AN14424

基于FRDM-MCXA系列的CAN引导加载程序设计

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文档信息

信息	内容
关键词	AN14424、CAN引导加载程序
摘要	本文介绍了如何使用两块FRDM-MCXA156开发板来实现一个基于CANFD总线的简单引导加载程序升级工程。

1 介绍

本文介绍了一个针对FRDM-MCXA156的简单CAN引导加载程序工程。

使用CAN更新MCU固件是一项基本且通常需要的任务。本工程采用两块FRDM-MCXA156电路板，通过CAN总线和USB实现固件更新，其基本架构如图1所示。

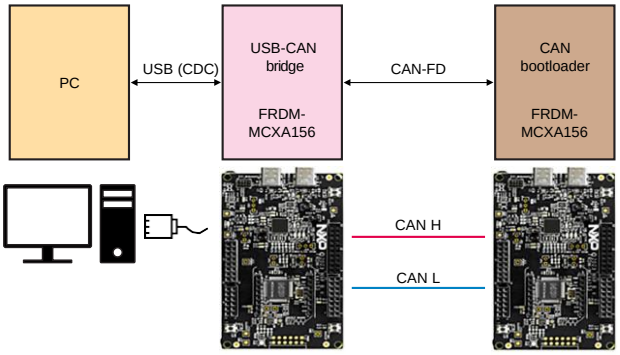

图1. 结构框图

1.1 USB-CAN桥接器

本工程使用FRDM-MCXA156的硬件，通过USB与PC连接。在PC端，USB端口被视为一个通信设备类（CDC）虚拟串口（类似于SDK示例：`usb_device_cdc_vcom`）。这种配置允许PC端使用如`blhost`的工具，通过CDC虚拟串口将数据传输到USB-CAN桥接器。USB-CAN桥接器随后将这些数据中继到CAN总线上，从而实现串行数据和CAN数据之间的透传。

1.2 CAN引导加载程序

本工程还使用FRDM-MCXA156硬件作为引导加载程序。它可以通过CAN总线接收固件数据，并验证新固件的完整性。在成功验证后，系统会切换到应用程序。

2 软件

此演示实现了一个简单的CAN引导加载程序升级框架。它使用一块FRDM-MCXA156电路板作为USB-CAN桥接器，达成USB（作为CDC虚拟串口）和CAN-FD之间的数据传输。另一块FRDM-MCXA156电路板作为CAN引导加载程序工程，通过CAN与USB-CAN桥接器进行通信，以接收数据并更新应用程序。

进入引导加载程序模式的条件：

1. 在CAN引导加载程序代码启动1秒后（可配置）。
2. CAN引导加载程序接收到任何有效的恩智浦KBOOT协议消息时。
3. 当按下SW2 (WAKEUP)引脚，MCU复位时。

表1. 工程分类和说明

工程	路径	说明
usb_can_bridge	.\mcux_can_bootloader	作为USB-CAN桥接器，其中USB被视为一个USB CDC端口，由SDK示例*usb_device_cdc_vcom*修改而来。
can_bootloader	.\ mcux_can_bridge	CAN引导加载程序工程，与USB-CAN桥接器配合使用。
app_example	.\app_example	CAN引导加载程序的示例应用程序，其起始地址已从默认的0x0000_0000更改为0x00008000 (32K)，这与SDK示例HelloWorld仅在这方面有所不同。

汇总：

此应用程序实际上实现了两个工程：

- usb_can_bridge：USB (CDC VCOM)/CAN双向传输
- can_bootloader：基于CAN 2.0的二级引导加载程序工程

固件升级过程：PC运行恩智浦blhost软件，通过USB CDC VCOM与usb_can_bridge电路板进行通信。usb_can_bridge负责将USB CDC数据转换为CANFD帧，并与can_bootloader电路板进行通信，以实现can_bootloader电路板上应用程序的固件升级。

表2列出了CAN总线的默认配置。

表2. CAN总线的默认配置

工程	CAN_FD控制字段波特率	CAN_FD数据字段波特率	CAN TX ID	CAN RX ID
usb_can_bridge	500 Kbps	2 Mbps	0x09	0x08
can_bootloader	500 Kbps	2 Mbps	0x08	0x09

用户可以在*main.c*中修改默认参数，如CAN_TX、波特率等。

```
#define CAN_BIT_RATE                    (500*1000)
#define CAN_BIT_RATE_FD                 (2*1000*1000)
#define CAN_TX_ID                       (0x09)
#define CAN_RX_ID                       (0x08)
```

2.1 传输协议

usb_can_bridge和Can_bootloader之间的通信协议非常简单。每个CANFD帧传输一个固定的64字节有效载荷，其中前8个字节为控制字段（与UDS协议兼容），第8-64字节为串行数据。前8个字节定义如下：

- 字节0-6：保留
- 字节7：数据字段长度：1-56

注：*即使数据长度小于56字节，每个CANFD帧的数据字段也固定为64字节。末尾的多余部分将被自动丢弃。*

3 硬件

本工程使用两块FRDM-MCXA156电路板：

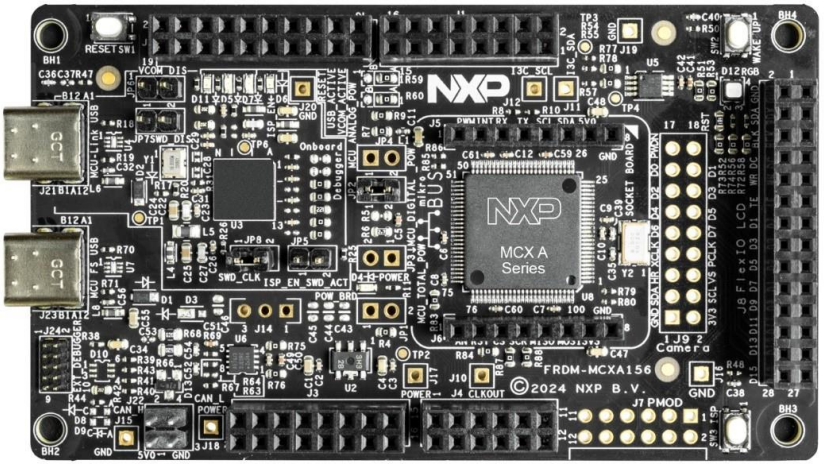

图2. FRDM-MCXA156电路板

3.1 引脚表

表3描述了本工程中的引脚使用情况。它适用于`usb_can_bridge`和`can_bootloader`两个工程。

表3. 引脚表

功能	GPIO	说明
LPUART0_RXD	PORT0_2	UART_RXD
LPUART0_TXD	PORT0_3	UART_TXD
CAN0_TXD	PORT1_13	CAN总线发送信号
CAN0_RXD	PORT1_12	CAN总线接收信号

4 设置

开始之前，您必须：

- 熟悉相关基本操作，例如使用 MCUX SDK 下载和调试 `HelloWorld` 或 `led_blinky` 等入门示例。更多详细信息，请参阅《面向 MCX A144/5/6 A154/5/6 MCU 的 FRDM 开发板》。
- 了解恩智浦的引导加载程序工具 `blhost` 的基本用法。更多详细信息，请参阅《恩智浦微控制器的 MCU 引导加载程序》。

要设置测试环境，请执行以下步骤：

1. 连接测试环境，如图 3 所示。

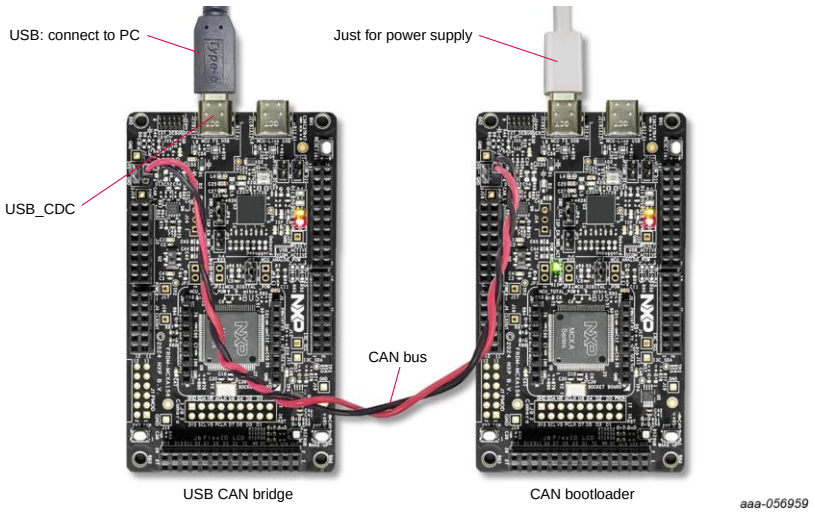

图3. 连接

`can_bootloader` 电路板的电源可以连接到任何能够提供 5V 电压的 PC 上。

2. 将 `usb_can_bridge` 和 `can_bootloader` 工程分别烧录到两块电路板上，并编译 `app_example` 工程生成 *app_example.hex*。将此 hex 文件放到与 blhost 软件相同的文件夹中。
3. 将 USB 线缆插入 `usb_can_bridge` 电路板的 J23（MCU FS USB）接口，然后按下复位按钮。PC 会识别出一个 USB-CDC 串口并弹出相应的 COM 端口。如果 USB 没有被正确识别，请使用 SDK 示例来验证软件和硬件的设置：*boards\frdmmcxa156\usb_examples\usb_device_cdc_vcom*。

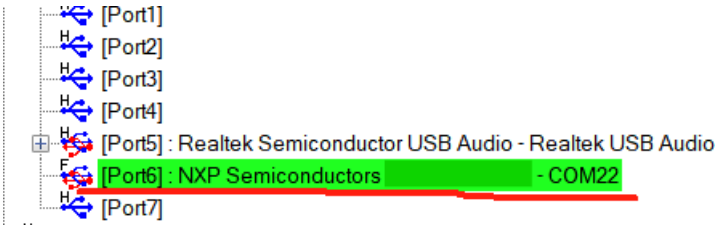

图4. SDK示例

将 USB 线缆插入 `can_bootloader` 电路板的 J21 (MCU-Link USB)接口，尽管连接到 J23 也是可行的。此 USB 端口仅用于为电路板供电。

4. 用双绞线连接两块电路板的 `CAN_H` 和 `CAN_L`，如图 4 所示。
5. 按住 CAN 引导加载程序电路板上的 SW2 (WAKEUP)。然后按下 SW1（RESET），CAN 引导加载程序进入引导模式。打开命令行并输入：

```
$ ./blhost.exe -p COM22 get-property 1
```

如果收到以下响应，则表明硬件连接正常，且blhost已成功连接到CAN引导加载程序。

```
Ping responded in 1 attempt(s)
Inject command 'get-property'
Response status = 0 (0x0) Success.
Response word 1 = 1258357760 (0x4b010400)
Current Version = K1.4.0
```

6. 输入flash-image命令，后面跟上所编译的*app_example.hex*文件的路径。此命令将擦除应用程序所在的Flash，并将新的hex固件写入Flash中。

```
$ ./blhost.exe -p COM22 -- flash-image app_example.hex erase
```

如果一切顺利，会出现如下响应：

```
Ping responded in 1 attempt(s)
Inject command 'flash-image'
Successful generic response to command 'flash-erase-region'
Wrote 7340 bytes to address 0x8000
Successful generic response to command 'write-memory'
(1/1)100% Completed!
Successful generic response to command 'write-memory'
Response status = 0 (0x0) Success.
```

5 结果

复位CAN引导加载程序电路板，其LED指示灯会闪烁。如果检查此电路板的串行日志输出，会显示如下信息：

```
MCXA CAN bootloader
APP ADDR:0x8000
TIMEOUT!, JUMP!
jump to 0x    8000
I AM MCX APP EXAMPLE APP
MAIN ADDRESS:0x98B5
LED Toggle!
LED Toggle!
LED Toggle!
...
```

以下是blhost命令和日志的完整列表：

```
$ ./blhost.exe -p COM22 get-property 1
Ping responded in 1 attempt(s)
Inject command 'get-property'
Response status = 0 (0x0) Success.
Response word 1 = 1258357760 (0x4b010400)
Current Version = K1.4.0

$ ./blhost.exe -p COM22 -- flash-image app_example.hex erase
Ping responded in 1 attempt(s)
Inject command 'flash-image'
Successful generic response to command 'flash-erase-region'
Wrote 7320 bytes to address 0x8000
Successful generic response to command 'write-memory'
(1/1)100% Completed!
Successful generic response to command 'write-memory'
Response status = 0 (0x0) Success.
```

```
$ ./blhost.exe -p COM22 reset
Ping responded in 1 attempt(s)
Inject command 'reset'
Successful generic response to command 'reset'
Response status = 0 (0x0) Success.
```

6 常见问题解答

- 问：为什么不使用BooROM的内置CAN接口，而要实现一个新的CAN引导加载程序?
  答：BootROM提供的CAN协议在官方文档中并没有完整的描述，而且它需要一个名为BusPal的工具来进行串行到CAN的转换。从软件和硬件架构以及客户定制的角度来看，这都是不实用的。
- 问：这个演示是否考虑了可靠的更新或安全方面的问题?
  答：没有，此演示旨在为客户提供一个CAN引导加载程序实现的概念验证，并没有考虑任何"高级"功能。

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8 修订历史

表4汇总了本文的修订情况。

表4. 修订历史

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AN14424 v.1.0	2024年8月29日	首次公开发布

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