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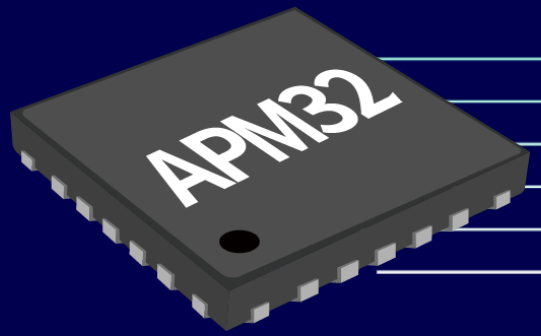
APM32E103 EVAL评估板与SDK

使用说明

Version: 2022.11



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APM32E103 EVAL评估板概述

APM32E103 EVAL评估板，是工业级增强型APM32E1系列MCU的完整演示和开发平台。

■搭载一颗32位MCU APM32E103ZET6

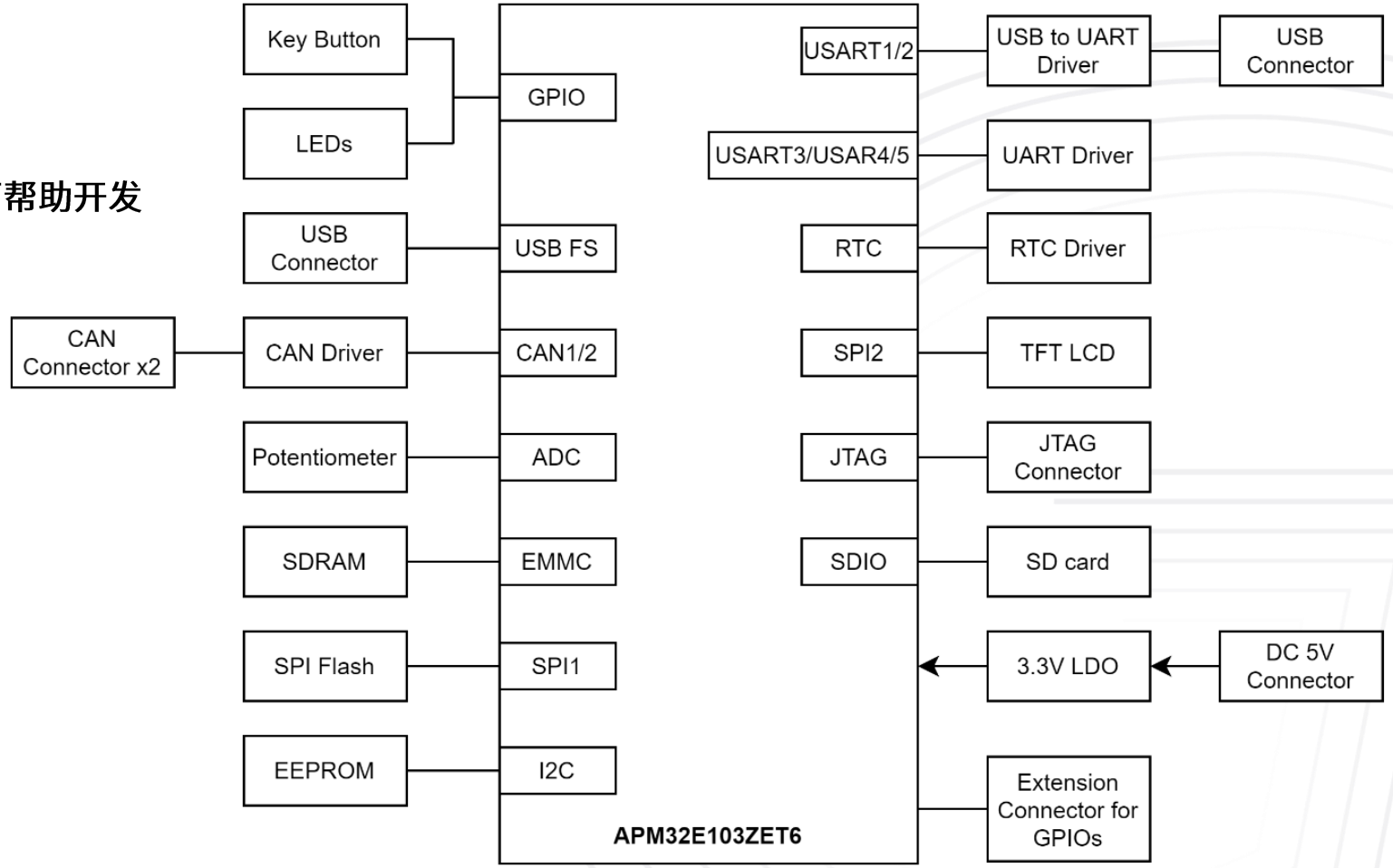
➢基于Arm® Cortex® -M3内核

➢工作主频120MHz

➢Flash 512KB、SRAM 128KB

■ 集成丰富外设功能，同时配套EVAL SDK，可帮助开发者评估或者开发应用程序

- TFT LCD
- EEPROM
- SPI FLASH
- SD card
- SDRAM
- Potentiometer
- USB
- RTC
- CAN x 2
- Button x 3
- LED x 3



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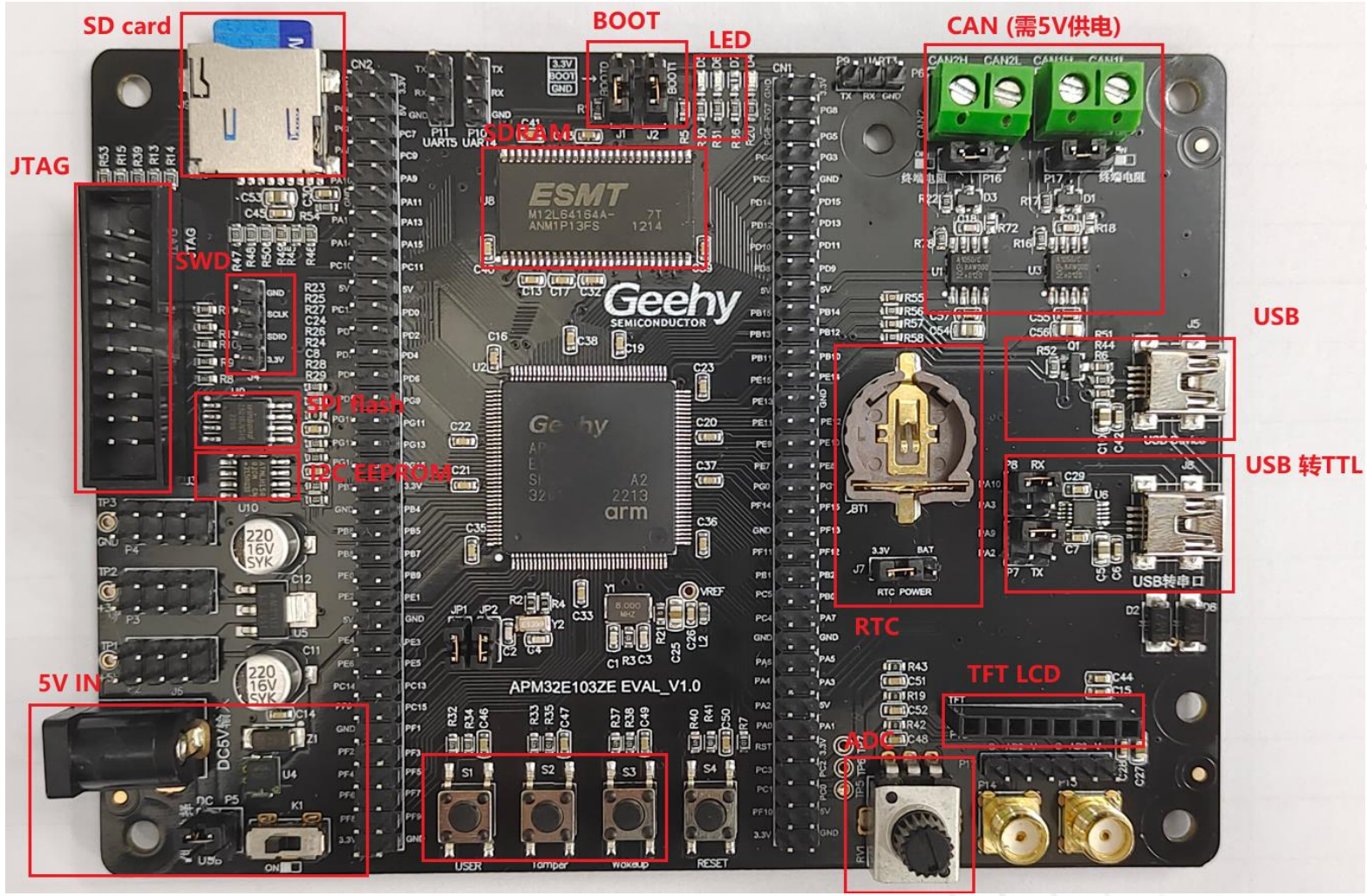
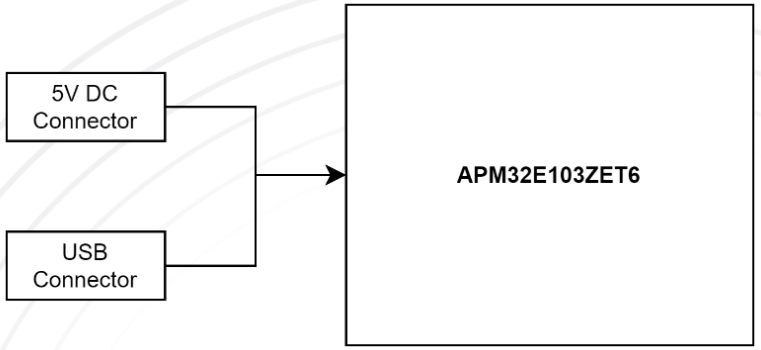
APM32E103 EVAL评估板实物



APM32E103 EVAL评估板外设资源——1

外设资源	性能描述
电源	• APM32E103 EVAL评估板，可由外部5V直流电源供电，也可通过USB供电 • JTAG接口可供电给MCU（3.3V），其他所需电压则由板载电压调节器提供 • 已在板上预留丰富的5V/3.3V/GND排针，以供用户使用外部接口
电池接口	• 板载CR1220标准电池接口
时钟	■ APM32E103 EVAL评估板，搭载两个外部时钟 • X1，32.768KHz时钟用于RTC • X1，8MHz时钟用于APM32E103ZET6，若使用芯片内部RC时钟，则可移除该时钟或关闭HSE使能
复位	■ 提供两个复位控制 • RESET按键，按下时会发出复位信号 • JTAG Reset信号
仿真接口	• 标准20-pin IDC JTAG连接接口。 • 四线SWD连接接口



APM32E103 EVAL评估板外设资源——2

外设资源	性能描述
LCD屏幕	• 提供一个2.4英寸的TFT LCD屏，像素240 x 320 • 控制芯片ILI9341，可由SPI驱动
LED灯	• 板载3个通用红色LED灯，可用作显示
按键	• 提供3个按键，可用于LCD菜单切换或其他输入用途
EEPROM	• 板载AT24C32 EEPROM芯片，可由I2C外设驱动
Flash	• 板载一个Flash芯片，提供2MB的外部存储空间，由SPI驱动
CAN	• 提供CAN1和CAN2两个控制器局域网络接口（使用时需5V供电）
SD 卡	• 板载5个触摸按键，分别连接到组1中的两个电容传感通道和组2中的三个电容传感通道
SDRAM	• 板载SDRAM芯片，提供用户使用

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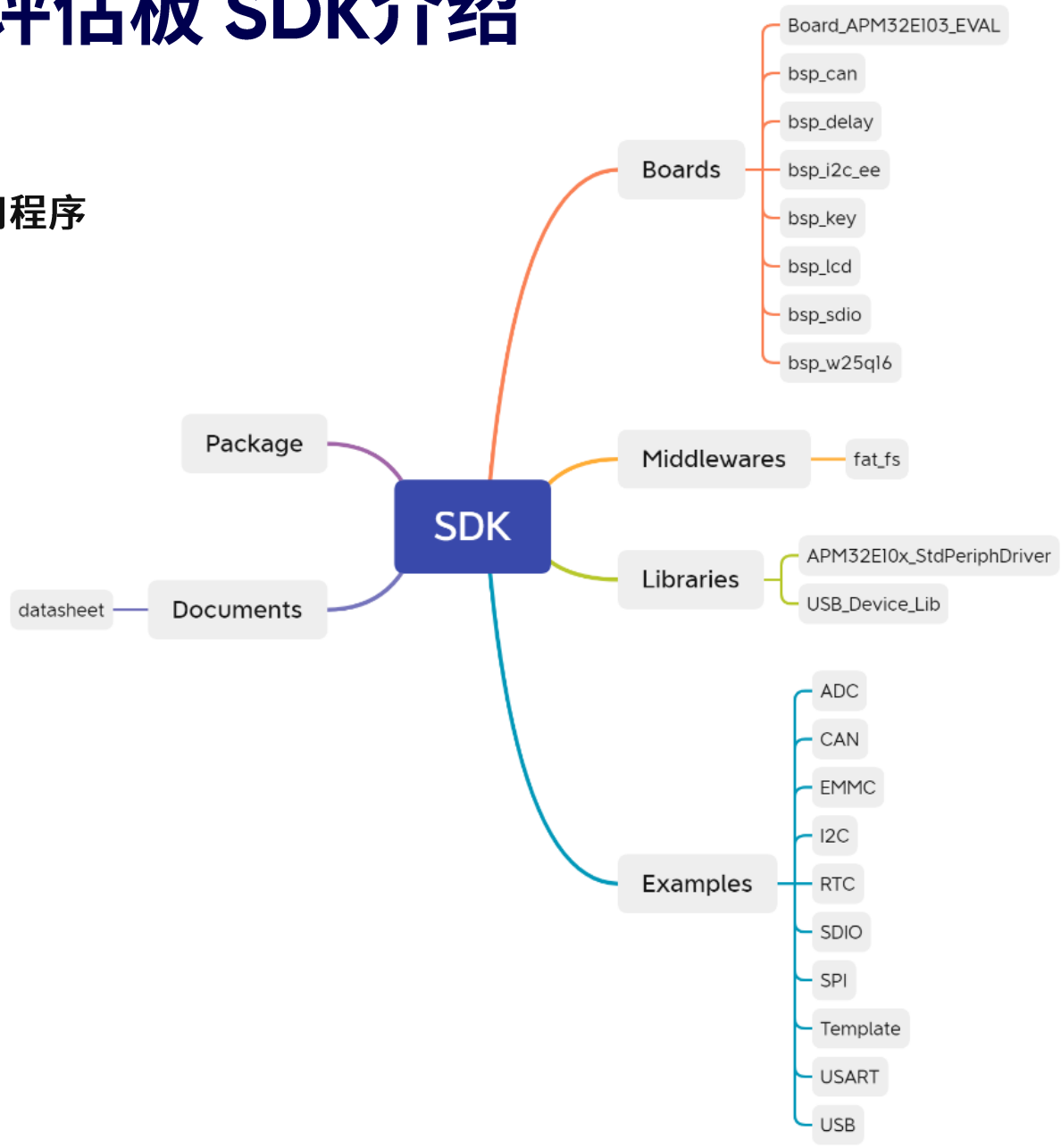
APM32E103 EVAL评估板 SDK介绍

■ SDK包括许多易于重复使用的应用程序

- CAN双机通信
- EEPROM读写
- LCD多级菜单
- RTC日历
- TSC
- HDMI-CEC双机通信



SDK——ADC/CAN/I2C EEPROM

ADC

采用10K电位器作为采样源，
可用旋钮调节，
AD采样通道为PC0(通道10)

CAN Dual例程

用于展示如何使用CAN模块，
仅需短接CAN1和CAN2的H/L接线，
并5V供电(CAN控制器芯片供电要求)即
可使用例程

I2C EEPROM

采用AT24C32，器件地址为0xA0，
寻址地址为16bit；测试过程是往
EEPROM写入和读取255个数据
并进行比较

Potentiometer Example

2776 mV

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CAN Dual Examples

Press KEY1 for CAN1 transmit
and CAN2 receive test

Press KEY2 for CAN2 transmit
and CAN1 receive test

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I2C EEPROM Example

Press KEY1 to start test

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SDK——RTC Clocks/SDIO SD Card/SPI Flash

RTC_Clocks

RTC_Clocks例程
模拟一个24小时制的时钟

RTC Clocks Example

23::59:30

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SDIO SD Card

SDIO SD card例程将读取
插入SD卡座的数据,
并尝试对目标文件进行新建，
写入和删除操作

SDIO SD Card Examples

SD Init Success
File System mount Success!
Scan the file Success!
Write the file Success!
Delete the file Success!

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SPI Flash

该例程采用SPI访问外部Flash芯片
W25Q16，大小为2MB;
测试过程是往Flash写入和读取数据
并进行比较

SPI Flash Example

Flash ID : 0xEF4015
Device ID: 0x14

Press KEY1 to start test

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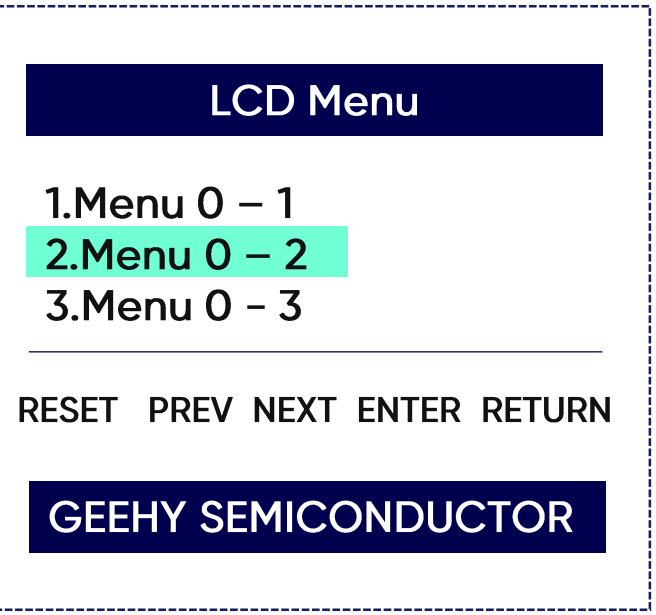
SDK——LCD Menu/USART Printf

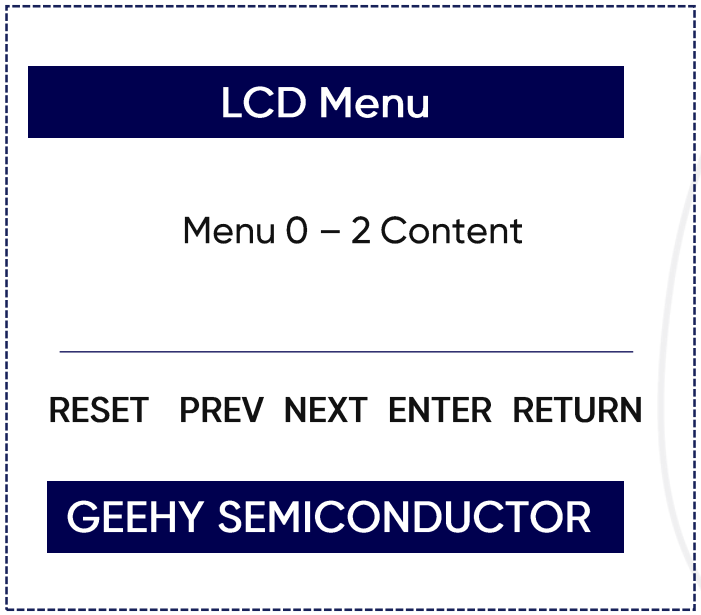
LCD Menu

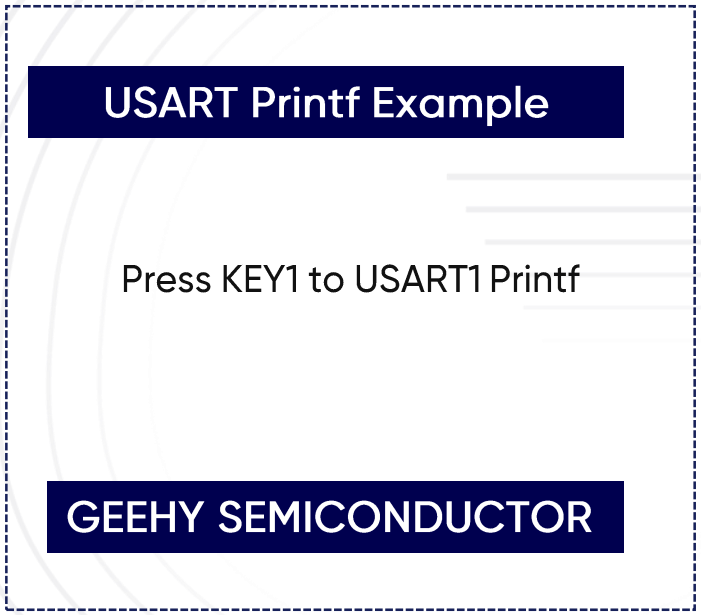
该例程使用SPI驱动
2.4英寸的LCD屏，
展示一个多级菜单的样例

USART Printf

该例程展示以轮询方式发送串口数据，
测试过程是通过按下按键1 USART1
发送字符串’ Hello USART1’到上位机







SDK——USB CDC Virtual COM Port

该例程USB CDC Virtual COM口的实现

USART CDC Example

ID Vendor = 0x314B

ID Product = 0x0108

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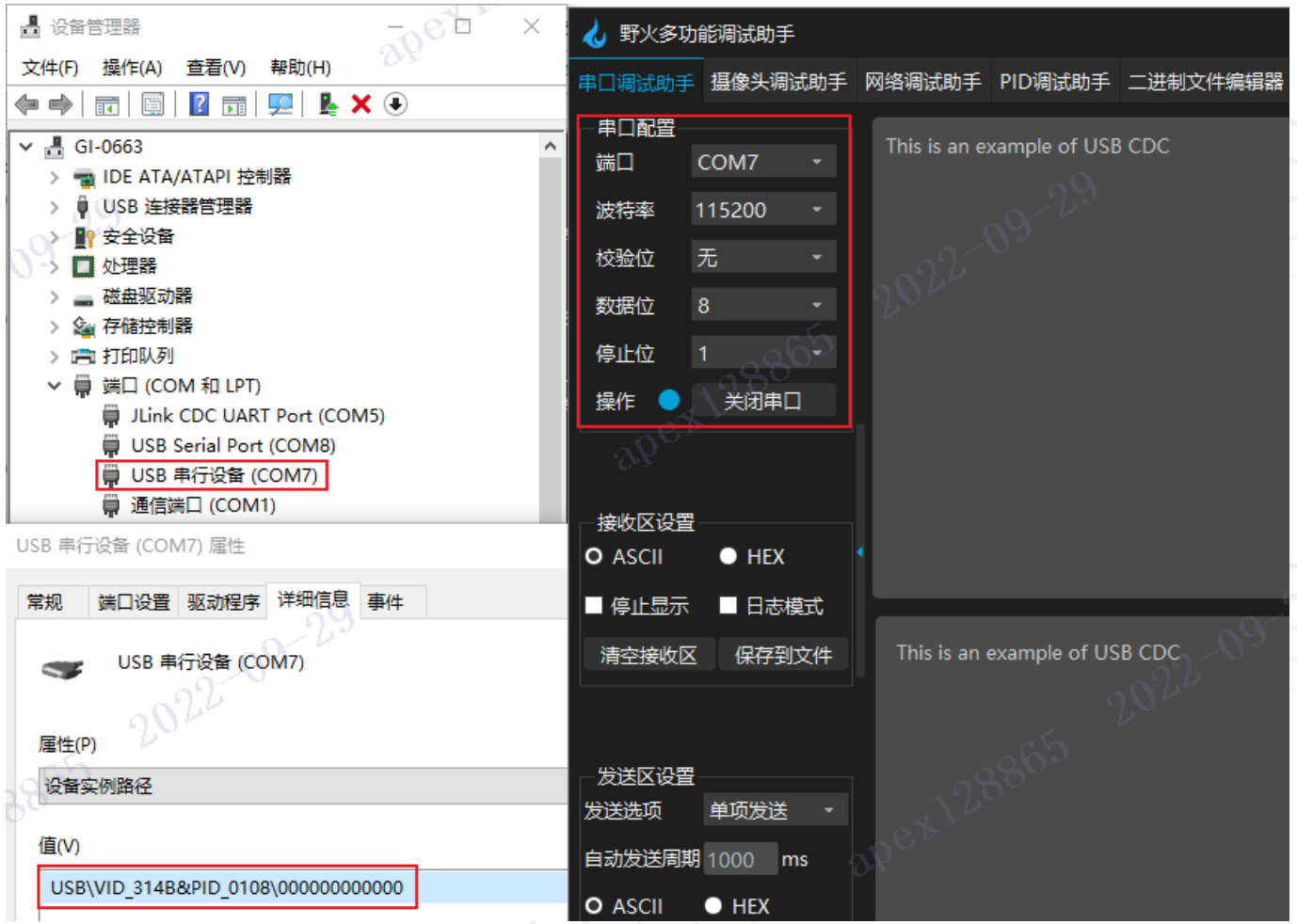

SDK——USB HID Mouse/USB MSC Disk

USB HID Mouse

该例程USB HID Mouse的实现

USB HID Example

ID Vendor = 0x314B
ID Product = 0x0107
KEY1 to Right key
KEY2 to Left key
KEY3 to UP key

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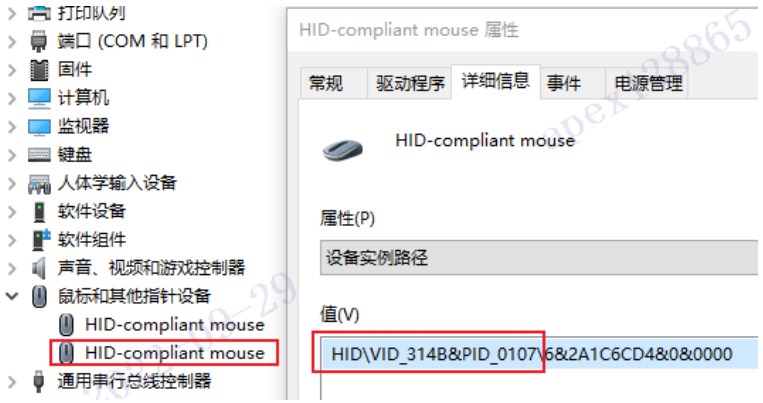

USB MSC Disk

该例程USB MSC Disk的实现

USB MSC Disk Example

ID Vendor = 0x314B
ID Product = 0x0109

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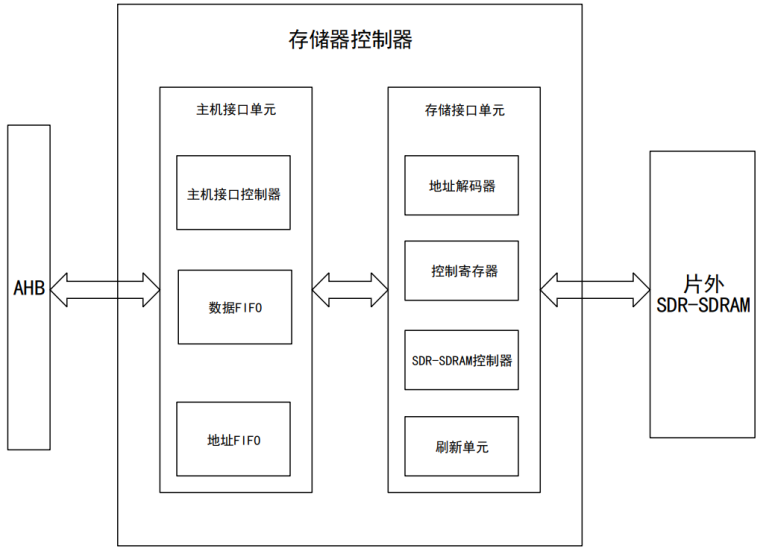
SDK——SDRAM

DMC是一个动态存储控制器，
可用于外接片外 SDR-SDRAM



External RAM 与 External device

- External RAM 区，这个区域可以直接执行代码
- External device 区，这个区域不可以直接执行代码

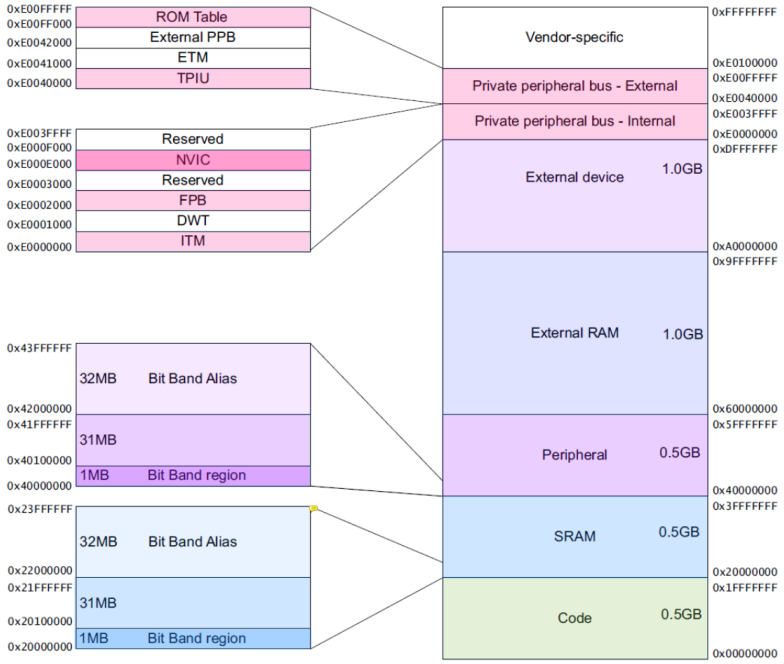


图 5.1　Cortex-M3 预定义的存储器映射

SDK——SDRAM

External RAM 与 External device

■ SDRAM大小计算

- M12L64164A 总容量大小
- 1M x 16 Bit x 4 Banks = 64MBit = 8MB
- M12L64164A Banks大小
- 1,048,576 words = 2MB

M12L64164A (2C)

Automotive Grade

1M x 16 Bit x 4 Banks

Synchronous DRAM

GENERAL DESCRIPTION

The M12L64164A is 67,108,864 bits synchronous high data rate Dynamic RAM organized as 4 x 1,048,576 words by 16 bits. Synchronous design allows precise cycle controls with the use of system clock I/O transactions are possible on every clock cycle. Range of operating frequencies, programmable burst length and programmable latencies allow the same device to be useful for a variety of high bandwidth, high performance memory system applications.

■ 理论支持的最大SDRAM大小计算

- 地址线A0-A10，Bank线1
- 2^(11+11+1) * 16 Bit = 8,388,608 * 16 Bit = 128MBit = 16MB

表格 24DMC 引脚（适用 APM32E103xCxE 非合封产品）

信号名称	输入/输出	管脚	功能
A0	输出	PF13	地址
A1	输出	PF14	地址
A2	输出	PF15	地址
A3	输出	PG0	地址
A4	输出	PE8	地址
A5	输出	PE9	地址
A6	输出	PE10	地址
A7	输出	PE11	地址
A8	输出	PE12	地址
A9	输出	PE13	地址
A10	输出	PF12	地址
BA	输出	PF11	Bank 地址

SDK——SDRAM

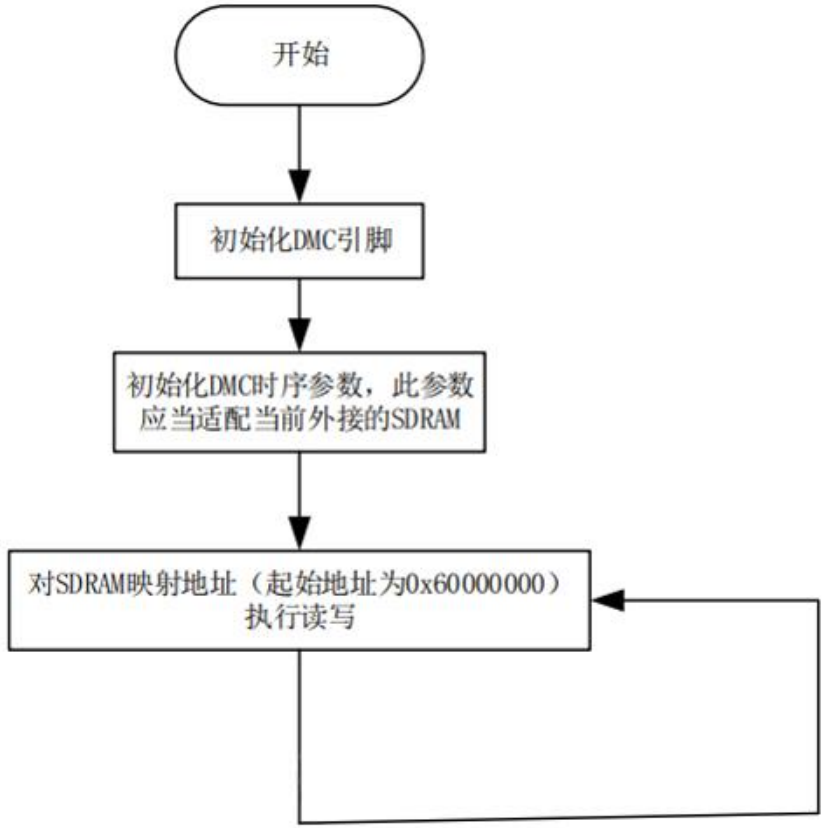
■ 实际支持的最大SDRAM大小计算

- 行地址线芯片仅支持A0-A10，列地址线A0-A7，Bank线1
- 2^(11+8+1) * 16 Bit = 1,048,576 * 16 Bit = 16MBit = 2MB

PIN FUNCTION DESCRIPTION

PIN	NAME	INPUT FUNCTION
CLK	System Clock	Active on the positive going edge to sample all inputs
$\overline{CS}$	Chip Select	Disables or enables device operation by masking or enabling all inputs except CLK , CKE and L(U)DQM
CKE	Clock Enable	Masks system clock to freeze operation from the next clock cycle. CKE should be enabled at least one cycle prior new command. Disable input buffers for power down in standby.
A0 ~ A11	Address	Row / column address are multiplexed on the same pins. Row address : RA0~RA11 column address : CA0~CA7
BA1 , BA0	Bank Select Address	Selects bank to be activated during row address latch time. Selects bank for read / write during column address latch time.
$\overline{RAS}$	Row Address Strobe	Latches row addresses on the positive going edge of the CLK with $\overline{RAS}$ low. Enables row access & precharge.
$\overline{CAS}$	Column Address Strobe	Latches column address on the positive going edge of the CLK with $\overline{CAS}$ low. Enables column access.
$\overline{WE}$	Write Enable	Enables write operation and row precharge. Latches data in starting from $\overline{CAS}$, $\overline{WE}$ active.
L(U)DQM	Data Input / Output Mask	Makes data output Hi-Z, t_{SHZ} after the clock and masks the output. Blocks data input when L(U)DQM active.
DQ0 ~ DQ15	Data Input / Output	Data inputs / outputs are multiplexed on the same pins.
VDD / VSS	Power Supply / Ground	Power and ground for the input buffers and the core logic.
VDDQ / VSSQ	Data Output Power / Ground	Isolated power supply and ground for the output buffers to provide improved noise immunity.
NC	No Connection	This pin is recommended to be left No Connection on the device.

■ 初始化流程



SDK——SDRAM

■ 初始化流程

- 初始化 DMC 的 GPIO
- 对所有使用 GPIO 引脚模式初始化，把 DMC SDRAM 所有信号线全都初始化为复用功能，所有引脚配置都一样

```
/** SDRAM pins assignment */
/**
 +-------------------------+-------------------------+-------------------------+
 | PB10 <-> MMC_SDRAM_UNQM | PC10 <-> MMC_SDRAM_D8   | PD2  <-> MMC_SDRAM_D10  |
 | PB11 <-> MMC_SDRAM_CKE  | PC11 <-> MMC_SDRAM_D9   | PD3  <-> MMC_SDRAM_D11  |
 |                         |                         | PD4  <-> MMC_SDRAM_D12  |
 |                         |                         | PD5  <-> MMC_SDRAM_D13  |
 |                         |                         | PD6  <-> MMC_SDRAM_D14  |
 +-------------------------+-------------------------+-------------------------+
 | PE3  <-> MMC_SDRAM_D4   | PF0  <-> MMC_SDRAM_D7   | PG0  <-> MMC_SDRAM_D15  |
 | PE5  <-> MMC_SDRAM_D5   | PF2  <-> MMC_SDRAM_NCS  | PG9  <-> MMC_SDRAM_D9   |
 | PE6  <-> MMC_SDRAM_D6   | PF4  <-> MMC_SDRAM_NRAS | PG12 <-> MMC_SDRAM_D0   |
 | PE8  <-> MMC_SDRAM_A4   | PF5  <-> MMC_SDRAM_NCAS | PG13 <-> MMC_SDRAM_D1   |
 | PE9  <-> MMC_SDRAM_A5   | PF6  <-> MMC_SDRAM_NWE  | PG14 <-> MMC_SDRAM_D2   |
 | PE10 <-> MMC_SDRAM_A6   | PF10 <-> MMC_SDRAM_LDQM | PG15 <-> MMC_SDRAM_D3   |
 | PE11 <-> MMC_SDRAM_A7   | PF11 <-> MMC_SDRAM_Bank |                         |
 | PE12 <-> MMC_SDRAM_A8   | PF12 <-> MMC_SDRAM_A10  |                         |
 | PE13 <-> MMC_SDRAM_A9   | PF13 <-> MMC_SDRAM_A0   |                         |
 | PE14 <-> MMC_SDRAM_A5   | PF14 <-> MMC_SDRAM_A1   |                         |
 | PE15 <-> MMC_SDRAM_CLK  | PF15 <-> MMC_SDRAM_A2   |                         |
 +-------------------------+-------------------------+-------------------------+
*/

gpioConfig.speed = GPIO_SPEED_50MHz;
gpioConfig.mode = GPIO_MODE_AF_PP;
```

■ 初始化流程

- 配置 FMC 的模
- 根据硬件连接的SDRAM 特性，对时序结构体以及初始化结构体进行赋值

```
uint32_t sdramCapacity;
DMC_Config_T dmcConfig;
DMC_TimingConfig_T timingConfig;

RCM_EnableAHBPeriphClock(RCM_SDRAM_PERIPH);

timingConfig.latencyCAS = DMC_CAS_LATENCY_3;        //!< Configure CAS latency period
timingConfig.tARP       = DMC_AUTO_REFRESH_10;      //!< Configure auto refresh period
timingConfig.tRAS       = DMC_RAS_MINIMUM_5;        //!< Configure line activation and precharging minimum time
timingConfig.tCMD       = DMC_ATA_CMD_7;            //!< Configure active to active period
timingConfig.tRCD       = DMC_DELAY_TIME_2;         //!< Configure RAS To CAS delay Time
timingConfig.tRP        = DMC_PRECHARGE_2;          //!< Configure precharge period
timingConfig.tWR        = DMC_NEXT_PRECHARGE_2;     //!< Configure time between the Last Data and The Next Precharge for write
timingConfig.tXSR       = 6;                        //!< Configure XSR0
timingConfig.tRFP       = 0xC3;                     //!< Configure refresh Cycle

dmcConfig.bankWidth     = DMC_BANK_WIDTH_1;         //!< Configure bank address width
dmcConfig.clkPhase      = DMC_CLK_PHASE_REVERSE;    //!< Configure clock phase
dmcConfig.rowWidth      = DMC_ROW_WIDTH_11;         //!< Configure row address width
dmcConfig.colWidth      = DMC_COL_WIDTH_8;          //!< Configure column address width
dmcConfig.memorySize    = DMC_MEMORY_SIZE_2MB;
dmcConfig.timing        = timingConfig;

DMC_Config(&dmcConfig);
DMC_ConfigOpenBank(DMC_BANK_NUMBER_2);
DMC_EnableAccelerateModule();

DMC_Enable();
```

SDK——SDRAM

■ 扩展功能

- 使用指针的方式访问 SDRAM 存储器
- 完成初始化 SDRAM 后，就可利用它的存储数据了，由于 SDRAM 存储空间是被映射到内核寻址区域的，可以通过映射地址直接访问 SDRAM，访问这些地址时， DMC 外设自动读写 SDRAM，程序上无需额外操作

```
/*!
void SDRAM_WriteWord(uint32_t address, uint32_t data)
{
    *(__IOM uint32_t*)address = data;
}

/*!
void SDRAM_WriteHalfWord(uint32_t address, uint16_t data)
{
    *(uint16_t*)address = (uint16_t)data;
}

/*!
void SDRAM_WriteByte(uint32_t address, uint8_t data)
{
    *(uint8_t*)address = data;
}
```

■ 扩展功能

- 直接指定变量存储到 SDRAM 空间
- 每次存取数据都使用指针来访问过于麻烦，为了简化操作，可以直接指定变量存储到SDRAM 空间。

```
uint32_t data[20] __attribute__((at(0x60000000)));
```

附录 | 参考资料

- 《APM32E103xCxE数据手册》
- 《APM32E103xCxE用户手册》
- 《 Cortex M3权威指南(中文)》
- 《M12L64164A(2C)_Automotive grade》

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