

简介

可信平台设计套件（Trust Platform Design Suite, TPDS）是一套全面的工具和服务，旨在辅助开发和部署安全可信的应用程序与系统。该套件包含一系列软件、硬件和服务，可将加密、身份验证和授权等安全功能集成到产品中。可信平台设计套件提供仿真环境、测试工具和认证流程，以确保应用程序满足所需的安全标准。该工具可简化安全系统的创建过程，降低实现安全可信功能的复杂度，同时满足与数据保护和隐私相关的监管和合规要求。

本文档说明了如何使用可信平台设计套件 v2（TPDS）在 32 位 MCU 安全器件上配置密钥。本密钥配置指南的目标是在安全元件内部编程、存储或写入密钥。作为示例，本文档参考了 PIC32CM LS60 单片机（MCU）。

目录

简介.....	1
1. 使用可信平台设计套件在 PIC32CM LS60 Curiosity Pro 评估工具包上配置密钥.....	3
2. 总结.....	14
3. 资源.....	15
4. 版本历史.....	16
Microchip 信息.....	17
商标.....	17
法律声明.....	17
Microchip 器件代码保护功能.....	17

1. 使用可信平台设计套件在 PIC32CM LS60 Curiosity Pro 评估工具包上配置密钥

PIC32CM LS60 系列配备了安全、超低功耗的 PIC32CM LS60 Arm® Cortex®-M23 单片机。该 MCU 将 TrustFLEX ECC608 安全子系统和 Arm TrustZone® 技术集成在单一封装中。此外，还具有增强型外设触摸控制器（Peripheral Touch Controller, PTC）以及智能模拟功能，例如运放、ADC、DAC 和模拟比较器。

注：在本文档的范围内，配置密钥时不会锁定安全元件中的插槽，以防止将来对这些插槽的访问被永久锁定。有关更多信息，请参见“[ATECC608B Data Sheet](#)”（DS40002239）。

本演示使用以下软件和硬件工具：

- [可信平台设计套件 v2](#)
- [PIC32CM LS60 Curiosity Pro 评估工具包](#)

要在 PIC32CM LS60 Curiosity Pro 评估工具包上配置密钥，请按照以下步骤操作：

1. 从 **Start**（开始）菜单中，启动可信平台设计套件。

图 1-1. TPDS 启动控制台

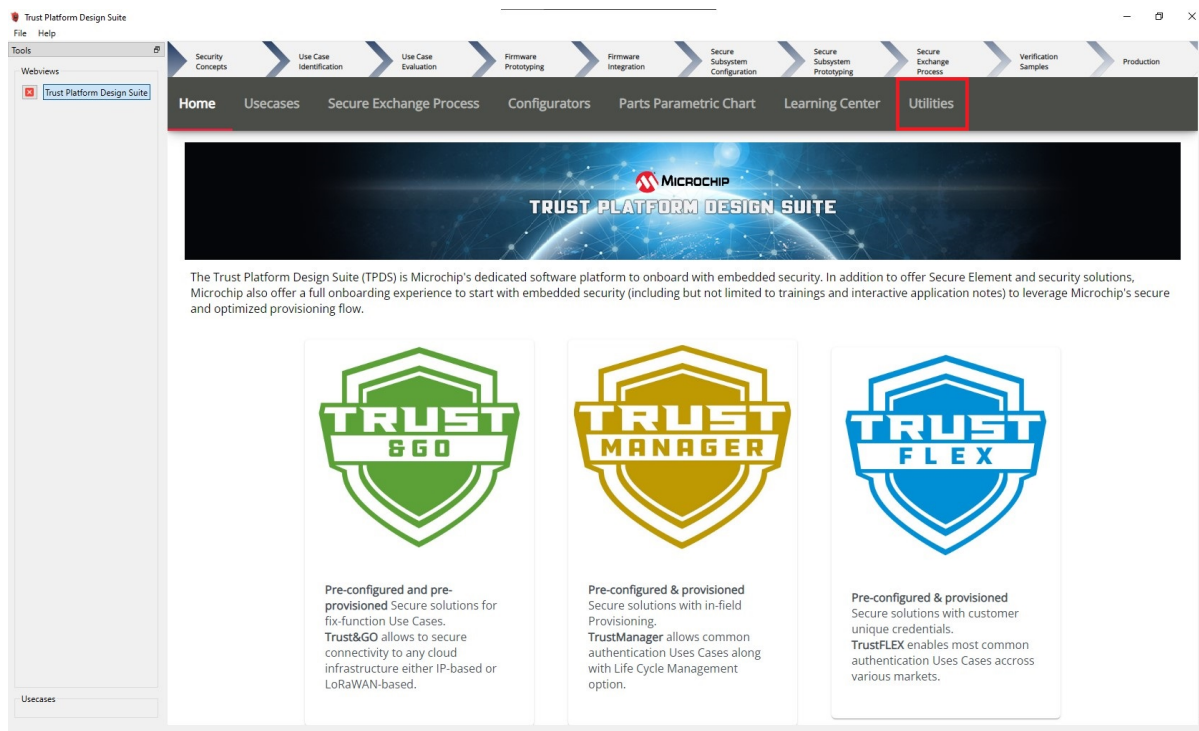
```

Trust Platform Design Suite
-----
This prompt runs Trust Platform GUI, Do NOT close this window.
-----
[DEBUG 2024-11-21 17:37:14,116 26940 19548] Loading configuration data from C:\Users\... \trustplatform\TPDS_config.j
son
[DEBUG 2024-11-21 17:37:14,125 26940 8332 ] Retrieving versions: https://pypi.org/simple/PySide6
[DEBUG 2024-11-21 17:37:14,126 26940 22760] Retrieving versions: https://pypi.org/simple/pip
[DEBUG 2024-11-21 17:37:14,126 26940 1784 ] Retrieving versions: https://pypi.org/simple/azure-iot-hub
[DEBUG 2024-11-21 17:37:14,127 26940 8744 ] Retrieving versions: https://pypi.org/simple/azure-identity
[DEBUG 2024-11-21 17:37:14,127 26940 2736 ] Retrieving versions: https://pypi.org/simple/azure-mgmt-iot-hub
[DEBUG 2024-11-21 17:37:14,128 26940 22808] Retrieving versions: https://pypi.org/simple/azure-iot-device
[DEBUG 2024-11-21 17:37:14,129 26940 22704] Retrieving versions: https://pypi.org/simple/azure-iot-hub-provisioningservic
eclient
[DEBUG 2024-11-21 17:37:14,129 26940 19216] Retrieving versions: https://pypi.org/simple/azure-mgmt-iot-hubprovisioningse
rvices
[DEBUG 2024-11-21 17:37:14,130 26940 19232] Retrieving versions: https://pypi.org/simple/azure-mgmt-resource
[DEBUG 2024-11-21 17:37:14,253 26940 19216] azure-mgmt-iot-hubprovisioningservices: 1.1.0
[DEBUG 2024-11-21 17:37:14,255 26940 22704] azure-iot-hub-provisioningserviceclient: 1.2.0
[DEBUG 2024-11-21 17:37:14,263 26940 1784 ] azure-iot-hub: 2.6.1
[DEBUG 2024-11-21 17:37:14,268 26940 2736 ] azure-mgmt-iot-hub: 3.0.0
[DEBUG 2024-11-21 17:37:14,283 26940 8744 ] azure-identity: 1.19.0
[DEBUG 2024-11-21 17:37:14,302 26940 19232] azure-mgmt-resource: 23.2.0
[DEBUG 2024-11-21 17:37:14,310 26940 22808] azure-iot-device: 2.14.0
[DEBUG 2024-11-21 17:37:14,340 26940 8332 ] PySide6: 6.8.0.2
[DEBUG 2024-11-21 17:37:14,513 26940 22760] pip: 24.3.1
[DEBUG 2024-11-21 17:37:14,521 26940 19548] Started "C:\Users\... \tpds\2.3.9\python.exe -m pip list -v" with pid 1436
8
[DEBUG 2024-11-21 17:37:15,482 26940 19548] Process (14368) ended with code (0)

```

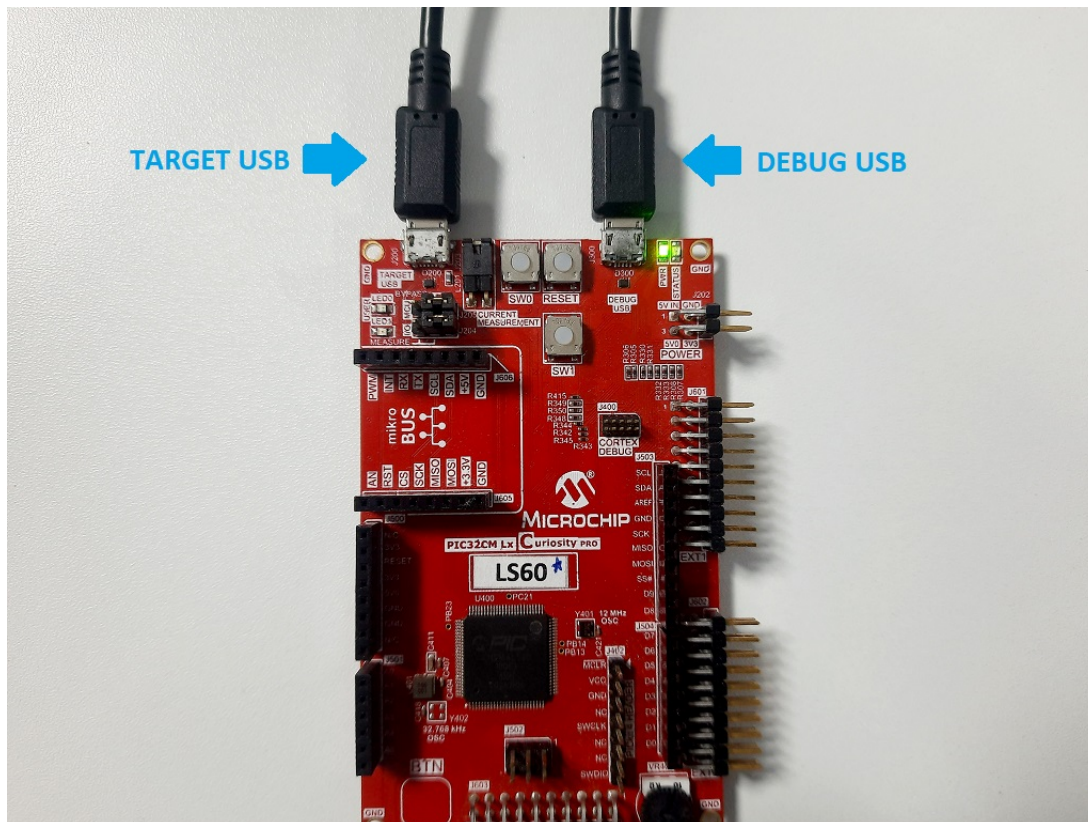
2. 打开 TPDS 后，单击 **Utilities**（实用工具）选项卡。

图 1-2. Preferences（首选项）配置



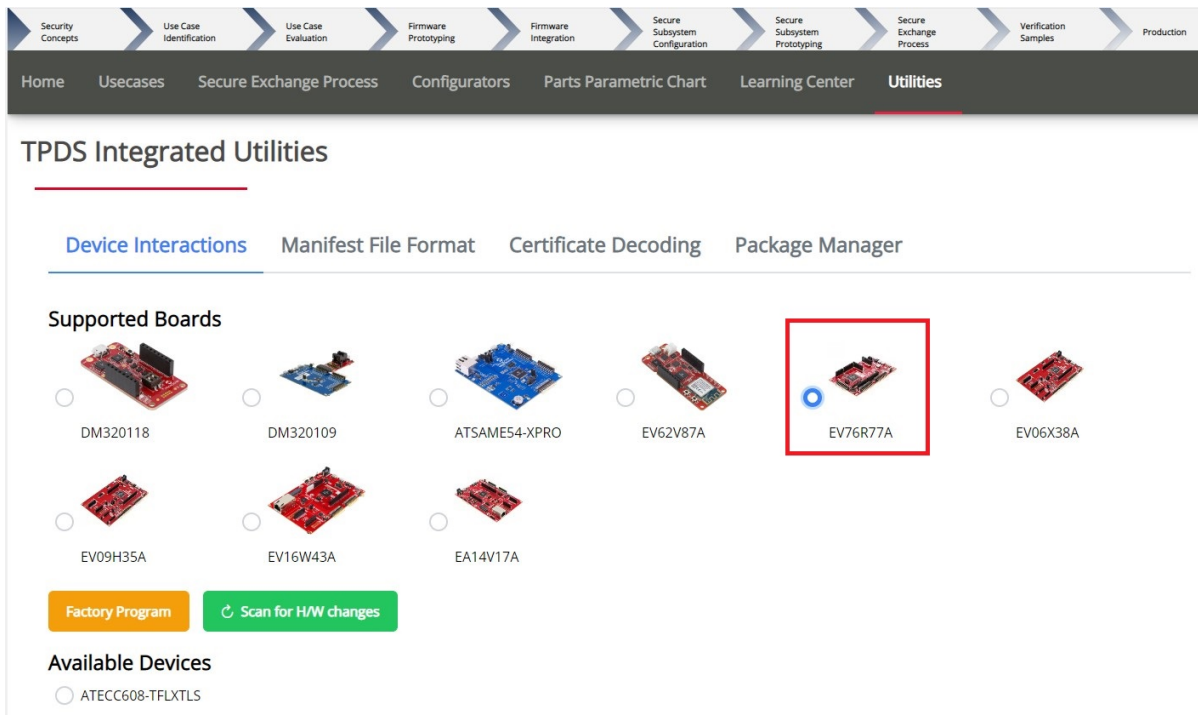
3. 连接两根 micro-USB 线缆：一根线缆从 PIC32CM LS60 Curiosity Pro 评估工具包上的 DEBUG USB 端口连接到 PC，另一根线缆从 PIC32CM LS60 Curiosity Pro 评估工具包上的 TARGET USB 端口连接到 PC。此配置允许通过 TPDS 进行密钥配置。

图 1-3. 硬件连接



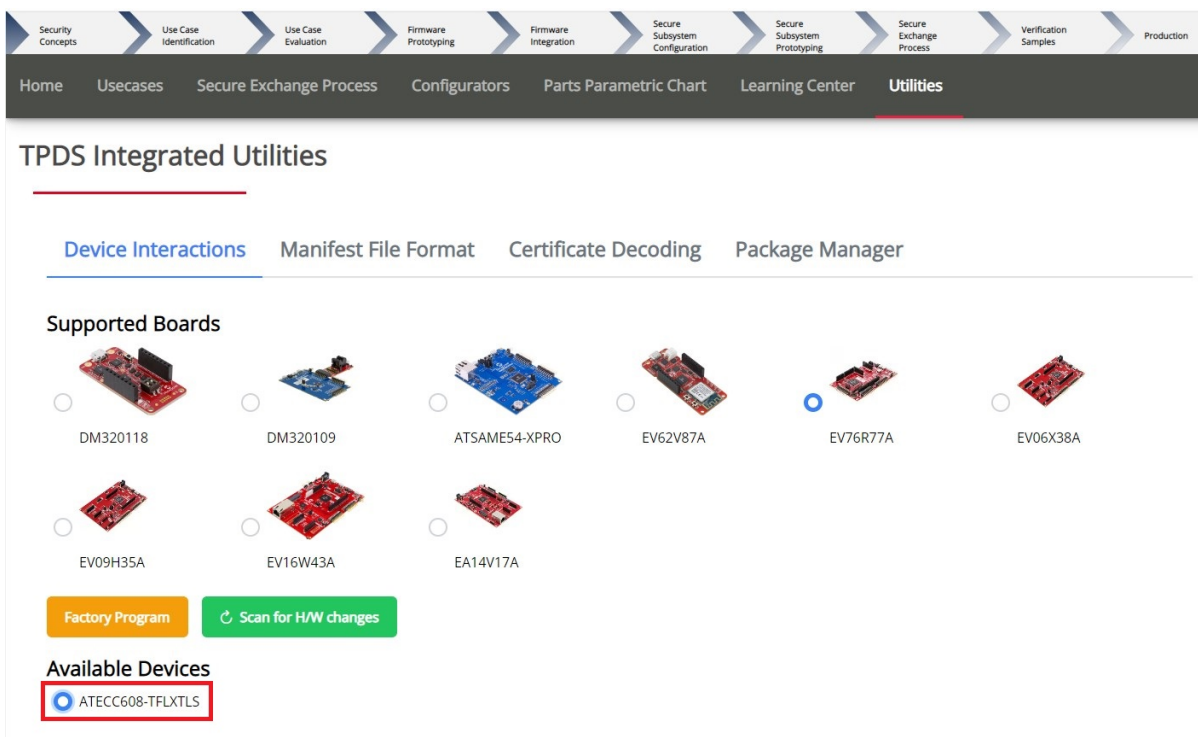
4. 在 TPDS Integrated Utilities (TPDS 集成实用工具) 下, 单击 **Device Interactions** (器件交互), 然后在 Supported Boards (支持的开发板) 下, 选择 **EV76R77A**。
注: EV76R77A 是 PIC32CM LS60 Curiosity Pro 评估工具包的部件编号。

图 1-4. 开发板选择



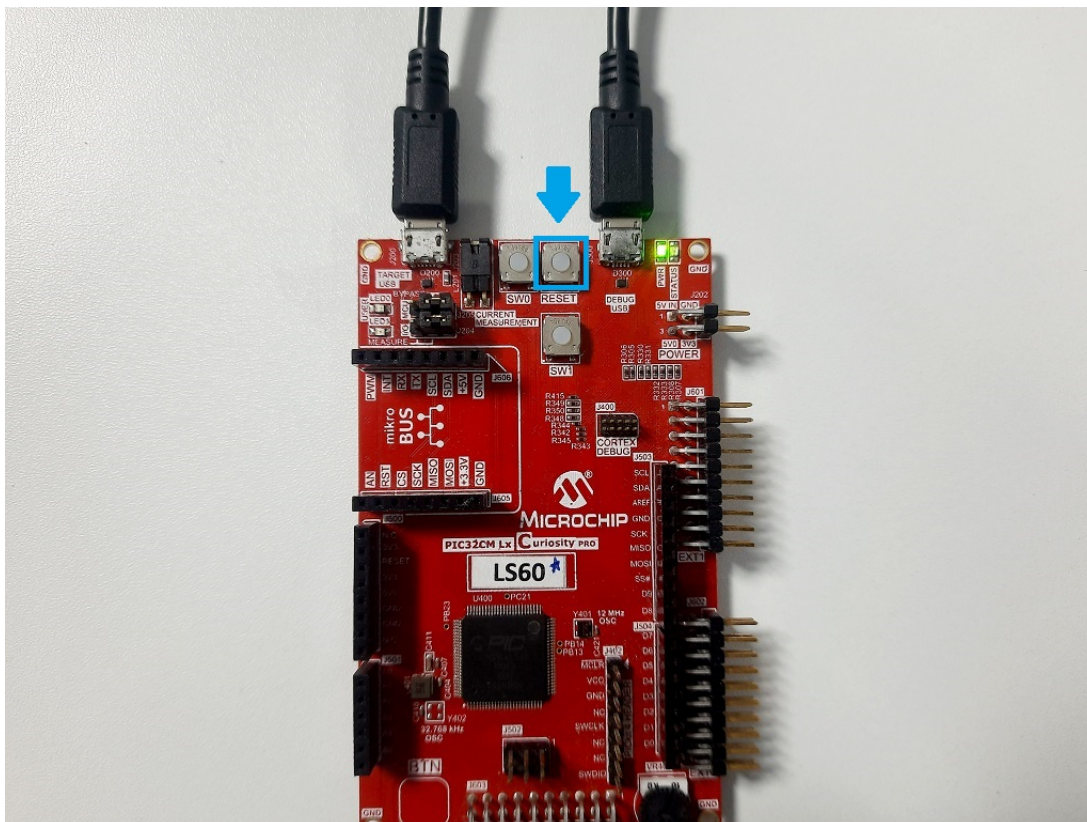
- 从 **Available Devices**（可用器件）部分中，选择 **ATECC608-TFLXTLS**。

图 1-5. 选择 ATECC608-TFLXTLS



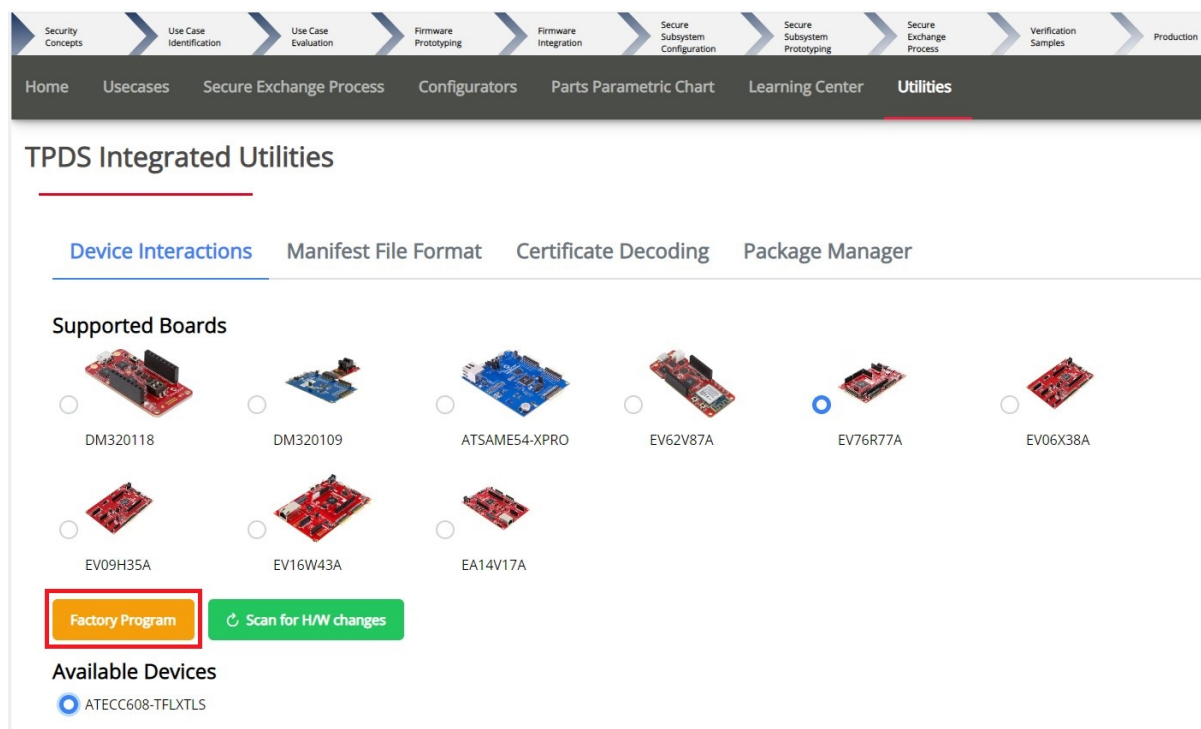
- 按下 PIC32CM LS60 Curiosity Pro 评估工具包上的复位按钮以复位器件，如下所示。

图 1-6. 复位 PIC32CM LS60 Curiosity Pro 评估工具包



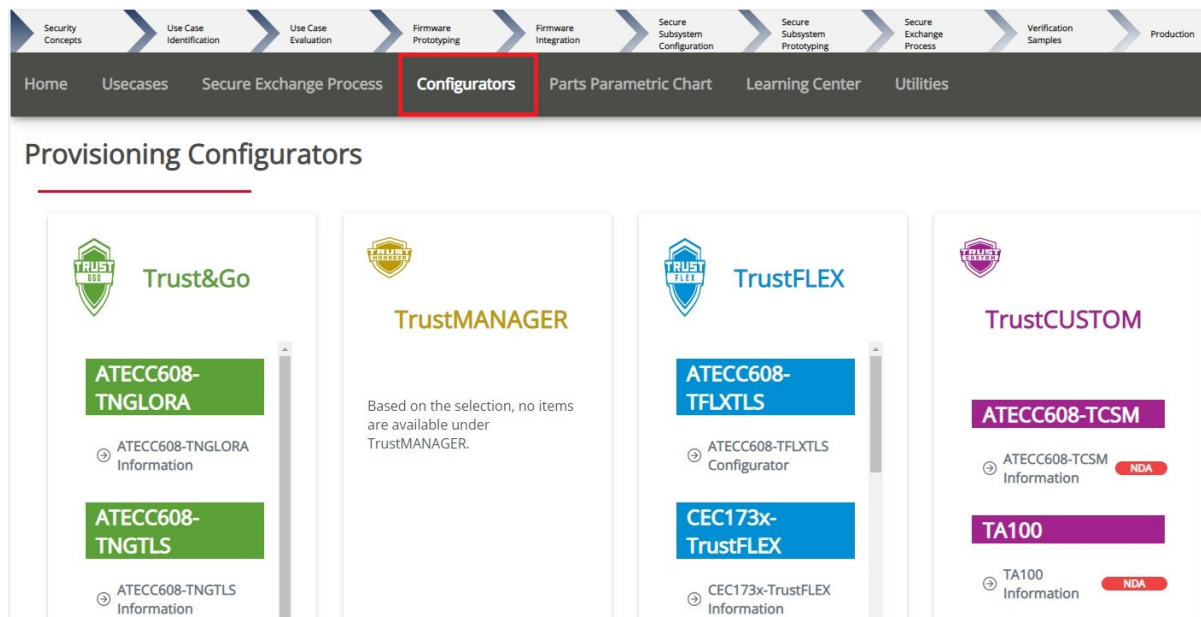
7. 单击 **Factory Program**（出厂程序）以在 PIC32CM LS60 Curiosity Pro 评估工具包上对密钥配置固件进行编程。

图 1-7. 密钥配置固件程序



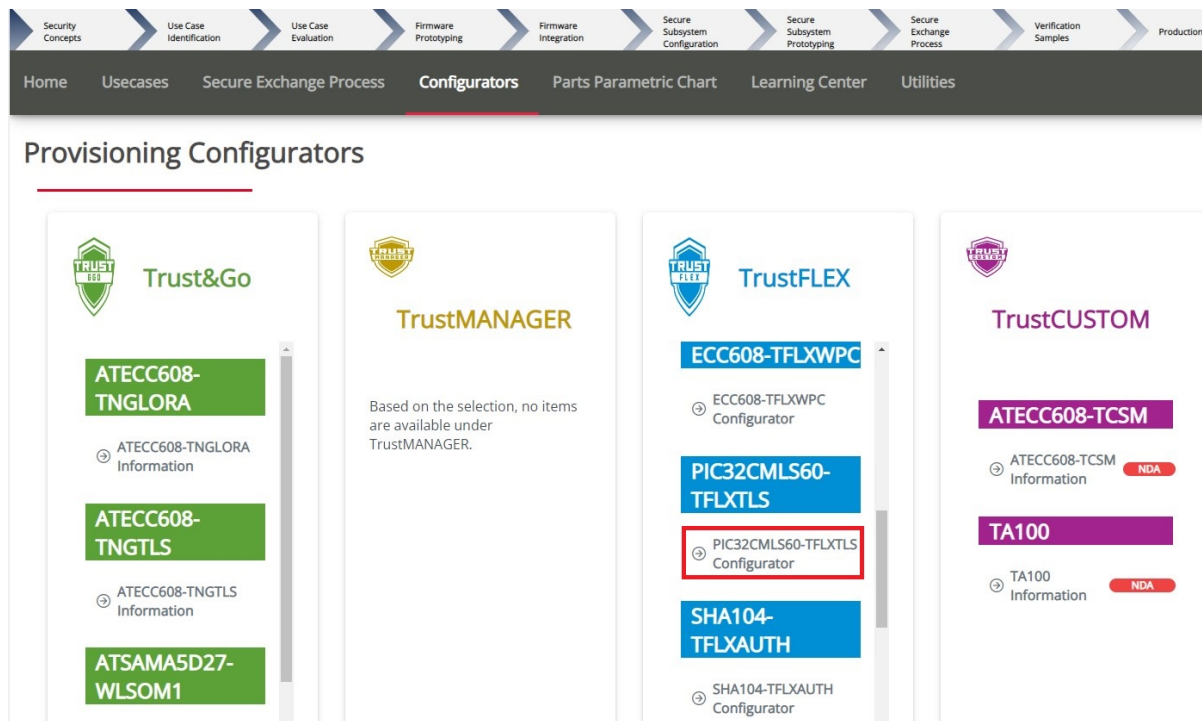
8. 编程成功完成后，单击 **Configurators**（配置器）选项卡。

图 1-8. 配置选择



9. 在 Provisioning Configurators（配置配置器）中的 TrustFLEX 部分下，单击 **PIC32CMLS60-TFLXTLS Configurator**（PIC32CMLS60-TFLXTLS 配置器）。

图 1-9. 选择 PIC32CMLS60-TFLXTLS 配置器



10. 在 PIC32CMLS60 TrustFLEX XML 生成器中选择 Slot 以配置密钥，如下所示。

图 1-10. Slot 5 选择

PIC32CMLS60 TrustFLEX XML Generator

PIC32CMLS60 Package:

- I2C
 SWI

Click on table rows for more info.

Slot Number	Slot Use-case	Description	Slot Property
Slot 0	Primary private key	Primary authentication key	Permanent, Ext Sign, ECDH
Slot 1	Internal sign private key	Private key that can only be used to attest internal keys and state of the device. Can't be used to sign arbitrary messages.	Permanent, Int Sign
Slot 2	Secondary private key 1	Secondary private key for other uses	Updatable, Ext Sign, ECDH, Lockable
Slot 3	Secondary private key 2	Secondary private key for other uses	Updatable, Ext Sign, ECDH, Lockable
Slot 4	Secondary private key 3	Secondary private key for other uses	Updatable, Ext Sign, ECDH, Lockable
Slot 5	Secret key	Storage for a secret key	No read, Encrypted write(6), Lockable, AES key
Slot 6	IO protection key	Key used to protect the I2C bus communication (IO) of certain commands. Requires setup before use.	No read, Clear write, Lockable
Slot 7	Secure Boot digest	Storage location for Secure Boot digest. This is an internal function, so no reads or writes are enabled.	No read, No write
Slot 8	General data	General public data storage (416 bytes)	Clear read, Always write, Lockable
Slot 9	AES key	Intermediate key storage for ECDH and KDF output	No read, Always write, AES key
Slot 10	Device compressed certificate	Certificate primary public key in the Crypto Authentication compressed format	Clear read, No write
Slot 11	Signer public key	Public key for the CA (signer) that signed the device cert	Clear read, No write
Slot 12	Signer compressed certificate	Certificate for the CA (signer) certificate for the device certificate in the CryptoAuthentication compressed format	Clear read, No write

11. 在 Slot 5 部分中选择 **Enter HEX data**（输入 HEX 数据）。

图 1-11. Slot 5 中的 HEX 数据选项

Slot 5	Secret key	Storage for a secret key	No read, Encrypted write(6), Lockable, AES key
--------	------------	--------------------------	--

SLOT 5

Slot Description:
This slot provides a storage location for a symmetric key to use with the ATECC608B's symmetric key commands. The primary use case was to support secondary symmetric authentication. For example, many cloud providers perform symmetric authentication using HMAC SHA256, which could be done with a key in this slot. Slot can only be updated with an encrypted write using the IO protection key as a write key. The IO protection key must be setup prior to writing this slot. This slot is also marked as an AES slot so it can be used with the AES command if required.

Provisioning:
The data entered in the below step will be stored in the device slot during provisioning.

Provisioning data input method:

Slot Unused

Enter HEX data

Upload data through .pem file

Input hex data here:
Slot expects 32 bytes of data.

Example:
42 94 AB 92 20 CB 2C 7A
.....

Disable slot write:
If the following checkbox is checked, the contents of the slot cannot be modified under any circumstances.

Disable slot write

12. 在输入部分以随机十六进制值的形式输入**密钥**，然后单击 **Verify**（验证）以验证数据长度。

图 1-12. 输入密钥

Slot 5	Secret key	Storage for a secret key	No read, Encrypted write(6), Lockable, AES key
--------	------------	--------------------------	--

SLOT 5

Slot Description:
This slot provides a storage location for a symmetric key to use with the ATECC608B's symmetric key commands. The primary use case was to support secondary symmetric authentication. For example, many cloud providers perform symmetric authentication using HMAC SHA256, which could be done with a key in this slot. Slot can only be updated with an encrypted write using the IO protection key as a write key. The IO protection key must be setup prior to writing this slot. This slot is also marked as an AES slot so it can be used with the AES command if required.

Provisioning:
The data entered in the below step will be stored in the device slot during provisioning.

Provisioning data input method:

Slot Unused

Enter HEX data

Upload data through .pem file

00 01 02 03 04 05 06 07 08 09 0A 0B 0C
0D 0E 0F 10 11 12 13 14 15 16 17 18 19
1A 1B 1C 1D 1E 1F

←

Disable slot write:
If the following checkbox is checked, the contents of the slot cannot be modified under any circumstances.

Disable slot write

注:

- 单击 **Modify**（修改）以更改 Slot 5 的内容。

图 1-13. Slot 5 内容修改

Provisioning data input method:

- Slot Unused
- Enter HEX data
- Upload data through .pem file

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C
0D 0E 0F 10 11 12 13 14 15 16 17 18 19
1A 1B 1C 1D 1E 1F
```

Modify

Disable slot write:

If the following checkbox is checked, the contents of the slot cannot be modified under any circumstances.

Disable slot write

- 在这种情况下，密钥（Slot 5）依赖于 Slot 6 中的 I/O 保护密钥。这种依赖性至关重要，因为必须保护该密钥免受物理攻击。请确保按照步骤 10 到 12 中定义的流程，正确添加 I/O 保护密钥的取值。

图 1-14. 输入 I/O 保护密钥

SLOT 6**Slot Description:**

Using the IO protection features is optional, but the IO protection key is saved here. The idea is that on first boot, a random key will be generated and saved to this slot and the MCU's NVM, then the slot locked. Locking may not be necessary, if key rotation is needed for this key, but it does open up the device to a DOS attack where the key is changed unexpectedly.

Provisioning:

The data entered in the below step will be stored into the device slot during provisioning.

Provisioning data input method:

- Slot Unused
- Enter HEX data
- Upload data through .pem file

```
00 01 02 03 04 05 06 07 08 09 0A 0B 0C
0D 0E 0F 10 11 12 13 14 15 16 17 18 19
1A 1B 1C 1D 1E 1F
```

Modify

Disable slot write:

If the following checkbox is checked, the contents of the slot cannot be modified under any circumstances.

Disable slot write

13. 向下滚动并单击 Prototyping（原型设计）部分中的 **Generate Provisioning Package**（生成配置包）。

图 1-15. 配置包生成

Prototyping		Production
<p>Generate Provisioning Package</p> <p>The prototype package is for prototyping and learning only. Do NOT share the prototype package because secrets are in plain text. Alternatively, you may use dummy secrets.</p>	<p>Provision Prototype Samples</p> <p>Click here to provision the PIC32CMLS60-TFLXTLS-PROTO with the package generated from "Generate provisioning Package - Prototype". Make sure to load the generated zip file.</p>	<p>Generate Encrypted Provisioning Package</p> <p>Click here to generate the Secure Exchange Package then upload it to Microchip Provisioning Service (through Microchip Technical Support Portal). You will be prompted to add the HSM encryption keys when starting the generation process.</p>

Both "Generate Provisioning Package" buttons compile all the data provided in the above slots into a zip package containing .ENC.xml/xml, .c, .h and certificate files.

1. **.xml** file contains device configuration and user data to be loaded into the PIC32CMLS60-PROTO slots. In the prototyping package, all user data are in unencrypted plain text whereas in the production package, user data are encrypted.
2. **.c, .h** are 'C' source files that are meant to be used with CryptoAuthLib. These files are required to use certificates in CryptoAuthLib.
3. **Certificate** files are generated for verification purpose.

注：在原型设计包中，为配置包生成的 XML 中的所有用户数据均为未加密的明文。如需获得加密的配置包，请使用生产（Production）包。

14. 配置包保存在以下位置：*Users/xxx/Downloads/TPDS_Downloads*。
15. 选择所需的 Provisioning Package（配置包），然后单击 **OK**（确定）。

图 1-16. 配置包位置

16. 单击 **Provision Prototype Samples**（配置原型样片）以在安全元件内部编程密钥。

图 1-17. 配置密钥

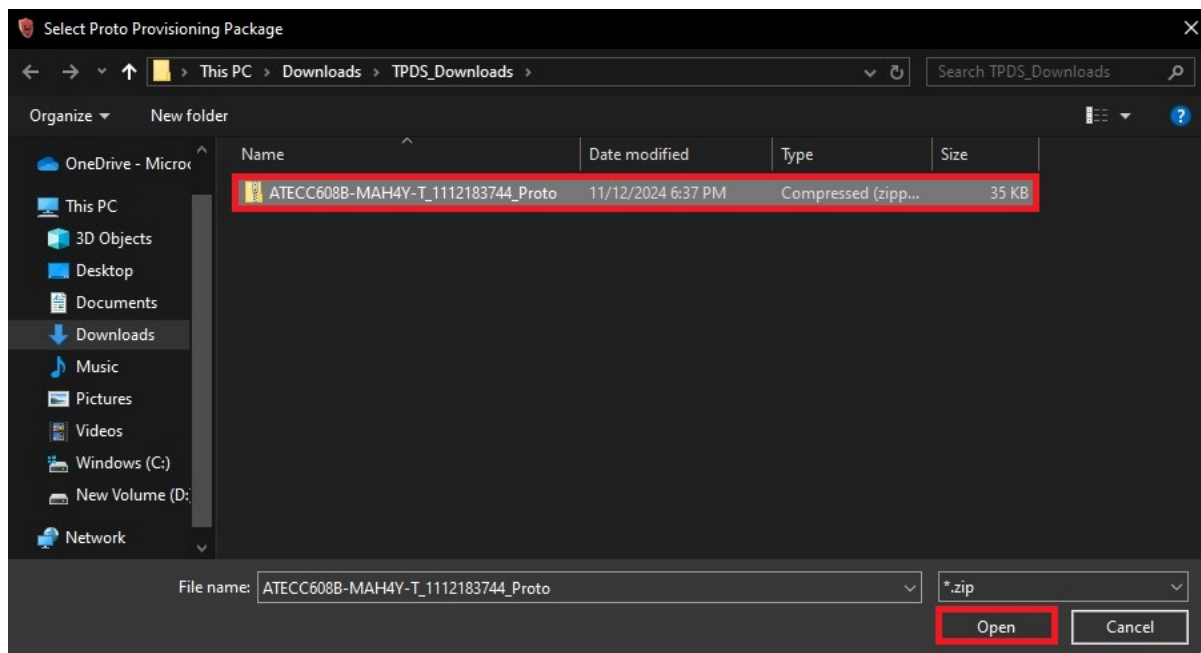
Prototyping		Production
<p>Generate Provisioning Package</p> <p>The prototype package is for prototyping and learning only. Do NOT share the prototype package because secrets are in plain text. Alternatively, you may use dummy secrets.</p>	<p>Provision Prototype Samples</p> <p>Click here to provision the PIC32CMLS60-TFLXTLS-PROTO with the package generated from "Generate provisioning Package - Prototype". Make sure to load the generated zip file.</p>	<p>Generate Encrypted Provisioning Package</p> <p>Click here to generate the Secure Exchange Package then upload it to Microchip Provisioning Service (through Microchip Technical Support Portal). You will be prompted to add the HSM encryption keys when starting the generation process.</p>

Both "Generate Provisioning Package" buttons compile all the data provided in the above slots into a zip package containing .ENC.xml/xml, .c, .h and certificate files.

1. **.xml** file contains device configuration and user data to be loaded into the PIC32CMLS60-PROTO slots. In the prototyping package, all user data are in unencrypted plain text whereas in the production package, user data are encrypted.
2. **.c, .h** are 'C' source files that are meant to be used with CryptoAuthLib. These files are required to use certificates in CryptoAuthLib.
3. **Certificate** files are generated for verification purpose.

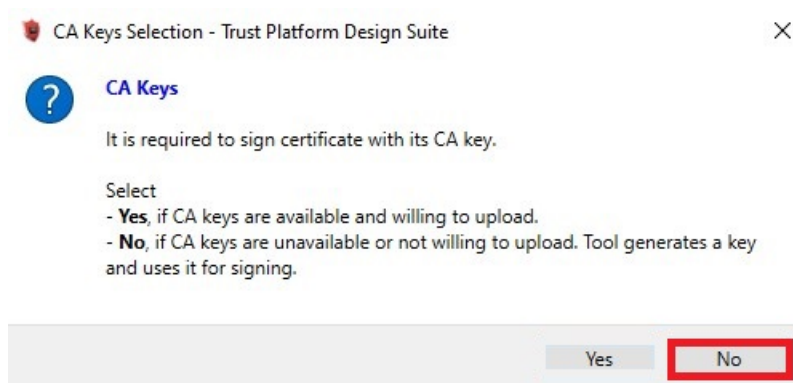
17. 转到配置包下载位置：*Users/xxx/Downloads/TPDS_Downloads*，选择 **ATECC608-***.zip** 文件，然后单击 **Open**（打开）。

图 1-18. 导航到配置包位置



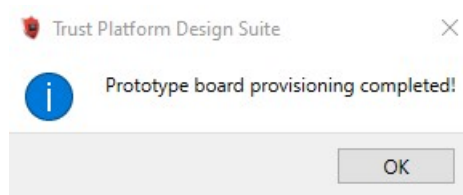
18. 选择 **No**（否）以使用 TPDS 工具生成 CA 密钥。

图 1-19. 导航到配置包位置



19. 将提示以下消息以指示密钥配置已完成。

图 1-20. 完成密钥配置



2. 总结

通过利用 TPDS 的密钥配置功能，密钥可存储在安全元件或硬件安全模块（Hardware Security Module, HSM）内的一个安全、防篡改的环境中。它使用户能够存储和管理对于各种安全功能（如加密、身份验证和安全通信）至关重要的加密密钥。

3. 资源

- [可信平台设计套件 v2](#)
- 若要安装可信平台设计套件（TPDS）v2，请参见：
 - developerhelp.microchip.com/xwiki/bin/view/applications/security/trust-platform-v2/
- [PIC32CM LS60 Curiosity Pro 评估工具包](#)

4. 版本历史

版本 A——2025 年 4 月

这是本文档的初始版本。

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