

Readme

APM32F4xx DAL SDK

Rev: V1.2

1 Introduction

The Geehy Semiconductor APM32F4xx device abstract library 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](#)

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2 About SDK

2.1 DAL SDK files

The complete SDK directory:

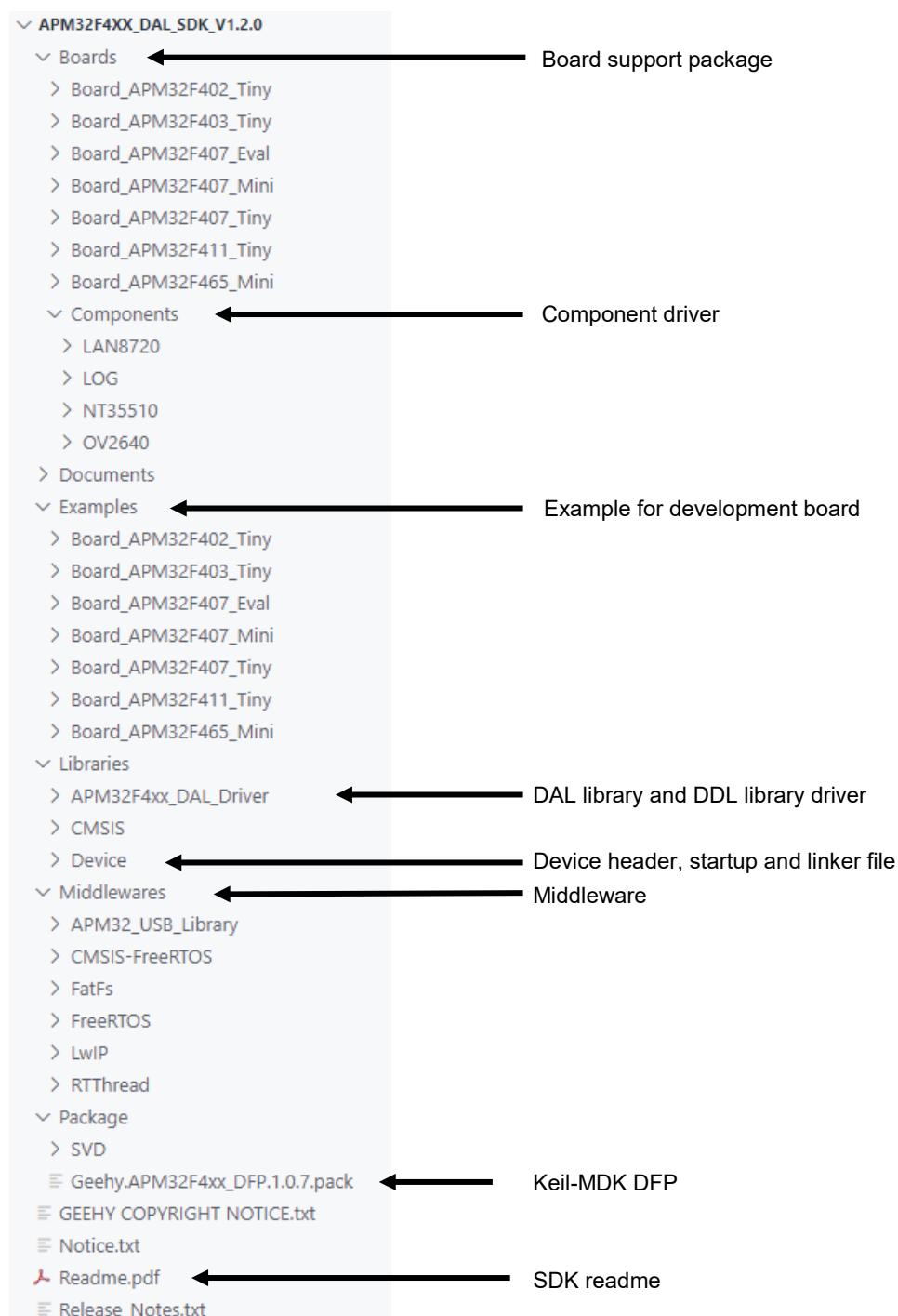


Figure 1 DAL SDK of APM32F4xx

DAL SDK are composed of the following set of files:

2.1.1 Boards

Table 1 List of boards

File	Description
board_apm32f4xx_xxx.c	Board support package file of development board. It includes the basic on-board peripheral drivers. Example: board_apm32f407_mini.c
board_apm32f4xx_xxx.h	Header file of the board support package main driver C file. It includes common data, handle and enumeration structures, define statements and macros, as well as the exported generic APIs. Example: board_apm32f407_mini.h
board_xxx.c	Driver file of component. It includes the basic dirver function for component. Example: board_lan8720.c
board_xxx.h	Header file of the component main driver C file. It includes common data, handle and enumeration structures, define statements and macros, as well as the exported generic APIs. Example: board_lan8720.h

2.1.2 Libraries

Table 2 DAL driver files

File	Description
apm32f4xx_dal_ppp.c	Peripheral or module driver file. It includes the APIs that are common to all APM32F4xx devices. Example: apm32f4xx_dal_adc.c
apm32f4xx_dal_ppp.h	Header file of the peripheral or module driver C file. It includes common data, handle and enumeration structures, define statements and macros, as well as the exported generic APIs. Example: apm32f4xx_dal_adc.h

File	Description
apm32f4xx_dal_ppp_ex.c	Extension file of a Peripheral or module driver. It includes the specific APIs for a given part number or family. Example: apm32f4xx_dal_adc_ex.c
apm32f4xx_dal_ppp_ex.h	Header file of the peripheral or module extension C file. It includes specific data, handle and enumeration structures, define statements and macros, as well as the exported generic APIs. Example: apm32f4xx_dal_adc_ex.h
apm32f4xx_dal.c	DAL initialization file. It includes the DAL initialization function and DBGMCU function. Remap and time delay based on SysTick APIs.
apm32f4xx_dal.h	Header file of apm32f4xx_dal.c
apm32f4xx_device_cfg_template.c	Template file to be copied to the application folder. It includes the Device Config and Device Reset of the peripheral used in the application.
apm32f4xx_dal_cfg_template.h	Template file allowing to customize the drivers for a given application.
apm32f4xx_dal_def.h	Common DAL resources.

2.1.3 Examples

Table 3 Application files

File	Description
apm32f4xx_device_cfg.c/h	It includes the Device Config and Device Reset of the peripheral used in the application.
apm32f4xx_ppp_cfg.c/h	Peripheral or service configuration file. It includes the Config and Reset of the peripheral / module used in the application. Example: apm32f4xx_adc_cfg.c/h, apm32f4xx_rmc_cfg.c/h

apm32f4xx_device_cfg.c/h	It includes the Device Config and Device Reset of the peripheral used in the application.
apm32f4xx_ppp_cfg.c/h	Peripheral or service configuration file. It includes the Config and Reset of the peripheral / module used in the application. Example: apm32f4xx_adc_cfg.c/h, apm32f4xx_rcm_cfg.c/h
apm32f4xx_int.c/h	This file contains the exceptions handler and peripherals interrupt service routine.
main.c/h	This file contains the main program, mainly: - Call to DAL_DeviceConfig() - Application code.

2.2 Devices supported by DAL and DDL drivers

Table 4 List of devices supported by DAL and DDL drivers

IP / Module	APM32F405xx	APM32F407xx	APM32F417xx	APM32F465xx	APM32F411xx	APM32F402xx	APM32F403xx	NA	NA	NA
apm32f4xx_dal.c	✓	✓	✓	✓	✓	✓	✓			
apm32f4xx_dal_adc.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_adc_ex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_can.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_cortex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_crc.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_cryp.c			✓							
apm32f4xx_dal_cryp_ex.c			✓							
apm32f4xx_dal_comp.c						✓				
apm32f4xx_dal_dac.c	✓	✓	✓	✓						
apm32f4xx_dal_dac_ex.c	✓	✓	✓	✓						
apm32f4xx_dal_dci.c		✓	✓							
apm32f4xx_dal_dci_ex.c		✓	✓							
apm32f4xx_dal_dma.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_dma_ex.c	✓	✓	✓	✓	✓	✓				
apm32f4xx_dal_eint.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_eth.c		✓	✓							
apm32f4xx_dal_flash.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_flash_ex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_flash_ramfunc.c						✓				
apm32f4xx_dal_gpio.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_gpio_ex.c							✓	✓		
apm32f4xx_dal_hash.c			✓							
apm32f4xx_dal_hash_ex.c			✓							
apm32f4xx_dal_hcd.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_i2c.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_i2c_ex.c						✓				
apm32f4xx_dal_i2s.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_i2s_ex.c	✓	✓	✓	✓	✓	✓				
apm32f4xx_dal_irda.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_iwdt.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_mmc.c	✓	✓	✓	✓	✓	✓				
apm32f4xx_dal_nand.c	✓	✓	✓	✓	✓	✓				
apm32f4xx_dal_nor.c	✓	✓	✓	✓	✓	✓				
apm32f4xx_dal_pccard.c	✓	✓	✓	✓	✓					
apm32f4xx_dal_pcd.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_pcd_ex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_pmu.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_pmu_ex.c	✓	✓	✓	✓	✓	✓				

IP / Module	APM32F405xx	APM32F407xx	APM32F417xx	APM32F465xx	APM32F411xx	APM32F402xx	APM32F403xx	NA	NA	NA
apm32f4xx_dal_qspi.c					✓					
apm32f4xx_dal_rcm.c	✓	✓	✓	✓	✓	✓	✓			
apm32f4xx_dal_rcm_ex.c	✓	✓	✓	✓	✓	✓	✓			
apm32f4xx_dal_rng.c	✓	✓	✓	✓	✓					
apm32f4xx_dal_RTC.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_RTC_ex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_sd.c	✓	✓	✓	✓	✓					
apm32f4xx_dal_sdram.c		✓	✓							
apm32f4xx_dal_smartcard.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_smbus.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_spi.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_sram.c	✓	✓	✓	✓	✓					
apm32f4xx_dal_tmr.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_tmr_ex.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_uart.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_usart.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_dal_wwdt.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_adc.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_crc.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_comp.c						✓				
apm32f4xx_ddl_dac.c	✓	✓	✓	✓	✓					
apm32f4xx_ddl_dmc.c		✓	✓							
apm32f4xx_ddl_dma.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_eint.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_gpio.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_i2c.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_pmu.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_rcm.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_rng.c	✓	✓	✓	✓	✓					
apm32f4xx_ddl_RTC.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_sdmmc.c	✓	✓	✓	✓	✓					
apm32f4xx_ddl_smcc.c	✓	✓	✓	✓	✓					
apm32f4xx_ddl_spi.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_TMR.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_usart.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_usb.c	✓	✓	✓	✓	✓	✓	✓	✓		
apm32f4xx_ddl_utils.c	✓	✓	✓	✓	✓	✓	✓	✓		

3 About boards

The boards folder includes a board support package for APM32F4xx 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 APM32F4xx board. For other user development board use, some minor modifications may be required.

Boards have a hierarchy as follows:

- Board_APM32F402_Tiny folder
- Board_APM32F403_Tiny folder
- Board_APM32F407_Mini folder
- Board_APM32F407_Eval folder
- Board_APM32F407_Tiny folder
- Board_APM32F411_Tiny folder
- Board_APM32F465_Mini folder
- Components folder
 - * LAN8720
 - * NT35510
 - * OV2640

4 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.

5 About examples

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

The examples provided are built for APM32F4xx xxx board. For other user development board use, some minor modifications may be required.

Example projects have a hierarchy as follows:

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

All example applications tested with: **APM32F4xx DAL V1.1.3**, include the following examples:

Table 5 List of examples supported for evaluation board

IP / Module	Example	APM32F407_MINI	APM32F407_TINY	APM32F407_EVAL	APM32F465_MINI	APM32F411_TINY	APM32F402_TINY	APM32F403_TINY	NA	NA
ADC	ADC_AnalogWindowWatchdog	✓	✓		✓	✓	✓	✓		
	ADC_ContinuousConversion	✓	✓		✓	✓	✓	✓		
	ADC_DualInterleavedMode	✓	✓		✓					
	ADC_DualRegulSimulMode	✓	✓		✓		✓	✓		
	ADC_MultiChannelScan	✓	✓		✓	✓	✓	✓		
	ADC_TemperatureSensor	✓	✓		✓	✓	✓	✓		
	ADC_TripleInterleavedMode	✓	✓		✓					
	ADC_DMA	✓	✓		✓	✓	✓	✓		
	ADC_VBAT	✓	✓		✓	✓				
	ADC_ContinuousConversionADC2					✓				

IP / Module	Example	APM32F407_MINI	APM32F407_TINY	APM32F407_EVAL	APM32F465_MINI	APM32F411_TINY	APM32F402_TINY	APM32F403_TINY	NA	NA
BAKPR	BAKPR_Tamper						✓	✓		
CAN	CAN_LoopBack	✓	✓		✓	✓	✓	✓		
	CAN_LoopBackCAN2	✓	✓							
	CAN_Normal	✓	✓				✓	✓		
COMP	COMP_PWMBreak					✓				
	COMP_WindowComparator					✓				
CRYP	CRYP_TDES	✓	✓							
	CRYP_AES	✓	✓							
CRC	CRC_Calculation	✓	✓		✓	✓				
DAC	DAC_ADC	✓	✓		✓					
DCI	DCI_OV2640_JPEG	✓		✓						
	DCI_OV2640_RGB				✓					
DMA	DMA_FIFOMode	✓	✓			✓				
	DMA_ADC							✓		
	DMA_FMCToRAM	✓	✓		✓	✓	✓			
DMC	DMC_SDRAM				✓					
DSP	DSP_bayes	✓								
	DSP_class_marks	✓								
	DSP_convolution	✓								
	DSP_dotproduct	✓								
	DSP_fft_bin	✓								
	DSP_fir	✓								
	DSP_graphic_equalizer	✓								
	DSP_linear_interp	✓								
	DSP_matrix	✓								
	DSP_signal_converge	✓								
	DSP_sin_cos	✓								
	DSP_svm	✓								
	DSP_Template	✓								
	DSP_variance	✓								
EINT	EINT_Config	✓	✓		✓	✓	✓	✓		

IP / Module	Example								
	APM32F407_MINI	APM32F407_TINY	APM32F407_EVAL	APM32F465_MINI	APM32F411_TINY	APM32F402_TINY	APM32F403_TINY	NA	NA
ETH	ETH_Ping	✓	✓						
	ETH_TCP_Client	✓	✓						
FMC	FMC_Flash_EEPROM	✓	✓						
	FMC_Read_Write	✓	✓			✓	✓		
	FMC_Protection					✓	✓		
	FMC_Write	✓	✓	✓	✓	✓	✓		
GPIO	GPIO_Toggle	✓	✓	✓	✓	✓	✓		
HASH	HASH_SHA1	✓	✓						
I2C	I2C_TwoBoardsPolling	✓	✓	✓	✓	✓	✓		
I2S	I2S_TwoBoardsInterrupt					✓	✓		
	I2S_Interrupt	✓	✓	✓	✓				
IAP	IAP_Application1	✓	✓		✓	✓	✓		
	IAP_Application2	✓	✓		✓	✓	✓		
	IAP_BootLoader	✓	✓		✓	✓	✓		
IWDT	IWDT_Reset	✓	✓	✓	✓	✓	✓		
NVIC	NVIC_Priority	✓	✓	✓	✓	✓	✓		
	NVIC_WFI	✓	✓			✓	✓		
PMU	PMU_STANDBY	✓	✓	✓	✓	✓	✓		
	PMU_STOP	✓	✓	✓	✓	✓	✓		
	PMU_BOR	✓	✓						
	PMU_Consumption	✓	✓		✓	✓	✓		
	PMU_PVD	✓	✓						
QSPI	QSPI_ReadWrite					✓			
	QSPI_ReadWriteDMA					✓			
	QSPI_ReadWriteInterrupt					✓			
RCM	RCM_ClockConfig	✓	✓	✓	✓	✓	✓		
RNG	RNG_MultiRNG	✓	✓		✓				
RTC	RTC_Alarm	✓	✓	✓	✓	✓	✓		
	RTC_Second					✓	✓		
RTOS	FreeRTOS	✓	✓			✓			
	CMSIS-FreeRTOS					✓	✓		
	RT-thread	✓	✓						
	RTX5	✓	✓		✓	✓	✓		

IP / Module	Example	APM32F407_MINI	APM32F407_TINY	APM32F407_EVAL	APM32F403_TINY	APM32F411_TINY	APM32F402_TINY	APM32F403_TINY	NA	NA
SMC	LCD_DrawFigure			✓						
SDIO	SDIO_FatFs	✓	✓	✓		✓				
SPI	SPI_FullDuplex	✓	✓		✓	✓	✓	✓		
	SPI_Flash			✓						
Systick	SysTick_TimeBase	✓	✓				✓	✓		
TMR	TMR_TMR1DMAburst	✓	✓			✓	✓	✓		
	TMR_InputCapture	✓	✓		✓	✓	✓	✓		
	TMR_SinglePulse	✓	✓			✓	✓	✓		
	TMR_PWMInput	✓	✓			✓	✓	✓		
	TMR_PWMOutput	✓	✓		✓	✓	✓	✓		
	TMR_TimeBase	✓	✓		✓	✓	✓	✓		
	TMR_6Steps	✓	✓			✓	✓	✓		
	TMR_32BitCount	✓	✓				✓	✓		
	TMR_CascadeSynchro	✓	✓			✓	✓	✓		
	TMR_EncoderInterface	✓	✓			✓	✓	✓		
	TMR_ExtTriggerSynchro	✓	✓			✓	✓	✓		
	TMR_OCActive	✓	✓			✓	✓	✓		
	TMR_OCIInactive	✓	✓			✓	✓	✓		
	TMR_OCToggle	✓	✓			✓	✓	✓		
	TMR_ParallelSynchro	✓	✓			✓	✓	✓		
	TMR_TMR1PWMOutput	✓	✓			✓	✓	✓		
	TMR_TMR1Synchro	✓	✓			✓	✓	✓		
USART	TMR_TMR2PWMOutput	✓	✓			✓	✓	✓		
	TMR_TMR8DMA	✓	✓			✓	✓	✓		
	TMR_TMR9OCToggle	✓	✓							
	TMR_TMR11PWMOutput	✓	✓							
	UART_TwoBoardsDMA	✓	✓	✓	✓	✓	✓	✓		
	UART_TwoBoardsInterrupt	✓	✓	✓		✓	✓	✓		
	UART_TwoBoardsPolling	✓	✓	✓		✓	✓	✓		
	USART_IrDA						✓	✓		
	USART_LIN						✓	✓		
	USART_Printf						✓	✓		
	USART_Smartcard						✓	✓		

IP / Module	Example	APM32F407_MINI	APM32F407_TINY	APM32F407_EVAL	APM32F465_MINI	APM32F411_TINY	APM32F402_TINY	APM32F403_TINY	NA	NA
USART	UART_RS485			✓			✓	✓		
OTG	OTGD_CDC	✓		✓	✓	✓	✓	✓		
	OTGD_Composite_CDC	✓								
	OTGD_Composite_CDC_WINUSB	✓								
	OTGD_Custom_HID	✓								
	OTGD_HID	✓		✓	✓	✓	✓	✓		
	OTGD_HID_Keyboard	✓								
	OTGD_MSC	✓		✓	✓	✓	✓	✓		
	OTGD_MSC_HS1	✓								
	OTGD_WINUSB	✓		✓	✓	✓	✓	✓		
	OTGH_CDC	✓			✓	✓	✓	✓		
	OTGH_HID	✓			✓	✓	✓	✓		
	OTGH_MSC	✓			✓	✓	✓	✓		
	OTGH_DynamicSwitch						✓	✓		
	OTGH_MSC_FWUpgrade						✓	✓		
	OTGH_MSC_HS1	✓								
	OTGD_CDC_HS2		✓							
	OTGD_Custom_HID_HS2		✓							
	OTGD_HID_HS2		✓							
	OTGD_HID_Keyboard_HS2		✓							
	OTGD_MSC_HS_IN_FS		✓							
	OTGD_MSC_HS2		✓							
	OTGD_WINUSB_HS2		✓							
	OTGH_CDC_HS2		✓	✓						
	OTGH_HID_HS2		✓	✓						
	OTGH_MSC_HS2		✓	✓						
WWDT	WWDT_OverTime	✓	✓		✓	✓	✓	✓		

6 About libraries

The libraries folder includes a series library. It can provide supports for APM32F4xx MCU such as device support and device abstract library etc. The libraries can be found in the [~/Libraries](#) directory.

APM32F4xx MCU include following library:

- Libraries folder
 - * APM32F4xx_DAL_Driver
 - * CMSIS
 - * Device

7 About middlewares

The middlewares folder includes a series third-party middleware. The middlewares can be found in the [~/middlewares](#) directory.

The middlewares used by APM32F4xx include following:

- Middlewares folder
 - * APM32_USB_Library
 - * FatFs
 - * CMSIS-FreeRTOS
 - * FreeRTOS
 - * lwip
 - * RTThread

8 About Package

The Package folder includes Geehy APM32F4xx DFP Package. The Package can be found in the [~/Package](#) directory.

The package used by APM32F4xx include following:

- Package folder
 - * SVD
 - * Geehy.APM32F4xx_DFP.1.0.7.pack

9 Revision History

Table 1 File Revision History

Date	Rev	Description
2023.09.13	1.0	First Release version of APM32F4xx DAL SDK.
2024.02.01	1.1	Add the chapter description for "Devices supported by DAL and DDL drivers."
2024.12.31	1.2	Add a description for APM32F402/403xx device driver support.

Statement

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