GigaDevice Semiconductor Inc.

GD32L23x 系列软件开发指南

应用笔记

AN197

1.0 版本

（2024 年 4 月）

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1. 前言

本文是专为 GD32L23x 系列 MCU 提供，介绍了如何搭建基于 GD32L23x 芯片的工程并调试，以及如何使用各个模块。该应用笔记的目的是对 GD32L23x 系列 MCU 上的外设资源进行示例性的功能介绍，使用户能了解如何使用 GD32L23x 系列芯片进行快速软件开发。

有关深度睡眠模式1和深度睡眠模式2的更多信息，请参阅***AN094 GD32L233从深度睡眠模式1唤醒的多种***和***AN167 GD32L233深度睡眠模式2的使用说明***。

有关SLCD显示的低功耗方案的更多信息，请参阅***AN087 基于GD32L233 SLCD显示的低功耗方案***。

有关GD32L235与GD32L233系列间的差异，请参阅***AN179 GD32L235与GD32L233系列间的差异***。从GD32L233移植到GD32L235的方法，请参阅***AN184 从GD32L233系列移植到GD32L235系列***。

有关GD32L23x FLASH模拟EEPROM的方法，请参阅***AN201 GD32L23x系列FLASH模拟EEPROM***。

Embedded Builder软件支持GD32L23x系列，使用方法请参阅《Embedded Builder User Manual》

表 1-1. 适用产品

类型	型号
MCU	GD32L23x系列

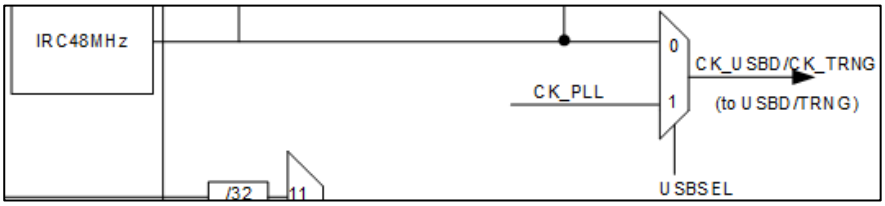
2. 软件功能开发

2.1. UBSD 使用注意事项

2.1.1. USBD 时钟配置

USBD 模块时钟树，如*图 2-1. USBD 外设时钟树*所示。

图 2-1. USBD 外设时钟树



通过 USBSEL 选择器可以选择内部 IRC48M 时钟或者外部 CK_PLL 时钟，CK_PLL 通过 PLL 分频和倍频配置。USBD 的启动时钟是 48MHz。

使用内部 IRC48M 时钟或者外部 PLL 时钟，需要使用 RCU 的控制寄存器（RCU_CTL）对 IRC48M 或 PLL 进行使能。

USBSEL 选择器可以选择两种时钟源如下：

- CK_PLL：通过 PLL 分频和倍频配置。
- CK_IRC48M：通过内部 48M 时钟提供（需校准精度为±500ppm）。

USBD 时钟配置代码，如*图 2-2. USBD 外设时钟配置代码*所示。

图 2-2. USBD 外设时钟配置代码

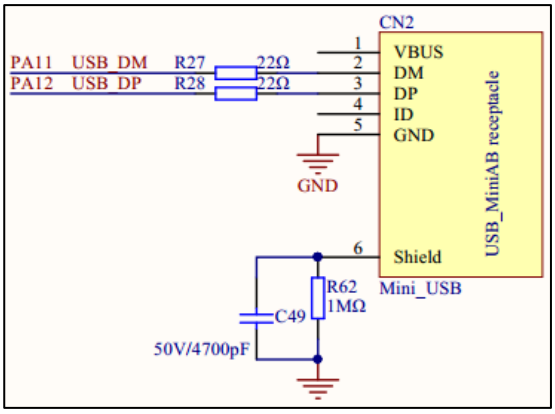
```
void rcu_config(void)
{
    rcu_usbd_clock_config(RCU_USBDSRC_PLL);

    /* enable USB APB1 clock */
    rcu_periph_clock_enable(RCU_USBD);
}
```

2.1.2. USBD 相关 GPIO 配置

USBD 的 DP/DM 引脚为专用脚，当 USBD 时钟使能之后，DM(PA11)和 DP(PA12)引脚默认是 USBD 的数据传输引脚，无需单独配置。值得注意的是，在启动 USBD 之前，需要将 USBD 的 DP 上拉，DP 上拉的方式有三种：第一，通过内部寄存器（DPC）使能位上拉；第二，通过 GPIO 引脚输出控制上拉；第三，外接 3.3V 上拉。USBD 的控制电路，如*图 2-3. USBD 控制电路*所示。

图 2-3. USBD 控制电路



2.1.3. USBD 数组和端点配置

GD32L23x 系列芯片使用的是 M23 内核，定义数组变量时需要偶地址对齐，2 字节或 4 字节对齐，否则设备可能无法正常枚举。定义的数组变量 2 字节对齐，如*图 2-4. 设备描述符数组定义*所示。

图 2-4. 设备描述符数组定义

```
__ALIGNED(2) usb_desc_dev cdc_dev_desc =
{
    .header =
    {
        .bLength            = USB_DEV_DESC_LEN,
        .bDescriptorType    = USB_DESCTYPE_DEV,
    },
    .bcdUSB                 = 0x0200U,
    .bDeviceClass           = USB_CLASS_CDC,
    .bDeviceSubClass        = 0x00U,
    .bDeviceProtocol        = 0x00U,
    .bMaxPacketSize0        = USBD_EP0_MAX_SIZE,
    .idVendor               = USBD_VID,
    .idProduct              = USBD_PID,
    .bcdDevice              = 0x0100U,
    .iManufacturer          = STR_IDX_MFC,
    .iProduct               = STR_IDX_PRODUCT,
    .iSerialNumber          = STR_IDX_SERIAL,
    .bNumberConfigurations  = USBD_CFG_MAX_NUM,
};
```

GD32L23x 系列的 USBD 最多支持 8 个端点（包含端点 0），端点配置的地址范围是 0x00-0x1FF，端点地址应满足 16 bit 位对齐。

2.1.4. 其他注意事项

- USBD 是全速设备接口，只能做 USB 设备，不能做 USB 主机。
- USBD 的数据传输支持 USB 2.0 协议，是一种半双工传输。
- USBD 正常工作时的数字信号是呈方波形式的差分信号。

3. 版本历史

表 3-1. 版本历史

版本号	说明	日期
1.0	首次发布	2024 年 04 月 23 日

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