN6	Unused
69	PH7, AIN7	Unused
70	PI0, AIN8	Unused
71	PI1, AIN9	Unused
72	PJ0, AIN10	Unused
73	PJ1, AIN11	Unused

No	Name	Usage
74	PJ2, AIN12	Unused
75	PJ3, AIN13	Unused
76	PJ4, AIN14	Unused
77	PJ5, AIN15	Unused
78	PJ6, AIN16, INTA	Unused
79	PJ7, AIN17, INTB	Unused
80	AVSS	GND
81	AVDD5	+5V
82	DVSS	GND
83	DVDD5	+5V
84	PL0, BOOT	Unused
85	FTEST3	Unused
86	PB0, TRACECLK	Unused
87	PB1, TRACEDATA0	Unused
88	PB2, TRACEDATA1	Unused
89	PB3, TMS, SWDIO	TMS
90	PB4, TCK, SWCLK	TCK
91	PB5, TDO, SWV	TDO
92	PB6, TDI	TDI
93	PB7, TRST	TRST
94	PF0, TB7IN	Unused
95	PF1, TB7OUT, ALARM	PPG Output
96	PF2, ENCA1, SCLK3, CTS3	Unused
97	PF3, ENCB1, TX3	Unused
98	PF4, ENCZ1, RX3	Unused
99	PD6, RX2	Unused
100	PD5, TX2	Unused

5 Development Environment

Following is development environment:



1. Hardware board:
   1) IAR TMPM380-SK Evaluation Board
   2) TOSHIBA TMPM380 Evaluation Board. (Not for sale)

2. Development tool:
   - IAR:
     1) J-Link: IAR J-Link-ARM 7.0 / J-Link 6.0
     2) IDE: IAR Embedded workbench 5.5 version
   - KEIL:
     1) U-Link: Realview ULINK2
     2) IDE: KEIL uVision 4.10

***Note:** For ENC and PMD modules, the development tool version is different

- IAR:
  1) J-Link: IAR J-Link-ARM 7.0 / J-Link 6.0
  2) IDE: IAR Embedded workbench 6.50.1 version
- KEIL:
  1) IDE: KEIL uVision 4.60

6 Functions

This chapter will focus on the functions demonstrated in driver usage example.

6-1 Operation mode

There are five operation modes for TMPM380: NORMAL, SLOW, IDLE, SLEEP and STOP mode.

IDLE, SLEEP and STOP mode are low power mode.

To shift to lower power mode, in system control register STBYCR0<STBY2:0>, select the IDLE, SLEEP or STOP mode, and run the WFI (Wait For Interrupt) command.

- **NORMAL mode:**

This mode is to operate the CPU core and the peripheral hardware by using the high-speed clock(fosc1 or fosc2). It is shifted to the NORMAL mode with fosc2(internal high-speed oscillator) after reset.

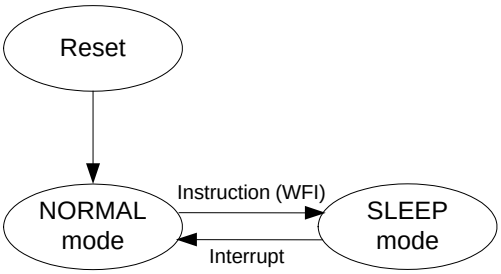
Note: Only SLEEP mode is demostrated in driver example.

- **SLEEP mode:**

The internal low-speed oscillator (fs), real time clock and RMC can operate. By releasing the SLEEP mode, the device returns to the preceding mode of the SLEEP mode and starts operation.

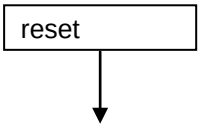
RTC interrupt, RMC interrupt and the extern interrupt can release the SLEEP mode.

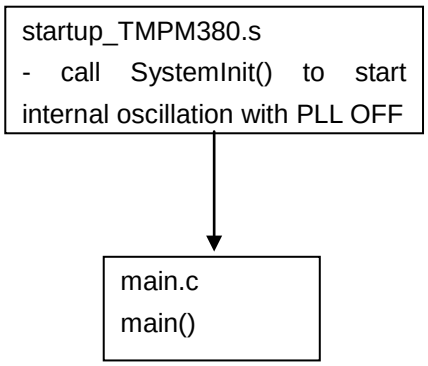
Note: The sample program of SLEEP mode is integrated into CG example.



6-2 STARTUP

Start up is running between reset and main function.





In main(), we demo the WDT and OFD functions, TMPM380 can be operated by both internal OSC and external OSC, however OFD circuit can detect only external OSC clock frequency using internal OSC clock.
When you use M380 OFD function, It is necessary to select "use the internal oscillation with PLL OFF" in "System Init", then start external oscillation and use the OFD drivers to perform the Oscillation Frequency Detector function.

6-3 ADC

There is a "slide volume" potentiometer connected to PN0/AIN0 on IAR TMPM380-SK Evaluation Board, the voltage on it will be measured and displayed it on 7-seg LED.

6-4 CG

6-4-1 Power mode change

Change the CPU operation mode. Only 2 modes are supported, NORMAL and SLEEP. Press remote controller power key to switch the power mode. And also maybe set the peripheral power according to power mode.

Current Mode	Action (remote key)	Operation	Terminal display
NORMAL	Press [9], [CH DOWN], [VOL DOWN]	NORMAL → SLEEP	Now, Going to Sleep
SLEEP	Press [7], [CH UP], [VOL UP]	SLEEP → NORMAL	Wakeup from Sleep

6-5 DMAC

6-5-1 Memory to peripheral

This function implements transmission from UART0 to UART1, the string “TOSHIBA” is sent

via UART0 to UART1.
The string is transferred from a RAM area to UART0 data register by DMAC, each character of the string is sent via UART0 and received by UART1. After UART1 received the data, it is saved in a character array.

The received value can be checked by RAM variable, the character array in debugger.

Note: In order to run this sample software, the IAR TMPM380-SK Evaluation Board must be modified: Connect the TX of UART0 and RX of UART1 via wire.

6-6 FLASH

This function demonstrates the feature of flash APIs such as erase and write operation.
The demo runs in Normal mode and User Boot Mode of Single chip mode.

- Reset procedure: includes Mode judgment, Programming routine(flash APIs), Copy routine

・ Mode judgment routine: judge to enter User Boot Mode or Normal Mode

・ Copy routine: copy programming routine(flash APIs) from flash to RAM

・ Programming routine: runs at RAM and swap Program A and Program B code in flash

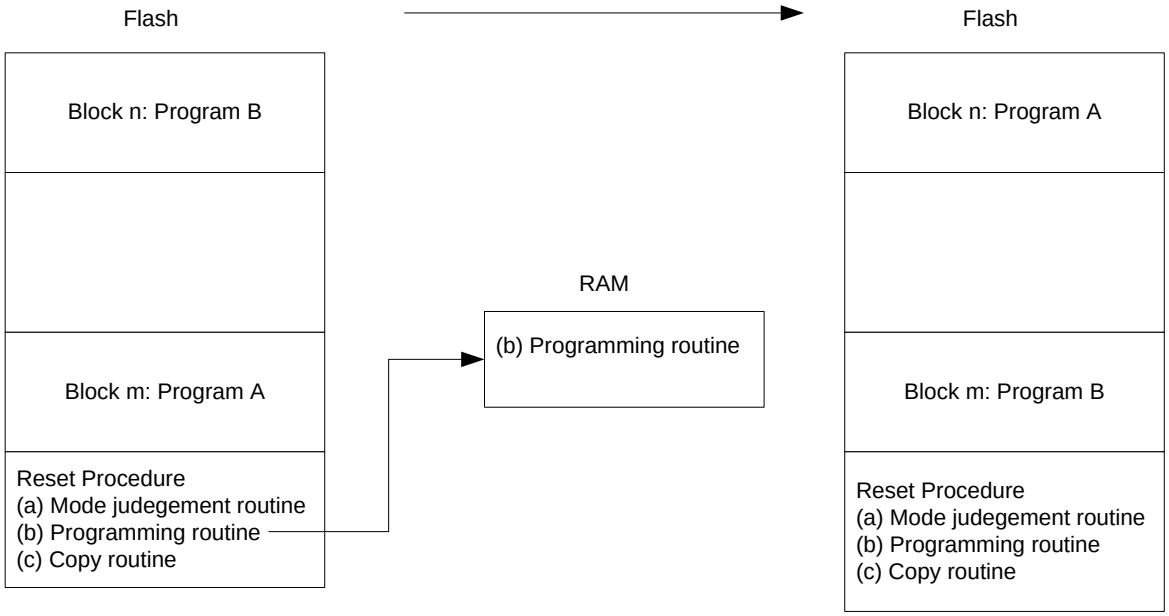
- Program A/B (Reset procedure) are programmed in flash block in advance.

- Program A/B(A: LED 4,6,8,10 blink, B: LED 5,7,9,11 blink)

By default, the program A will run firstly

- Toggle switch1(TSW1) is used for mode judgement in Reset procedure

Toggle switch1(TSW1)-high position Normal mode
Toggle switch1(TSW1)-low position User boot mode

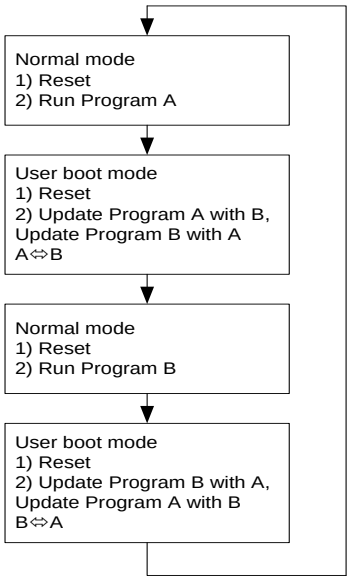


Demo sequence

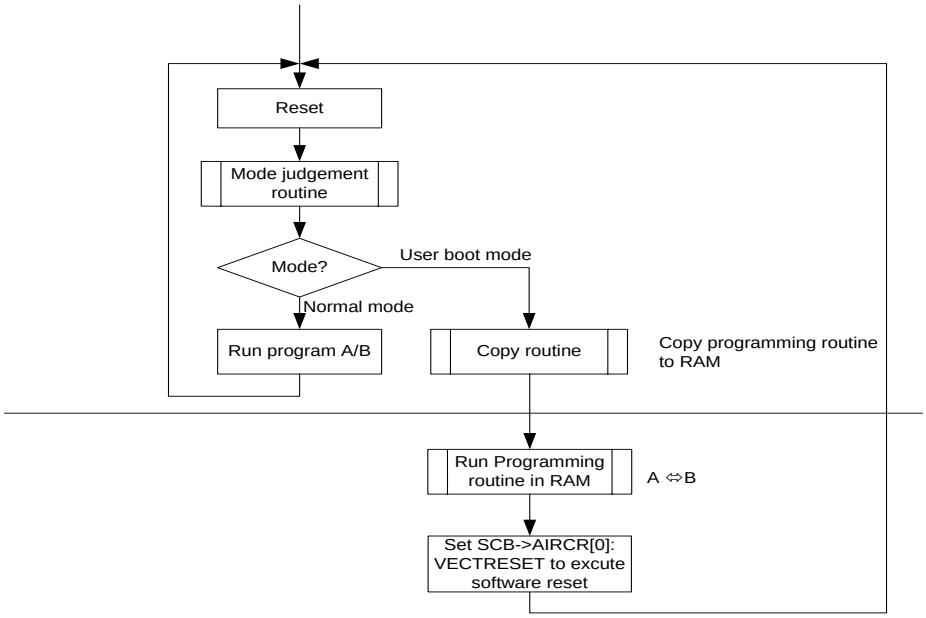
(1) Power on
Change the switch "TSW1" to high position, then power on or press RESET button. ProgramA will run at first.
LED 4,6,8,10 blink.

(2) Change the switch "TSW1" to low position, then press RESET button, 7-segments LED will display "0"->"1"->"2"->"3".

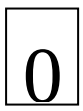
(3) After displaying "3", change the switch "TSW1" to high position, and system will reset automatically to run ProgramB.
LED 5,7,9,11 blink.



- **Demo process flow**



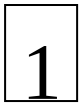
When the demo entering user boot mode, 7-segments LED will display as below:



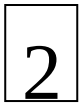
(user boot mode)

While RAM transferring or flash programming, 7-segments LED displays the current processing.

7-segments LED display sample:



(RAM transferring)



(Swap A and B)

(Swap finished, wait for reset)

6-7 GPIO

This is a simple application based on the Peripheral Driver (GPIO), use GPIO functions to configure GPIO to LED, then turn on the LED, or turn off the LED.

6-8 RMC

6-8-1 RMC receiving

This module intends to catch the remote signal data and decode it. Decoded data will be displayed on terminal on IAR. Custom code or address code and command code will be displayed in Hex format.

Display format: TMPM380 RMC Demo
RMC_1: XX XX
RMC_1: YY YY

Format	Terminal soft display
1	RMC_1 :
2	RMC_2 :
3	RMC_3 :
4	RMC_4 :
5	RMC_5 :

Following additional hardware connection should be added on the IAR TMPM380-SK

Evaluation Board.
1: Connects a remote control receiver to PA3 on the IAR TMPM380-SK Evaluation Board.
2: The power 3V supply to the remote control receiver.

6-9 RTC

This function implements data and time counting by RTC.
The initial date setting is 2010-10-22, and clock setting is 12:50:55, 24hours format. LEDs are used to show current ones place of second data.
Current RTC data and time can be checked by RAM variable DateStruct and TimeStruct in debugger.

6-10 SBI

This function intends to support the I2C bus slave mode.
Connect two I2C buses (SBI0 & SBI1) on TOSHIBA TMPM380 evaluation board.
One is working as I2C master, and the other is working as I2C slave.
Use SBI interrupt to handle I2C bus read/write.
Address of I2C slave: 0xB0.
I2C Slave (SBI1) receives “TOSHIBA” from I2C Master (SBI0).

Received results can be checked by RAM variable gI2CrxData[] in debugger.

Note: In order to run this sample software, use TOSHIBA TMPM380 evaluation board which must be modified.
Connect the pin PC1(SCL0) and pin PG1(SCL1).
Connect the pin PC0(SDA0) and pin PG0(SDA1).

6-11 SIO/UART

6-11-1 Retarget

This function intends to retarget the stdin and stdout of the C lib.
Stdin and stdout are retargeted to UART2. Then application code can use printf() to output data from serial port.

6-11-2 UART FIFO

In this sample program, UART0 sent the data "TMPM3801" to UART1 use FIFO, and at same time UART0 receive the data "TMPM3802" which send from UART1 and also use FIFO.
Set one breakpoint before the function ResetIdx(),when program stop in the breakpoint you

can read the RxBuffer = "TMPM3802",and RxBuffer1 = "TMPM3801".

6-11-3 SIO

This demo will show synchronously transfer and receive usage of SIO module in TMPM380
It use the channel SIO0, SIO1 and transfer data synchronously between them.(connect TXD0 with RXD1, connect TXD1 with RXD0, connect sclk0 with sclk1)

6-12 SSP

6-12-1 SSP0 to SSP1 via DMAC

For M380, there are 2 SSP channels, SSP0 is set as SPI Mast while SSP1 is set as SPI Slave, then connect correspond pins, use DMA to transmit/receive infinite self increased data.

Note: TOSHIBA TMPM380 evaluation board must be modified as below:

	SSP0 pins	Note	SSP1 pins
1	PC3/SP0FSS	Connect PC3 to PN3	PN3/SP1FSS
2	PC2/SP0CLK	Connect PC2 to PN2	PN2/SP1CLK
3	PC1/SP0DI	Connect PC1 to PN0	PN1/SP1DI
4	PC0/SP0DO	Connect PC0 to PN1	PN0/SP1DO

* SSP0 to SSP1 via DMAC demo should run on TOSHIBA TMPM380 Evaluation Board.

6-12-2 SSP0 Self Loop Back

Infinite data is sent and checked if the received data is OK or not. And if transmission is set to lowest speed mode(lowest bit rate), what happens will be checked.

Note: The SD card socket must be left nothing inside.

6-13 TMRB

6-13-1 General Timer

This function implements a general timer utilizing MCU timer.
Timer trailingtiming is set to 1ms.
Use this timer for LED blinking and the period is 1s (500ms ON and 500ms OFF).

6-13-2 PPG Output

Use Toggle Switch 1 to change PPG waveform. LeadingTiming can be changed as following: 10%, 25%, 50%, 75%, 90%

Power on to enter PPG mode and starts the PPG output.

Change the leadingtiming every switch changing:

10% → 25% → 50% → 75% → 90% → 10%

6-14 VLTD

This application implements power supply voltage status detecting by VLTD.

When the power supply voltage is lower than the detection voltage, LED4 is turned on and a “Low voltage!” message is printed (In DEBUG mode). When the power supply voltage is normal again, LED4 is turned off and a “High voltage!” message is printed (In DEBUG mode).

6-15 WDT

The watchdog timer cannot be used in the STOP mode, SLEEP mode and SLOW mode where high-speed frequency clock is stopped. Before transition to these modes, the watchdog timer should be disabled.

Watch dog timer is enabled after reset, and is disabled in SystemInit().

The driver example step:

1. Initialize WDT by setting detection time and selecting WDT interrupt as counter overflow operation.
2. There are two demos for WDT.

   DEMO1:

   If timer is overflow then WDT will be cleared, and NMI interrupt is generated.

   DEMO2:

   WDT clear code will be written to the watchdog timer control register, and watch dog timer counter will be cleared.

6-16 ENC

This example detects the rolling of mouse wheel by TMPM380 ENC driver.

Demo procedure:

1. Use a wire to connect the pinA (see diagram 1) of mouse wheel encoder with the pin7 (ENCA0) of TMPM380FYDFG MCU board.

2. Use a wire to connect the pinB (see diagram 1) of mouse wheel encoder with the pin6 (ENCB0) of TMPM380FYDFG MCU board.
3. Connect the USB of mouse with the PC, the Com (see diagram 1) of mouse wheel encoder will connect with 5V.
4. After running the program, LED4 will blink.
5. While rolling the mouse wheel forward, LED4 will blink faster and faster. When the blink speed reaches to the maximum, it will back to the minimum speed.
6. While rolling the mouse wheel backward, LED4 will blink slower and slower. When the blink speed reaches to the minimum, it will back to the maximum speed.

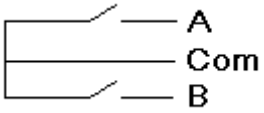


Diagram 1

6-17 PMD

This example demonstrates the phase outputs in PMD module.

Demo procedure:

1. Open the project and choose one demo to define: DEMO_U_PHASE or DEMO_3_PHASE. And then run the demo.
2. Use a wire to connect the EMG1 (pin 30) with the DVSS (pin 84) to pull it low. (LED4 will light on) It means that PMD is in EMG protection.
3. Use a wire to connect the EMG1 (pin 30) with the DVDD5 (pin 85) to pull it high. (LED4 will light off) It means that PMD is in normal operation.
4. Connect UO1 (pin 24) to oscilloscope to observe the waveform.
5. Connect XO1 (pin 25) to oscilloscope to observe the waveform.
6. Connect VO1 (pin 26) to oscilloscope to observe the waveform.
7. ConnectYO1 (pin 27) to oscilloscope to observe the waveform.
8. Connect WO1 (pin 28) to oscilloscope to observe the waveform.
9. Connect ZO1 (pin 29) to oscilloscope to observe the waveform.

Phenomenon:
If the DEMO_U_PHASE is defined, the phase outputs are same.
The waveform duty cycle of UO1 is 25%, the upper output is 5V, and the period is 820us.XO1 is the inverting of UO1.
VO1 and WO1 are same with UO1, and YO1 and ZO1 are same with XO1

If the DEMO_3_PHASE is defined, the phase outputs are different.

The waveform duty cycle of UO1 is 25%, the upper output is 5V, and the period is 820us.XO1 is the inverting of UO1.
The waveform duty cycle of VO1 is 50%, the upper output is 5V, and the period is 820us.YO1 is the inverting of VO1.
The waveform duty cycle of WO1 is 75%, the upper output is 5V, and the period is 820us.ZO1 is the inverting of WO1.

7 Software

This software project creates the sample applications based on IAR TMPM380-SK Evaluation Board which will demonstrate the main feature of TMPM380 MCU.

Use current driver software and IAR EWARM or KEIL MDK to implement the sample applications. Create an independent project for each feature.

The workspace structure and project names are defined as following:

IAR EWARM:

```
├─WDT_NMI
        ├─APP
        │   main.c
        │   tmpm380_wdt_int.c
        ├─TX03_CMSIS
        │   │   system_TMPM380.c
        │   │   system_TMPM380.h
        │   │   TMPM380.h
        │   │
        │   └─startup
        │         startup_TMPM380.s
        │
        ├─TX03_Periph_Driver
        │   ├─inc
        │   │   tmpm380_wdt.h
        │   │   tmpm380_gpio.h
        │   │   tx03_common.h
        │   │
        │   └─src
        │         tmpm380_wdt.c
        │         tmpm380_gpio.c
        └─TMPM380-EVAL
                  led.c
                  led.h
```

KEIL MDK:

```
├─WDT_NMI
        ├─APP
        │   main.c
        │   tmpm380_wdt_int.c
        │
        ├─TX03_CMSIS
        │   │   system_TMPM380.c
        │   │   system_TMPM380.h
        │   │   TMPM380.h
        │   │
        │   └─startup
        │         startup_TMPM380.s
        │
        ├─TX03_Periph_Driver
        │    tmpm380_wdt.c
        │    tmpm380_gpio.c
        │
        └─TMPM380-EVAL
              led.c
```

7-1 ADC

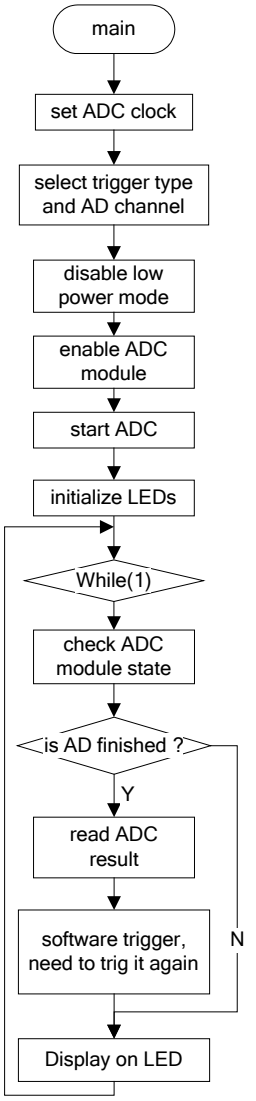
7-1-1 Example: Read AD Value By Software Trigger

This is a simple example based on the TX03 Peripheral Driver (ADC, GPIO).

The example includes:

1. ADC configuration and initialization
2. Read AD result of AIN0 by software trigger

- **Flowchart**



- **Code and Explanation for the Example**

At first, set ADC clock, select software trigger with ADC_REG0 & AIN0, disable low power mode, and enable ADC module.

```
/* set ADC clock */
ADC_SetClk(ADC_HOLD_FIX, ADC_FC_DIVIDE_LEVEL_NONE);

/* select trigger and AD channel, this time we use sofeware trigger, */
/* the VR1 is connected to AIN0, remember to input with macro TRG_ENABLE() */
ADC_SetSWTrg(ADC_REG0, TRG_ENABLE(AIN0));

/* to let ADC module work, we must disable low power mode */
ADC_SetLowPowerMode(DISABLE);

/* enable ADC module */
ADC_Enable();
```

Then start ADC:

```
ADC_Start(TRG_SOFTWARE);
```

Initialize LEDs on board before display:

```
LEDInit();
```

After ADC start, check AD convertion finished or not, if ADC is finished, read the ADC result data and display it on LED.

```
while (1) {
    /* check ADC module state */
    adcState = ADC_GetConvertState(TRG_SOFTWARE);

    if (adcState == DONE) {
        /* read ADC result when it is finished */
        result = ADC_GetConvertResult(ADC_REG0);

        /* get the real ADC result without other information */
        myResult = result.Bit.Result;

        /* software trigger, need to trig it again */
        ADC_Start(TRG_SOFTWARE);
    }

    delay++;
    if (delay >= adjustLight) {
        delay = 0U;
        DisplayLED(myResult);
    } else {
        /* do nothing */
    }
}
```

7-2 CG

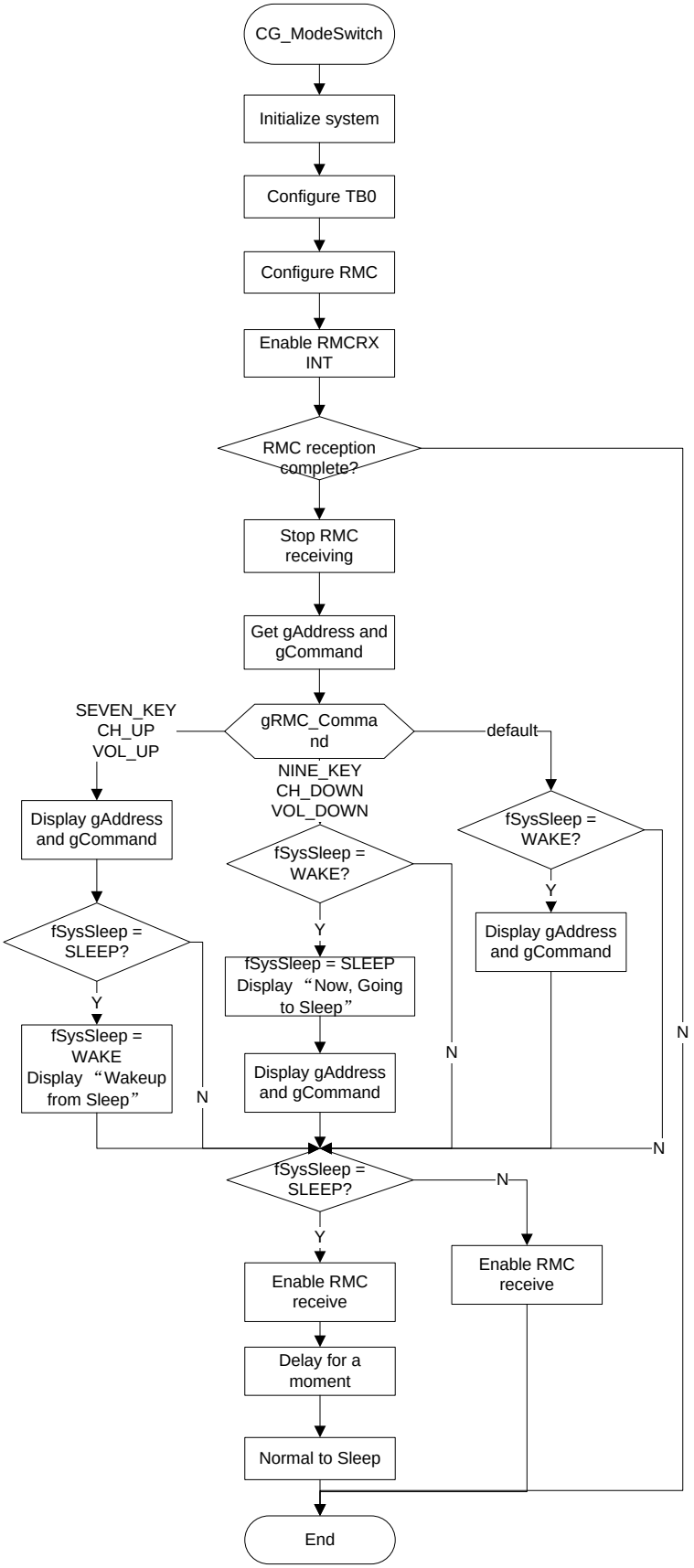
7-2-1 Example: Power mode change

This is a simple example based on the TX03 Peripheral Driver(CG, RMC, GPIO, TMRB).

The example includes:

1. Basic setup operation of CG
2. How to switch between normal mode and sleep mode
3. How to enable multiple clock circuit

- **Flowchart**


CG_ModeSwitch
Initialize system
Configure TB0
Configure RMC
Enable RMCRX INT
RMC reception complete?
Stop RMC receiving
Get gAddress and gCommand
gRMC_Command
SEVEN_KEY
CH_UP
VOL_UP
NINE_KEY
CH_DOWN
VOL_DOWN
default
Display gAddress and gCommand
fSysSleep = SLEEP?
fSysSleep = WAKE Display "Wakeup from Sleep"
fSysSleep = WAKE?
fSysSleep = SLEEP Display "Now, Going to Sleep"
Display gAddress and gCommand
fSysSleep = WAKE?
Display gAddress and gCommand
fSysSleep = SLEEP?
Enable RMC receive
Delay for a moment
Normal to Sleep
Enable RMC receive
End
Y
N

- **Code and Explanation for the Example**

The following simple example is based on TX03 Peripheral Driver (CG), which will switch between normal mode and sleep mode.

Normal setup for CG (after reset)

The following code is just an example for setting CG in normal mode. It is supposed that the high-speed oscillator is 10MHz.

Example code is as the following:

```
    /* Set fgear = fc/2 */
    CG_SetFgearLevel(CG_DIVIDE_2);
    /* Set fperiph to fgear */
    CG_SetPhiT0Src(CG_PHIT0_SRC_FGEAR);
    CG_SetPhiT0Level(CG_DIVIDE_64);
    /* Set SCOUT source */
    CG_SetSCOUTSrc(CG_SCOUT_SRC_PHIT0);
    /* Set port M as HOSC */
    CG_SetPortM(CG_PORTM_AS_HOSC);
    /* Enable high-speed oscillator */
    CG_SetFosc(CG_FOSC_OSC1, ENABLE);
    /* Set fosc source */
    CG_SetFoscSrc(CG_FOSC_OSC1);
    /* Enable low-speed oscillator */
    CG_SetFs(ENABLE);
    /* Set low power consumption mode sleep */
    CG_SetSTBYMode(CG_STBY_MODE_SLEEP);
    /* Set high-speed and low-speed oscillator to be enabled after releasing stop mode
*/
    CG_SetExitStopModeFosc(ENABLE);
    CG_SetExitStopModeFs(ENABLE);
    /* Set pin status in stop mode to "active" */
    CG_SetPinStateInStopMode(ENABLE);
    /* Set up pll and wait for pll to warm up , set fc source to fpll */
    CG_EnableClkMulCircuit();
    /* Set system clock to fgear */
    CG_SetFsysSrc(CG_FSYS_SRC_FGEAR);
```

Setup to enter sleep mode

Set CG module: slow ->sleep mode.

Frist set TMRB and RMC, and enable RMC interrupt, and clear interrupt request.

```
    CG_ClearINTReq(CG_INT_SRC_RMC_RX);
    CG_SetSTBYReleaseINTSrc(CG_INT_SRC_RMC_RX,
                                    CG_INT_ACTIVE_STATE_RISING, ENABLE);
    NVIC_ClearPendingIRQ(INTRMCRX_IRQn);
    NVIC_EnableIRQ(INTRMCRX_IRQn);
```

Prepare to enter sleep mode. First disable some modules except CPU, RTC, I/O and RMC if it has been enabled. Then set system clock to fs and set warm up time, wait for warm up is complete. Set RMC interrupt to wake up system. Finally use __WFI() instruction enter sleep mode.

```
    /* Set CG module: Normal ->Sleep mode */
    /* Add code here to disable modules (except CPU, RTC, I/O and RMC) if it has been
enabled... */
    /* Then set system clock to fs */
    FunctionalState fs_st;
    fs_st = CG_GetFsState();
```

```
if (fs_st == DISABLE) {
    CG_SetFs(ENABLE);
    CG_SetWarmUpTime(CG_WARM_UP_SRC_XT1, CG_WUODR_EXT);
    /* Start warm up */
    CG_StartWarmUp();
    /* Check whether warm up ends or not */
    while (CG_GetWarmUpState() == BUSY);
} else {
    /* Do nothing */
}

CG_SetWarmUpTime(CG_WARM_UP_SRC_OSC2, CG_WUODR_EXT);
/* Set RMC wake up system */
CG_SetSTBYReleaseINTSrc(CG_INT_SRC_RMC_RX,
                        CG_INT_ACTIVE_STATE_RISING, ENABLE);
/* Enter sleep mode */
__WFI();
```

Enable multiple clock circuit

Set PLL and set the source of fc. First enable PLL, then set warm up time and wait warm up time is complete. Finally set fPLL for fc source.

```
WorkState st = BUSY;
retval = CG_SetPLL(ENABLE);
if (retval == SUCCESS) {
    /* Set warm up time */
    CG_SetWarmUpTime(CG_WARM_UP_SRC_OSC2, CG_WUODR_PLL);
    CG_StartWarmUp();

    do {
        st = CG_GetWarmUpState();
    } while (st != DONE);

    retval = CG_SetFcSrc(CG_FC_SRC_FPLL);
} else {
    /*Do nothing */
}
```

7-3 DMAC

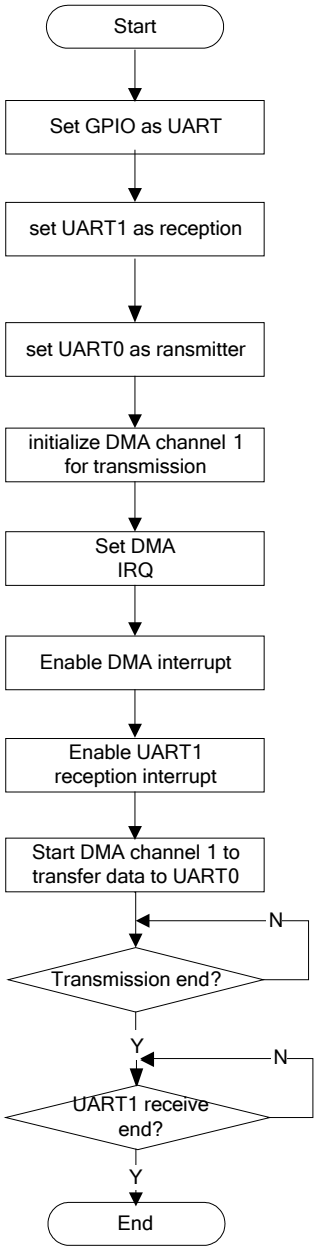
7-3-1 Example: Memory to peripheral

This is a simple example based on the TX03 Peripheral Driver (DMAC, GPIO, SIO).

The example includes:

1. UART0/1 configuration and DMAC initialization
2. Transfer data from memory to UART0 via DMAC

- **Flowchart:**



- **Code and Explanation for the Example**

The following simple example is based on TX03 Peripheral Driver (DMAC), which will transfer data from memory to UART0.

Firstly set UART0 as transmitter and enable it

```
UART_InitStruct.Mode = UART_ENABLE_TX;
UART_Enable(UART0);
UART_Init(UART0, &UART_InitStruct);
```

Configure and initialize DMA channel1 for transmission

```
DMAC_InitStruct.SrcAddr = (uint32_t) SRC_Buffer;
DMAC_InitStruct.SrcIncrementState = ENABLE;
DMAC_InitStruct.SrcBitWidth = DMAC_BYTE;
DMAC_InitStruct.SrcBurstSize = DMAC_1_BEAT;
DMAC_InitStruct.DstAddr = (uint32_t) (UART0_BASE_ADDR + UART0_BUF_OFFSET);
DMAC_InitStruct.DstIncrementState = DISABLE;
DMAC_InitStruct.DstBitWidth = DMAC_BYTE;
DMAC_InitStruct.DstBurstSize = DMAC_1_BEAT;
DMAC_InitStruct.TxSize = size;
DMAC_InitStruct.TxDirection = DMAC_MEMORY_TO_PERIPH;
DMAC_InitStruct.TxPeriph = DMAC_SIO_0_RTX;
DMAC_InitStruct.TxINT = ENABLE;

DMAC_Init(myChannel, &DMAC_InitStruct);
```

Enable DMA IRQ

```
NVIC_ClearPendingIRQ(INTDMACTC_IRQn);
NVIC_EnableIRQ(INTDMACTC_IRQn);
```

Enable DMA circuit, transfer end interrupt, burst transfer request for UART0 and start channel 1 of DMAC to transfer

```
DMAC_Enable();
DMAC_SetTxINTConfig(myChannel, DMAC_INT_TX_END, ENABLE);
DMAC_SetSWBurstReq(DMAC_SIO_0_RTX);
DMAC_SetDMAChannel(myChannel, ENABLE);
```

Wait the end of DMAC transmission

```
while (TxEndFlag != DONE) {
    /* Do nothing */
}
```

Set flag for DMAC transmission end in DMAC ISR

```
state = DMAC_GetINTReq();
if (state.Bit.CH1_INTReq == 1U) {
    tmp = DMAC_GetTxINTReq(DMAC_CHANNEL_1);
    if (tmp == DMAC_TX_END_REQ) {
        TxEndFlag = DMAC_GetChannelTxState(DMAC_CHANNEL_1);
        DMAC_ClearTxINTReq(DMAC_CHANNEL_1, DMAC_INT_TX_END);
    } else {
        /* Do nothing */
    }
} else {
    /* Do nothing */
}
```

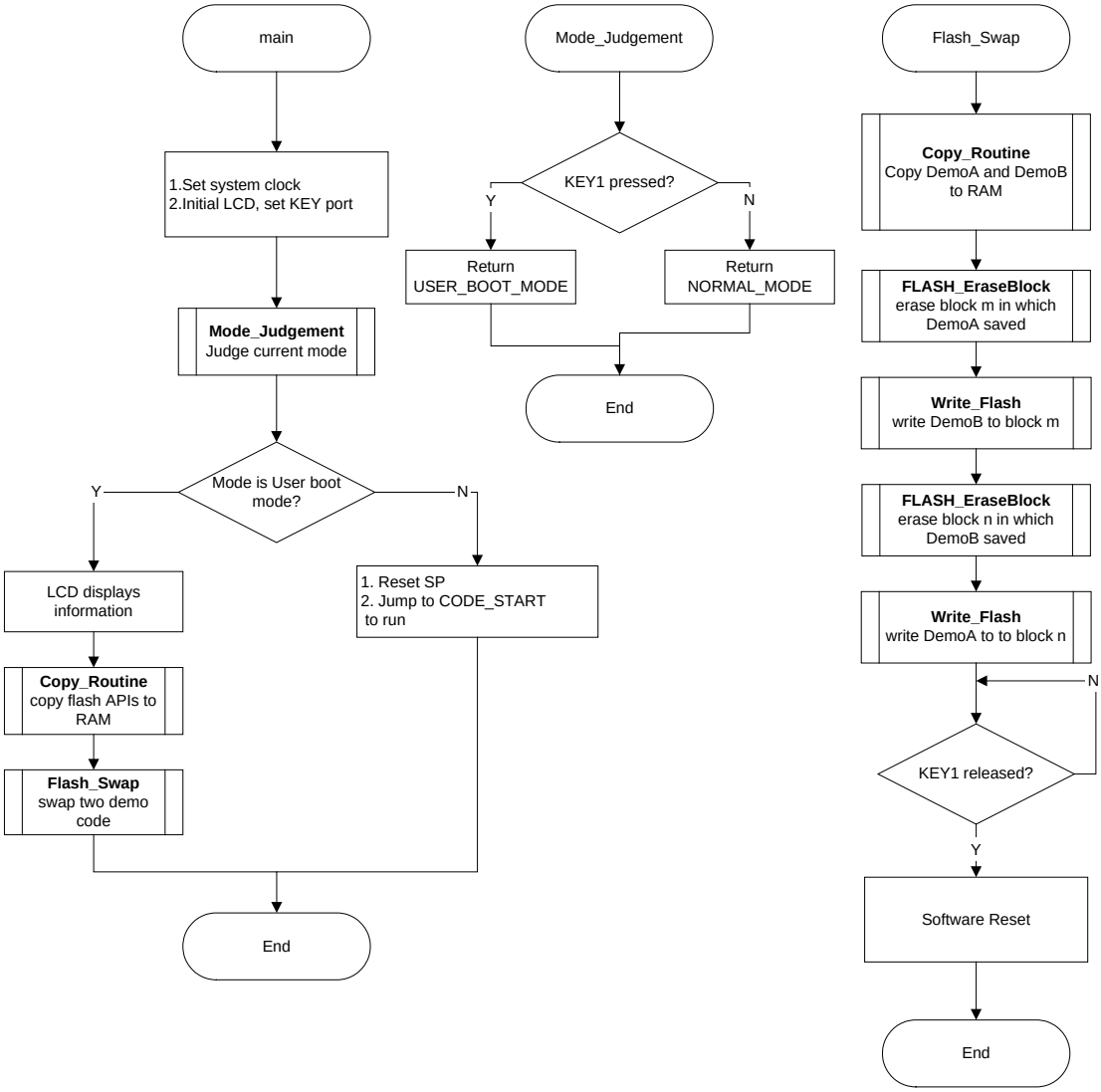
7-4 FLASH

This is a simple example based on the TX03 Peripheral Driver (FLASH, GPIO, CG).

The example includes:

1. On-board programming method of Flash Memory (Rewrite/Erase)
2. Operation mode: Single chip mode (Normal mode and User boot mode)
3. Use User boot mode to update code in Flash Memory

- **Flowchart**



- **Code and Explanation for the Example**

At first configure system clock and initialize SWITCH port and LED. SWITCH port (GPIO) is used to judge current mode when reset and LED will display current operation information.

```
CG_SetPLL(DISABLE);                                 /* Disable PLL */
CG_SetFcSrc(CG_FC_SRC_FOSC);                        /* Select fosc */
GPIO_SetInput(GPIO_PD, GPIO_BIT_0);                 /* set port D to input */
LEDInit();                                           /* LED initialization */
LedDisable(LED_CH1 | LED_CH2 | LED_CH4);            /* Turn off all LED channel */
```

Use function Mode_Judgement() to judge which mode will be entered after reset.

```
uint8_t Mode_Judgement(void)
{
    return (GPIO_ReadDataBit(GPIO_PD, GPIO_BIT_0) ==
            GPIO_BIT_VALUE_0) ? USER_BOOT_MODE : NORMAL_MODE;
```

```
    }
```

If the SWITCH is high when reset, the routine will enter normal mode. Then the routine will reset SP and jump to address “CODE_START” to run. Demo A saved in at address “CODE_START” which belongs to block m, so Demo A will run (LED4, 6, 8, 10 blink).

```
    #if defined ( __CC_ARM     )          /* RealView Compiler */
        ResetSP();                        /* reset SP */
    #elif defined ( __ICCARM__ )          /* IAR Compiler */
        asm("MOV R0, #0");                /* reset SP */
        asm("LDR SP, [r0]");
    #endif
        startup = CODE_START;
        startup();                        /* jump to code start address to run */
```

If the SWITCH is low when reset, the routine will enter user boot mode. LED will display “0” to indicate this mode. Then the routine will copy APIs for flash operation from address “FLASH_API_ROM” in Flash memory to address “FLASH_API_RAM” in RAM, because Flash memory cannot erase/program itself when runs the code at the same time. LED displays “1” to indicate RAM transferring.

```
    Status_Display(ch0);      /* LED status 1: enter user boot mode */
    Status_Display(ch1);      /* LED status 2: RAM transferring */
    Copy_Routine(FLASH_API_RAM, FLASH_API_ROM, SIZE_FLASH_API);
                                          /* copy flash API to RAM */
```

After copying Flash operation APIs to RAM, the routine will jump to function Flash_Swap(), this function has been copied from Flash memory to RAM by using Copy_Routine() above.

In function Flash_Swap(), firstly it will copy Demo A and B from Flash memory to RAM, then call function FC_EraseBlock () and Write_Flash() to erase and program Flash memory. The code of Demo A and B will be exchanged in Flash memory. LED displays “2” to indicate swapping two demos.

```
    Copy_Routine(DEMO_A_RAM, DEMO_A_FLASH, SIZE_DEMO_A);
    /* copy A to RAM */
    Copy_Routine(DEMO_B_RAM, DEMO_B_FLASH, SIZE_DEMO_B);
    /* copy B to RAM */

    Status_Display(ch2);              /* LED status 2: swap the demo */

    /* erase A in block m */
    if (FC_SUCCESS == FC_EraseBlock((uint32_t) DEMO_A_FLASH)) {
        /* Do nothing */
    } else {
        return ERROR;
    }

    /* write B to block m */
    if (FC_SUCCESS == Write_Flash(DEMO_A_FLASH, DEMO_B_RAM,
    SIZE_DEMO_B)) {
        /* Do nothing */
    } else {
        return ERROR;
    }

    /* erase B in block n */
    if (FC_SUCCESS == FC_EraseBlock((uint32_t) DEMO_B_FLASH)) {
        /* Do nothing */
    } else {
        return ERROR;
```

```
}

/* write A to block n */
if (FC_SUCCESS == Write_Flash(DEMO_B_FLASH, DEMO_A_RAM,
SIZE_DEMO_A)) {
      /* Do nothing */
} else {
      return ERROR;
}
```

LED displays “3” to indicate the swap operation has completed. After SWITCH changed to high, it will execute software reset by using SCB->AIRCR register. Then this demo will run again to enter normal mode, because Demo A and B have been exchanged, the address “CODE_START” has become the start address of Demo B, Demo B will run (LED5, 7, 9, 11 blink).

```
Status_Display(ch3);                    /* LED status 3: complete and restart */

while (GPIO_ReadDataBit(GPIO_PD, GPIO_BIT_0) == GPIO_BIT_VALUE_0) {
            /* wait for KEY1 release */
}
reg_value = SCB->AIRCR;        /* software reset */
reg_value = (uint32_t) 0x05FA0001;
SCB->AIRCR = reg_value;
```

Flash memory operation function FC_EraseBlock() will erase a specified block automatically. The block is specified by parameter “BlockAddr”. First, this function will check whether the parameter “BlockAddr” is illegal. Then it will use Flash driver FC_GetBlockProtectState() to check if the specified block is protected.

```
if (ENABLE == FC_GetBlockProtectState(BlockNum)) {
      retval = FC_ERROR_PROTECTED;
}
```

If the block is protected, it will return “FC_ERROR_PROTECTED”, otherwise it will send automatic block erase command to erase the block.

```
*addr1 = (uint32_t) 0x000000AA;      /* bus cycle 1 */
*addr2 = (uint32_t) 0x00000055;      /* bus cycle 2 */
*addr1 = (uint32_t) 0x00000080;      /* bus cycle 3 */
*addr1 = (uint32_t) 0x000000AA;     /* bus cycle 4 */
*addr2 = (uint32_t) 0x00000055;      /* bus cycle 5 */
*BA = (uint32_t) 0x00000030;           /* bus cycle 6 */
```

Then the function will use Flash driver FC_GetBusyState() to monitor when erasing operation finished. At the same time, use a timeout counter to check if the operation is overtime.

```
while (BUSY == FC_GetBusyState()) {
                                        /* check if FLASH is busy with overtime counter */
      if (!(counter--)) {                       /* check overtime */
            retval = FC_ERROR_OVER_TIME;
            *addr1 = FC_RESET_CMD;        /* Reset FLASH */
             break;
      } else {
             /* Do nothing */
      }
}
```

Function Write_Flash() will call FC_WritePage () to write data automatically in one page. The process of this function is basically same as FC_EraseBlock () except the automatic page program command.

```
*addr1 = (uint32_t) 0x000000AA;            /* bus cycle 1 */
```

```
*addr2 = (uint32_t) 0x00000055;          /* bus cycle 2 */
*addr1 = (uint32_t) 0x000000A0;          /* bus cycle 3 */
for (i = 0U; i < 64U; i++) {             /* bus cycle 4~67 */
      *addr3 = *source;
      source++;
}
```

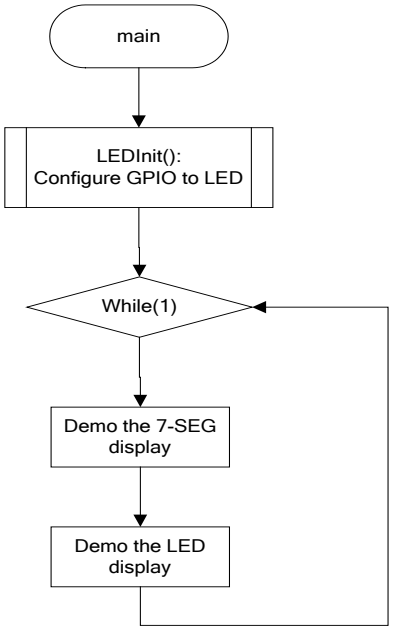
7-5 GPIO

This is a simple example based on the TX03 Peripheral Driver (GPIO).

The example includes:

1. GPIO initialization
2. Write data to GPIO

- **Flow chart:**



- **Code and Explantion for the Example:**

At first, Configure GPIO to LED. For example, set the port as output pin, set port data.

```
GPIO_SetOutput(LED_CH_PORT,0XF0U);
reg = GPIO_ReadData(LED_CH_PORT);
reg &= 0x0FU;
GPIO_WriteData(LED_CH_PORT,reg);

GPIO_SetOutput(LED_DATA_PORT,0XFFU);
GPIO_WriteData(LED_DATA_PORT,0XFFU);
```

In the While process, do the LED demo: LED on and LED off, and display Second%10U.

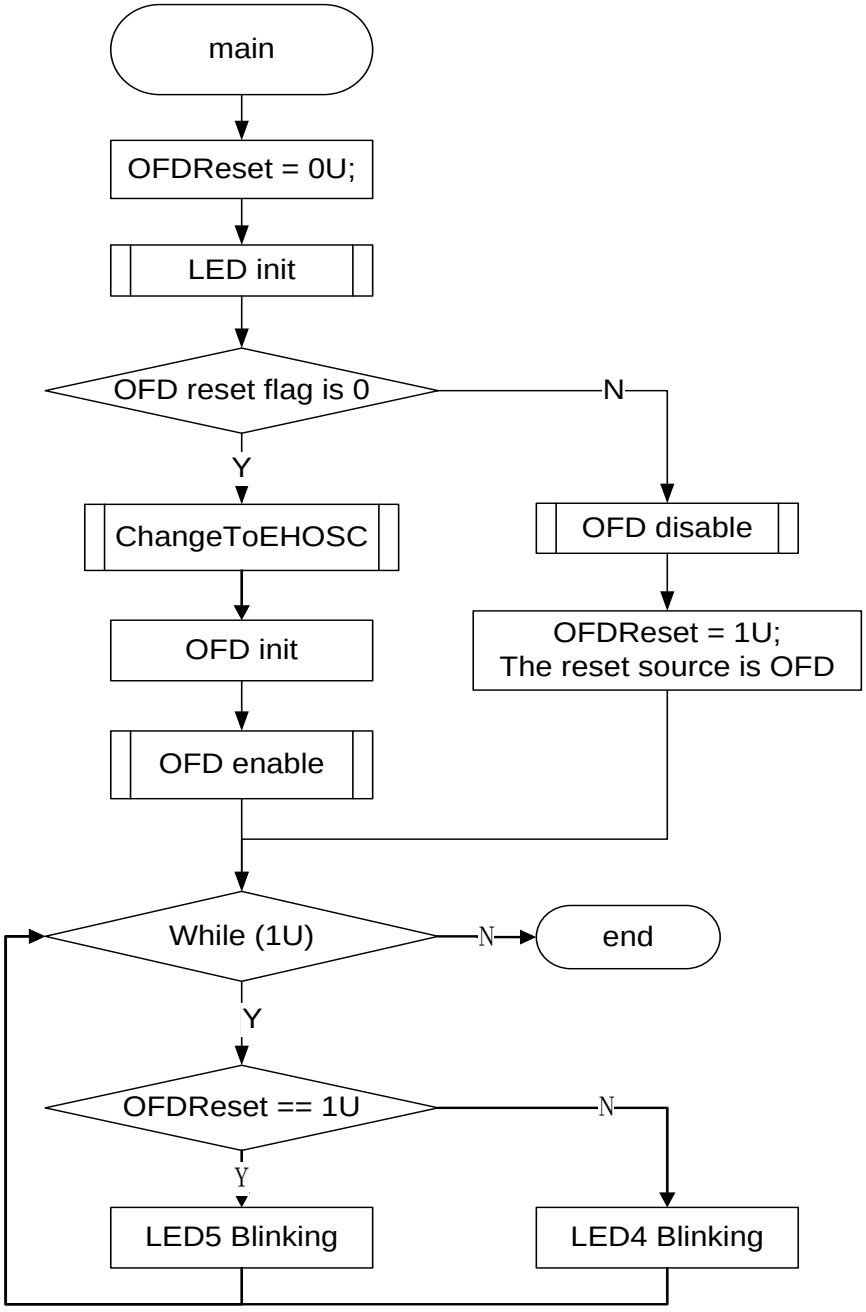
7-6 OFD

This is a simple example based on the TX03 Peripheral Driver (OFD, CG, and GPIO).

The example includes:

1. OFD initialization (set OFD detect frequency range)
2. OFD reset flag checking (in CG)
3. OFD enable and disable.

- **Flowchart**



- **Code and Explanation for the Example**

At first, initialize LED.

```
LED_Init ();
```

Check the OFD reset flag.

```
resetFlag = CG_GetResetFlag();
if (resetFlag.Bit.OFDReset == 0U) {
  /* reset source isn't OFD */
}
```

In normal reset, for example, when the MCU is reset by power up, the OFD flag will be '0', then the program change to use the external oscillation and initialize OFD to set OFD detect frequency range.

Below code is to set up the CG to use the external oscillation.

```
void ChangeToEHOSC(void)
{
    /* Use the external oscillation */
    TSB_CG->OSCCR &= 0x000FFFFFUL;
    TSB_CG->OSCCR |= 0xFFF00000UL;     /*Set the warm up time WUODR[13:2] */
    TSB_CG_OSCCR_HOSCON = 1U;     /*Set port as X1/X2 for external oscillator */
    TSB_CG_OSCCR_XEN1 = 1U;        /*Enable external oscillator */
    TSB_CG_OSCCR_WUPSEL2 = 1U;
    TSB_CG_OSCCR_WUPSEL1 = 0U;   /*Select warm-up clock */
    TSB_CG_OSCCR_WUEON = 1U;      /*Start warm up */
    while (TSB_CG_OSCCR_WUEF) {
    }                                    /* Warm-up */
    TSB_CG_OSCCR_OSCSEL = 1U;     /* Use the external oscillation */
    TSB_CG_OSCCR_XEN2 = 1U;        /* Enable internal oscillator for OFD */
}
```

To configurate the OFD, set to enable to write its register at first.

```
OFD_SetRegWriteMode(ENABLE);
```

Then set detection frequency.

```
OFD_SetDetectionFrequency(OFD_HIGHER_COUNT,
                                                    OFD_LOWER_COUNT);
```

If define DEMO2, the abnormal frequency range is set.

```
OFD_SetDetectionFrequency(OFD_HIGHER_COUNT_ABNORMAL,
                                                OFD_LOWER_COUNT_ABNORMAL);
```

Enable OFD after initialization.

```
OFD_Enable();
```

After above setting, OFD will be ready to detect the frequency of external clock. If the clock exceeds the detection frequency range (for example, take the external oscillator

out, or make it short, or define DEMO2), OFD will generate a reset signal in the reset source register which is in CG module. Then the MCU will be reset automatically.
If the OFD reset flag is detected, MCU will run under the default inner oscillator, then OFD function will be disabled and the variable OFDReset will be set to 1.

```
OFD_Disable();
OFDReset = 1U;
```

LED4 and LED5 indicate the system clock status as below.

LED status	Meaning
LED4 blinking	MCU run normally with external oscillator works OK, OFD function is enabled and ready to detect oscillator abnormal status
LED5 blinking	External oscillator failure, causes the OFD reset, MCU use the default setting to run under inner oscillator. OFD function is disabled.

```
while (1U) {
    if (OFDReset == 1U) {
        LED_On(LED5);
        Delay();
        LED_Off(LED5);
        Delay();
    } else {
        LED_On(LED4);
        Delay();
        LED_Off(LED4);
        Delay();
    }
}
```

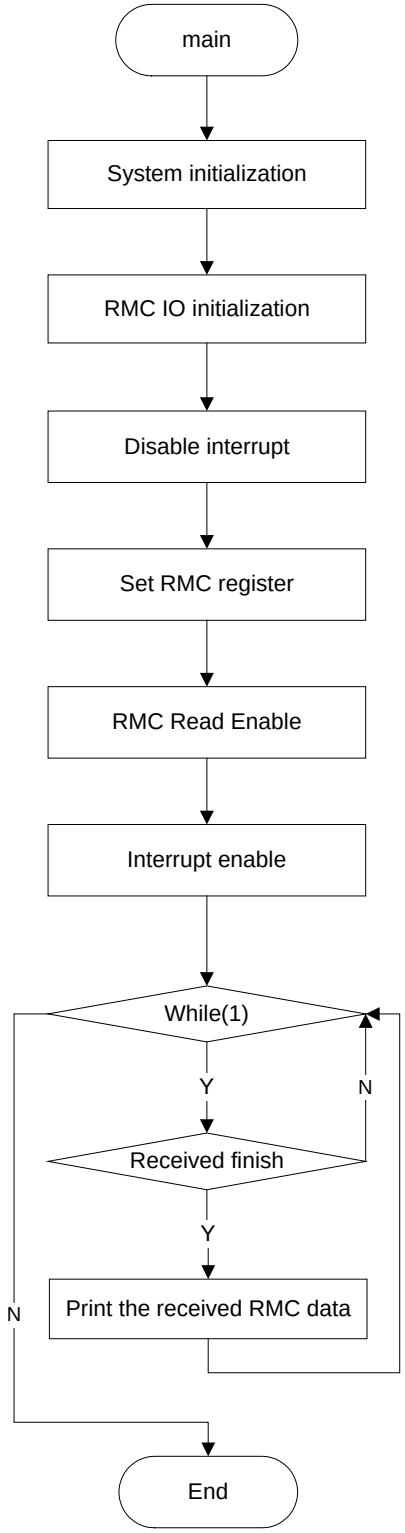
7-7 RMC

7-7-1 Example: RMC receiving

This is a simple example based on the TX03 Peripheral Driver (RMC, UART, GPIO).

The example includes:
1. RMC IO initialization
2. Receiving RMC data

- **Flow Chart**



- **Code and Explanation for the Example**

At first, in main(), create a myRMC structure, then fill all the data fields.

For example

```
RMC_InitTypeDef myRMC;

myRMC.LeaderPara.MaxCycle = RMC_MAX_CYCLE;
myRMC.LeaderPara.MinCycle = RMC_MIN_CYCLE;
myRMC.LeaderPara.MaxLowWidth = RMC_MAX_LOW_WIDTH;
myRMC.LeaderPara.MinLowWidth = RMC_MIN_LOW_WIDTH;
myRMC.LeaderPara.LeaderDetectionState = ENABLE;
myRMC.LeaderPara.LeaderINTState = DISABLE;
myRMC.FallingEdgeINTState = DISABLE;
myRMC.SignalRxMethod = RMC_RX_IN_CYCLE_METHOD;
myRMC.LowWidth = RMC_TRG_LOW_WIDTH;
myRMC.MaxDataBitCycle = RMC_TRG_MAX_DATA_BIT_CYCLE;
myRMC.LargerThreshold = RMC_LARGER_THRESHOLD;
myRMC.SmallerThreshold = RMC_SMALLER_THRESHOLD;
myRMC.InputSignalReversedState = DISABLE;
myRMC.NoiseCancellationTime = RMC_NOISE_CANCELLATION_TIME;
```

Then, enable and initialize the RMC channel 0.

```
RMC_Enable(TSB_RMC0);
```

Then, disable the RMC when system is in idle mode.

```
RMC_SetIdleMode(TSB_RMC0, DISABLE);
```

Initial the specified RMC channel with the structure which includes the basic RMC configuration.

```
RMC_Init(TSB_RMC0, &myRMC);
```

Enable the reception of the specified RMC0 channel.

```
RMC_SetRxCtrl(TSB_RMC0, ENABLE);
```

In interrupt INTRMCRX_IRQHandler():
Get the interrupt factor for the specified RMC0 channel.

```
RMC_INTFactor myRMC_INTFactor;
myRMC_INTFactor = RMC_GetINTFactor(TSB_RMC0);
```

Get the leader detection result for the specified RMC0 channel.

```
RMC_LeaderDetection myRMC_LeaderDetection;
myRMC_LeaderDetection = RMC_GetLeader(TSB_RMC0);
```

Get the received data from the specified RMC0 channel.

```
RMC_RxDataTypeDef myRMC_RxDataDef;
myRMC_RxDataDef = RMC_GetRxData(TSB_RMC0);
```

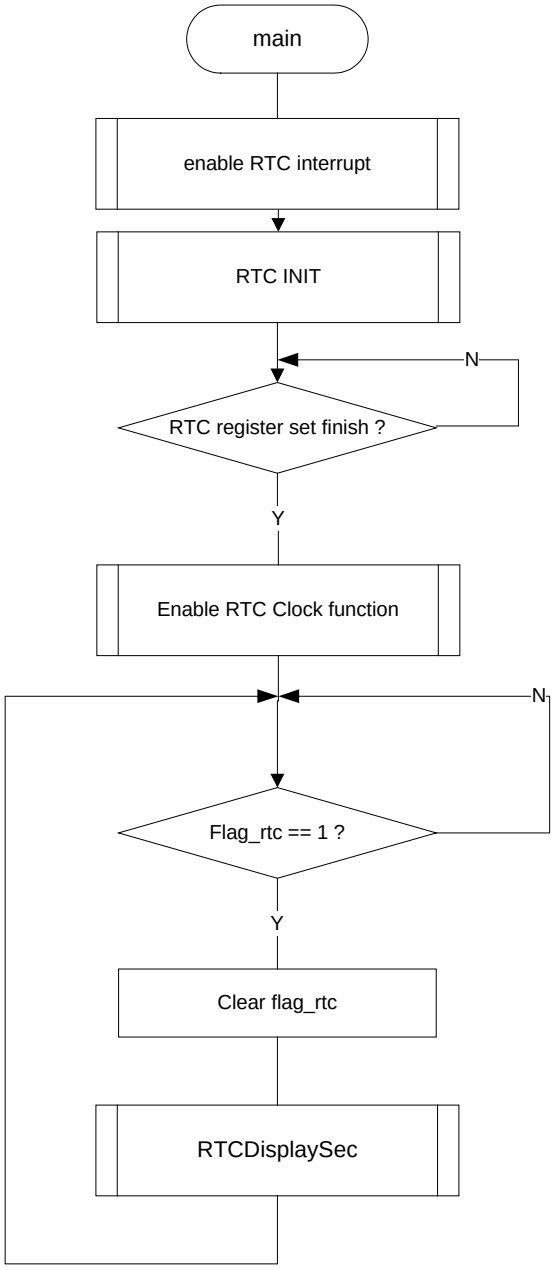
7-8 RTC

This is a simple example based on the TX03 Peripheral Driver (RTC, CG, GPIO).

The example includes:

1. RTC initialization
2. Get RTC date and time

- **Flow chart:**



- **Code and Explanation for the Example:**

At first set source(RTC interrupt) to exit sleep mode

```
CG_SetSTBYReleaseINTSrc(CG_INT_SRC_RTC,
                        CG_INT_ACTIVE_STATE_FALLING, ENABLE);
```

Initialize RTC .Create a RTC_DateTypeDef and RTC_TimeTypeDef structure and fill all the data fields. For example, Initial setting: 2010/10/22 12:50:55, 24hours format.

```
Date_Struct.LeapYear = RTC_LEAP_YEAR_2;
Date_Struct.Year = (uint8_t) 10U;
Date_Struct.Month = (uint8_t) 10U;
Date_Struct.Date = (uint8_t) 22U;
```

```
Date_Struct.Day = RTC_FRI;

Time_Struct.HourMode = RTC_24_HOUR_MODE;
Time_Struct.Hour = (uint8_t) 12U;
Time_Struct.Min = (uint8_t) 50U;
Time_Struct.Sec = (uint8_t) 55U;
```

Disable clock and alarm function.

```
RTC_DisableClock();
RTC_DisableAlarm();
```

Reset RTC sec counter, enable 1Hz interrupt, enable RTCINT.

```
RTC_ResetClockSec();
RTC_SetAlarmOutput(RTC_PULSE_1_HZ);
RTC_SetRTCINT(ENABLE);
```

Set RTC time and date value

```
RTC_SetTimeValue(&Time_Struct);
RTC_SetDateValue(&Date_Struct);
```

After the setting above, enable RTC interrupt. Waiting for RTC register set finished , then enable RTC Clock function.

```
NVIC_EnableIRQ(INTRTC_IRQn);

/* waiting for RTC register set finish */
while (fRTC_1HZ_INT != 1U) {
      /* Do nothing */
}
fRTC_1HZ_INT = 0U;

/* Enable RTC Clock function */
RTC_EnableClock();
```

In RTC interrupt request function,The RTC interrupt will occurs a interrupt flag every second. Then RTC interrupt request will be cleared.

```
fRTC_1HZ_INT = 1U;
CG_ClearINTReq(CG_INT_SRC_RTC);
```

After interrupt flag occus RTC ones place of second value will be sent to LED.
Following is shown how to get RTC date and time value.

```
Sec = RTC_GetSec();
tmp = Sec % 10U;
SegArrayDisplay(ledchar[tmp]);
```

7-9 SBI

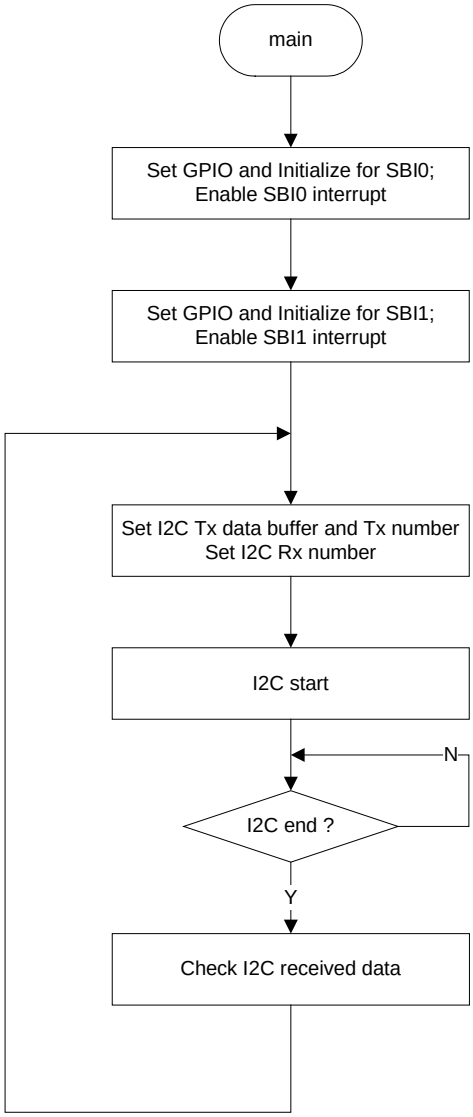
This is a simple example based on the TX03 Peripheral Driver (SBI, GPIO).

The example includes:

1. SBI configuration and I2C initialization
2. I2C master send data process

3. I2C slave receive data process

- **Flow Chart**



- **Code and Explanation for the Example**

At first, configure GPIO for SBI0 and SBI1 I2C mode.

```
SBI0_IO_Configuration();
SBI1_IO_Configuration();
```

Initialize and configure SBI0 channel and enable INTSBI0.

```
myI2C.I2CSelfAddr = SELF_ADDR;
myI2C.I2CDataLen = SBI_I2C_DATA_LEN_8;
myI2C.I2CACKState = ENABLE;
myI2C.I2CClkDiv = SBI_I2C_CLK_DIV_328;
SBI_Enable(TSB_SBI0);
SBI_SWReset(TSB_SBI0);
SBI_InitI2C(TSB_SBI0, &myI2C);
NVIC_EnableIRQ(INTSBI0_IRQn);
```

Then enable, initialize and configure SBI1 channel and enable INTSBI1.

```
myI2C.I2CSelfAddr = SLAVE_ADDR;
myI2C.I2CDataLen = SBI_I2C_DATA_LEN_8;
myI2C.I2CACKState = ENABLE;
myI2C.I2CClkDiv = SBI_I2C_CLK_DIV_328;
SBI_Enable(TSB_SBI1);
SBI_SWReset(TSB_SBI1);
SBI_InitI2C(TSB_SBI1, &myI2C);
NVIC_EnableIRQ(INTSBI1_IRQn);
```

After the above setting, start I2C read.
Clear I2C Rx buffer, initialize the SBI Tx buffer and length, and clear Rx buffer.

```
        /* Initialize TRx buffer and Tx length */
    case MODE_SBI_I2C_INITIAL:
        gI2CTxDataLen = 7U;
        gI2CTxData[0] = gI2CTxDataLen;
        gI2CTxData[1] = 'T';
        gI2CTxData[2] = 'O';
        gI2CTxData[3] = 'S';
        gI2CTxData[4] = 'H';
        gI2CTxData[5] = 'I';
        gI2CTxData[6] = 'B';
        gI2CTxData[7] = 'A';
        gI2CWCnt = 0U;
        for (gICnt = 0U; gICnt < 8U; gICnt++) {
            gI2CRxData[gICnt] = 0U;
        }
        gSBIMode = MODE_SBI_I2C_START;
        break;
```

Check if the I2C bus is free or not, SBI_SetSendData() is used to set data “SLAVE_ADDR”.and direction is “SBI_I2C_SEND” to SBI data buffer; then SBI_GenerateI2CStart(TSB_SBI2) is used to to start I2C process.

```
        /* Check I2C bus state and start TRx */
    case MODE_SBI_I2C_START:
        i2c_state = SBI_GetI2CState(TSB_SBI0);
        if (!i2c_state.Bit.BusState) {
            SBI_SetSendData(TSB_SBI0, SLAVE_ADDR | SBI_I2C_SEND);
            SBI_GenerateI2CStart(TSB_SBI0);
            gSBIMode = MODE_SBI_I2C_TRX;
        } else {
            /* Do nothing */
        }
        break;
```

The data transfer is handled in INTSBI2.
The data receive is handled in INTSBI0.

In INTSBI0 function, I2C master send process is handled according to I2C bus state. During I2C master sending, SBI_SetSendData() is used to send next data, SBI_GenerateI2CStop() is used to stop I2C when I2C process is finished.

```
void INTSBI0_IRQHandler(void)
{
    TSB_SBI_TypeDef *SBIx;
    SBI_I2CState sbi_sr;

    SBIx = TSB_SBI0;
    sbi_sr = SBI_GetI2CState(SBIx);

    if (sbi_sr.Bit.MasterSlave) {          /* Master mode */
```

```
        if (sbi_sr.Bit.TRx) {     /* Tx mode */
            if (sbi_sr.Bit.LastRxBit) { /* LRB=1: the receiver requires no further data. */
                SBI_GenerateI2CStop(SBIx);
            } else {                /* LRB=0: the receiver requires further data. */
                if (gI2CWCnt <= gI2CTxDataLen) {
                    SBI_SetSendData(SBIx, gI2CTxData[gI2CWCnt]);
                                                                    /* Send next data */
                    gI2CWCnt++;
                } else {            /* I2C data send finished. */
                    SBI_GenerateI2CStop(SBIx);    /* Stop I2C */
                }
            }
        } else {                    /* Rx Mode */
            /* Do nothing */
        }
    } else {                        /* Slave mode */
        /* Do nothing */
    }
}
```

In INTSBI1 function, I2C slave receive process is handled according to I2C bus state, SBI_GetReceiveData() is used to read received data in SBI buffer, I2C stop condition is controlled by master.

```
void INTSBI1_IRQHandler(void)
{
    uint32_t tmp = 0U;
    TSB_SBI_TypeDef *SBIy;
    SBI_I2CState sbi1_sr;

    SBIy = TSB_SBI1;
    sbi1_sr = SBI_GetI2CState(SBIy);

    if (!sbi1_sr.Bit.MasterSlave) {        /* Slave mode */
        if (!sbi1_sr.Bit.TRx) { /* Rx Mode */
            if (sbi1_sr.Bit.SlaveAddrMatch) {
                /* First read is dummy read for Slave address recognize */
                tmp = SBI_GetReceiveData(SBIy);
                gI2CRCnt = 0U;
            } else {
                /* Read I2C received data and save to I2C_RxData buffer */
                tmp = SBI_GetReceiveData(SBIy);
                gI2CRxData[gI2CRCnt] = tmp;
                gI2CRCnt++;
            }
        } else {                    /* Tx Mode */
            /* Do nothing */
        }
    } else {                        /* Master mode */
        /* Do nothing */
    }
}
```

7-10 SIO/UART

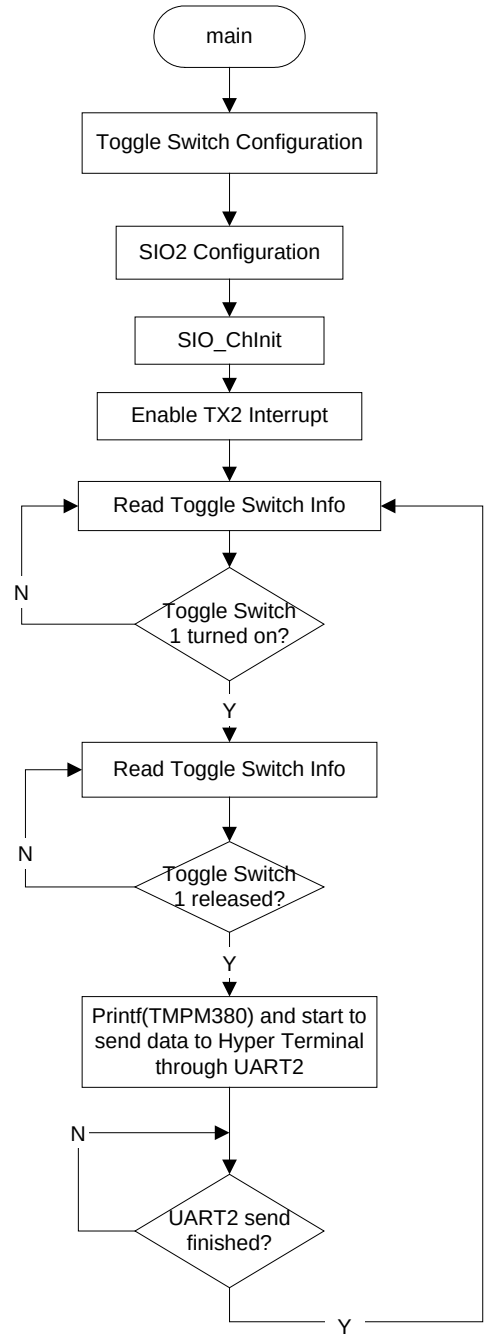
7-10-1 Example: Retarget

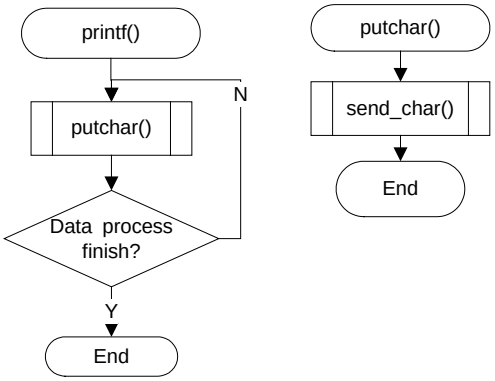
This is a simple example based on the TX03 Peripheral Driver (UART, GPIO).

The example includes:

1. UART configuration and initialization.
2. UART TX process.
3. Use UART2 TX interrupt to send data.
4. Retarget printf() to UART2.

- **Flowchart**


main
Toggle Switch Configuration
SIO2 Configuration
SIO_ChInit
Enable TX2 Interrupt
Read Toggle Switch Info
N
Toggle Switch 1 turned on?
Y
Read Toggle Switch Info
N
Toggle Switch 1 released?
Y
Printf(TMPM380) and start to send data to Hyper Terminal through UART2
N
UART2 send finished?
Y


printf()
N
putchar()
Data process finish?
Y
End
putchar()
send_char()
End

- **Code and Explanation for the Example**

At first, Configure Toggle Switch and SIO2, then Initialize UART2.
Use GPIO peripheral drivers configure GPIO for Toggle Switch.

```
GPIO_SetPullUp(TSW_PORT, GPIO_BIT_0, ENABLE);
GPIO_SetPullUp(TSW_PORT, GPIO_BIT_1, ENABLE);
GPIO_SetPullUp(TSW_PORT, GPIO_BIT_2, ENABLE);
GPIO_SetInputEnableReg(TSW_PORT, GPIO_BIT_0, ENABLE);
GPIO_SetInputEnableReg(TSW_PORT, GPIO_BIT_1, ENABLE);
GPIO_SetInputEnableReg(TSW_PORT, GPIO_BIT_2, ENABLE);
```

Use GPIO peripheral drivers configure GPIO for UART2.

```
GPIO_SetOutputEnableReg(GPIO_PD, GPIO_BIT_5, ENABLE);
GPIO_EnableFuncReg(GPIO_PD, GPIO_FUNC_REG_1, GPIO_BIT_5);
GPIO_EnableFuncReg(GPIO_PD, GPIO_FUNC_REG_1, GPIO_BIT_6);
GPIO_SetInputEnableReg(GPIO_PD, GPIO_BIT_6, ENABLE);
GPIO_SetPullUp(GPIO_PD, GPIO_BIT_6, ENABLE);
GPIO_SetPullUp(GPIO_PD, GPIO_BIT_5, ENABLE);
```

Create a UART_InitTypeDef structure and fill all the data fields. For example,

```
UART_InitTypeDef myUART;

myUART.BaudRate = 115200;      /* baud rate = 115200 */
myUART.DataBits = UART_DATA_BITS_8; /* no handshake, 8-bit data, clock by baud rate generator */
myUART.StopBits = UART_STOP_BITS_1; /* 1-bit stop, LSB,    W-buff enable */
myUART.Parity = UART_NO_PARITY;
myUART.Mode = UART_ENABLE_TX;
myUART.FlowCtrl = UART_NONE_FLOW_CTRL;
```

Use UART peripheral drivers enable and initialize UART2.

```
UART_Enable(UART2);
UART_Init(UART2, &myUART);
```

After above setting, enable UART2 TX interrupt.

```
NVIC_EnableIRQ(INTTX2_IRQn);
```

Then Read Toggle Switch info:

```
TSW_info = GPIO_ReadData(TSW_PORT) & TSWBITS;
```

Then Judge whether Toggle Switch 1 has been turned on, if Toggle Switch is turned on, then wait for Toggle Switch 1 released:

```
if (TSW_info == TSW1) {
do {
    wait_TSW1 = 0U;
    TSW_info = GPIO_ReadData(TSW_PORT) & TSWBITS;
    } while (TSW_info != TSWRELEASE);                /* wait for TSW1 released */
}
```

After Toggle Switch 1 has been released, start to send data by printf() through UART2.

```
printf("%s\r\n", TxBuffer);        /* SIO2 send data */
```

Function printf() will call putchar() for IAR Compiler and fputc() for RealView Compiler to output data to UART2.

```
#if defined ( __CC_ARM     )          /* RealView Compiler */
struct __FILE {
      int handle;                     /* Add whatever you need here */
};
```

```
FILE __stdout;
FILE __stdin;
int fputc(int ch, FILE * f)
#elif defined ( __ICCARM__ )       /*IAR Compiler */
int putchar(int ch)
#endif
{
      return (send_char(ch));
}

uint8_t send_char(uint8_t ch)
{
      while (gSIORdIndex != gSIOWrIndex) {            /* wait for finishing sending */
            /* do nothing */
      }
      gSIOTxBuffer[gSIOWrIndex++] = ch;     /* fill TxBuffer */
      if (fSIO_INT == CLEAR) {       /* if SIO INT disable, enable it */
            fSIO_INT = SET;               /* set SIO INT flag */
            UART_SetTxData(UART2, gSIOTxBuffer[gSIORdIndex++]);
            NVIC_EnableIRQ(INTTX2_IRQn);
      }

      return ch;
}
```

The rest process of data flow is finished in ISR of UART2 TX interrupt.

UART2 TX interrupt routine:

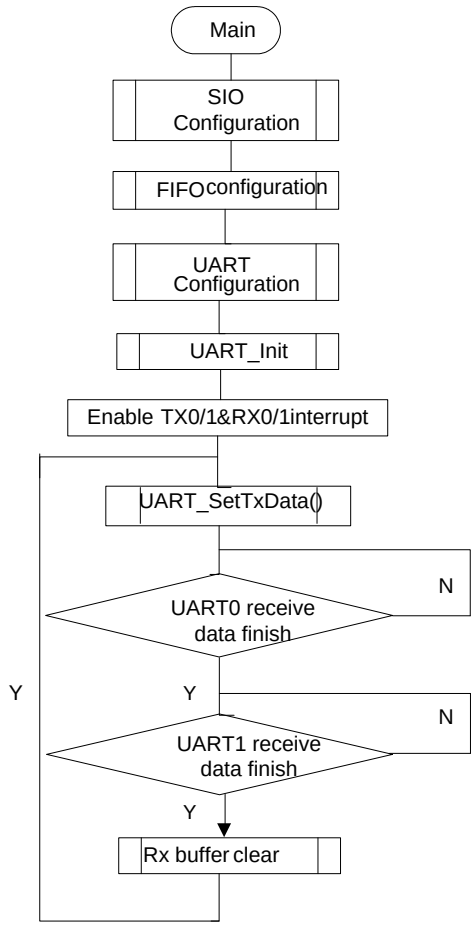
```
void INTTX2_IRQHandler(void)
{
      if (gSIORdIndex < gSIOWrIndex) {       /* buffer is not empty */
            UART_SetTxData(UART2, gSIOTxBuffer[gSIORdIndex++]);/* send data */
            fSIO_INT = SET;               /* SIO0 INT is enable */
      } else {
            /* disable SIO2 INT */
            fSIO_INT = CLEAR;
            NVIC_DisableIRQ(INTTX2_IRQn);
            fSIOTxOK = YES;
      }
      if (gSIORdIndex >= gSIOWrIndex) {     /* reset buffer index */
            gSIOWrIndex = CLEAR;
            gSIORdIndex = CLEAR;
      } else {
            /* do nothing */
      }
}
```

7-10-2 Example: UART FIFO

This is a simple example based on the TX03 Peripheral Driver (UART, GPIO).

The example includes:
UART and FIFO configuration and initialization.
UART send and receive data use FIFO process.

- **Flowchart**



- **Code and Explanation for the Example**

At first configure the GPIO and initialize UART.

Use GPIO peripheral drivers configure GPIO for UART0 and UART1.

```
void SIO_Configuration(TSB_SC_TypeDef * SCx)
{
	if (SCx == TSB_SC0) {
		TSB_PE->CR |= GPIO_BIT_0;
		TSB_PE->FR1 |= GPIO_BIT_0;
		TSB_PE->FR1 |= GPIO_BIT_1;
		TSB_PE->IE |= GPIO_BIT_1;
	} else if (SCx == TSB_SC1) {
		TSB_PA->CR |= GPIO_BIT_5;
		TSB_PA->FR1 |= GPIO_BIT_5;
		TSB_PA->FR1 |= GPIO_BIT_6;
		TSB_PA->IE |= GPIO_BIT_6;
	}
}
```

Create a UART_InitTypeDef structure and fill all the data fields. For example,

```
	UART_InitTypeDef myUART;

   /* configure SIO0 for reception */
```

```
    UART_Enable(UART_RETARGET);
    myUART.BaudRate = 115200U;    /* baud rate = 115200 */
    myUART.DataBits = UART_DATA_BITS_8; /* no handshake, 8-bit data, clock by baud rate generator */
    myUART.StopBits = UART_STOP_BITS_1; /* 1-bit stop, LSB,    W-buff enable */
    myUART.Parity = UART_NO_PARITY;
    myUART.Mode = UART_ENABLE_TX|UART_ENABLE_RX;
    myUART.FlowCtrl = UART_NONE_FLOW_CTRL;
    UART_Init(UART_RETARGET, &myUART);
```

Use UART peripheral drivers to enable and initialize UART0/1 channels.

```
    UART_Enable(UART0);
    UART_Init(UART0, &myUART);

    UART_Enable(UART1);
    UART_Init(UART1, &myUART);
```

FIFO configuration.

```
    UART_RxFIFOByteSel(UART0,UART_RXFIFO_RXFLEVEL);
    UART_RxFIFOByteSel(UART1,UART_RXFIFO_RXFLEVEL);

    UART_TxFIFOINTCtrl(UART0,ENABLE);
    UART_TxFIFOINTCtrl(UART1,ENABLE);

    UART_RxFIFOINTCtrl(UART0,ENABLE);
    UART_RxFIFOINTCtrl(UART1,ENABLE);

    UART_TRxAutoDisable(UART0,UART_RXTXCNT_AUTODISABLE);
    UART_TRxAutoDisable(UART1,UART_RXTXCNT_AUTODISABLE);

    UART_FIFOConfig(UART0,ENABLE);
    UART_FIFOConfig(UART1,ENABLE);

    UART_RxFIFOFillLevel(UART0, UART_RXFIFO4B_FLEVLE_4_2B);
    UART_RxFIFOFillLevel(UART1, UART_RXFIFO4B_FLEVLE_4_2B);

    UART_RxFIFOINTSel(UART0,UART_RFIS_REACH_EXCEED_FLEVEL);
    UART_RxFIFOINTSel(UART1,UART_RFIS_REACH_EXCEED_FLEVEL);

    UART_RxFIFOClear(UART0);
    UART_RxFIFOClear(UART1);

    UART_TxFIFOFillLevel(UART0, UART_TXFIFO4B_FLEVLE_0_0B);
    UART_TxFIFOFillLevel(UART1, UART_TXFIFO4B_FLEVLE_0_0B);

    UART_TxFIFOINTSel(UART0,UART_TFIS_REACH_NOREACH_FLEVEL);
    UART_TxFIFOINTSel(UART1,UART_TFIS_REACH_NOREACH_FLEVEL);

    UART_TxFIFOClear(UART0);
    UART_TxFIFOClear(UART1);
```

After above setting, enable UART0/1 interrupt.

```
    NVIC_EnableIRQ(INTTX0_IRQn);
    NVIC_EnableIRQ(INTRX1_IRQn);

    NVIC_EnableIRQ(INTTX1_IRQn);
    NVIC_EnableIRQ(INTRX0_IRQn);
```

The rest process of data flow is finished in ISR of UART0/1 RX and TX interrupt routine

UART0 TX interrupt routine:

```
void INTTX0_IRQHandler(void)
{
	volatile UART_Err err;

	if (TxCounter < NumToBeTx) {
		UART_SetTxData(UART0, TxBuffer[TxCounter++]);
	} else {
		err = UART_GetErrState(UART0);
	}
}
```

UART1 TX interrupt routine:

```
void INTTX1_IRQHandler(void)
{
	volatile UART_Err err;

	if (TxCounter1 < NumToBeTx1) {
		UART_SetTxData(UART1, TxBuffer1[TxCounter1++]);
	} else {
		err = UART_GetErrState(UART1);
	}
}
```

UART0 RX interrupt routine:

```
void INTRX0_IRQHandler(void)
{
	volatile UART_Err err;

	err = UART_GetErrState(UART0);
	if (UART_NO_ERR == err) {
		RxBuffer[RxCounter++] = (uint8_t) UART_GetRxData(UART0);
	}
}
```

UART1 RX interrupt routine:

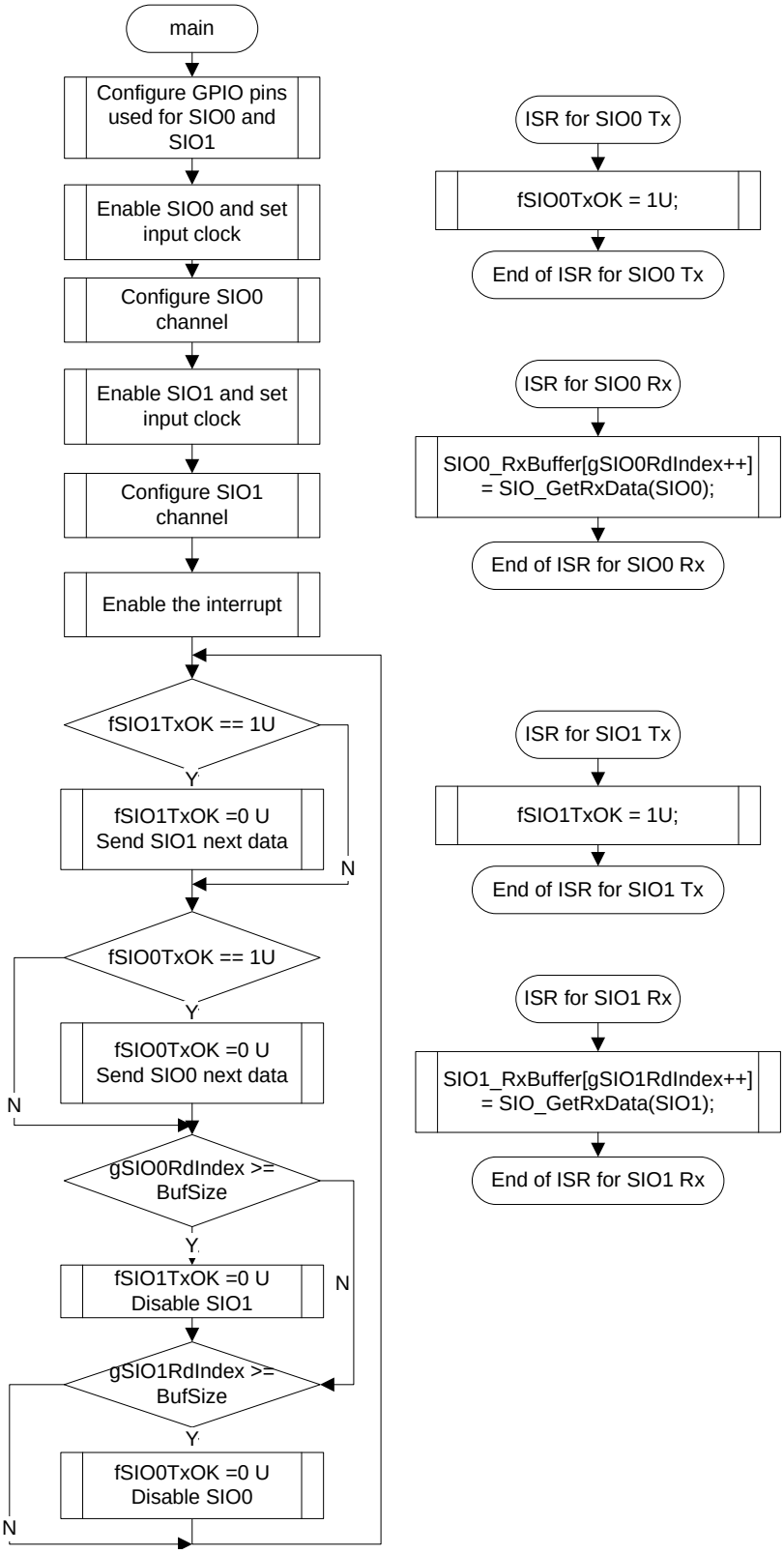
```
void INTRX1_IRQHandler(void)
{
	volatile UART_Err err;

	err = UART_GetErrState(UART1);
	if (UART_NO_ERR == err) {
		RxBuffer1[RxCounter1++] = (uint8_t) UART_GetRxData(UART1);
	}
}
```

7-10-3 Example: SIO

This is a simple example based on the TX03 Peripheral Driver (SIO).

The example includes:
1. Basic setup operation of SIO
2. The data transfer between SIO0 and SIO1
3. SIO interrupt of Tx and Rx

- **Flowchart**


main
Configure GPIO pins used for SIO0 and SIO1
Enable SIO0 and set input clock
Configure SIO0 channel
Enable SIO1 and set input clock
Configure SIO1 channel
Enable the interrupt
fSIO1TxOK == 1U
Y
fSIO1TxOK =0 U
Send SIO1 next data
N
fSIO0TxOK == 1U
Y
fSIO0TxOK =0 U
Send SIO0 next data
N
gSIO0RdIndex >= BufSize
Y
fSIO1TxOK =0 U
Disable SIO1
N
gSIO1RdIndex >= BufSize
Y
fSIO0TxOK =0 U
Disable SIO0
N
ISR for SIO0 Tx
fSIO0TxOK = 1U;
End of ISR for SIO0 Tx
ISR for SIO0 Rx
SIO0_RxBuffer[gSIO0RdIndex++] = SIO_GetRxData(SIO0);
End of ISR for SIO0 Rx
ISR for SIO1 Tx
fSIO1TxOK = 1U;
End of ISR for SIO1 Tx
ISR for SIO1 Rx
SIO1_RxBuffer[gSIO1RdIndex++] = SIO_GetRxData(SIO1);
End of ISR for SIO1 Rx

- **Code and Explanation for the Example**

At first, configure the GPIO pins for SIO by setting the CR, FR1, IE register of proper port.

Then, enable SIO0 configure the input clock and SIO0 initialization structure.

```
/*Enable the SIO0 channel */
SIO_Enable(SIO0);

/*initialize the SIO0 struct */
SIO0_Init.InputClkEdge = SIO_SCLKS_TXDF_RXDR;
SIO0_Init.IntervalTime = SIO_SINT_TIME_SCLK_8;
SIO0_Init.TransferMode = SIO_TRANSFER_FULLDPX;
SIO0_Init.TransferDir = SIO_LSB_FRIST;
SIO0_Init.Mode = SIO_ENABLE_TX | SIO_ENABLE_RX;
SIO0_Init.DoubleBuffer = SIO_WBUF_ENABLE;
SIO0_Init.BaudRateClock = SIO_BR_CLOCK_T4;
SIO0_Init.Divider = SIO_BR_DIVIDER_2;
SIO_Init(SIO0, SIO_CLK_BAUDRATE, &SIO0_Init);
```

Enable SIO1 configure the input clock and SIO1 initialization structure.

```
/*Enable the SIO1 channel */
SIO_Enable(SIO1);

/*initialize the SIO1 struct */
SIO1_Init.InputClkEdge = SIO_SCLKS_TXDF_RXDR;
SIO1_Init.TransferMode = SIO_TRANSFER_FULLDPX;
SIO1_Init.TransferDir = SIO_LSB_FRIST;
SIO1_Init.Mode = SIO_ENABLE_TX | SIO_ENABLE_RX;
SIO1_Init.DoubleBuffer = SIO_WBUF_ENABLE;

SIO_Init(SIO1, SIO_CLK_SCLKINPUT, &SIO1_Init);
```

Enable the interrupt of SIO TX, RX.

```
/* Enable SIO0 Channel TX interrupt */
NVIC_EnableIRQ(INTTX0_IRQn);
/* Enable SIO1 Channel RX interrupt */
NVIC_EnableIRQ(INTRX1_IRQn);

/* Enable SIO1 Channel TX interrupt */
NVIC_EnableIRQ(INTTX1_IRQn);
/* Enable SIO0 Channel RX interrupt */
NVIC_EnableIRQ(INTRX0_IRQn);
```

After all the basic configure, Enter the data transfer routine .

```
while (1) {
        /* SIO1 send data from TXD1*/
        if (fSIO1TxOK == 1U) {
            fSIO1TxOK = 0U;
            SIO_SetTxData(SIO1, SIO1_TxBuffer[gSIO1WrIndex++]);
        } else {
            /*Do Nothing */
        }
        /* SIO0 send data from TXD0*/
        if (fSIO0TxOK == 1U) {
            fSIO0TxOK = 0U;
            SIO_SetTxData(SIO0, SIO0_TxBuffer[gSIO0WrIndex++]);
        } else {
```

```
            /*Do Nothing */
        }

        /*SIO0 receive data end */
        if (gSIO0RdIndex >= BufSize) {
            fSIO1TxOK = 0U;
            SIO_Disable(SIO1);
        } else {
            /*Do Nothing */
        }
        /*SIO1 receive data end */
        if (gSIO1RdIndex >= BufSize) {
            fSIO0TxOK = 0U;
            SIO_Disable(SIO0);
        } else {
            /*Do Nothing */
        }    }
```

In ISR of SIO0 Tx, set transfer is ok.

```
void INTTX0_IRQHandler (void)
{
    fSIO0TxOK = 1U;
}
```

In ISR of SIO0 Rx, get the receive data from RX buffer

```
void INTRX0_IRQHandler(void)
{
    SIO0_RxBuffer[gSIO0RdIndex++] = SIO_GetRxData(SIO0);
}
```

In ISR of SIO1 Tx, set transfer is ok.

```
void INTTX1_IRQHandler(void)
{
    fSIO1TxOK = 1U;
}
```

In ISR of SIO1 Rx, get the receive data from RX buffer.

```
void INTRX1_IRQHandler(void)
{
    SIO0_RxBuffer[gSIO1RdIndex++] = SIO_GetRxData(SIO1);
}
```

7-11 SSP

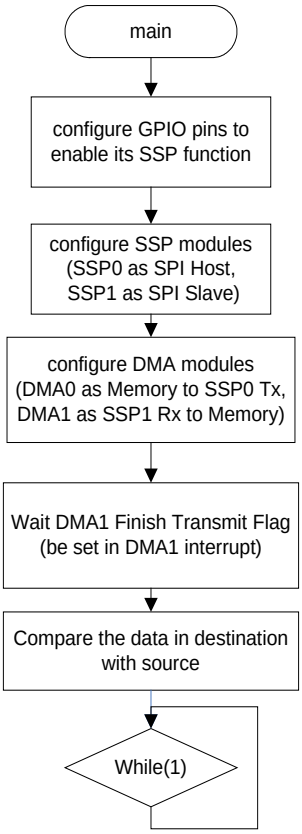
7-11-1 Example: SSP0 to SSP1 via DMAC

This is a simple example based on the TX03 Peripheral Driver (SSP, DMAC, GPIO).
It will send some data from SSP0 to SSP1 via DMA.

The example includes:

1. Configuration of SSP0 as SPI Host, and SSP1 as SPI Slave
2. Configuration of DMA0 as Memory to SSP0 Tx, and DMA1 as SSP1 Rx to Memory
3. Check the data transmit flow: Memory → SSP0 Tx → SSP1 Rx → Memory

- **Flowchart**



- **Code and Explanation for the Example**

Below is the main.c for the flowchart above.

```
int main(void)
{
	GPIO_SetSSP();
	initSSP();
	InitDMA();

	/* Wait the end of transmission */
	while (TxEndFlag != DONE) {
		/* Do nothing */
	}

	/* now DMA is finished, Set a Break Point here, */
	/* after function Buffercompare() is called, result == SAME */
	result = Buffercompare( SRC_Buffer, DST_Buffer, BUFFER_SIZE);

	while(1) {
		/* do nothing */
	}
}
```

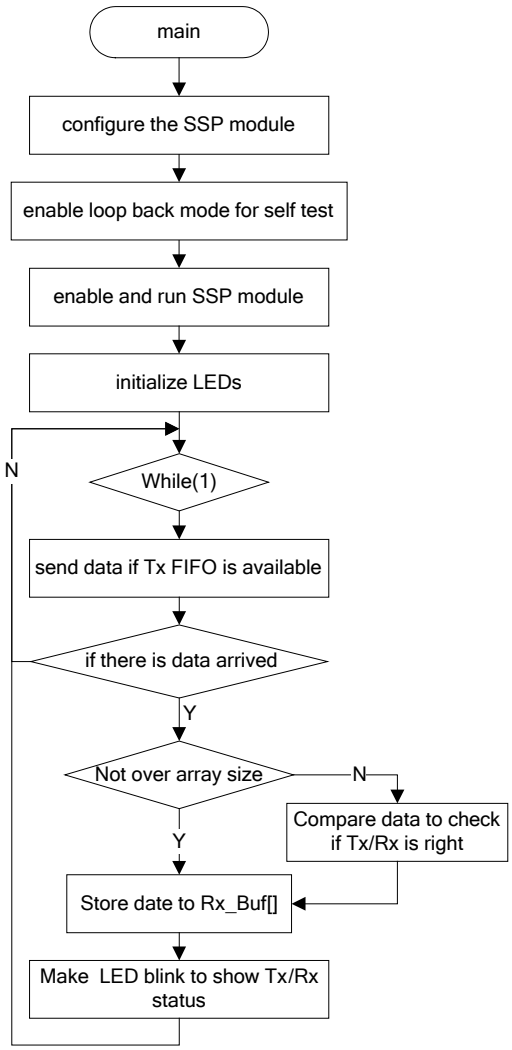
For detail of functions: GPIO_SetSSP(), initSSP(), InitDMA() above, please refer to the comments in the code file.

7-11-2 Example: SSP0 Self Loop Back

This is a simple example based on the TX03 Peripheral Driver (SSP, GPIO).

The example includes:
1. Configuration and initialization SSP module channel 0
2. Enable its loop back mode to do self Tx/Rx

- **Flowchart**



- **Code and Explanation for the Example**

```
int main(void)
{
    SSP_InitTypeDef initSSP;
    SSP_FIFOState fifoState;
```

```
    uint16_t datTx = 0U;            /* must use 16bit type */
    uint32_t cntTx = 0U;
    uint32_t cntRx = 0U;

    uint16_t receive = 0U;
    uint16_t Rx_Buf[MAX_BUFSIZE] = { 0U };
    uint16_t Tx_Buf[MAX_BUFSIZE] = { 0U };

    /* configure the SSP module */
    initSSP.FrameFormat = SSP_FORMAT_SPI;

    /* default is to run at maximum bit rate */
    initSSP.PreScale = 2U;
    initSSP.ClkRate = 1U;
    /* define BITRATE_MIN to run at minimum bit rate */
    /*    BitRate = fSYS / (PreScale x (1 + ClkRate)) */
#ifdef BITRATE_MIN
    initSSP.PreScale = 254U;
    initSSP.ClkRate = 255U;
#endif
    initSSP.ClkPolarity = SSP_POLARITY_LOW;
    initSSP.ClkPhase = SSP_PHASE_FIRST_EDGE;
    initSSP.DataSize = 16U;
    initSSP.Mode = SSP_MASTER;
    SSP_Init(TSB_SSP0, &initSSP);

    /* enable loop back mode for self test */
    SSP_SetLoopBackMode(TSB_SSP0, ENABLE);

    /* enable and run SSP module */
    SSP_Enable(TSB_SSP0);

    /* initialize LEDs on M380-SK board before display something */
    LEDInit();

    while (1) {

        datTx++;
        /* send data if Tx FIFO is available */
        fifoState = SSP_GetFIFOState(TSB_SSP0, SSP_TX);
        if ((fifoState == SSP_FIFO_EMPTY) || (fifoState == SSP_FIFO_NORMAL)) {
            SSP_SetTxData(TSB_SSP0, datTx);
            if (cntTx < MAX_BUFSIZE) {
                Tx_Buf[cntTx] = datTx;
                cntTx++;
            } else {
                /* do nothing */
            }
        } else {
            /* do nothing */
        }

        /* check if there is data arrived */
        fifoState = SSP_GetFIFOState(TSB_SSP0, SSP_RX);
        if ((fifoState == SSP_FIFO_FULL) || (fifoState == SSP_FIFO_NORMAL)) {
            receive = SSP_GetRxData(TSB_SSP0);
            if (cntRx < MAX_BUFSIZE) {
                Rx_Buf[cntRx] = receive;
                cntRx++;
```

```
                } else {
                    /* Place a break point here to check if receive data is right.   */
                    /* Success Criteria:                                             */
                    /* Every data transmited from Tx_Buf is received in Rx_Buf. */
                    /* When the line "#define BITRATE_MIN" is commented, the SSP is
run in maxium */
                    /* bit rate, so we can find there is enough time to transmit date from 1
to */
                    /* MAX_BUFSIZE one by one. but if we uncomment that line, SSP is
run in */
                    /* minimum bit rate, we will find that receive data can't catch "datTx++",
*/
                    /* in this so slow bit rate, when the Tx FIFO is available, the cntTx */
                    /* has been increased so much.                                   */
                    __NOP();
                    result = Buffercompare( Tx_Buf, Rx_Buf, MAX_BUFSIZE);
                }

            } else {
                /* do nothing */
            }

            DisplayLED(receive);
        }
}
```

7-12 TMRB

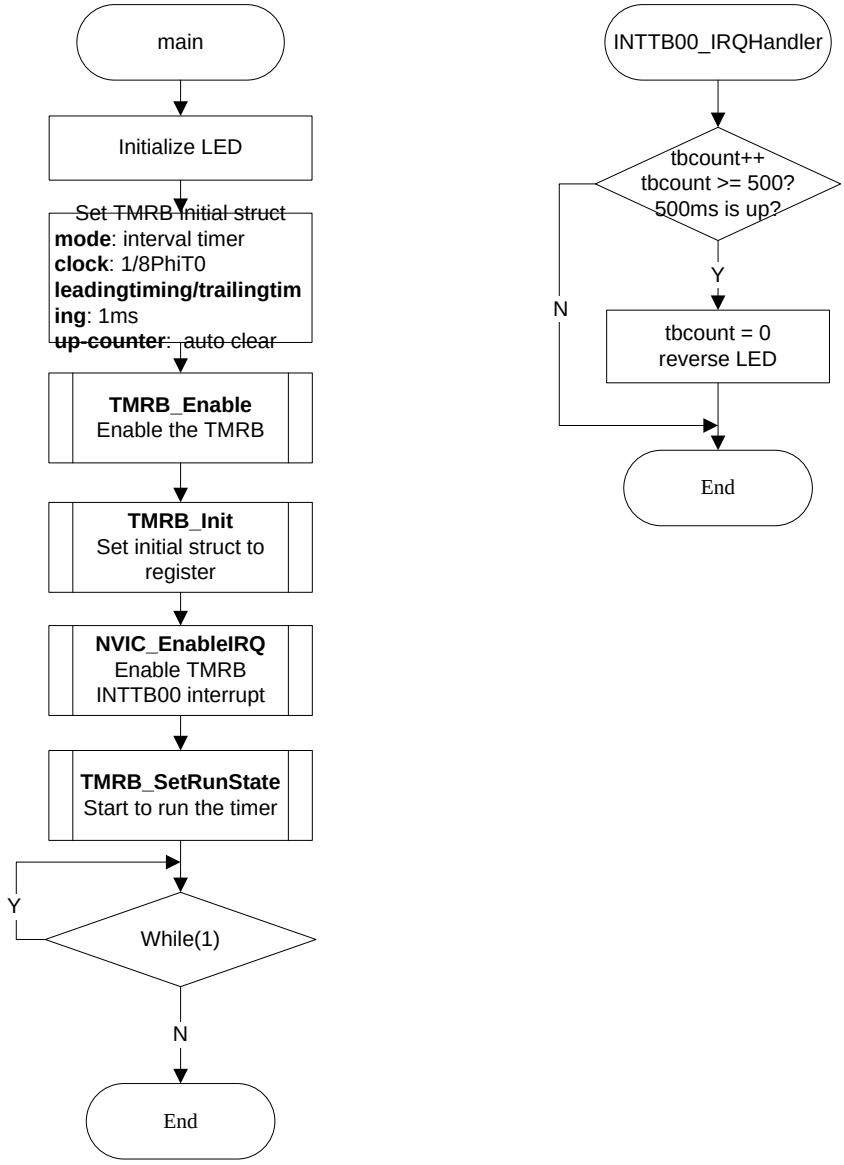
7-12-1 Example: General Timer

This is a simple example based on the TX03 Peripheral Driver (TMRB, GPIO).

The example includes:

1. TMRB0 initialization
2. General Timer for 1ms

- **Flow Chart**



- **Code and Explanation for the Example**

At first, initialize LED channel on SK board and turn on LED.

```
LEDInit();                                          /* LED initialize */
LedDisable(LED_CH1 | LED_CH2 | LED_CH3);
LedOn(LED11);                                       /* Turn on LED11 */
```

Prepare TMRB initialization structure, fill TMRB mode, clock, up-counter clear method, trailingtiming and leadingtiming. This demo will set trailingtiming and leadingtiming to 1ms, macro TMRB_1MS equals 0x1388, because fphiT0 = fsys = fc = 10MHz * PLL = 40MHz, ftmrb = 1/8 fphiT0 = 5MHz, Ttmrb = 0.2us, 1ms/0.2us = 5000 = 0x1388 (Please see CG part for more detail information about the clock setting)

```
TMRB_InitTypeDef m_tmrb;

m_tmrb.Mode = TMRB_INTERVAL_TIMER;      /* internal timer */
m_tmrb.ClkDiv = TMRB_CLK_DIV_8;          /* 1/8PhiT0 */
m_tmrb.TrailingTiming = TMRB_1MS;                   /* periodic time is 1ms */
m_tmrb.UpCntCtrl = TMRB_AUTO_CLEAR;     /* up-counter auto clear */
```

```
m_tmrb.LeadingTiming = TMRB_1MS;                    /* periodic time is 1ms */
```

Enable the TMRB module and set the initialization structure to specified registers. Enable INTTB00 interrupt, this interrupt will be triggered every 1ms, in the end, start the TMRB to run.

```
TMRB_Enable(TSB_TB0);                               /* enable the TMRB0 */
TMRB_Init(TSB_TB0, &m_tmrb);                        /* initial the TMRB0 */
NVIC_EnableIRQ(INTTB00_IRQn);                       /* enable INTTB00 interrupt */
TMRB_SetRunState(TSB_TB0, TMRB_RUN);                /* run TMRB0*/
```

Then the main routine will enter “While(1)” to wait the interrupt happens. In interrupt routine, use a counter to count. If 500ms is up, reverse the LED and count again.

```
tbcount++;
if (tbcount >= 500U) {                              /* 500ms is up */
    tbcount = 0U;
    /* reverse LED output */
    ledon = (ledon == 0U) ? 1U : 0U;
    if (0U == ledon) {
        LedOff(LED11);
    } else {
        LedOn(LED11);
    }
} else {
    /* do nothing */
}
```

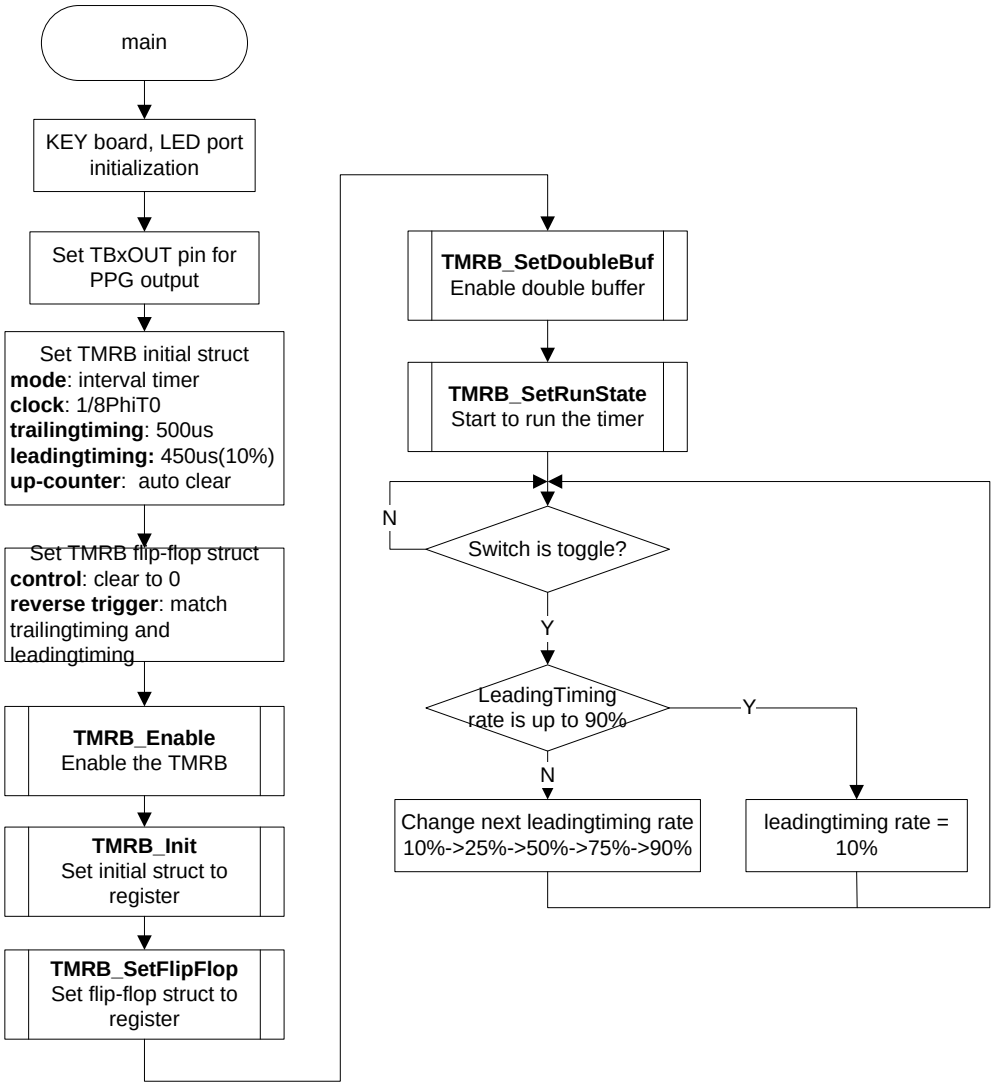
7-12-2 Example: PPG Output

This is a simple example based on the TX03 Peripheral Driver (TMRB, GPIO).

The example includes:

1. TMRB7 initialization
2. PPG process setting and start
3. PPG leadingtiming adjustment

- **Flow Chart**



- **Code and Explanation for the Example**

At first, initialize KEY board and LED channel, set PF1 as TB7OUT for PPG output.

```
GPIO_SetInput(KEYPORT, GPIO_BIT_0);                    /* set KEY port to input */

LEDInit();                                                    /* LED initialization */
LedDisable(LED_CH1 | LED_CH2 | LED_CH3 | LED_CH4);   /* Turn off all LED */

/* Set PF1 as TB7OUT for PPG output */
GPIO_SetOutput(GPIO_PF, GPIO_BIT_1);
GPIO_EnableFuncReg(GPIO_PF, GPIO_FUNC_REG_1, GPIO_BIT_1);
GPIO_SetPullUp(GPIO_PF, GPIO_BIT_1, ENABLE);           /* Enable pull up */
```

Prepare TMRB initialization structure, and then fill TMRB mode, clock, up-counter clear method, trailingtiming and leadingtiming into it. This demo will set trailingtiming to 500us, macro TMRB7TIME equals 0x09C4, because fphiT0 = fsys = fc = 10MHz * PLL = 40MHz, ftmrb = 1/8 fphiT0 = 5MHz, Ttmrb = 0.2us, 500us/0.2us = 2500 = 0x09C4 (Please see CG part for more detail information about the clock setting)

```
TMRB_InitTypeDef m_tmrb;
```

```
    m_tmrb.Mode = TMRB_INTERVAL_TIMER;        /* internal timer */
    m_tmrb.ClkDiv = TMRB_CLK_DIV_8;           /* 1/8PhiT0 */
    m_tmrb.TrailingTiming = TMRB7TIME;                /* trailingtiming is 500us
*/
    m_tmrb.UpCntCtrl = TMRB_AUTO_CLEAR;       /* up-counter auto clear */
    m_tmrb.LeadingTiming = LeadingTiming[Rate];                              /*
leadingtiming, initial value 10% */
```

Set flip-flop initialization structure, and fill flip-flop control, reverse trigger parameter into it. Reverse trigger is set to match leadingtiming and match trailingtiming.

```
    PPGFFInital.FlipflopCtrl = TMRB_FLIPFLOP_CLEAR;
    PPGFFInital.FlipflopReverseTrg=TMRB_FLIPFLOP_MATCH_TRAILINGTIMING|
    TMRB_FLIPFLOP_MATCH_LEADINGTIMING;
```

Enable the TMRB module and set the initialization structure and flip-flop structure to specified registers. Enable double buffer, and disable capture function. In the end, start the TMRB to run.

```
    TMRB_Enable(TSB_TB7);
    TMRB_Init(TSB_TB7, &m_tmrb);
    TMRB_SetFlipFlop(TSB_TB7, &PPGFFInital);
    /* enable double buffer */
    TMRB_SetDoubleBuf(TSB_TB7,ENABLE, TMRB_WRITE_REG_SEPARATE);
    TMRB_SetRunState(TSB_TB7, TMRB_RUN);
```

Wait switch from low to high, and at the same time, display current leadingtiming on 7-seg LED array.

```
    do {                          /* wait if switch is Low */
            keyvalue = GPIO_ReadDataBit(KEYPORT, GPIO_BIT_0);
            SegDisplay(leadingtiming_num[Rate]); /* display current leadingtiming */
       } while (GPIO_BIT_VALUE_0 == keyvalue);
```

If the switch is changed to high, change the leadingtiming according to 10%->25%->50%->75%->90%, then from 90% to 10% again.

```
    Rate++;
    if (Rate >= LEADINGTIMINGMAX) {
        Rate = LEADINGTIMINGINIT;
        } else {
            /* Do nothing */
        }

    TMRB_ChangeLeadingTiming(TSB_TB7,  LeadingTiming[Rate]);       /*  change
leadingtiming rate */
```

The calculation method of leadingtiming value:
TrailingTiming = 500us, ftmrb = 1/8 fphiT0 = 5MHz, Ttmrb = 0.2us (these time parameters will be different if use different CG setting)

LeadingTiming = 10%: high-level time is 500*10% = 50us, low-level time is 500-50 = 450us, counter value = 450us/Ttmrb = 0x8CA
LeadingTiming = 25%: high-level time is 500*25% = 125us, low-level time is 500-125 = 375us, counter value = 375us/Ttmrb = 0x753

LeadingTiming = 50%: high-level time is 500*50% = 250us, low-level time is 500-250 = 250us, counter value = 250us/Ttmrb = 0x4E2

LeadingTiming = 75%: high-level time is 500*75% = 375us, low-level time is 500-375 = 125us, counter value = 125us/Ttmrb = 0x271

LeadingTiming = 90%: high-level time is 500*90% = 450us, low-level time is 500-450 = 50us, counter value = 50us/Ttmrb = 0xFA

That is the calculation method of leadingtiming array

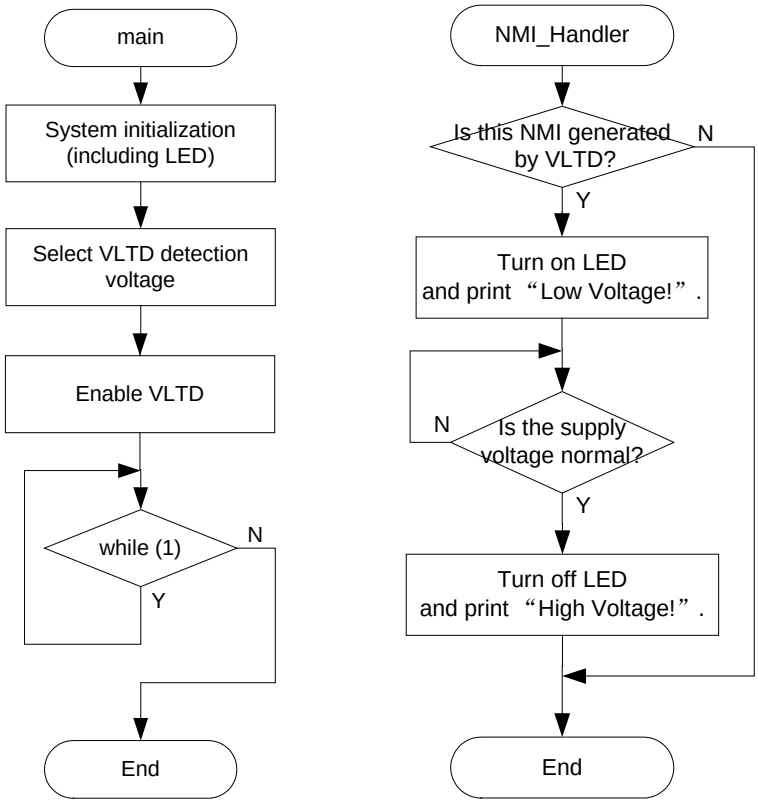
```
uint32_t LeadingTiming[5] = { 0x8CAU, 0x753U, 0x4E2U, 0x271U, 0xFAU };
/* leadingtiming: 10%, 25%, 50%, 75%, 90% */
```

7-13 VLTD

This is a simple example based on the TX03 Peripheral Driver (VLTD, GPIO).

The example includes:
1. VLTD configuration
2. VLTD status monitoring

- **Flowchart**



- **Code and Explanation for the Example**

Main program : [main.c]

In void main(void):

Initialize the system first. Disabe WDT explicitly to prevent confusion.

```
WDT_Disable ();
LEDInit();
```

Set detection voltage and enable VLTD.

```
VLTD_SetVoltage(VLTD_DETECT_VOLTAGE_46);
VLTD_Enable ();
```

Then a usual while(1) loop.

NMI handler : [tmpm380_vltd_int.c]

In void NMI_Handler(void):

Make sure the NMI is generated by VLTD.

```
if (CG_GetNMIFlag().Bit.VoltageDetection == 1U) {
{
```

Turn on LED and print a message to the terminal.

```
        LedOn(LED4);
#ifdef DEBUG
        printf("Low voltage!\n");
#endif
```

Wait for the power supply voltage to be normal.

```
        while (VLTD_GetStatus() == 1U)
        {
            __NOP();
        }
```

Turn off LED and print a message to the terminal.

```
        LedOff(LED4);
#ifdef DEBUG
        printf("High voltage!\n");
#endif
}
```

At last the NMI_Handler() function returns.

7-14 WDT

This is a simple example based on the TX03 Peripheral Driver (WDT, GPIO).

The example includes:

1. WDT initialization.
2. In DEMO1 WDT isn't cleared before timer overflow, NMI interrupt is generated.
3. In DEMO2 WDT is cleared before timer overflow, the LED will blink all the time.

- **Code and Explanation for the Example**

The following code is an example for initializing WDT. Detect time is set to 2^25/fsys, and interrupt will be generated when timer overflow.

```
WDT_InitTypeDef WDT_InitStruct;
```

```
WDT_InitStruct.DetectTime = WDT_DETECT_TIME_EXP_25;
WDT_InitStruct.OverflowOutput = WDT_NMIINT;
```

Initialize WDT and enable it.

```
WDT_Init(&WDT_InitStruct);
WDT_Enable();
```

In DEMO1 Waiting for the NMI interrupt flag.

```
while(1)
{
}
```

In DEMO1 When NMI interrupt is occurred the WDT will be disabled and the LED blink will be stopped.

```
WDT_Disable();
```

In DEMO2 WDT will be cleared and the LED will blink all the time.

```
WDT_WriteClearCode();
```

7-15 ENC

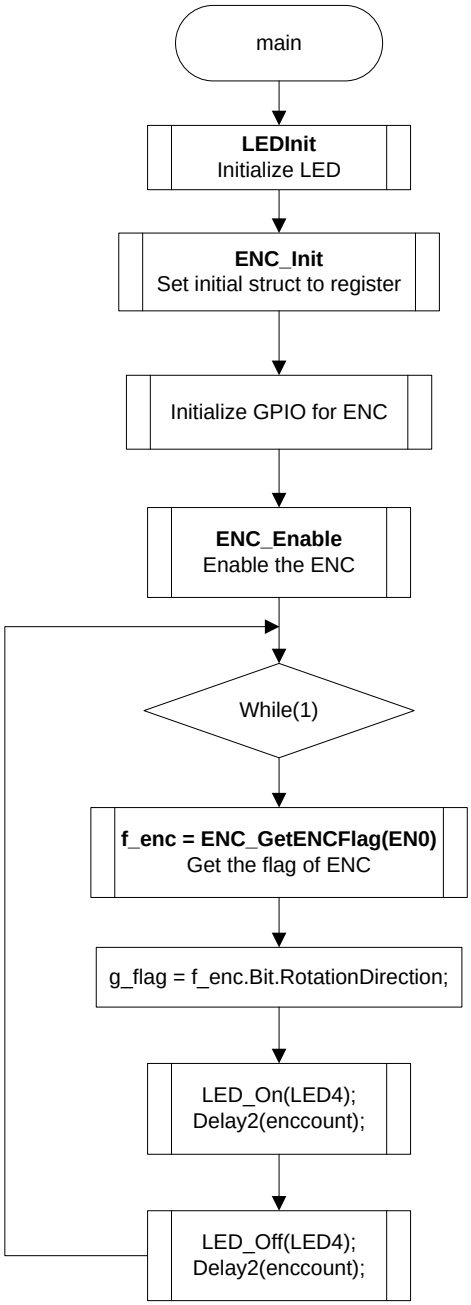
7-15-1 Example: Rolling Detection

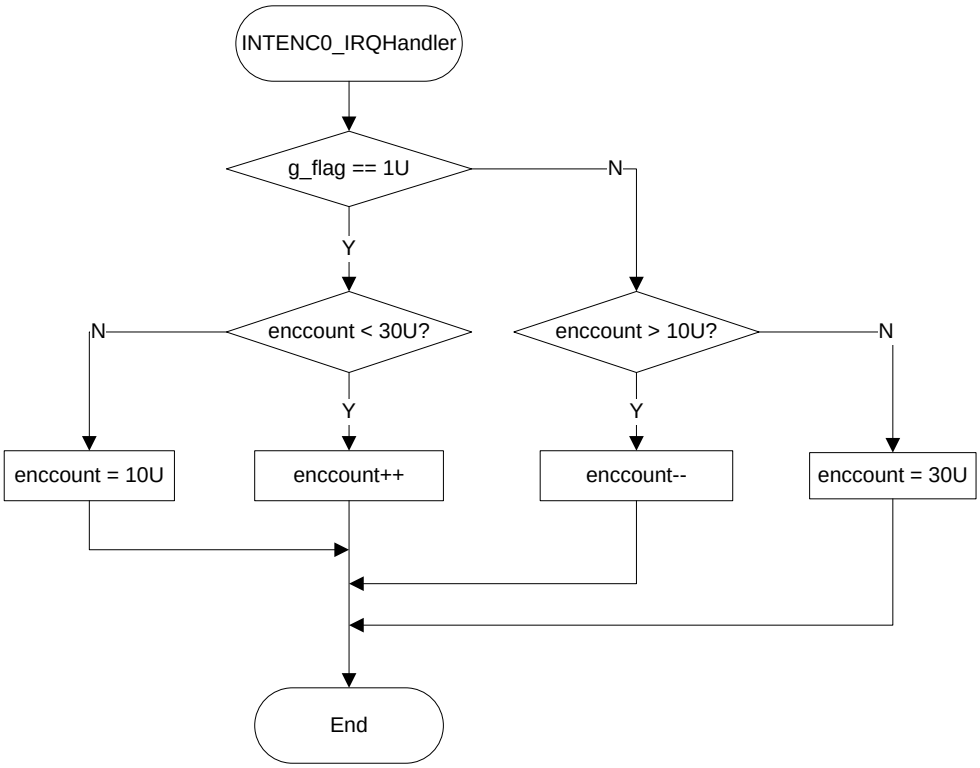
This is a simple example based on the TX03 Peripheral Driver (ENC, GPIO).

The example includes:

1. ENC0 initialization.
2. Rolling detection of mouse wheel.

- **Flowchart**


main
LEDInit
Initialize LED
ENC_Init
Set initial struct to register
Initialize GPIO for ENC
ENC_Enable
Enable the ENC
While(1)
f_enc = ENC_GetENCFlag(EN0)
Get the flag of ENC
g_flag = f_enc.Bit.RotationDirection;
LED_On(LED4);
Delay2(enccount);
LED_Off(LED4);
Delay2(enccount);



- **Code and Explanation for the Example**

The following simple example is based on TX03 Peripheral Driver (ENC), which will detect the rolling of mouse wheel.

At first, initialize LED channel on eval board.

```
    /* LED initialization */
    LEDInit();
```

Prepare ENC initialization structure, and initialize the ENC0.

```
    /* ENC0 initialization */
    m_enc.ModeType = ENC_ENCODER_MODE;
    m_enc.PhaseType = ENC_TWO_PHASE;
    m_enc.CompareStatus = ENC_COMPARE_DISABLE;
    m_enc.ZphaseStatus = ENC_ZPHASE_DISABLE;
    m_enc.FilterValue = ENC_FILTER_VALUE31;
    m_enc.IntEn = ENC_INTERRUPT_ENABLE;
    m_enc.PulseDivFactor = ENC_PULSE_DIV1;

    ENC_Init(EN0,&m_enc);
    ENC_SetCounterReload(EN0,0xFFFU);
```

Initialize the GPIO for ENC0.Set the PD0 and PD1 as inputs of ENC0.

```
    /* GPIO initialization */
    GPIO_SetInputEnableReg(GPIO_PD, GPIO_BIT_0, ENABLE);/*Set PD0 as
input */
    GPIO_EnableFuncReg(GPIO_PD, GPIO_FUNC_REG_1, GPIO_BIT_0);/*Set
PD0 as ENCA0 */
    GPIO_SetInputEnableReg(GPIO_PD, GPIO_BIT_1, ENABLE);/*Set PD1 as
input */
    GPIO_EnableFuncReg(GPIO_PD, GPIO_FUNC_REG_1, GPIO_BIT_1);/*Set
```

```
PD1 as ENCB0 */
```

Enable the ENC0 and ENC0 interrupt.

```
    /* Enable ENC0 */
    ENC_Enable(EN0);
    /* Enable ENC0 interrupt */
    NVIC_EnableIRQ(INTENC0_IRQn);
```

Get the status of rotation direction of ENC0 to indicate the rolling direction of the mouse wheel.Blink the LED4 according to the cycle of rolling

```
    /* LED4 blink speed based on the rolling of mouse wheel */
    while(1){
        f_enc = ENC_GetENCFlag(EN0);
        g_flag = f_enc.Bit.RotationDirection;
        LedOn(LED4);
        Delay2(enccount);
        LedOff(LED4);
        Delay2(enccount);
    }
```

Enccount is the count of rolling, and it changed in the interupt routine.
While rolling the mouse wheel forward, enccount decreased. When enccount reaches to 10, it will back to 30.
While rolling the mouse wheel backward, enccount added. When enccount reaches to 30, it will back to 10.

```
   if(g_flag == 1U){
        if(enccount < 30U){
            enccount++;
        } else {
            enccount = 10U;
        }
    } else {
        if(enccount > 10U){
            enccount--;
        } else {
            enccount = 30U;
        }
    }
```

7-16 PMD

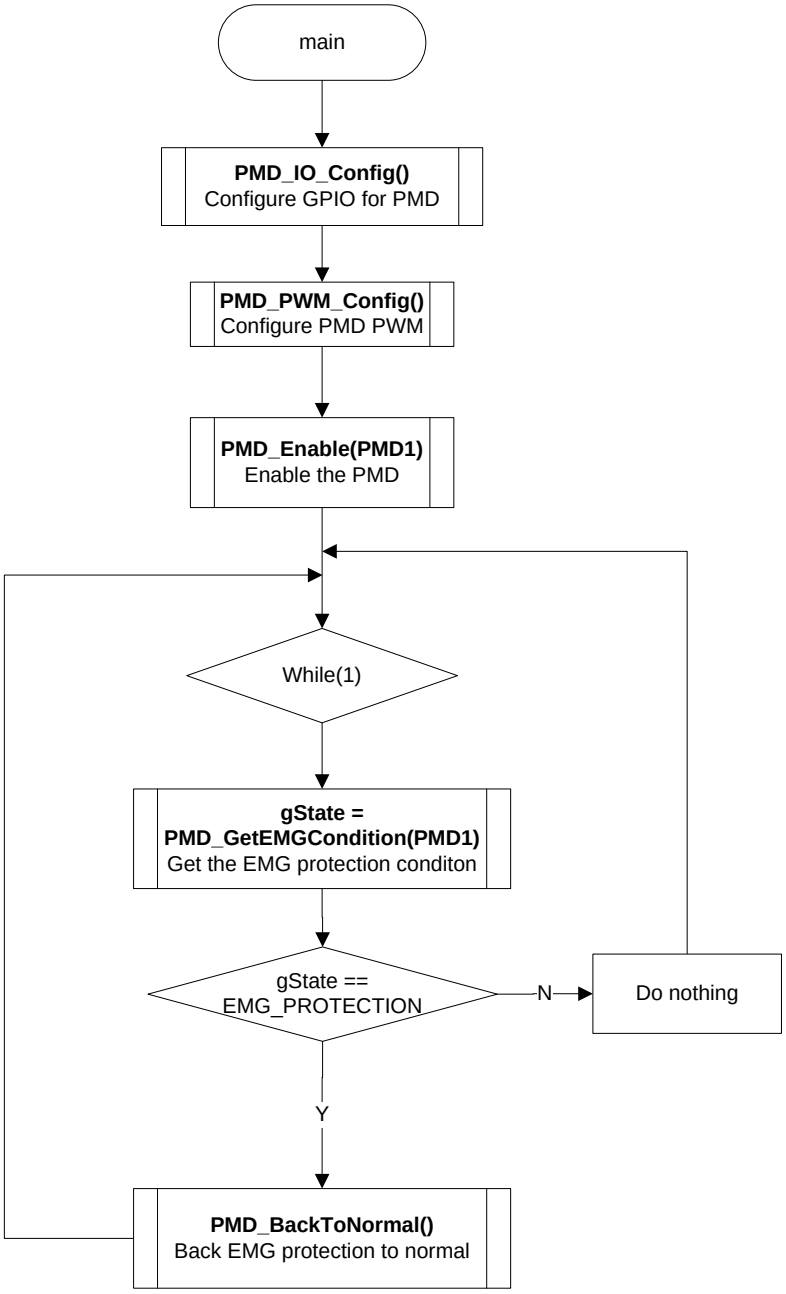
7-16-1 Example: Phase Output

This is a simple example based on the TX03 Peripheral Driver (PMD, GPIO).

The example includes:

1. PMD and GPIO initialization.
2. EMG protection detection.
3. Back EMG protection to normal.

- **Flowchart**



- **Code and Explanation for the Example**

At first, configure the LED and PMD and GPIO.

```
/* LED initialization */
LEDInit();

/* GPIO configuration*/
PMD_IO_Config();

/* PMD PWM configuration*/
PMD_PWM_Config();
```

If the DEMO_U_PHASE is defined, the duty mode is U-phase in common,
If the DEMO_3_PHASE is defined, the duty mode is 3-phase independent.

```
/* PMD1 initialization */
    m_pmd.CycleMode = PMD_PWM_NORMAL_CYCLE;
#ifdef DEMO_U_PHASE
    m_pmd.DutyMode = PMD_DUTY_MODE_U_PHASE;          /* U-phase in common */
#endif
#ifdef DEMO_3_PHASE
    m_pmd.DutyMode = PMD_DUTY_MODE_3_PHASE;          /* 3-phase independent */
#endif
    m_pmd.IntTiming = PMD_PWM_INT_TIMING_MINIMUM;
    m_pmd.IntCycle = PMD_PWM_INT_CYCLE_1;
    m_pmd.CarrierMode = PMD_CARRIER_WAVE_MODE_1;     /* PWM mode 1 (center PWM, triangle wave) */
    m_pmd.CycleTiming = 0x3FFFU;

    PMD_Init(PMD1, &m_pmd);
```

Set the different compare value in the 3 phases.
In the duty mode U-phase in common, the outputs are same according to phase U.
In the duty mode 3-phase independent, the outputs are independent according to the compare value.

```
    PMD_SetAllPhaseCompareValue(PMD1,0x0FFFU,0x1FFFU,0x2FFFU);
```

And then enable the PMD.

```
    PMD_Enable(PMD1);
```

Judge the EMG protection condition.If the condition is in protection condition, LED4 will light on, and then back EMG protection to normal. If the condition is not in protection condition, LED4 will light off.

```
    while(1){
        /* Get the EMG protection condition*/
        gState = PMD_GetEMGCondition(PMD1);
        /* Judge the EMG protection condition */
        if (gState == EMG_PROTECTION) {
            /* LED4 will light on if the condition is in protection */
            LedOn(LED4);
            /* Back EMG protection to normal */
            PMD_BackToNormal();
            Delay(1000U);
        } else {
            /* LED4 will light off if the condition is not in protection */
            LedOff(LED4);
        }    }
```