

Readme

APM32A0xx SDK

Rev: v1.0

1 Introduction

The Geehy Semiconductor APM32A0xx MINI board software development kit includes a series driver library, a group of example applications that demonstrate key peripheral functionality, and other development files.

Software development kit have a hierarchy as follows:

- SDK directory
 - * [Boards](#)
 - * [Documents](#)
 - * [Examples](#)
 - * [Libraries](#)
 - * [Middlewares](#)
 - * [Package](#)

Table of Contents

1	Introduction	1
2	About boards	4
3	About documents.....	5
4	About examples.....	6
4.1	ADC_AnalogWindowWatchdog.....	10
4.2	ADC_ContinuousConversion.....	10
4.3	ADC_TMRTrigger	10
4.4	CAN_LoopBack	11
4.5	CEC_Communication	12
4.6	COMP_PWMSignalControl	12
4.7	CRC_CalcMessage.....	13
4.8	DAC_ADC.....	14
4.9	DMA_ADC.....	14
4.10	DMA_Usart	15
4.11	EINT	15
4.12	FMC_Write	16
4.13	GPIO_Toggle	17
4.14	I2C_TwoBoards.....	17
4.15	I2S_TwoBoards	17
4.16	IWDT_FeedDog.....	18
4.17	IWDT_FeedDog_Window	19
4.18	NVIC_WFI.....	20
4.19	PMU_WakeUp	20
4.20	RCM_ClockSwitch	22
4.21	RTC_Alarm	22
4.22	RTC_Calendar	23

4.23	RTC_Stamp	23
4.24	RTC_TimeStamp	24
4.25	SPI_FullDuplex	26
4.26	SPI_TwoBoards	28
4.27	SysTick	28
4.28	Template	29
4.29	TMR_ComplementaryOutput	29
4.30	TMR_InputCapture	30
4.31	TMR_PWMOutput	33
4.32	TMR_SinglePulse	35
4.33	TMR_SynchronizationWithTMR1	36
4.34	TMR_TimeBase	36
4.35	TSC_KeyLinearRotate	36
4.36	USART_Interrupt	37
4.37	USART_Polling	37
4.38	WWDT_OverTime	38
5	About libraries	40
6	About middlewares	41
7	About Package	42
8	Revision History	43

2 About boards

The boards folder includes a board support package for APM32A0xx MINI board. It can help drive the peripheral circuit or components on the board quickly. The BSP can be found in the [Boards](#) directory.

The BSP provided are built for APM32A0xx MINI board compatibility. For other user development board use, some minor modifications may be required.

Boards have a hierarchy as follows:

- Boards folder
 - * Board_APM32A091_MINI
 - inc
 - Board_APM32A091_MINI.h
 - src
 - Board_APM32A091_MINI.c
 - * Board.c
 - * Board.h

3 **About documents**

The documents folder includes a link file that can be redirected to the technical support center of Geehy semiconductor. The document can be found in the [Documents](#) directory.

4 About examples

The example applications can be found in the [Examples](#) directory.

The examples provided are built for APM32A0xx MINI board compatibility. For other user development board use, some minor modifications may be required.

Example projects have a hierarchy as follows:

- Example folder
 - * Include
 - * Project
 - IAR
 - Eclipse
 - MDK
 - * Source

All example applications tested with: **APM32a0xx StdPeriphDriver v1.0.0**, include the following examples:

- Examples
 - * ADC
 - [ADC_AnalogWindowWatchdog](#)
 - [ADC_ContinuousConversion](#)
 - [ADC_TMRTrigger](#)
 - [ADC_MultiChannelScan](#)
 - [ADC_VBAT](#)
 - * CAN
 - [CAN_LoopBack](#)
 - * CEC
 - [CEC_Communication](#)
 - * COMP
 - [COMP_AnalogWatchdog](#)
 - [COMP_PWMSignalControl](#)

- * CRC
 - [CRC_8BitsCRCMessage](#)
 - [CRC_CalcMessage](#)
- * DAC
 - [DAC_ADC](#)
 - [DAC_NoiseWave](#)
- * DMA
 - [DMA_ADC](#)
 - [DMA_Usart](#)
 - [DMA_MemoryToMemory](#)
- * EINT
 - [EINT](#)
- * FMC
 - [Flash_Emulation_Eeprom](#)
 - [FMC_Write](#)
- * GPIO
 - [GPIO_Toggle](#)
- * I2C
 - [I2C_TwoBoards](#)
- * I2S
 - [I2S_TwoBoards](#)
- * IAP
 - [IAP_Application1](#)
 - [IAP_Application2](#)
 - [IAP_BootLoader](#)
- * IWDT
 - [IWDT_FeedDog](#)
 - [IWDT_FeedDog_Window](#)

- * NVIC
 - [NVIC_WFI](#)
- * PMU
 - [PMU_Stop](#)
 - [PMU_WakeUp](#)
- * RCM
 - [RCM_ClockSwitch](#)
- * RTC
 - [RTC_Alarm](#)
 - [RTC_Calendar](#)
 - [RTC_Stamp](#)
 - [RTC_StopWatch](#)
 - [RTC_TimeStamp](#)
 - [RTC_LPWR_Wakeup](#)
- * RTOS
 - [FreeRTOS](#)
 - [RT-Thread](#)
 - [RTX](#)
- * SPI
 - [SPI_FLASH_Polling](#)
 - [SPI_FullDuplex](#)
 - [SPI_TwoBoards](#)
- * SysTick
 - [SysTick](#)
- * Template
 - [Template](#)
- * TMR
 - [TMR_6Steps](#)

- [TMR_32BitCount](#)
- [TMR_ComplementaryOutput](#)
- [TMR_DMA](#)
- [TMR_DMABurst](#)
- [TMR_EncoderInterface](#)
- [TMR_ExtTriggerSynchro](#)
- [TMR_InputCapture](#)
- [TMR_OCActive](#)
- [TMR_OCInactive](#)
- [TMR_OCToggle](#)
- [TMR_ParallelSynchro](#)
- [TMR_PWMInput](#)
- [TMR_PWMOutput](#)
- [TMR_SinglePulse](#)
- [TMR_SynchronizationWithTMR1](#)
- [TMR_TimeBase](#)

- * TSC
 - [TSC_KeyLinearRotate](#)

- * USART
 - [USART_Interrupt](#)
 - [USART_IrDA](#)
 - [USART_LIN](#)
 - [USART_Polling](#)
 - [USART_Smartcard](#)

- * WWDT
 - [WWDT_OverTime](#)

4.1 **ADC_AnalogWindowWatchdog**

4.1.1 **Example Description**

This example describes how to use ADC1 to monitor the voltage of ADC1_Channel0 continuously. When input Voltage of ADC1_Channel0(PA0) voltage is lower than 1.33v, LED2 is on, When input Voltage of ADC1_Channel0(PA0) voltage is higher than 1.66v, LED3 is on,

The converted voltage is displayed on serial assistant through USART1

4.1.2 **Directory content**

This example can be found in the [ADC_AnalogWindowWatchdog](#) directory.

4.2 **ADC_ContinuousConversion**

4.2.1 **Example Description**

This example describes how to use the ADC1 to convert continuously the voltage applied to the APM32A091 MINI ADC1_Channel0 input.

The converted voltage is displayed on serial assistant through USART1.

4.2.2 **Directory content**

This example can be found in the [ADC_ContinuousConversion](#) directory.

4.3 **ADC_TMRTrigger**

4.3.1 **Example Description**

This example describes how to use the ADC1 to convert continuously the voltage applied to the APM32A091 MINI ADC1_Channel0 input.

Each time the TMR1 CC4 event occurs, the ADC convert the variable voltage.

The converted voltage is displayed on serial assistant through USART1.

4.3.2 **Directory content**

This example can be found in the [ADC_TMRTrigger](#) directory.

4.4 **ADC_MultiChannelScan**

4.4.1 **Example Description**

This example describes how to use the ADC1 to scan continuously the voltage applied to the APM32A091 MINI ADC1_Channel0 and ADC1_Channel1 and ADC1_Channel2 input.

The converted voltage is displayed on serial assistant through USART1..

4.4.2 **Directory content**

This example can be found in the [ADC_MultiChannelScan](#) directory.

4.5 **ADC_VBAT**

4.5.1 **Example Description**

This example describes how to use the ADC to convert VBAT voltage applied to the APM32A091 MINI ADC_Channel 18.

The converted voltage is displayed on serial assistant through USART1.

4.5.2 **Directory content**

This example can be found in the [ADC_VBAT](#) directory.

4.6 **CAN_LoopBack**

4.6.1 **Example Description**

This example describes how to config a communication the CAN in loopback mode. CAN transmit a message to self. Then compare the received message with transmitted message. The LED2 turns on while the message is consistent, otherwise LED3 turns on. The communication status will displayed on serial assistant through USART1.

4.6.2 **Directory content**

This example can be found in the [CAN_LoopBack](#) directory.

4.7 CEC_Communication

4.7.1 Example Description

This example shows how to control CEC devices and communicate between two different boards.

To use this example, you need to load the same software into two APM32 boards (let's call them Master and Slave) then connect these two boards through CEC lines.

4.7.2 Directory content

This example can be found in the [CEC_Communication](#) directory

4.8 COMP_AnalogWatchdog

4.8.1 Example Description

This example describes how to make an analog watchdog using APM32A0xx COMP peripherals devices in window mode:

- The higher threshold is set $VREFINT = 0.92V$
- The lower threshold is set $VREFINT = 0.307V$
- The input voltage is configured to be connected to PA1.

When input Voltage is higher than the higher threshold, LED2 and LED3 are turned on,

When input Voltage is under than the lower threshold, LED3 is on,

When input Voltage is under the within threshold, LED2 is on.

4.8.2 Directory content

This example can be found in the [COMP_AnalogWatchdog](#) directory

4.9 COMP_PWMSignalControl

4.9.1 Example Description

This example shows how to use the comparator. COMP2 non-inverting input connect to PA3. And COMP2 inverting input is internally connected to VREFINT(1.22V) which is

used to compare with PA3 input.

- External voltage should be connected to PA3.
- Connect an oscilloscope to TMR1 channel PA8 to display waveform.
- While PA3 is lower than VREFINT (1.22V), PWM signal is displayed on PA8.
- While PA3 is higher than VREFINT, PA8 is in high level.

4.9.2 Directory content

This example can be found in the [COMP_PWMSignalControl](#) directory

4.10 CRC_8BitsCRCMessage

4.10.1 Example Description

This demo aims to demonstrate how to use a CRC peripheral to calculate the 8-bit CRC checksum of a message.

The CRC peripheral is configured to use an 8-bit CRC polynomial.

The computer of serial debugging assistant can display the corresponding information for CRCValue.

Set up CRCExpectedValue.

The phenomenon of CRCValue compases CRCExpectedValue. If CRCValue is equal to CRCExpectedValue, LED2 on. If CRCValue is not equal to CRCExpectedValue, LED3 on.

4.10.2 Directory content

This example can be found in the [CRC_8BitsCRCMessage](#) directory.

4.11 CRC_CalcMessage

4.11.1 Example Description

Write the calculated data to CRC DATA register and get the calculated result. The computer of serial debugging assistant can display the corresponding information for ComputedCRC.

4.11.2 Directory content

This example can be found in the [CRC_CalcMessage](#) directory.

4.12 DAC_ADC

4.12.1 Example Description

This example provides an example of how to use DAC channel 1(PA4) to output voltage to ADC channel 10(PC0). The converted voltage of PA4 is detected by ADC channel 10 and displayed on serial assistant through USART1.

-DAC generates voltage from 0V to 3.3V

-when the voltage is greater than 3.1V, then LED2 turns on and LED3 turns off.

-when the voltage is less than 0.8V, then LED2 turns off and LED3 turns on.

-when the voltage is greater than 0.8V but less than 3.1V, then LED2 and LED3 turn on.

4.12.2 Directory content

This example can be found in the [DAC_ADC](#) directory.

4.13 DAC_NoiseWave

4.13.1 Example Description

This example shows how to configure the DAC peripheral to generate NoiseWaveThe waveform can be displayed using an oscilloscope. using DAC_CHANNEL_1(PA4) to output NoiseWave..

4.13.2 Directory content

This example can be found in the [DMA_NoiseWave](#) directory.

4.14 DMA_ADC

4.14.1 Example Description

This example provides an example of how to use a DMA channel to transfer continuously a data from a peripheral (ADC1) to DMA transfer. The ADC channel1 for APM32A091 MINI Board is configured to be converted when device startup.

4.14.2 Directory content

This example can be found in the [DMA_ADC](#) directory.

4.15 DMA_Usart

4.15.1 Example Description

This example provides a basic communication between USART1 and USART2 using DMA1 capability.

After system reset, USART2 Transmit data from DMA_USART_TxBuf to USART1. Data received by USART1 is transferred by DMA and stored in DMA_USART_RxBuf. If the data of DMA_USART_TxBuf and DMA_USART_RxBuf are the same, LED2 and LED3 will constantly flicker alternately, or flicker together.

4.15.2 Directory content

This example can be found in the [DMA_Usart](#) directory.

4.16 DMA_MemoryToMemory

4.16.1 Example Description

This example shows how to configure the DMA peripheral to transmit data from momery to momery. After system reset, data transmit form one group to another through DMA. If the data received is equal to the data send, LED2 will light, otherwise, LED3 will light..

4.16.2 Directory content

This example can be found in the [DMA_MemoryToMemory](#) directory.

4.17 EINT

4.17.1 Example Description

This example shows how to configure external interrupt lines. In this example, 2 EINT lines (KEY1、KEY2) when using the APM32A091 MINI BOARD are configured to generate an interrupt on each falling edge. In the interrupt routine a led connected to a specific GPIO pin is toggled.

In this example

- EINT0 is mapped to PA0(KEY2)
- EINT1 is mapped to PA1(KEY1)

After EINT configuration:

- when falling edge is detected on EINT0, LED2 toggles
- when falling edge is detected on EINT1, LED3 toggles

4.17.2 Directory content

This example can be found in the [EINT](#) directory.

4.18 Flash_Emulation_Eeprom

4.18.1 Example Description

This example provides a description of how to program the flash address.

After Reset, the Flash will be unlock. Then erase the specifies address and write a data in the address. In the end, lock the flash.The data of the address after erasing and programing will displayed on serial assistant through USART1.

4.18.2 Directory content

This example can be found in the [Flash_Emulation_Eeprom](#) directory.

4.19 FMC_Write

4.19.1 Example Description

This example provides a description of how to program the flash address of APM32A091.

After Reset, the Flash will be unlock. Then erase the specifies address and write a data in the address. In the end, lock the flash. The data of the address after erasing and programing will displayed on serial assistant through USART2.

4.19.2 Directory content

This example can be found in the [FMC_Write](#) directory.

4.20 GPIO_Toggle

4.20.1 Example Description

This example describes how to use DOUT for toggling IO. The IO of LED2 and LED3 is configed to toggle constantly. The phenomenon of LED2 and LED3 constantly flickered alternately.

4.20.2 Directory content

This example can be found in the [GPIO_Toggle](#) directory.

4.21 I2C_TwoBoards

4.21.1 Example Description

This example shows how to control I2C devices and communicate between two different boards.

- At startup, Boards master and slave are both in slave receiver mode and wait for messages to be received.
- When KEY1 is pressed on Board master, the master transmitter sent "Hello master" to Board slave. Message is displayed on serial assistant through USART2.
- When KEY1 is pressed on Board slave, the slave transmitter sent "Hello master" to Board master. The message is displayed on serial assistant through USART2.

4.21.2 Directory content

This example can be found in the [I2C_TwoBoards](#) directory.

4.22 I2S_TwoBoards

4.22.1 Example Description

This example provides a small application in which system sends and receives data by polling though using I2S firmware library. All received information will be displayed by serial assistant.

To use this example, you need to load it on two APM32A091 boards (let's call them Board master and Board slave). Then connect these two boards through I2S lines and must master and slave connect to the same GND.

After the program is downloaded, please reset the motherboard and then reset the slave. When compare buffer is the same, the Board slave LED2 is on. The phenomenon of data interaction process can be displayed using serial assistant.

4.22.2 Directory contents

This example can be found in the [I2S_TwoBoards](#) directory.

4.23 IAP_Application1

4.23.1 Example Description

This example shows how to generate a APP firmware to IAP.LED2 are toggled with a timing defined by the Delay function..

4.23.2 Directory contents

This example can be found in the [IAP_Application1](#) directory.

4.24 IAP_Application2

4.24.1 Example Description

This example shows how to generate a APP firmware to IAP.LED3 are toggled with a timing defined by the Delay function.

4.24.2 Directory contents

This example can be found in the [IAP_Application2](#) directory.

4.25 IAP_BootLoader

4.25.1 Example Description

The example aim to show how to configure a bootloader firmware to IAP.

When device connet to HyperTerminal right, a usart menu will show to user.

4.25.2 Directory contents

This example can be found in the [IAP_BootLoader](#) directory.

4.26 IWDT_FeedDog

4.26.1 Example Description

The example aim to show how to configure IWDT and feed dog to prevent a system reset. After IWDT initialization , System enters into infinite loop and feed dog within one second to prevent system reset. In the loop ,System will output information to serial assistant to display system status.

4.26.2 Directory contents

This example can be found in the [IWDT_FeedDog](#) directory.

4.27 IWDT_FeedDog_Window

4.27.1 Example Description

The example aim to show how to update the IWDG reload counter at special window period. After IWDT initialization, System enters into infinite loop and resets when feeding dog not in window period. In the same time, System will output information to serial assistant to display system status.

The IWDG counter is refreshed in the eint interrupt when press the KEY1 in window value to prevent a IWDG reset.

4.27.2 Directory content

This example can be found in the [IWDT_FeedDog_Window](#) directory

4.28 NVIC_WFI

4.28.1 Example Description

This example describes how to use WFI event to enter sleep mode and wake up using external interrupt.

At startup, press KEY2(PA0) to occur Wait For Interrupt(WFI) event, and device will enter sleep mode. The device will wake up if press KEY2 again.

4.28.2 Directory content

This example can be found in the [NVIC_WFI](#) directory.

4.29 PMU_Stop

4.29.1 Example Description

This example shows how to enter STOP mode and wake up from this mode through EINT interrupt. There is an infinite loop that will keep LED2 steady light in main program which means program is running.

Press KEY2, system enters STOP mode and LED2 turn off, LED3 turn on.

Press KEY1 or KEY2, system wake up from stop mode and LED2 steady light ,LED3 turn off.

4.29.2 Directory content

This example can be found in the [PMU_Stop](#) directory.

4.30 PMU_WakeUp

4.30.1 Example Description

This example shows how to enter the system by external interrupt to:

- STANDBY mode and wake-up from this mode either with the RESET or give PC13 a falling edge to recover.

- SLEEP mode and wake-up from this mode either with the RESET or give PA6 a falling edge to recover.

- STOP mode and wake-up from this mode with the RESET.

phenomenon:

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-If press KEY1(SLEEP mode): LED2 is on, while LED3 remain in the previous state. After giving PA6 a falling edge, system running from reset state.

-If press KET2(STANDBY mode): LED2 and LED3 are off. After giving PC13 a rising edge, system continue running.

-If low down PA7(STOP mode): LED2 and LED3 remain in the previous state. After reset, system recover to normal state.

4.30.2 Directory content

This example can be found in the [PMU_WakeUp](#) directory.

4.31 RCM_ClockSwitch

4.31.1 Example Description

This example shows how to:

- Configure the PLL (clocked by HSE) as System clock source
- Configure HSI as System clock source
- Configure HSE as System clock source
- Output the System clock on MCO pin.

Through two buttons(KEY1、KEY2), switch the system clock.

phenomenon:

- If press KEY1(PLL as clock source): LED2 flashing quickly
- If press KEY2(HSI as clock source): LED2 flashing normally
- You can monitor the system clock on MCO pin (PA.8) or on serial assistant.

4.31.2 Directory content

This example can be found in the [RCM_ClockSwitch](#) directory.

4.32 RTC_Alarm

4.32.1 Example Description

This example shows how to configure RTC and ALARM.

phenomenon:

- After initialization, Alarm begin to count down with LED2 is on. Five second later, Alarm is waking up and LED2 is off.
- You can monitor the system state on serial assistant.

4.32.2 Directory content

This example can be found in the [RTC_Alarm](#) directory.

4.33 RTC_Calendar

4.33.1 Example Description

This example shows how to:

- Using RTC to set the system time and date.
- recover system time from reset state by using RTC_WriteBackup and RTC_ReadBackup function.

phenomenon:

- Time and date information are displayed through serial assistant.
- If reset (Power is on), system will read data from the backup area and display it.
- If reset (System Power from off to on), system will reinitialize the RTC.

4.33.2 Directory content

This example can be found in the [RTC_Calendar](#) directory.

4.34 RTC_Stamp

4.34.1 Example Description

This example shows how to write/read data to/from RTC Backup data registers and demonstrates the Tamper detection feature.

The associated firmware performs the following:

1. It configures the Tamper pin to be falling edge, and enables the Tamper interrupt.
2. It writes the data to all RTC Backup data registers
3. On applying a low level on the RTC_AF1 pin (PC.13, connected to Tamper button), the RTC backup data registers are reset and the Tamper interrupt is generated.

phenomenon:

- If Tamper1 interrupt happen, LED2 is on

- If Tamper2 interrupt happen, LED3 is on
- Time and Backup data are displayed in serial assistant.

4.34.2 Directory content

This example can be found in the [RTC_Stamp](#) directory.

4.35 RTC_StopWatch

4.35.1 Example Description

This example demonstrates a default 00:00:00 chronometer counter is displayed on the serial port assistant.

It corresponds to [Hours]:[minutes]:[seconds].

User can manipulate the timer function through key1 and key2:

- press key1 to start counter.
- press key2 to show counter value.
- press key1 to reset all the counter value.

4.35.2 Directory content

This example can be found in the [RTC_StopWatch](#) directory.

4.36 RTC_TimeStamp

4.36.1 Example Description

This example provides a short description of how to use the RTC peripheral and the Time Stamp feature.

The associated firmware performs the following:

- 1.It configures the RTC TimeStamp pin to be falling edge and enables the TimeStamp detection.
- 2.When RTC_TimeStamp pin is on the air, a interrupt will be generated and print TimeStamp information to serial assistant.

phenomenon:

- TimeStamp information is displayed in serial assistant.

4.36.2 Directory content

This example can be found in the [RTC_TimeStamp](#) directory.

4.37 RTC_LPWR_Wakeup

4.37.1 Example Description

This example shows how to configure RTC and ALARM .

phenomenon :

- After initialization, Alarm begin to count down with LED2 is on. Five second later, Alarm is waking up and LED2 is off.

- You can monitor the system state on serial assisatant..

4.37.2 Directory content

This example can be found in the [RTC_LPWR_Wakeup](#) directory.

4.38 FreeRTOS

4.38.1 Example Description

This example describes show how to how to use FreeRTOS create multiple tasks.

Usart test task : USART1 and USART2 send or received data to each other. Verification will occur after transmission,

if send and received data pass, LED3 will be on all the time.

if send and received data fault, LED3 will be off all the time.

if send or received data fault, LED3 will be constantly flickered alternately.

Led toggle task : The IO of LED2 is configed to toggle constantly

The phenomenon of LED2 constantly flickered alternately,

if Data transmission pass, LED3 will be on, and data interaction process can be displayed using serial assistant..

4.38.2 Directory content

This example can be found in the [FreeRTOS](#) directory.

4.39 RT-Thread

4.39.1 Example Description

This example describes how to use RT-Thread for APM32A0xx.

The IO of LED2 and LED3 is configed to toggle constantly.

The phenomenon of LED2 and LED3 constantly flickered alternately.

4.39.2 Directory content

This example can be found in the [RT-Thread](#) directory.

4.40 RTX

4.40.1 Example Description

This example describes show how to how to use RTX5 create multiple tasks.

Usart test task : USART1 and USART2 send or received data to each other. Verification will occur after transmission, if send and received data pass, LED3 will be on all the time. if send and received data fault, LED3 will be off all the time. if send or received data fault, LED3 will be constantly flickered alternately.

Led toggle task : The IO of LED2 is configed to toggle constantly

The phenomenon of LED2 constantly flickered alternately, if Data transmission pass, LED3 will be on, and data interaction process can be displayed using serial assistant.

4.40.2 Directory content

This example can be found in the [RTX](#) directory.

4.41 SPI_FLASH_Polling

4.41.1 Example Description

This demo is based on the APM32A091 board, it shows how to use SPI peripheral by making a master/slave full duplex communication between the SPI and the UART1.

The phenomenon of serial assistant can display information from USART2.

4.41.2 Directory content

This example can be found in the [SPI_FLASH_Polling](#) directory.

4.42 SPI_FullDuplex

4.42.1 Example Description

This demo is based on the APM32A091 board, it shows how to use SPI peripheral. By making a master/slave full duplex communication between the SPI and the UART1.

The phenomenon of serial assistant can display information from USART2.

4.42.2 Directory content

This example can be found in the [SPI_FullDuplex](#) directory.

4.43 SPI_TwoBoards

4.43.1 Example Description

This example provides a small application in which system sends and receives data by polling though using SPI firmware library. All received information will be displayed by serial assistant.

To use this example, you need to load it on two APM32A091 boards (let's call them Board master and Board slave). Then connect these two boards through SPI lines and must master and slave connect to the same GND. When compare buffer is the same, the LED2 is on.

The phenomenon of data interaction process can be displayed using serial assistant.

4.43.2 Directory content

This example can be found in the [SPI_TwoBoards](#) directory.

4.44 SysTick

4.44.1 Example Description

This example shows how to configure the SysTick to generate a time base equal to 1 ms. The system clock is set to 8 MHz, the SysTick is clocked by the HSE clock.

A "Delay" function is implemented based on the SysTick end-of-count event.

For LEDs are toggled with a timing defined by the Delay function.

4.44.2 Directory content

This example can be found in the [SysTick](#) directory.

4.45 Template

4.45.1 Example Description

This demo is based on the APM32A091 MINI board. it provides a template project.

4.45.2 Directory contents

This example can be found in the Template directory.

4.46 TMR_6Steps

4.46.1 Example Description

The program to show how to configure the TMR1 peripheral to generate 6 Steps.

In this example, a software COM event is generated each 100 ms.

The TMR1 is configured in Timing Mode, each time a COM event occurs, a new TMR1 configuration will be set in advance..

4.46.2 Directory contents

This example can be found in the [TMR_6Steps](#) directory.

4.47 TMR_32BitCount

4.47.1 Example Description

This example describes how to configure the TMR3 and TMR15 realize the 32-bit timer.

TMR15 as High 16 bit count value, TMR3 as Low 16 bit count value. User can view the counter value through serial terminal.

4.47.2 Directory contents

This example can be found in the [TMR_32BitCount](#) directory.

4.48 TMR_ComplementaryOutput

4.48.1 Example Description

This example shows how to configure the TMR1 peripheral to generate complementary TMR1 signals, to insert a defined dead time value.

The phenomenon of observe whether the output waveform is correct through the oscilloscope. Besides LED2 and LED3 constantly flashing.

using TMR1 CH1 PA7 to output PWM

using TMR1 CH1N PA8 to output PWM

4.48.2 Directory contents

This example can be found in the [TMR_ComplementaryOutput](#) directory.

4.49 TMR_DMABurst

4.49.1 Example Description

The program to show how to configure the TMR1 channel period

and the duty cycle by DMA burst to generate 7 PWM

with 7 different duty cycles (80%, 70%, 60%, 50%, 40%, 30% and 20%).

On the DMA update request, the DMA will do 6 transfers of half words into TMR1 registers (AUTORLD, REPCNT, CC1, CC2, CC3, CC4).

999 will be transferred into AUTORLD

0 will be transferred into REPCNT

800 will be transferred into CC1.

700 will be transferred into CC2.

600 will be transferred into CC3.

500 will be transferred into CC4.

The objective is to generate 7 PWM signal at 1 KHz:

- SystemCoreClock = 48 MHz.
- TMR1CLK = SystemCoreClock, Prescaler =47, TMR1 counter clock = 1 MHz
- TMR1_Period = (1000000 / 1000) - 1
- Channel 1 duty cycle = 80%
- Channel 2 duty cycle = 70%
- Channel 3 duty cycle = 60%
- Channel 4 duty cycle = 50%
- Channel 3N duty cycle = 40%
- Channel 2N duty cycle = 30%
- Channel 1N duty cycle = 20%

Display TMR1 waveform by oscilloscope.

4.49.2 Directory contents

This example can be found in the [TMR_DMABurst](#) directory.

4.50 TMR_EncoderInterface

4.50.1 Example Description

This example describes how to configure the TMR1 peripheral to Encoder mode.

4.50.2 Directory contents

This example can be found in the [TMR_EncoderInterface](#) directory.

4.51 TMR_ExtTriggerSynchro

4.51.1 Example Description

This example shows how to synchronize TMR1 and TMR peripherals in cascade mode with an external trigger

- TMR1 Master for TMR2 Config Toggle Mode and Enable event is used as Trigger Output
- TMR2 is slave for TMR1, And master for TMR3
- Config Toggle Mode and Enable event is used as Trigger Output
- The ITR0(TMR1) is used as input trigger
- TMR3 is slave for TMR2,
- Config Toggle Mode
- The ITR1(TMR2) is used as input trigger
- The TMR1 peripherals clock is 48 MHz.
- The Master Timer TMR1 frequency :
- $TMR1 \text{ frequency} = (48M) / (23 + 1) / 2 = 1\text{MHz}$
- The TMR2 is running at:
- $TMR2 \text{ frequency} = (48M) / (47 + 1) / 2 = 500\text{KHz}$
- The TMR3 is running at:
- $TMR3 \text{ frequency} = (48M) / (95 + 1) / 2 = 250\text{KHz}$

The starts and stops of the TMR1 counters are controlled by the external trigger.

The TMR2 starts and stops are controlled by the TMR1, and the TMR3 starts and stops are controlled by the TMR2.

4.51.2 Directory contents

This example can be found in the [TMR_ExtTriggerSynchro](#) directory.

4.52 TMR_InputCapture

4.52.1 Example Description

This example shows how to configure the TMR1 peripheral to capture the internal clock source from pin MCO.

The result will be displayed on serial assistant through USART2.

4.52.2 Directory contents

This example can be found in the [TMR_InputCapture](#) directory.

4.53 TMR_OCActive

4.53.1 Example Description

The program to show how to configure the TMR3 peripheral to generate 4 different signals with four different delays.

- SystemCoreClock = 48MHz.
- TMR3CLK = SystemCoreClock = 48MHz.Prescaler = 47, TMR counter clock = 1 MHz
- TMR3_Period = (1000000 / 1000) - 1
- TMR3 CH1 pulse = 800
- TMR3 CH1 delay = 800/1MHz = 800us
- TMR3 CH2 pulse = 600
- TMR3 CH2 delay = 600/1MHz = 600us
- TMR3 CH3 pulse = 400
- TMR3 CH3 delay = 400/1MHz = 400us
- TMR3 CH4 pulse = 200
- TMR3 CH4 delay = 200/1MHz = 200us

The CHx delay correspond to the time difference between PB6 falling edge and TMR3_CHx signal

rising edges. Reset system and display TMR3 waveform by oscilloscope.

4.53.2 Directory contents

This example can be found in the [TMR_OCActive](#) directory.

4.54 TMR_OCInactive

4.54.1 Example Description

The program to show how to configure the TMR3 peripheral in Output Compare Inactive mode.

4.54.2 Directory contents

This example can be found in the [TMR_OCInactive](#) directory.

4.55 TMR_OCToggle

4.55.1 Example Description

The program to show how to configure the TMR3 peripheral to generate 4 waveform with 4 different frequencies.

4.55.2 Directory contents

This example can be found in the [TMR_OCToggle](#) directory.

4.56 TMR_ParallelSynchro

4.56.1 Example Description

This example shows how to synchronize TMR peripherals in parallel mode.

4.56.2 Directory contents

This example can be found in the [TMR_ParallelSynchro](#) directory.

4.57 TMR_PWMInput

4.57.1 Example Description

This example describes how to use TMR3 Channel_2 measure frequency and duty cycle of external signal. User can view the "DutyCycle" "Frequency" value through serial terminal.

TMR4_IRQHandler Function to calculate:

DutyCycle = (TMR5_CC1*100)/(TMR5_CC2) %.

Frequency = (RCM_ReadHCLKFreq()/2) / (TMR5_CC2) Hz.

The minimum frequency value to measure is 1 Hz..

4.57.2 Directory contents

This example can be found in the [TMR_PWMInput](#) directory.

4.58 TMR_PWMOutput

4.58.1 Example Description

This example shows how to configure the TMR1 peripheral to generate PWM signals with different duty cycles. The TMR1 waveform can be displayed using an oscilloscope.

using TMR1 CHANNEL1(PA8) to output PWM

4.58.2 Directory contents

This example can be found in the [TMR_PWMOutput](#) directory.

4.59 TMR_SinglePulse

4.59.1 Example Description

This example shows how to use the TMR peripheral to generate a One-pulse Mode after a falling edge of an external signal is received in Timer Input pin.

The TMR3 waveform can be displayed using an oscilloscope.

4.59.2 Directory content

This example can be found in the [TMR_SinglePulse](#) directory..

4.60 TMR_SynchronizationWithTMR1

4.60.1 Example Description

This example shows how to synchronize TMR peripherals in cascade mode, two timers TMR1 and TMR3 are used.

The phenomenon of observe whether the output waveform is correct through the oscilloscope.

Using TMR3 CH1(PA6) to output PWM

4.60.2 Directory content

This example can be found in the [TMR_SynchronizationWithTMR1](#) directory.

4.61 TMR_TimeBase

4.61.1 Example Description

This example aims to show how to realize timing one second by using TMR14 peripheral generating time base.

LED2 and LED3 will toggle per second.

4.61.2 Directory content

This example can be found in the [TMR_TimeBase](#) directory.

4.62 TMR_DMA

4.62.1 Example Description

This example aims to show how to realize timing one second by using TMR14 peripheral generating time base.

LED2 and LED3 will toggle per second.

4.62.2 Directory content

This example can be found in the [TMR_TimeBase](#) directory.

4.63 TSC_KeyLinearRotate

4.63.1 Example Description

This example provides a description of how use the TSC (Touch sensing controller) device on APM32A091 to achieve Key, Linear, Rotation control.

The five touch keys to control LED on and off.

The linear rotation touch will display the value on the OLDE.

4.63.2 Directory content

This example can be found in the [TSC_KeyLinearRotate](#) directory.

4.64 USART_Interrupt

4.64.1 Example Description

Through The computer of serial debugging assistant, display the message sent and received between the MCU and USART1.

The phenomenon of serial assistant can display information from USART1 and debug information of USART2.

4.64.2 Directory content

This example can be found in the [USART_Interrupt](#) directory.

4.65 USART_IrDA

4.65.1 Example Description

The program shows how to using USART IrDA mode, in this case,

USART1 sends data to upper computer. You can check the data in a Serial Port Utility.

4.65.2 Directory content

This example can be found in the [USART_IrDA](#) directory.

4.66 USART_LIN

4.66.1 Example Description

The program shows how to using USART LIN mode, in this case,

USART1 sends data to upper computer. You can check the data in a Serial Port Utility.

4.66.2 Directory content

This example can be found in the [USART_LIN](#) directory.

4.67 USART_Polling

4.67.1 Example Description

The program aims to show how to send or received data by using USART, in this case, USART1 and USART2 send or received data to each other. Verification will occur after transmission, if passed, LED2 will be on.

The phenomenon of data interaction process can be displayed using serial assistant.

4.67.2 Directory content

This example can be found in the [USART_Polling](#) directory.

4.68 USART_Smartcard

4.68.1 Example Description

The program shows how to using USART Smartcard mode, in this case,

USART1 sends data to upper computer. You can check the data in a Serial Port Utility.

4.68.2 Directory content

This example can be found in the [USART_Smartcard](#) directory.

4.69 WWDT_OverTime

4.69.1 Example Description

This example aims to show how to use WWDT.

If `is_OverTime = 0`, System would not reset for feeding dog timely. LED2 Toggle.

If `is_OverTime = 1`, System will reset. LED3 ON.

4.69.2 Directory content

This example can be found in the [WWDT_OverTime](#) directory.

5 About libraries

The libraries folder includes a series library. It can provide supports for APM32A0xx MCU such as device support and standard peripheral. The libraries can be found in the [Libraries](#) directory.

APM32A0xx MCU include following library:

- Libraries folder
 - * APM32A0xx_StdPeriphDriver
 - * CMSIS
 - * Device
 - * TSC_Device_Lib

6 About middlewares

The middlewares can be found in the [Middlewares](#) directory.

The middlewares used by APM32A0xx MINI include following:

- Middlewares folder
 - * FreeRTOS
 - * RealThread
 - * RTX5

7 About Package

The Package folder includes Geehy APM32A0xx_DFP Package. The Package can be found in the [Package](#) directory.

The Package used by APM32A0xx MINI include following:

- Package folder
 - * SVD folder
 - * Geehy.APM32A0xx_DFP.1.0.0.pack

8 Revision History

Table 1 File Revision History

Date	Rev	Description
2023.04.15	1.0	First release version of APM32A0xx SDK v1.0

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8. Scope of Application

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