ECC608 AES Message Encryption

TPDS Usecase Guide

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ECC608 AES Message Encryption

This application example demonstrates AES encryption being run on Host MCU or MPU while having the master symmetric key held securely in ECC608 secure element.

Description

- The master symmetric key is stored in ECC608 and a derived key is generated using KDF command. The parameters used to calculate the derived key are then shared to the Cloud/ remote host so it can calculate the same derived key to perform AES operations.
- Storing the symmetric key in ECC608 ensures that the master key is never exposed.
- The derived key can also be set to expire (ephemeral key) after a set time frame in the software.
- Once the current key expires, the remote host and MCU/MPU system can agree on parameters and generate a fresh ephemeral key.

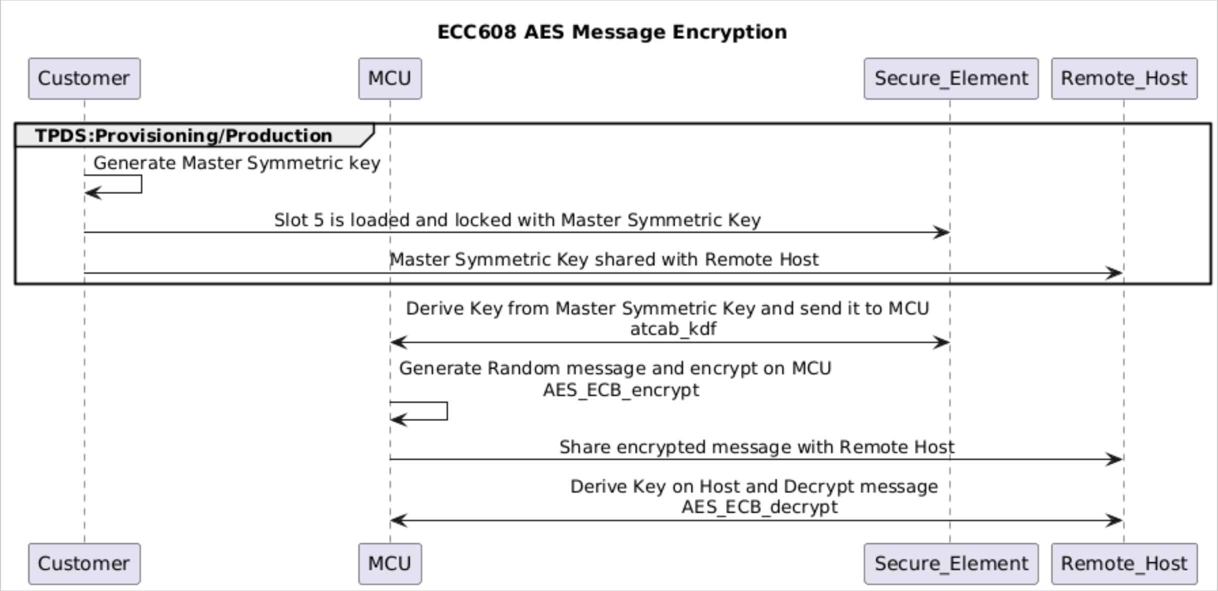

ECC608 AES Message Encryption
Customer
MCU
Secure_Element
Remote_Host
TPDS:Provisioning/Production
Generate Master Symmetric key
Slot 5 is loaded and locked with Master Symmetric Key
Master Symmetric Key shared with Remote Host
Derive Key from Master Symmetric Key and send it to MCU
atcab_kdf
Generate Random message and encrypt on MCU
AES_ECB_encrypt
Share encrypted message with Remote Host
Derive Key on Host and Decrypt message
AES_ECB_decrypt
Customer
MCU
Secure_Element
Remote_Host

Figure-1

Training Video

Microchip Security
Part I - Cryptography Primer

Figure-2

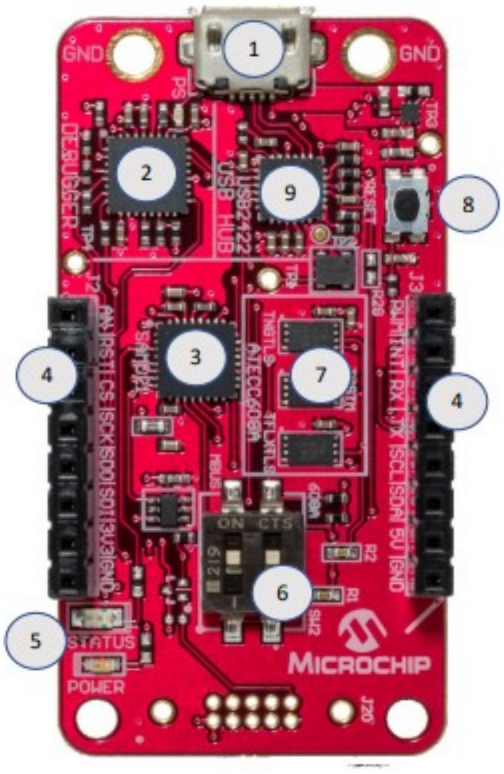
ATECC608 AES Message Encryption Execution

Prerequisites

- Trust Platform Design Suite
- MPLAB® X IDE
- Cryptoauth Trust Platform Development Kit

Setting up Cryptoauth Trust Platform Development Kit

- Ensure both the ON and CTS switches are in the ON position in the Dual SPST DIP Switch.



1. USB Connector
2. nEDBG On-board Debugger
3. ATSAMD21E18A Host MCU
4. mikroBUS™ Headers
5. Power and Status LEDs
6. Dual SPST DIP Switch
7. ATECC608A Secure Elements
8. Reset Switch
9. USB2422 Dual Port Hub

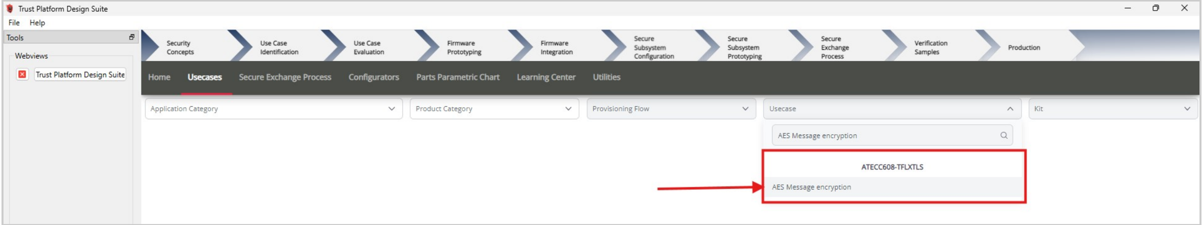
Figure-3

- Connect the micro USB port on the board to the computer using a micro USB cable.

Opening the ECC608 AES Message Encryption Use Case

- Open Trust Platform Design Suite and navigate to Usecases Section.

- In the Use Case dropdown,search for "AES Message Encryption" and select "AES Message encryption" under the ATECC608-TFLXTLS group.



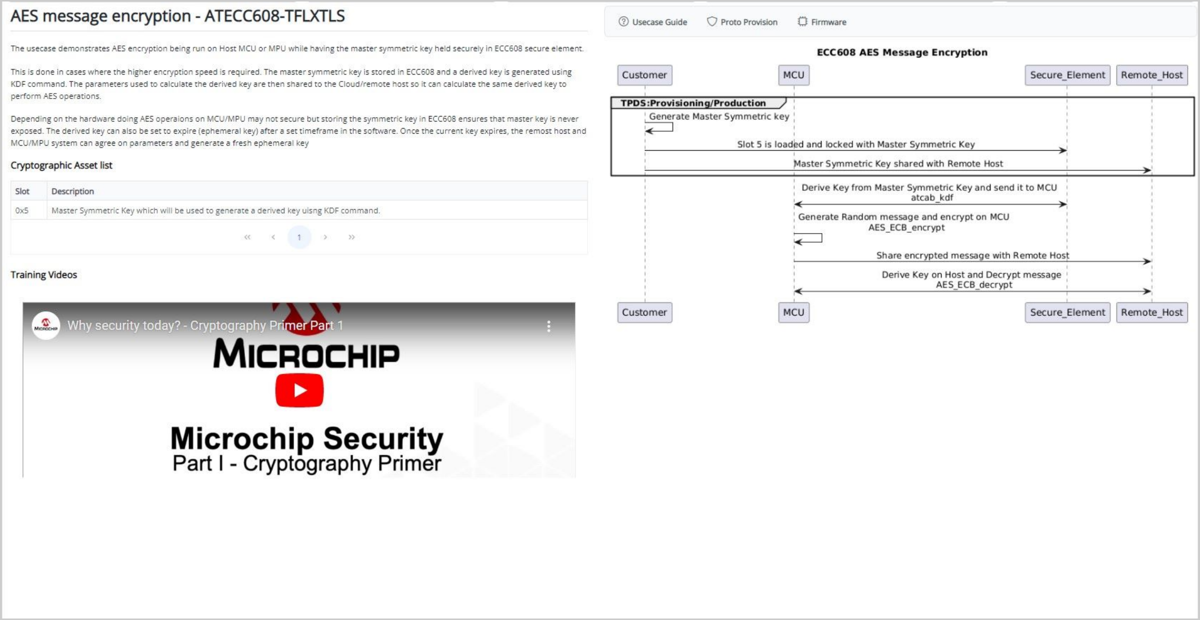
AES Message encryption

ATECC608-TFLXTLS

AES Message encryption

Figure-4

- The ECC608 AES Message Encryption use case will open.



AES message encryption - ATECC608-TFLXTLS

The usecase demonstrates AES encryption being run on Host MCU or MPU while having the master symmetric key held securely in ECC608 secure element.

This is done in cases where the higher encryption speed is required. The master symmetric key is stored in ECC608 and a derived key is generated using KDF command. The parameters used to calculate the derived key are then shared to the Cloud/remote host so it can calculate the same derived key to perform AES operations.

Depending on the hardware doing AES operaions on MCU/MPU may not secure but storing the symmetric key in ECC608 ensures that master key is never exposed. The derived key can also be set to expire (ephemeral key) after a set timeframe in the software. Once the current key expires, the remost host and MCU/MPU system can agree on parameters and generate a fresh ephemeral key

Cryptographic Asset list

Slot	Description
0x5	Master Symmetric Key which will be used to generate a derived key uisng KDF command.

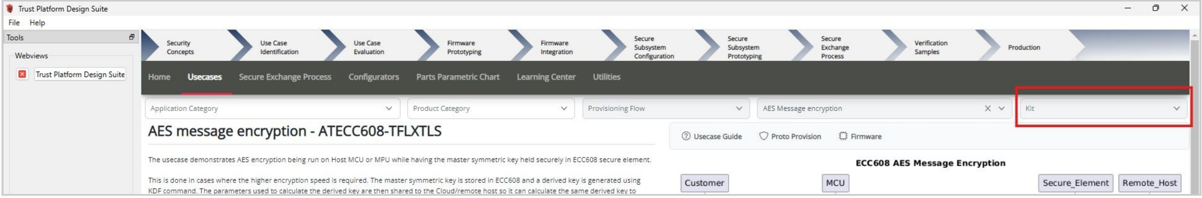
Training Videos

Why security today? - Cryptography Primer Part 1
Microchip
Microchip Security
Part I - Cryptography Primer
Usecase Guide
Proto Provision
Firmware
ECC608 AES Message Encryption
Customer
MCU
Secure_Element
Remote_Host
TPDS:Provisioning/Production
Generate Master Symmetric key
Slot 5 is loaded and locked with Master Symmetric Key
Master Symmetric Key shared with Remote Host
Derive Key from Master Symmetric Key and send it to MCU
atcab_kdf
Generate Random message and encrypt on MCU
AES_ECB_encrypt
Share encrypted message with Remote Host
Derive Key on Host and Decrypt message
AES_ECB_decrypt

Figure-5

Provisionig Usecases Resources

- From the Kit Dropdown, select the Cryptoauth Trust Platform Kit.



AES message encryption - ATECC608-TFLXTLS

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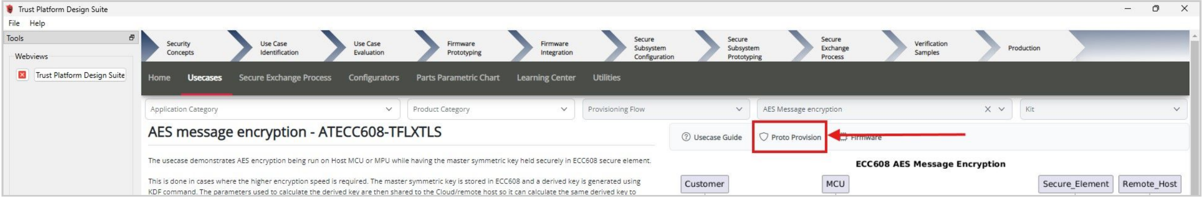
Figure-6

- Click on Proto Provision.



AES message encryption - ATECC608-TFLXTLS

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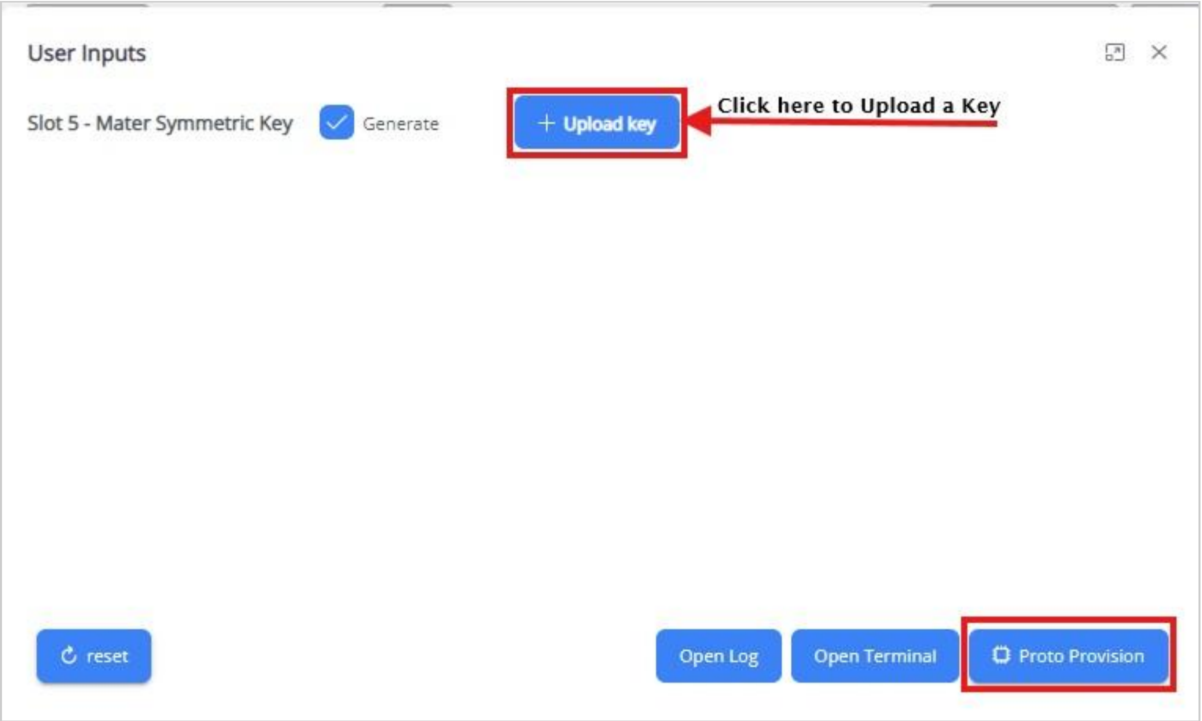
Figure-7

- Select the Generate option to create and use a new Symmetric Key, or upload a user-specific Symmetric Key for Mater Symmetric Key.

- Click on Proto Provision



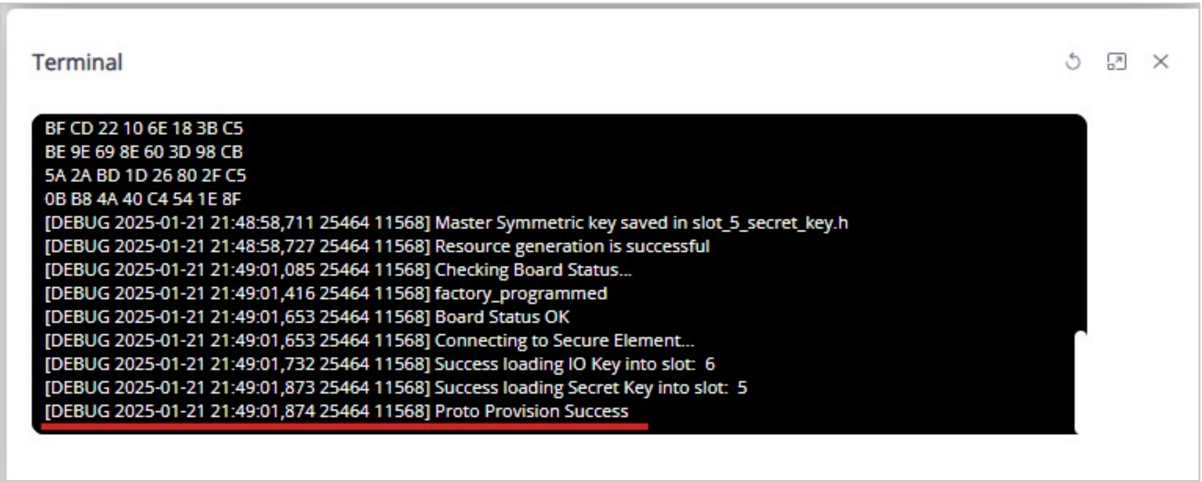
Slot 5 - Mater Symmetric Key ☑ Generate

Click here to Upload a Key

Figure-8

- The necessary resources will be created at `~/.trustplatform/aes_message_encryption`:
  - **slot_5_secret_key.h**: This file contains a 32-byte Master symmetric key, which is loaded into Slot 5, and it will be utilized to perform kdf operation to derive key in the Firmware project.
  - **slot_5_secret_key.pem**: This file contains the generated symmetric key in PEM format.
  - **slot_6_secret_key.h**: This file contains the IO Protection key which is loaded into Slot 6.
  - **slot_6_secret_key.pem**: This file contains the IO Protection key which is loaded into Slot 6 in PEM format.
- Click on Yes in the pop-up to load resources onto ECC608.

- **Proto Provision Success Toast** will pop up after successfully loading resources, Proto Provision Success will be logged on to Terminal.

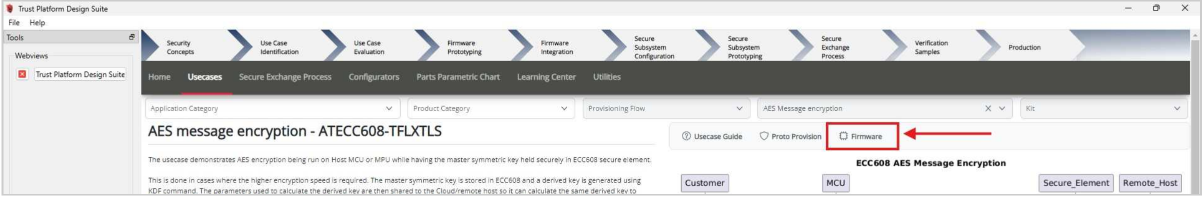


```
BF CD 22 10 6E 18 3B C5
BE 9E 69 8E 60 3D 98 CB
5A 2A BD 1D 26 80 2F C5
0B B8 4A 40 C4 54 1E 8F
[DEBUG 2025-01-21 21:48:58,711 25464 11568] Master Symmetric key saved in slot_5_secret_key.h
[DEBUG 2025-01-21 21:48:58,727 25464 11568] Resource generation is successful
[DEBUG 2025-01-21 21:49:01,085 25464 11568] Checking Board Status...
[DEBUG 2025-01-21 21:49:01,416 25464 11568] factory_programmed
[DEBUG 2025-01-21 21:49:01,653 25464 11568] Board Status OK
[DEBUG 2025-01-21 21:49:01,653 25464 11568] Connecting to Secure Element...
[DEBUG 2025-01-21 21:49:01,732 25464 11568] Success loading IO Key into slot:  6
[DEBUG 2025-01-21 21:49:01,873 25464 11568] Success loading Secret Key into slot:  5
[DEBUG 2025-01-21 21:49:01,874 25464 11568] Proto Provision Success
```

Figure-9

Build and Program Application

- Once the resources have been successfully loaded, open the Firmware Project by clicking on the Firmware button.



AES message encryption - ATECC608-TFLXTLS

The usecase demonstrates AES encryption being run on Host MCU or MPU while having the master symmetric key held securely in ECC608 secure element.

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Figure-10

- The project **aes_msg_enc_ecc608** will open in the MPLABX IDE.
- Right-click on **aes_msg_enc_ecc608** and select "Set as Main Project".

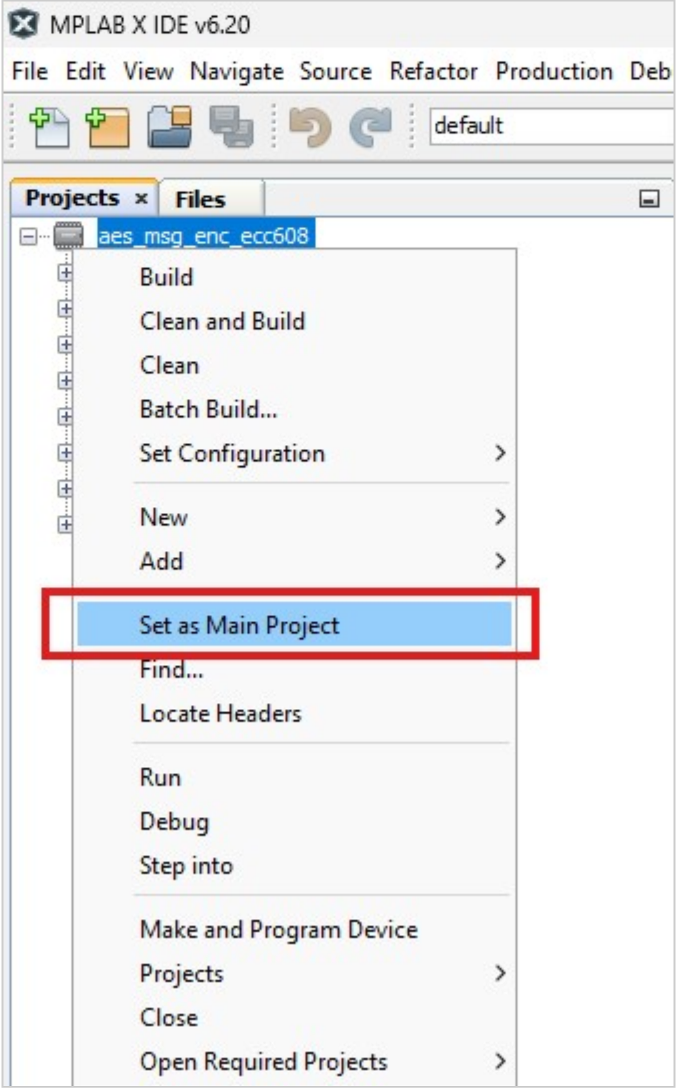


Figure-11

- Click on "Make and Program Device".

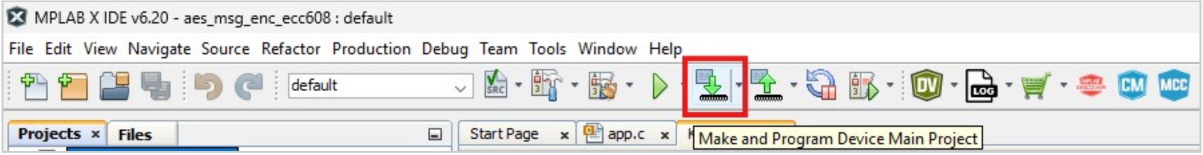
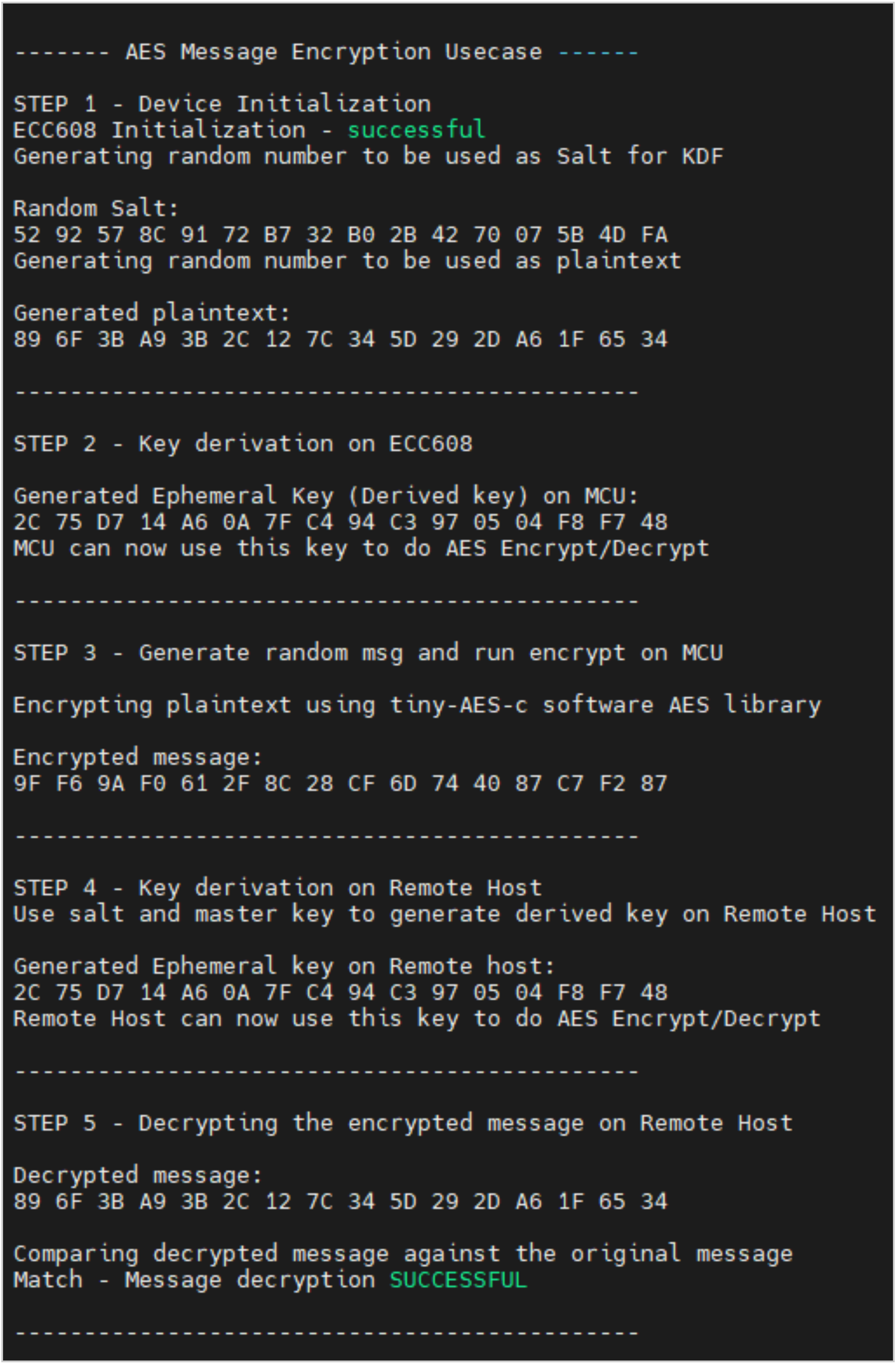

MPLAB X IDE v6.20 - aes_msg_enc_ecc608 : default
File Edit View Navigate Source Refactor Production Debug Team Tools Window Help
default
Projects
Files
Start Page
app.c
Make and Program Device Main Project

Figure-12

- After the programming process is complete, launch the Terminal application (e.g., Tera Term) on your computer.

- Connect to the Virtual COM port and configure the serial settings as follows:
  - Baud : 115200
  - Data : 8 Bits
  - Parity : None
  - Stop : 1 Bit
  - Flow Control : None
- Press the Reset button on Cryptoauth Trust Platform Development Kit
- Review the output message in the console:



```
------- AES Message Encryption Usecase ------

STEP 1 - Device Initialization
ECC608 Initialization - successful
Generating random number to be used as Salt for KDF

Random Salt:
52 92 57 8C 91 72 B7 32 B0 2B 42 70 07 5B 4D FA
Generating random number to be used as plaintext

Generated plaintext:
89 6F 3B A9 3B 2C 12 7C 34 5D 29 2D A6 1F 65 34

---------------------------------------------

STEP 2 - Key derivation on ECC608

Generated Ephemeral Key (Derived key) on MCU:
2C 75 D7 14 A6 0A 7F C4 94 C3 97 05 04 F8 F7 48
MCU can now use this key to do AES Encrypt/Decrypt

---------------------------------------------

STEP 3 - Generate random msg and run encrypt on MCU

Encrypting plaintext using tiny-AES-c software AES library

Encrypted message:
9F F6 9A F0 61 2F 8C 28 CF 6D 74 40 87 C7 F2 87

---------------------------------------------

STEP 4 - Key derivation on Remote Host
Use salt and master key to generate derived key on Remote Host

Generated Ephemeral key on Remote host:
2C 75 D7 14 A6 0A 7F C4 94 C3 97 05 04 F8 F7 48
Remote Host can now use this key to do AES Encrypt/Decrypt

---------------------------------------------

STEP 5 - Decrypting the encrypted message on Remote Host

Decrypted message:
89 6F 3B A9 3B 2C 12 7C 34 5D 29 2D A6 1F 65 34

Comparing decrypted message against the original message
Match - Message decryption SUCCESSFUL

---------------------------------------------
```

Figure-13

• Console displays a message stating the decrypted message matches the original message.

Conclusion

The ECC608 AES Message Encryption use case demonstrates a secure method for encrypting messages by storing the master symmetric key within the ECC608 secure element. This ensures the key is never exposed, enhancing security. The guide provides detailed steps for setting up the hardware and software, provisioning resources, and programming the application. Successful execution and verification confirm the system's effectiveness in securely handling AES encryption. This use case highlights the importance of secure key storage and management in cryptographic operations.

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