

AN14460

如何通过ISP对MCX N系列微控制器的内部闪存进行编程

第1.0版—2024年11月5日

应用笔记

文档信息

信息	内容
关键词	MCXNx4x/Nx3x、ISP、闪存编程、blhost、MCUXpresso安全预处理、MCX N、FRDM-MCXN947
摘要	本应用笔记描述了如何使用USB、UART、SPI、I2C的ISP接口，通过blhost或MCUXpresso安全预处理工具对MCX N系列MCU的内部闪存进行编程。



1 介绍

MCX N系列高度集成的Arm Cortex-M33微控制器专为高性能和低功耗而设计。MCX N系列内置了256KB的ROM，用于存储启动代码和时间关键型的软件库例程。复位后，Cortex-M33处理器从ROM存储器中开始执行代码。

本应用笔记描述了如何使用USB、UART、SPI、I2C的ISP接口，通过blhost或MCUXpresso安全预处理工具对MCX N系列MCU的内部闪存进行编程。

本文档基于MCX N系列MCU。不过，如果blhost或MCUXpresso安全预处理工具支持其ISP协议，本文档也适用于MCX全系列MCU。

2 MCX N系列MCU的ISP特性

MCX N系列中的在系统编程（ISP）具有以下特性：

- 支持多种外设接口（如 USB、UART、SPI、I2C、CAN）；
- 自动检测活动外设；
- UART 外设实现了自动波特率检测；
- CAN 外设对预定义的波特率（1 Mbit/s、500 kbit/s、250 kbit/s、125 kbit/s）实现了自动波特率检测；
- 所有外设均采用基于数据包的通用协议；
- 数据包错误检测和重传；
- CMPA 中提供闪存驻留的配置选项；
- 引导加载程序运行时对 RAM 进行保护；
- 检索设备属性，如闪存和 RAM 大小；
- 在系统启动或运行时在应用程序控制下，提供执行引导加载程序的多种选项；
- 支持内部闪存访问；
- 支持加密映像下载；
- 提供外部闪存访问；
- 在 CMPA 中，使用 blhost 工具的“write-memory”命令来对 CMPA 进行编程或更新。

3 系统要求

硬件要求：

- [FRDM-MCXN947](#)
- Windows PC
- Type C USB线缆

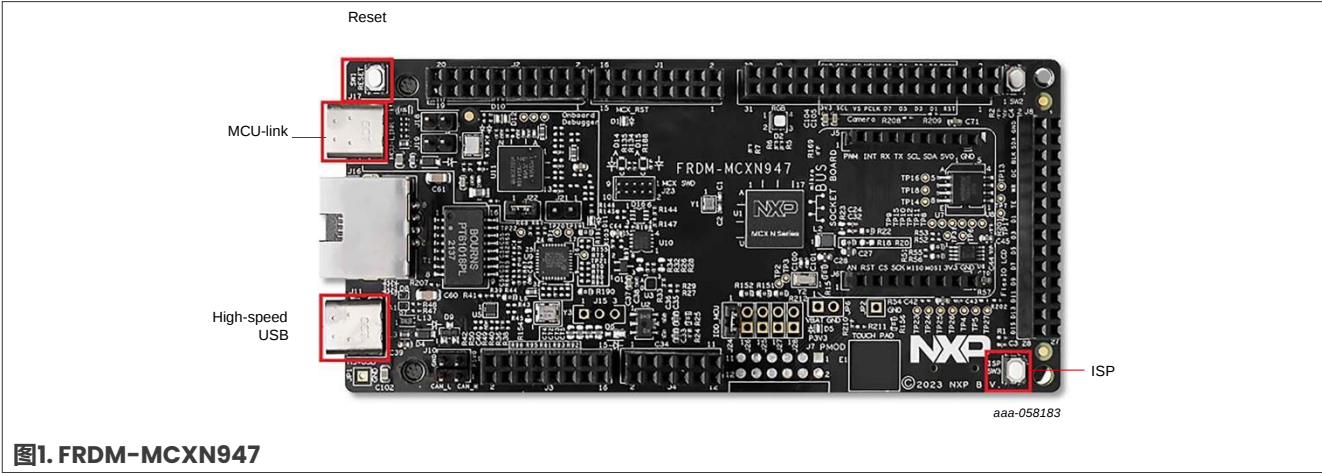
软件要求：

- [MCUXpresso安全预处理工具v9.0.1](#)

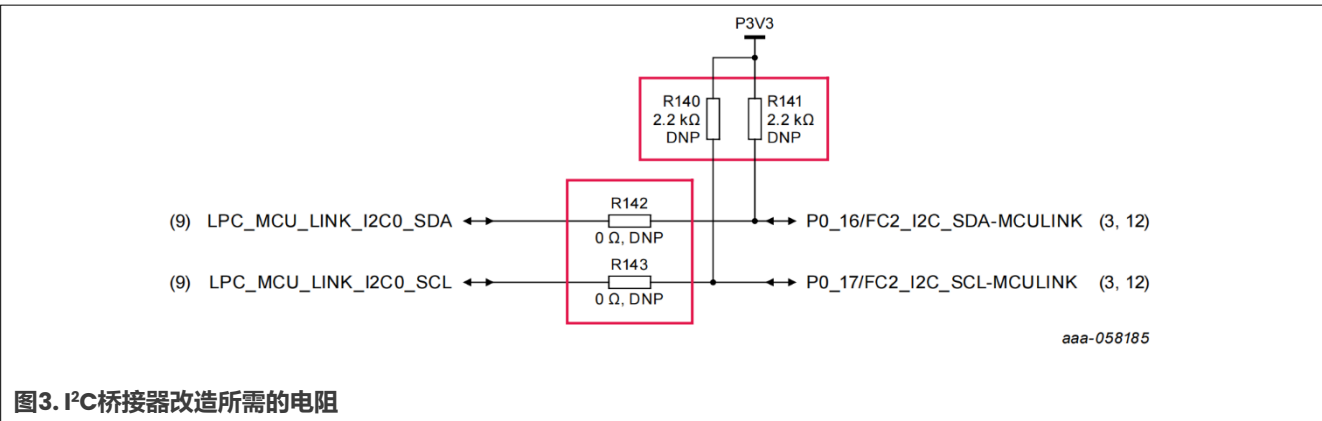
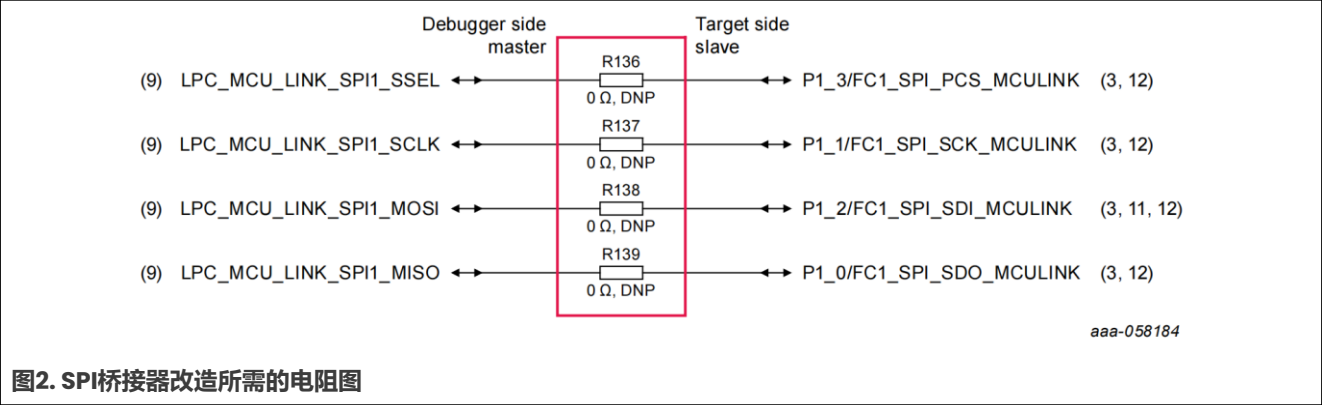
4 硬件设置

下图是FRDM-MCXN947开发板。RESET按键（SW1）、ISP按键（SW3）、MCU-Link USB连接器（J17）和高速USB连接器（J11）的布局如[图1](#)所示。

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要启用SPI桥接和I²C桥接功能，需要对FRDM-MCXN947开发板进行一些改造。要启用SPI桥接功能，需要将电阻R136、R137、R138、R139安装为0Ω。要启用I²C桥接功能，需要将电阻R142和R143安装为0Ω，同时将电阻R140和R141安装为2.2kΩ。



有关需要改造的电阻的位置，请参见图4。

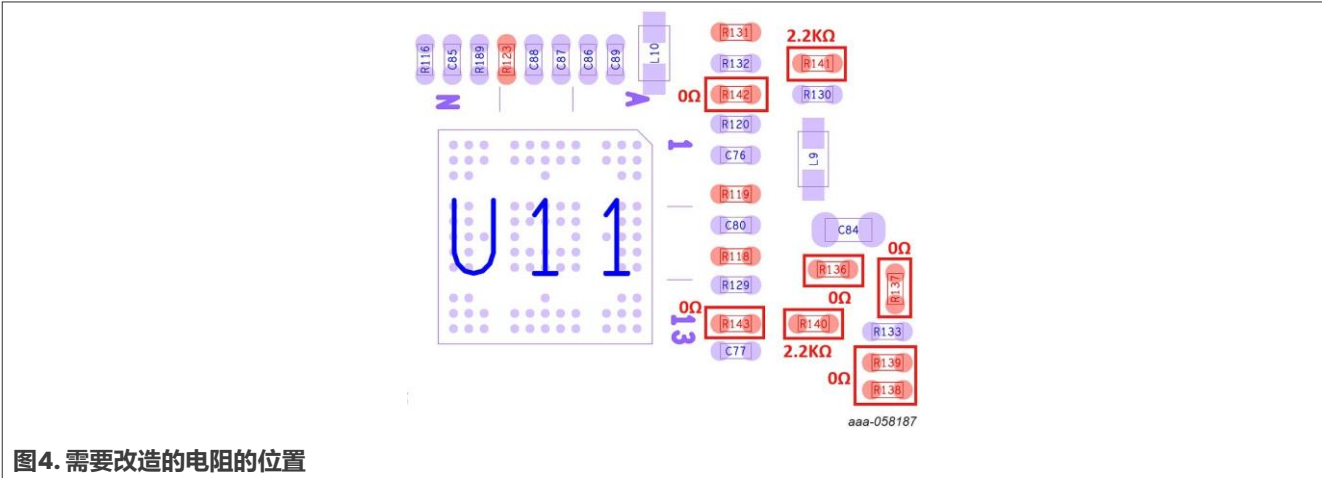


图4. 需要改造的电阻的位置

5 闪存编程

MCX N系列MCU包含了ISP功能，以支持通过串行接口（UART、I2C、SPI、CAN）以及USB HID进行映像编程。恩智浦提供了命令行工具blhost和MCUXpresso安全预处理GUI工具，以支持通过在系统编程（ISP）进行闪存编程。ISP启动流程如图5所示。

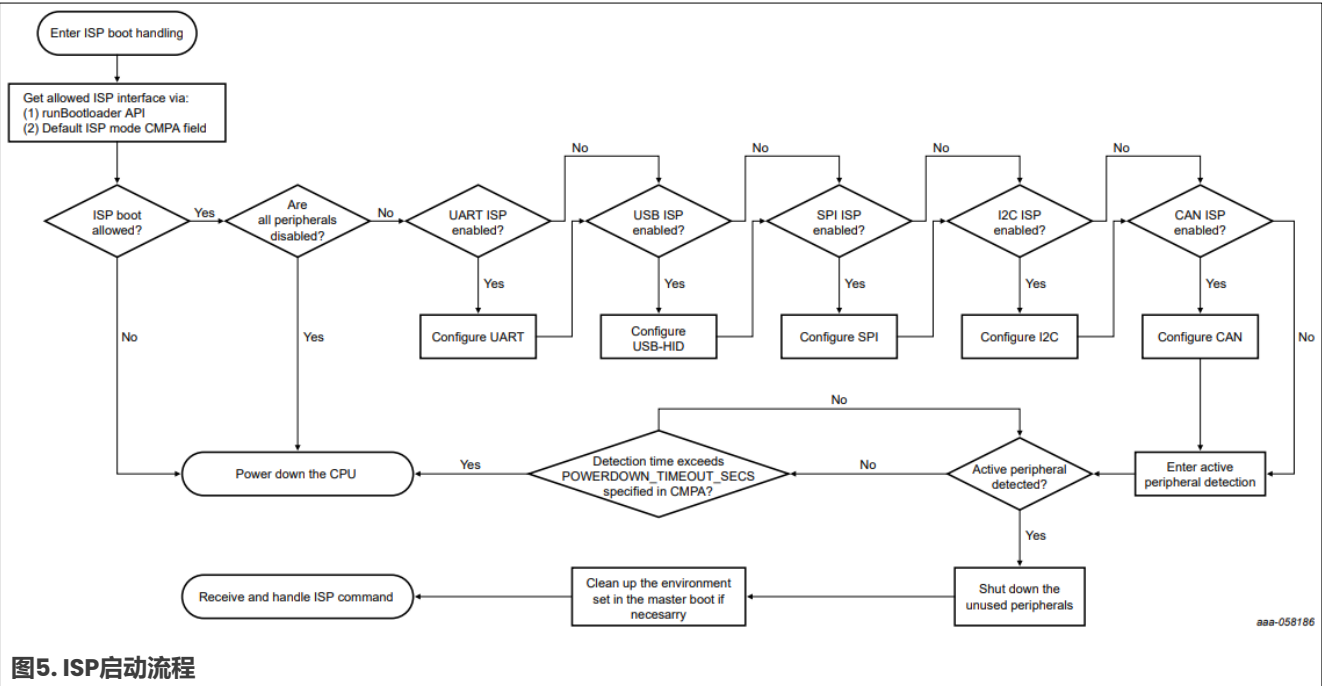


图5. ISP启动流程

5.1 使用MCUXpresso安全预处理工具进行闪存编程

要通过MCUXpresso安全预处理工具执行闪存编程，请按照以下步骤操作：

- 1. 按照以下操作顺序进入ISP模式：
 - a. 按下**RESET**按钮（SW1）
 - b. 按下**ISP**按钮（SW3）
 - c. 松开**RESET**按钮（SW1）

- d. 松开ISP按钮 (SW3)
2. 打开MCUXpresso安全预处理工具，并点击标记为“1”的**Selection of the target processor**按钮，以打开**Select Processor**窗口。如果当前处理器是目标处理器，则点击**OK**；如果不是，请通过点击**create a new workspace**来创建一个新工作区。

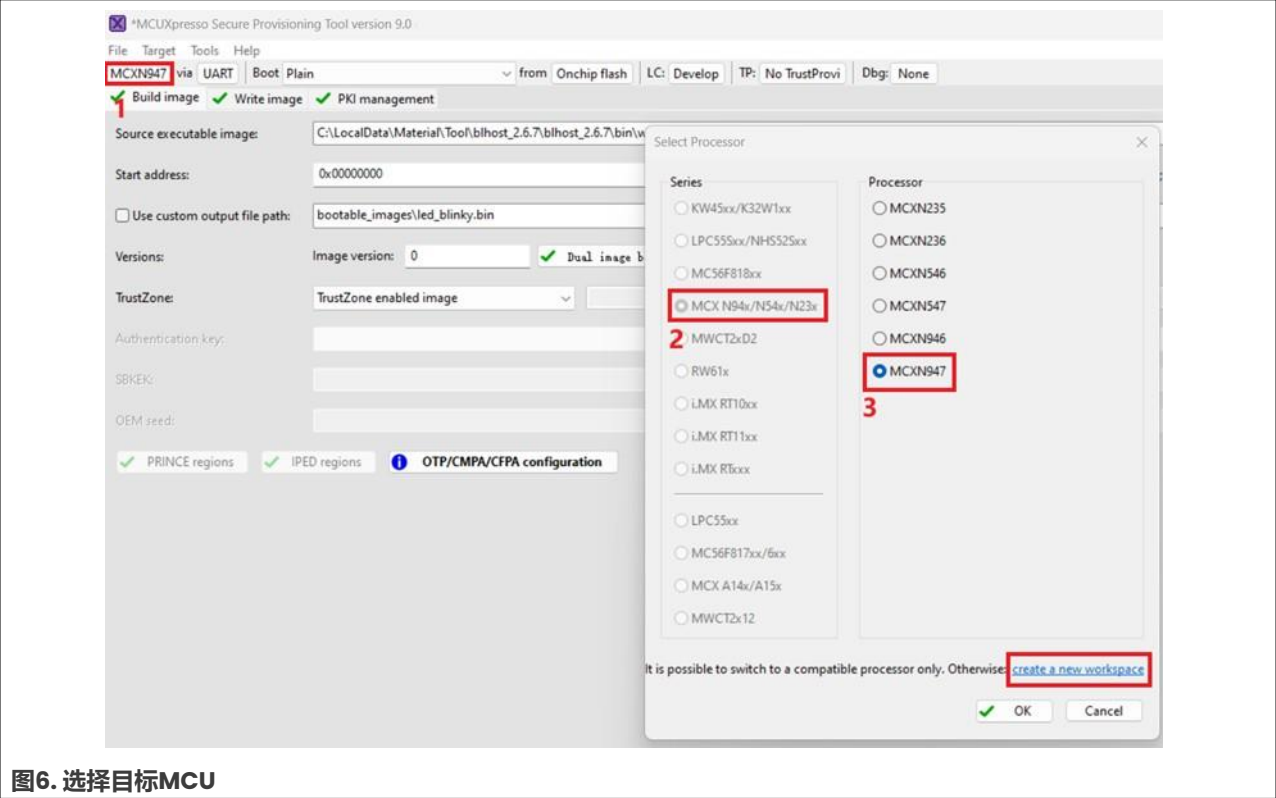


图6. 选择目标MCU

3. 选择用于闪存编程所需的通信接口。所支持的通信接口取决于所选处理器的ISP功能。对于MCXN947，支持USB HID、UART、SPI和I2C。点击标记为“1”的**Selection of the communication interface**按钮，以打开**Connection with Target Processor**窗口。

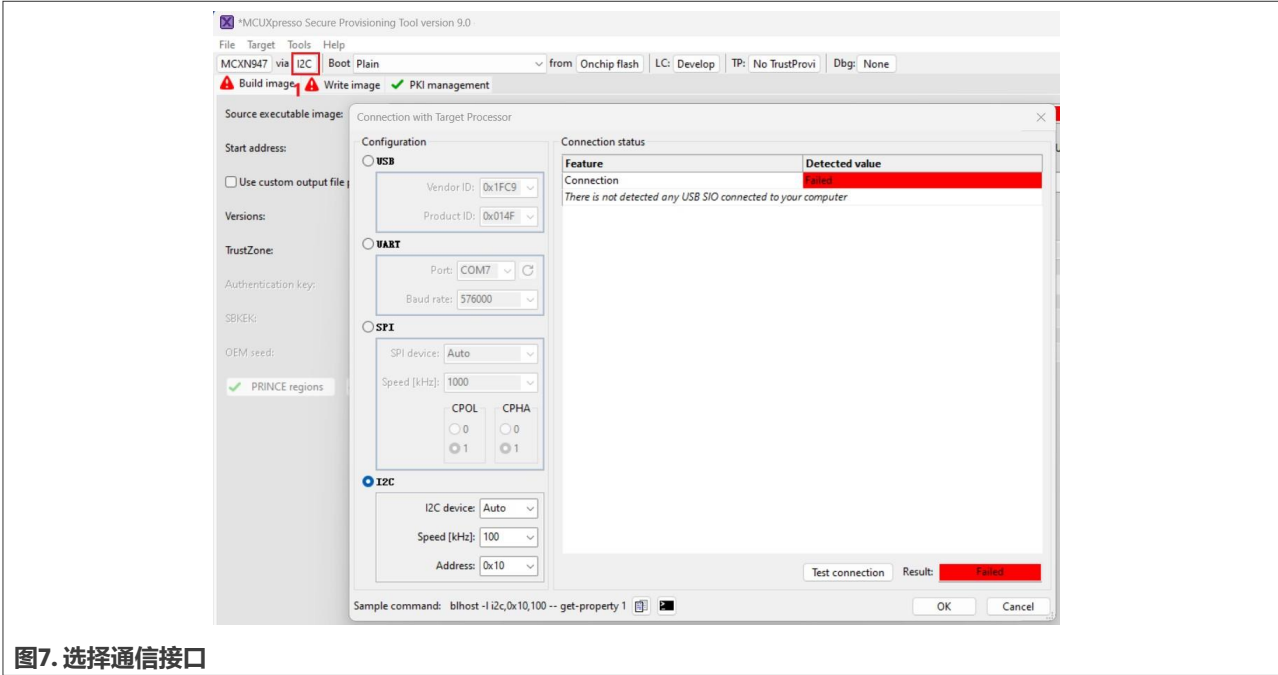


图7. 选择通信接口

4. 要通过USB接口编程闪存，请使用USB连接器J11。由于厂商ID和产品ID会根据所选定的处理器自动填写，因此，请通过点击**Test connection**按钮来检查PC与目标处理器之间的连接。如果结果为**OK**，表明连接已成功建立。

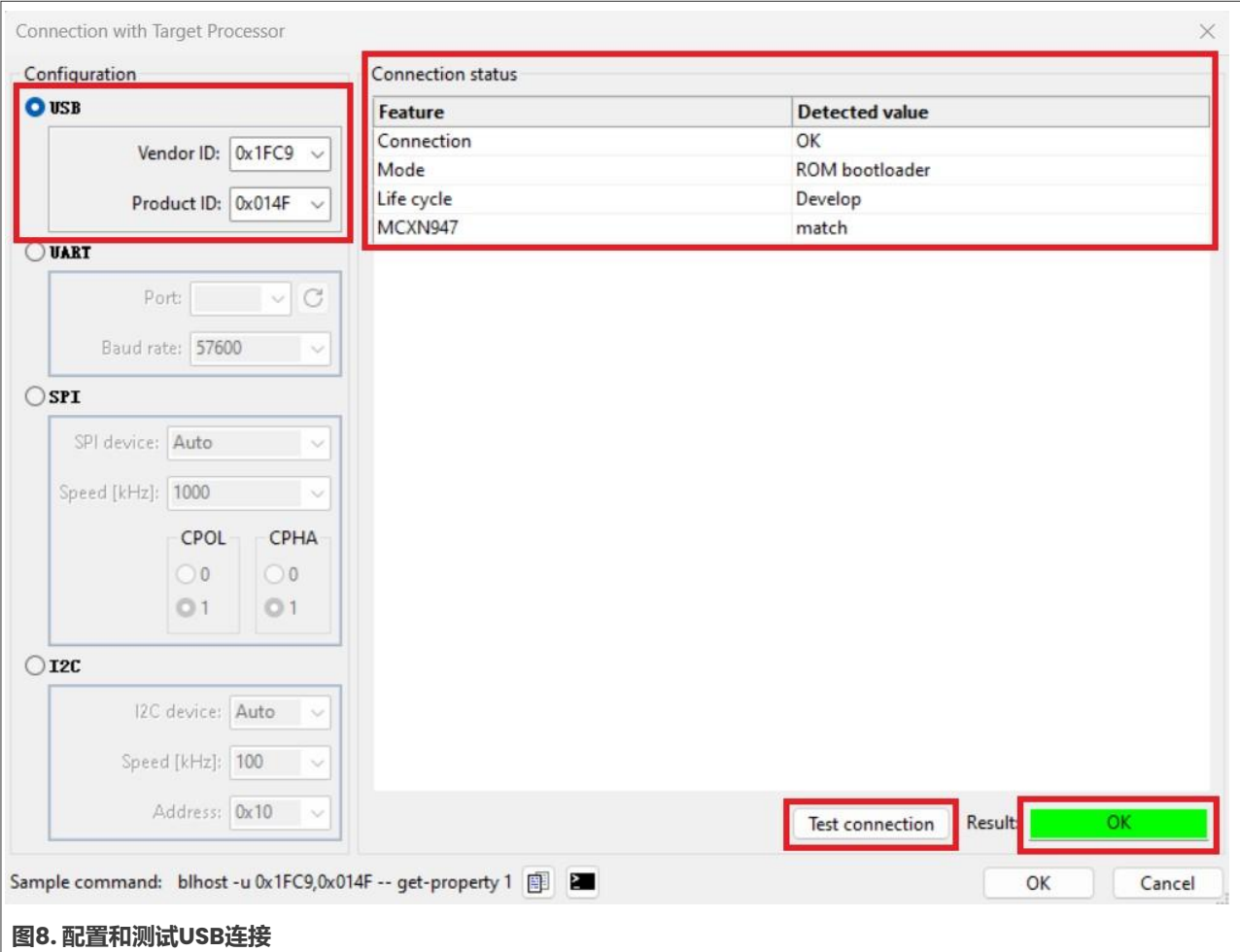


图8. 配置和测试USB连接

要通过UART/SPI/I²C接口编程闪存，请使用USB连接器J17。对于UART接口，请选择正确的端口号和适当的波特率，如图9所示。

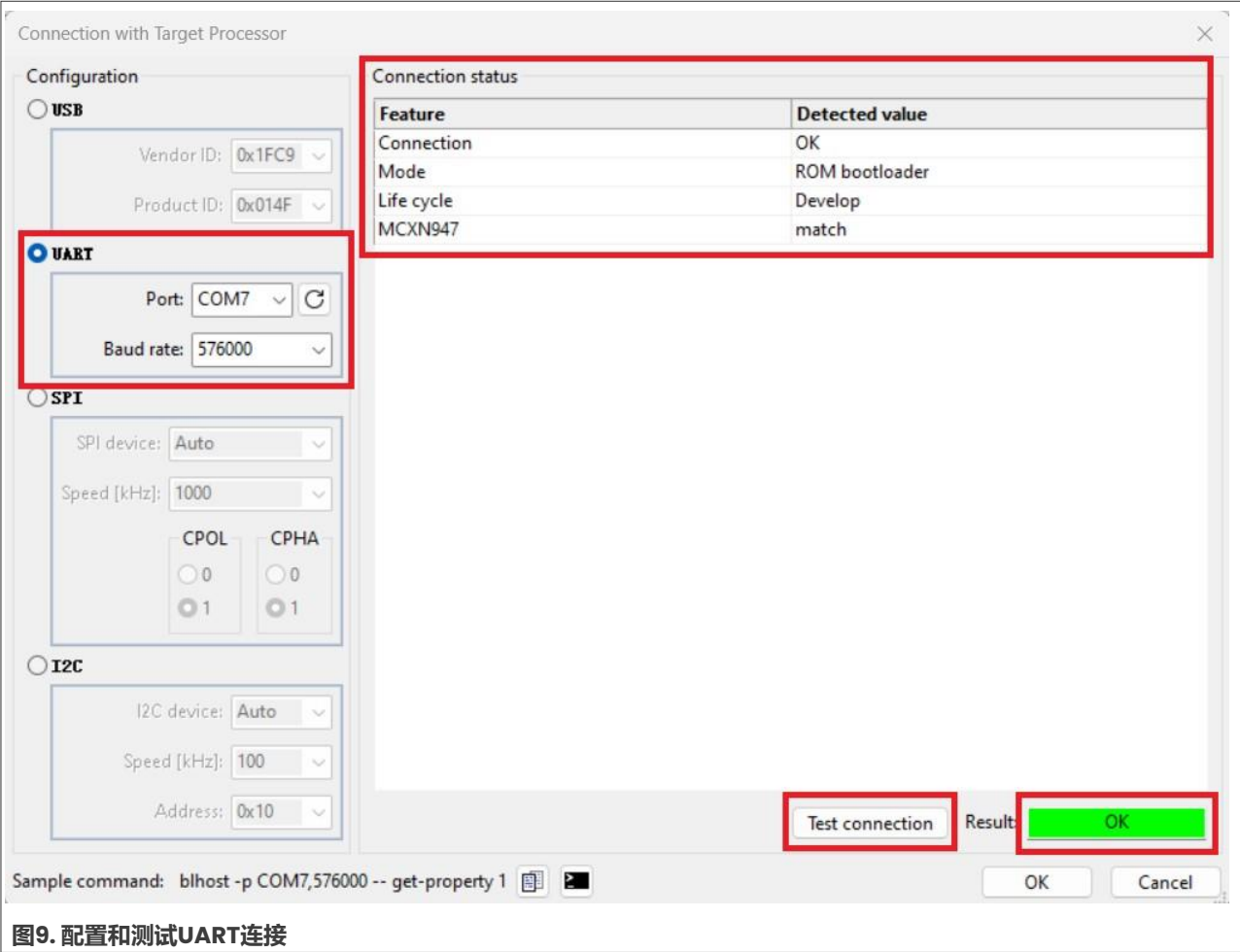


图9. 配置和测试UART连接

对于SPI接口，需设置通信速度、CPOL和CPHA。请使用默认设置，如图10所示。

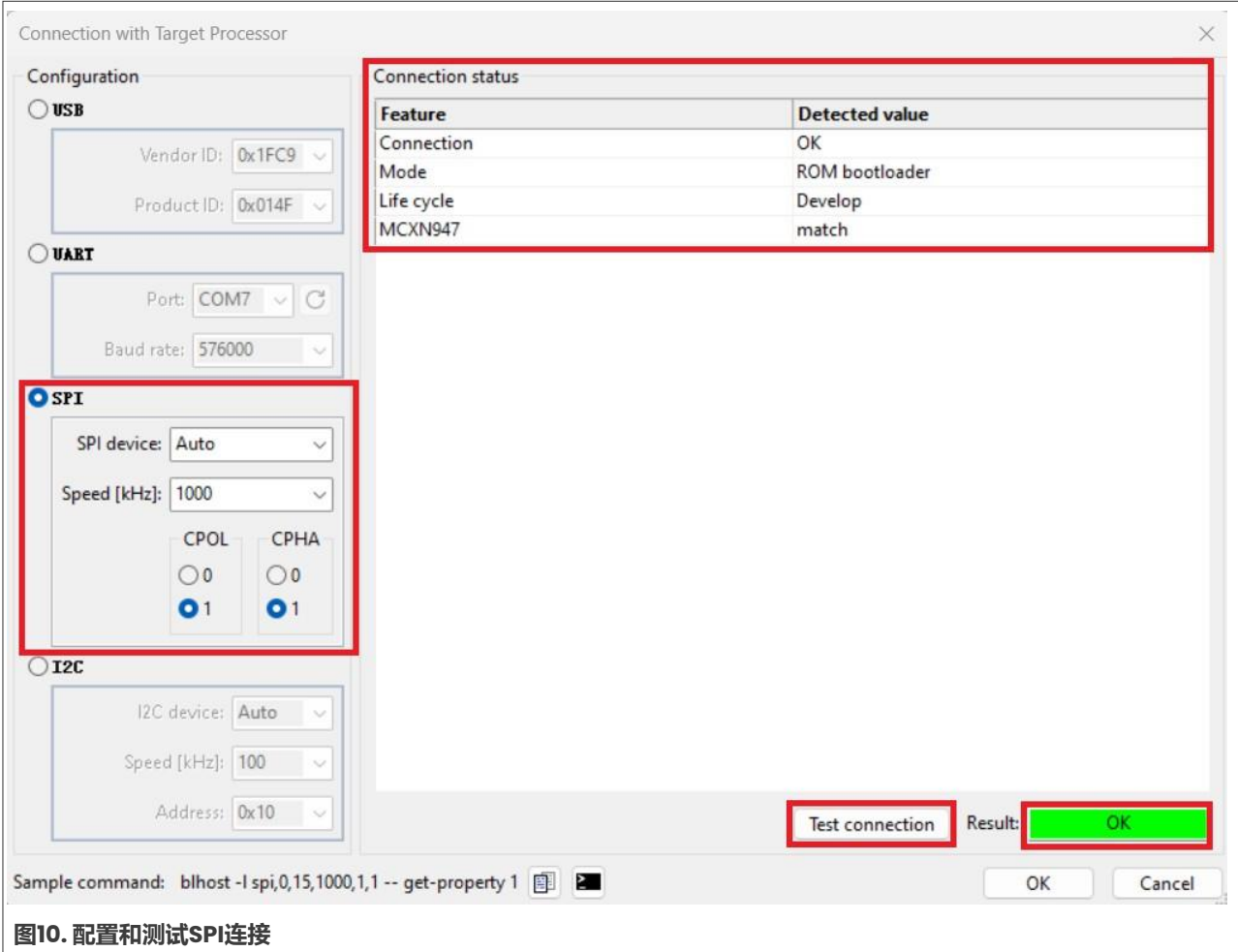
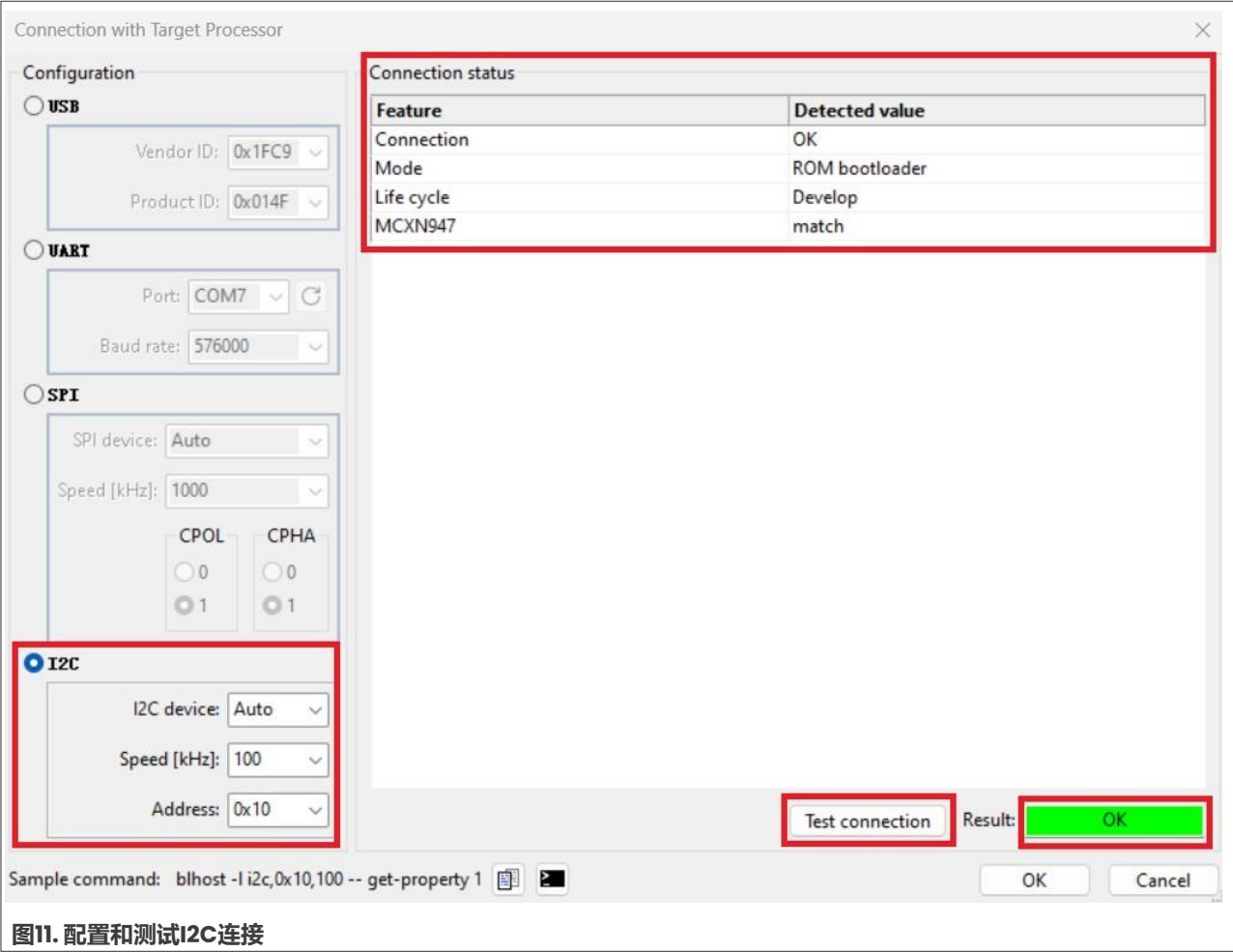


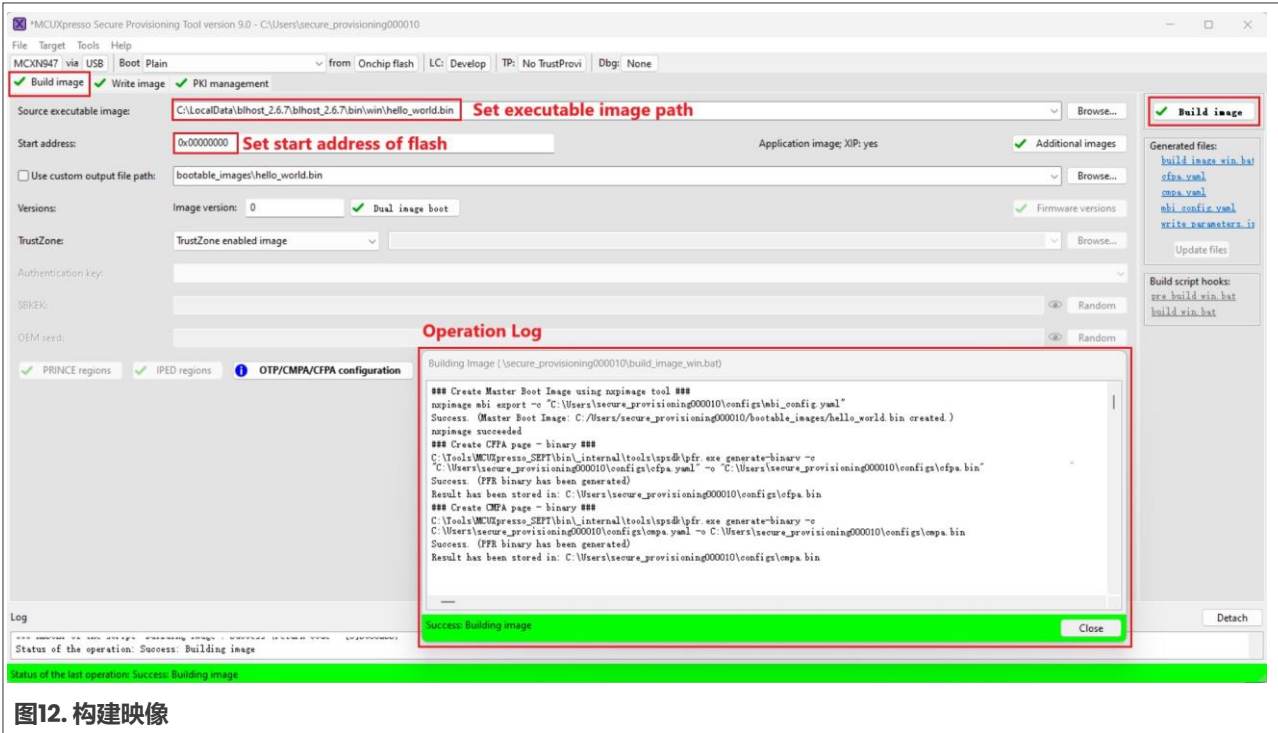
图10. 配置和测试SPI连接

对于I²C接口，需设置通信速度和地址。请使用默认设置，如图11所示。

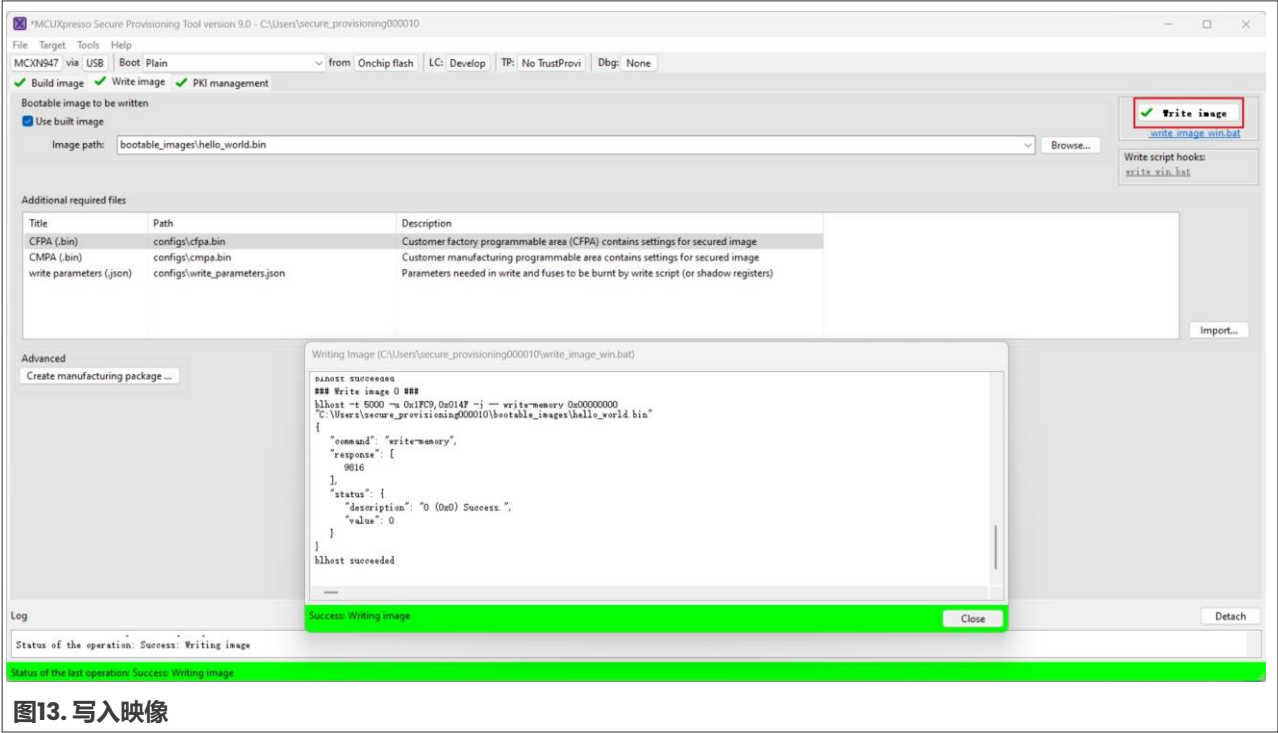


5. 一旦通信接口配置完成，通过点击**Build image**按钮来执行构建映像操作。查看日志信息以了解映像构建的详细信息。

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6. 通过点击**Write image**按钮来执行写入映像操作，此步骤会擦除闪存并将构建好的映像编程写入到闪存中。

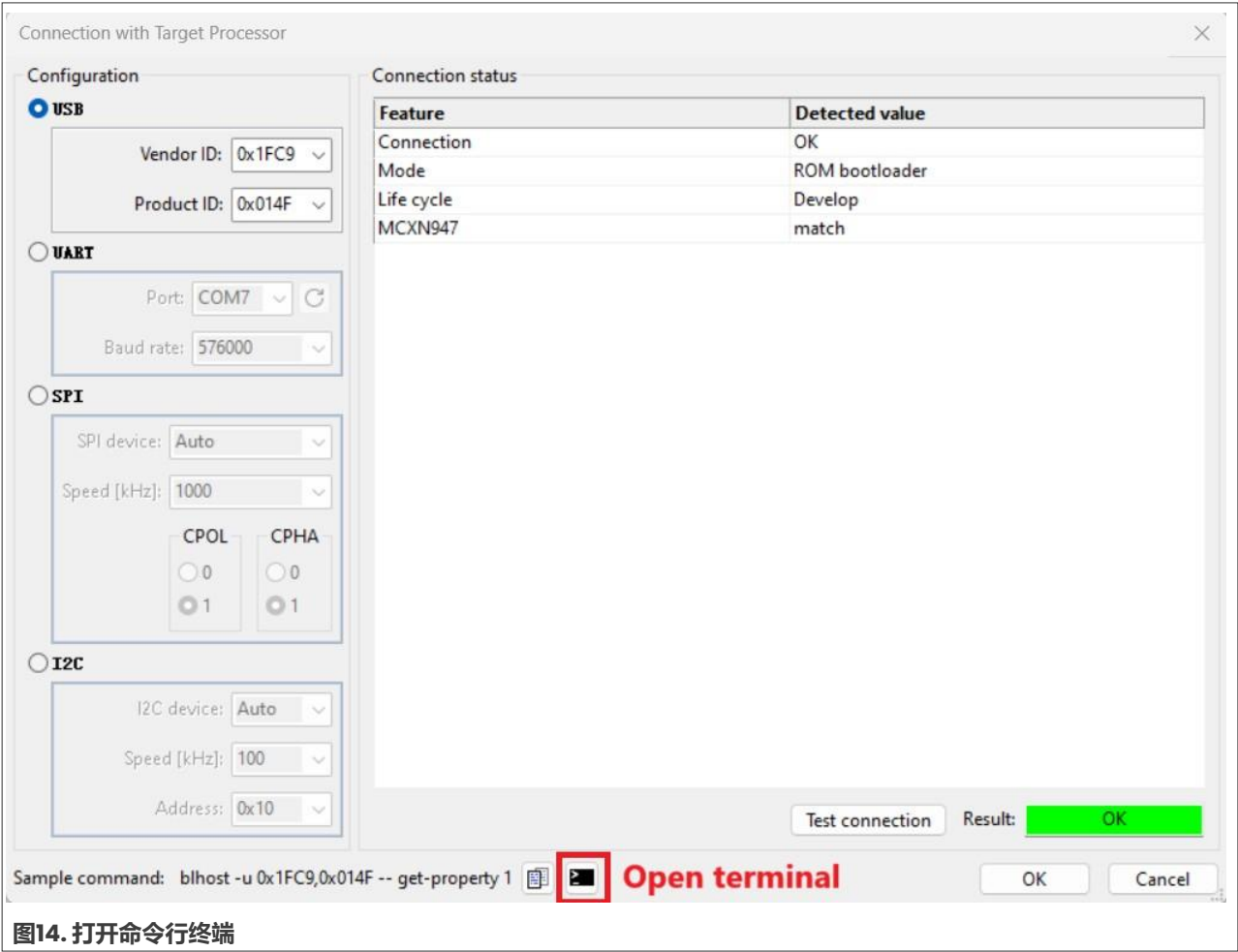


7. 给开发板上电或复位开发板以运行可执行映像。

5.2 使用blhost进行闪存编程

要通过blhost工具擦除和编程闪存，请按照以下步骤操作：

- 1. 按照以下操作顺序进入ISP模式：
 - a. 按下**RESET**按钮（SW1）
 - b. 按下**ISP**按钮（SW3）
 - c. 松开**RESET**按钮（SW1）
 - d. 松开**ISP**按钮（SW3）
- 2. 如图14所示，在**Connection with TargetProcessor**窗口中，通过点击下方的图标打开命令行终端。



- 3. 要检查目标MCU与PC上的命令行终端之间的通信连接是否成功建立，请执行如下所示的get-property命令。
对于USB接口：blhost -u 0x1FC9,0x014F -j -- get-property 1

```
blhost -u 0x1FC9,0x014F -j -- get-property 1
{
  "command": "get-property",
  "response": [
    1258488320
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图15. 检查USB ISP连接

对于UART接口: blhost -p COM14,115200 -j -- get-property 1

```
blhost -p COM14,115200 -j -- get-property 1
{
  "command": "get-property",
  "response": [
    1258488320
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图16. 检查UART ISP连接

对于SPI接口: blhost -l spi,0,15,1000,1,1 -j -- get-property 1

```
blhost -l spi,0,15,1000,1,1 -j -- get-property 1
{
  "command": "get-property",
  "response": [
    1258488320
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图17. 检查SPI ISP连接

对于I²C接口: blhost -l i2c,0x10,400 -j -- get-property 1

```
blhost -l i2c,0x10,400 -j -- get-property 1
{
  "command": "get-property",
  "response": [
    1258488320
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图18. 检查I²C ISP连接

4. 使用blhost的**flash-erase-region**或**flash-erase-all**命令来擦除目标闪存区域:

对于USB接口: blhost -u 0x1FC9,0x014F -j -- flash-erase-all

```
blhost -u 0x1FC9,0x014F -j -- flash-erase-all
{
  "command": "flash-erase-all",
  "response": [],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图19. 通过USB ISP擦除闪存

对于UART接口: blhost -p COM14,115200 -j -- flash-erase-all

```
blhost -p COM14,115200 -j -- flash-erase-all
{
  "command": "flash-erase-all",
  "response": [],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图20. 通过UART ISP擦除闪存

对于SPI接口: blhost -l spi,0,15,1000,1,1 -j -- flash-erase-all

```
blhost -l spi,0,15,1000,1,1 -j -- flash-erase-all
{
  "command": "flash-erase-all",
  "response": [],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图21. 通过SPI ISP擦除闪存

对于I²C接口: `blhost -l i2c,0x10,400 -j -- flash-erase-all`

```
blhost -l i2c,0x10,400 -j -- flash-erase-all
{
  "command": "flash-erase-all",
  "response": [],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图22. 通过I²C ISP擦除闪存

5. 使用blhost的write-memory命令将构建好的映像编程写入到目标闪存中:

对于USB接口: `blhost -u 0x1FC9,0x014F -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin`

```
blhost -u 0x1FC9,0x014F -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin
{
  "command": "write-memory",
  "response": [
    5800
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图23. 通过USB ISP编程闪存

对于UART接口: `blhost -p COM14,115200 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin`

```
blhost -p COM14,115200 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin
{
  "command": "write-memory",
  "response": [
    5800
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图24. 通过UART ISP编程闪存

对于SPI接口: `blhost -l spi,0,15,1000,1,1 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin`

```
blhost -l spi,0,15,1000,1,1 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin
{
  "command": "write-memory",
  "response": [
    5800
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图25. 通过SPI ISP编程闪存

对于I²C接口: blhost -l i2c,0x10,400 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin

```
blhost -l i2c,0x10,400 -j -- write-memory 0x0 C:\LocalData\bin\led_blinky.bin
{
  "command": "write-memory",
  "response": [
    5800
  ],
  "status": {
    "description": "0 (0x0) Success.",
    "value": 0
  }
}
```

图26. 通过I2C ISP编程闪存

- 6. 给开发板上电或复位开发板以运行可执行映像。此时，RGB LED(D2)应以1秒的时间间隔闪烁。也可以使用blhost的reset命令来复位开发板。

6 结论

本文档介绍了两种通过ISP在MCX N系列MCU上实现闪存擦除和编程的方法，包括使用MCUXpresso安全预处理工具和blhost工具。本文还提供了详细步骤，来说明如何使用MCUXpresso安全预处理工具执行闪存编程，以及使用哪些blhost命令来检查通信连接、擦除闪存以及编程闪存。

7 修订历史

表1. 修订历史

文档编号	发布日期	说明
AN14460 v.1.0	2024年11月5日	初始版本

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如何通过ISP对MCX N系列微控制器的内部闪存进行编程

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