

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](#)

Table of Contents

1	Introduction	1
2	About SDK	3
2.1	DAL SDK files.....	3
2.2	Devices supported by DAL and DDL drivers.....	7
3	About boards	9
4	About documents.....	10
5	About examples.....	11
6	About libraries	16
7	About middlewares	17
8	About Package	18
9	Revision History	19

2 About SDK

2.1 DAL SDK files

The complete SDK directory:

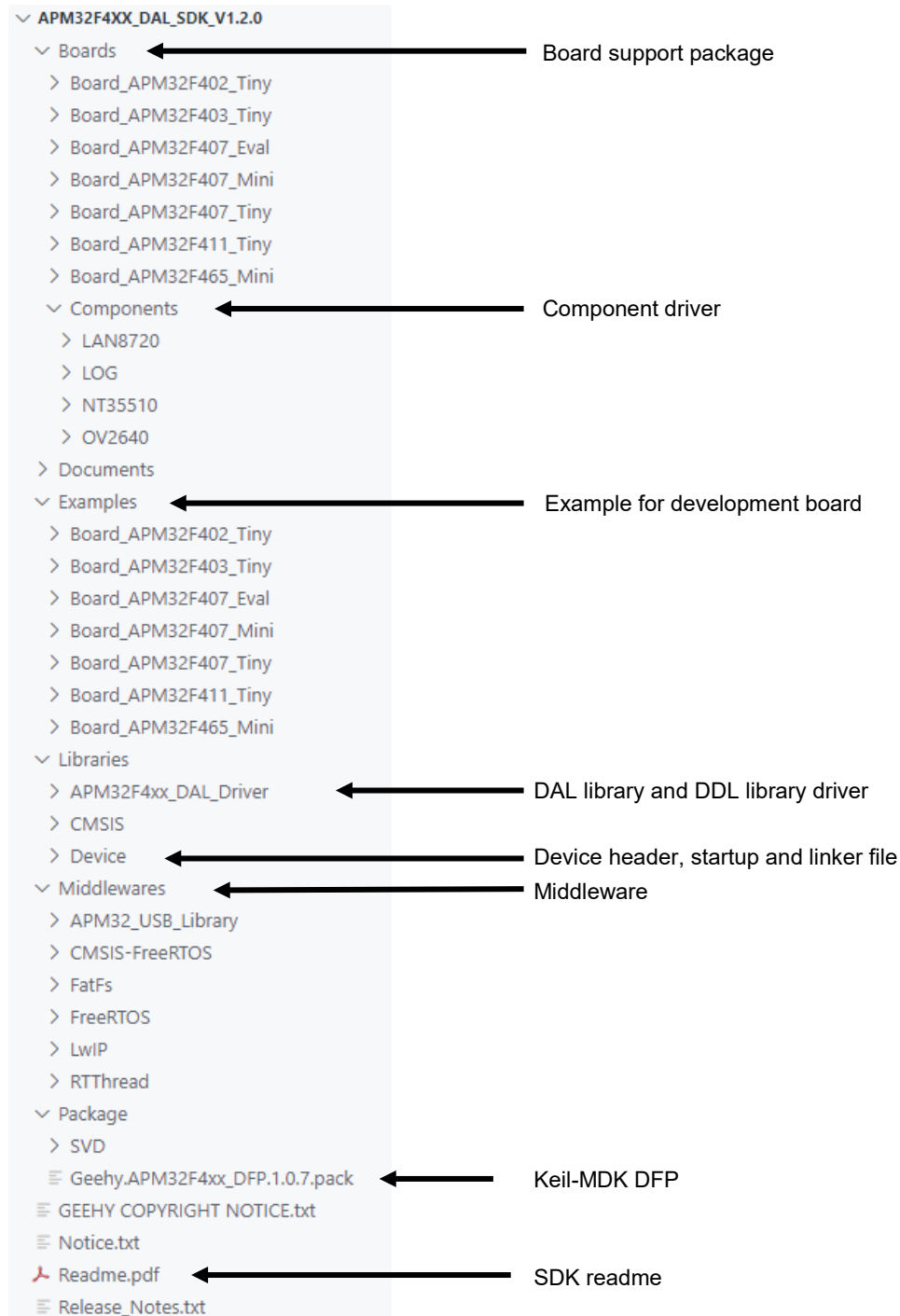


Figure 1 DAL SDK of APM32F4xx

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 driver 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_XXX.c	Peripheral or module driver file. It includes the APIs that are common to all APM32F4xx devices. Example: apm32f4xx_dal_adc.c
apm32f4xx_dal_XXX.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_rcm_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_iwtdt.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_smc.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_OCAActive	√	√			√	√	√		
	TMR_OCInactive	√	√			√	√	√		
	TMR_OCToggle	√	√			√	√	√		
	TMR_ParallelSynchro	√	√			√	√	√		
	TMR_TMR1PWMOutput	√	√			√	√	√		
	TMR_TMR1Synchro	√	√			√	√	√		
	TMR_TMR2PWMOutput	√	√			√	√	√		
	TMR_TMR8DMA	√	√			√	√	√		
	TMR_TMR9OCToggle	√	√							
	TMR_TMR11PWMOutput	√	√							
USART	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

This document is formulated and published by Geehy Semiconductor Co., Ltd. (hereinafter referred to as “Geehy”). The contents in this document are protected by laws and regulations of trademark, copyright and software copyright. Geehy reserves the right to make corrections and modifications to this document at any time. Please read this document carefully before using Geehy products. Once you use the Geehy product, it means that you (hereinafter referred to as the “users”) have known and accepted all the contents of this document. Users shall use the Geehy product in accordance with relevant laws and regulations and the requirements of this document.

1. Ownership

This document can only be used in connection with the corresponding chip products or software products provided by Geehy. Without the prior permission of Geehy, no unit or individual may copy, transcribe, modify, edit or disseminate all or part of the contents of this document for any reason or in any form.

The “极海” or “Geehy” words or graphics with “®” or “TM” in this document are trademarks of Geehy. Other product or service names displayed on Geehy products are the property of their respective owners.

2. No Intellectual Property License

Geehy owns all rights, ownership and intellectual property rights involved in this document.

Geehy shall not be deemed to grant the license or right of any intellectual property to users explicitly or implicitly due to the sale or distribution of Geehy products or this document.

If any third party's products, services or intellectual property are involved in this document, it shall not be deemed that Geehy authorizes users to use the aforesaid third party's products, services or intellectual property, unless otherwise agreed in sales order or sales contract.

3. Version Update

Users can obtain the latest document of the corresponding models when ordering Geehy products.

If the contents in this document are inconsistent with Geehy products, the agreement in the sales order or the sales contract shall prevail.

4. Information Reliability

The relevant data in this document are obtained from batch test by Geehy Laboratory or cooperative third-party testing organization. However, clerical errors in correction or errors caused by differences in testing environment may occur inevitably. Therefore, users should understand that Geehy does not bear any responsibility for such errors that may occur in this document. The relevant data in this document are only used to guide users as performance parameter reference and do not constitute Geehy's guarantee for any product performance.

Users shall select appropriate Geehy products according to their own needs, and effectively verify and test the applicability of Geehy products to confirm that Geehy products meet their own needs, corresponding standards, safety or other reliability requirements. If losses are caused to users due to the user's failure to fully verify and test Geehy products, Geehy will not bear any responsibility.

5. Legality

USERS SHALL ABIDE BY ALL APPLICABLE LOCAL LAWS AND REGULATIONS WHEN USING THIS DOCUMENT AND THE MATCHING GEEHY PRODUCTS. USERS SHALL UNDERSTAND THAT THE PRODUCTS MAY BE RESTRICTED BY THE EXPORT, RE-EXPORT OR OTHER LAWS OF THE COUNTRIES OF THE PRODUCTS SUPPLIERS, GEEHY, GEEHY DISTRIBUTORS AND USERS. USERS (ON BEHALF OR ITSELF, SUBSIDIARIES AND AFFILIATED ENTERPRISES) SHALL AGREE AND PROMISE TO ABIDE BY ALL APPLICABLE LAWS AND REGULATIONS ON THE EXPORT AND RE-EXPORT OF GEEHY PRODUCTS AND/OR TECHNOLOGIES AND DIRECT PRODUCTS.

6. Disclaimer of Warranty

THIS DOCUMENT IS PROVIDED BY GEEHY "AS IS" AND THERE IS NO WARRANTY OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, TO THE EXTENT PERMITTED BY APPLICABLE LAW.

GEEHY WILL BEAR NO RESPONSIBILITY FOR ANY DISPUTES ARISING FROM THE SUBSEQUENT DESIGN OR USE BY USERS.

7. Limitation of Liability

IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING WILL GEEHY OR ANY OTHER PARTY WHO PROVIDE THE DOCUMENT "AS IS", BE LIABLE FOR DAMAGES, INCLUDING ANY GENERAL, SPECIAL, DIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE USE OR INABILITY TO USE THE DOCUMENT (INCLUDING BUT NOT LIMITED TO LOSS OF DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY USERS OR THIRD PARTIES).

8. Scope of Application

The information in this document replaces the information provided in all previous versions of the document.

© 2023 - 2025 Geehy Semiconductor Co., Ltd. - All Rights Reserved