AN2617

Using the ATECC508A to Perform Symmetric Authentication of a Remote Device

Introduction

This application demonstrates the authentication of a remote device with a host (Curiosity PIC32MZ EF Development Board and the Secure click board using the ATECC508A cryptography module) using the symmetric authentication method, where the host and the remote devices share the same key. The application allows adding information to the configuration, using the configuration data, and key data to configure a secure click board. The application flow is realized through the interactive user interface console over the serial terminal program *Tera term*, which is interfaced through the USB of a computer.

For more information on the features and layout of the Curiosity PIC32MZ EF Development Board, refer to the PIC32MZ EF Curiosity Development Board User's Guide (DS70005282).

For more information on the features of the ATECC508A module, refer to the Product Data Sheet.

1. Required Tools and Applications

The following Microchip development tools are required to run the ATECC508A Symmetric Authentication demonstration:

- Curiosity PIC32MZ EF Development Board (DM320104), available from Microchip Direct
- Download and install latest version of MPLAB X Integrated Development Environment (IDE)
- Download and install the latest version of MPLAB XC32 C/C++ Compiler
- Optionally download and install the latest version of MPLAB® Harmony Integrated Software Framework

Note:

1. Using the MPLAB Harmony Integrated Software Framework will extend the functionality of this project by adding new modules, software frameworks, and libraries to the project.
2. This application project is developed on the following tools:
   - MPLAB X IDE v4.05
   - MPLAB XC32 C Compiler v1.44
   - MPLAB Harmony v2.05
   - MPLAB X IDE plug-in: MPLAB Harmony Configurator (MHC) v2.0.5.2

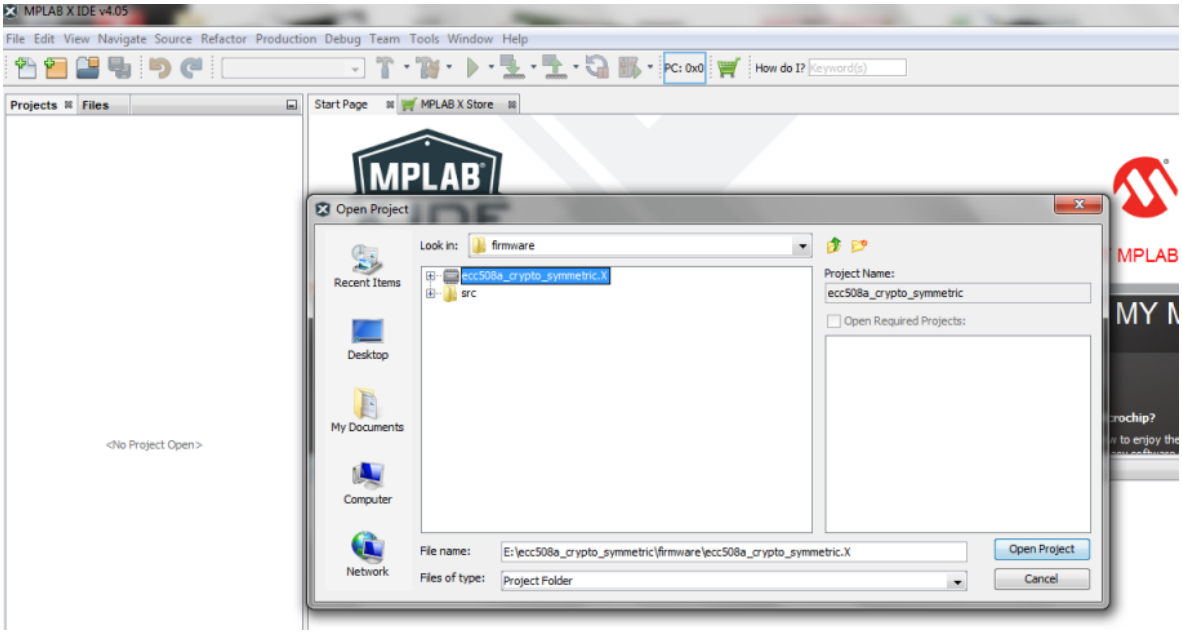
The following click board from Mikroelektronika is used, Secure click board (MIKROE-2522) – 2 Nos.

2. Building the Application

To build the application, use the following process:

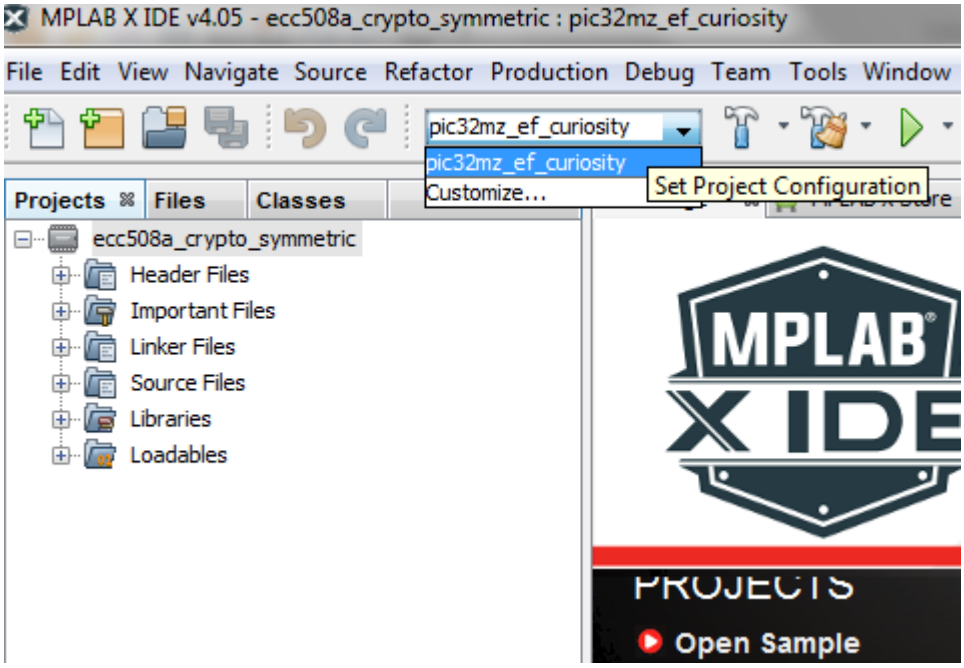
1. Download the *ecc508a_crypto_symmetric* project to the local computer. This project can be found under the *Curiosity Demo Examples* tab at http://www.microchip.com/Developmenttools/ProductDetails.aspx?PartNO=DM320104.
2. To build the project, in MPLAB X, *File>Open Project*, then select the `ecc508a_crypto_symmetric.X` project from *<path-of-project-in-your-pc>/ecc508a_crypto_symmetric/firmware* in MPLAB X IDE, as shown below.

Figure 2-1. Opening the Project



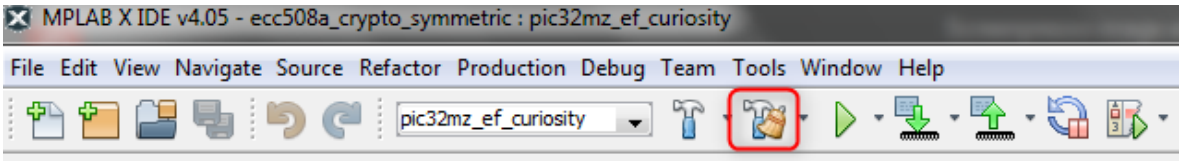
3. The project has only one configuration, *pic32mz_ef_curiosity*, for the Curiosity PIC32MZ EF Development Board. This is the default configuration when the project is open.

Figure 2-2. Choosing the Project Configuration



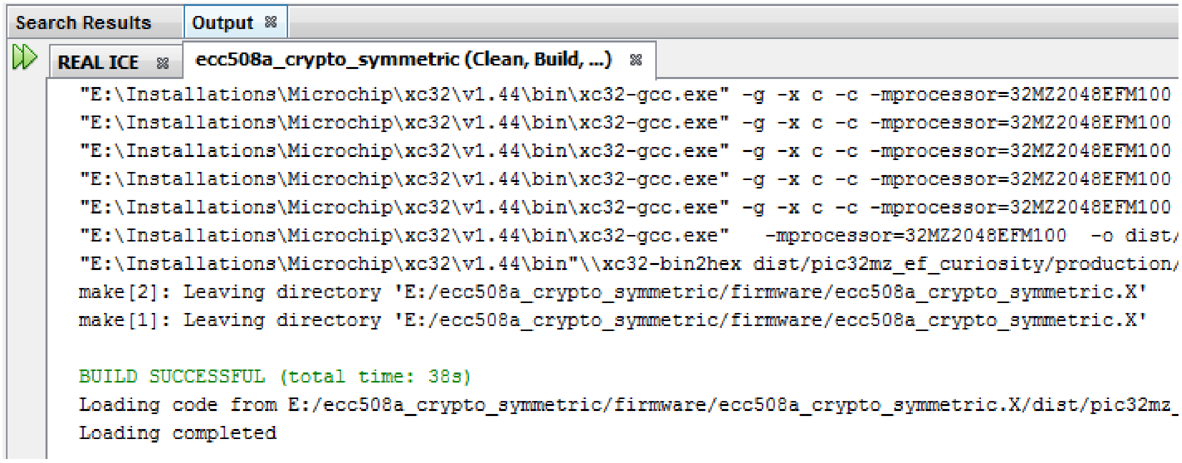
4. The *pic32mz_ef_curiosity* configuration sets up MPLAB X IDE to build and run the demonstration application on the Curiosity PIC32MZ EF Development Board, with the PIC32MZ2048EFM100 microcontroller.
5. The USB CDC class library is configured to enable interactive user interface control.
6. The I^2C driver is configured to use the I^2C1 instance of the peripheral at 100 kHz clock frequency. The application interacts with the ATECC508A (available on the Secure click board) over I2C1 to implement the host side of the application.
7. The I^2C driver is configured to use the I^2C2 instance of the peripheral at 100 kHz clock frequency. The application interacts with the ATECC508A (available on the Secure click board) over I^2C2 to implement the remote side of the application.
8. Clean and Build the project.

Figure 2-3. Clean and Build



9. Check the Build log, at the bottom of the MPLAB X IDE interface.

Figure 2-4. Build Log



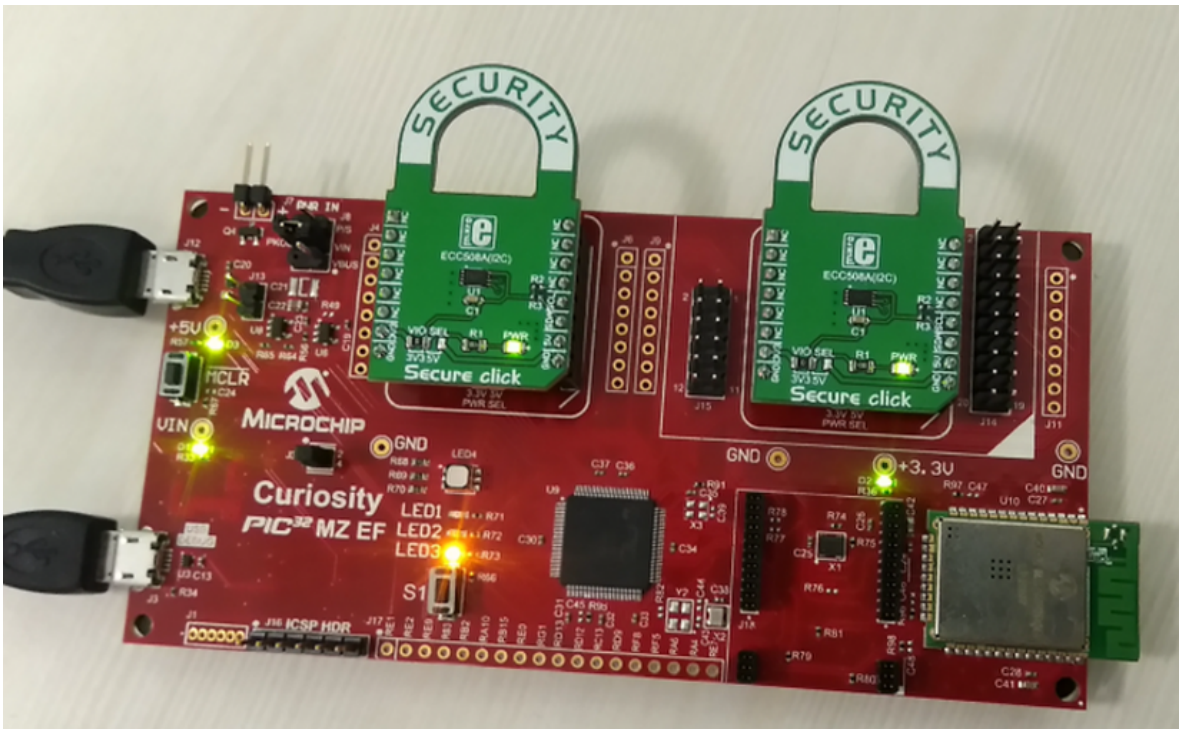
Note: Often a project will not compile on a Windows™ computer due to a limitation in the path length. The Windows operating system has a maximum path length of 260 characters. This limitation causes file paths to be truncated when attempting to compile, which leads to files not being found by the compiler. Try placing the project in the top level directory, usually `C:/`. For more information, refer to the Maximum Path Length Limitation section of the Naming Files, Paths, and Namespaces, which is available on the Microsoft Developer Network site.

3. Configuring the Hardware

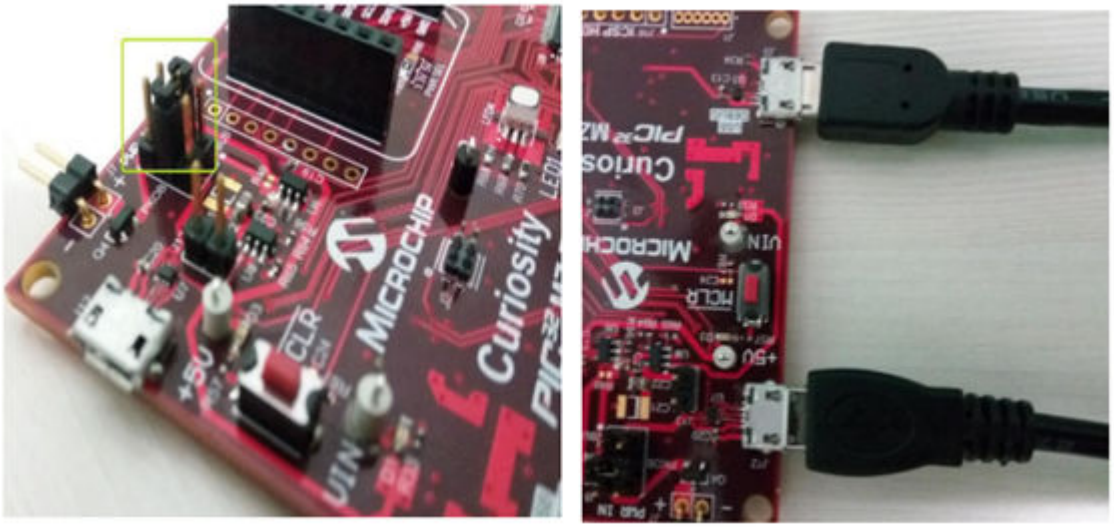
To configure the hardware, use the following steps:

1. For the host operation, mount a Secure click board on the mikroBUS socket J5.
2. For the remote device operation, mount a Secure click board on the mikroBUS socket J10.

Figure 3-1. Hardware Configuration



3. Power the Curiosity PIC32MZ EF Development Board from the host computer through a Type-A male to Micro-B USB cable connected to the Micro-B port (J3). The cable is not included with the kit. Ensure that a jumper is placed in the J8 header (between 4 and 3) to select the supply from the debug USB connector.
4. Ensure that the jumper is not present in the J13 header to use the Curiosity board in Device mode. In Device mode, the board acts as a USB device to the computer. Plug in a USB cable with a Micro-B type connector to Micro-B port (J12), and plug the other end into the computer.



For additional information on the hardware features and configurations refer to the following User's Guide:

PIC32MZ EF Curiosity Development Board User's Guide (DS70005282).

4. Running the Demonstration

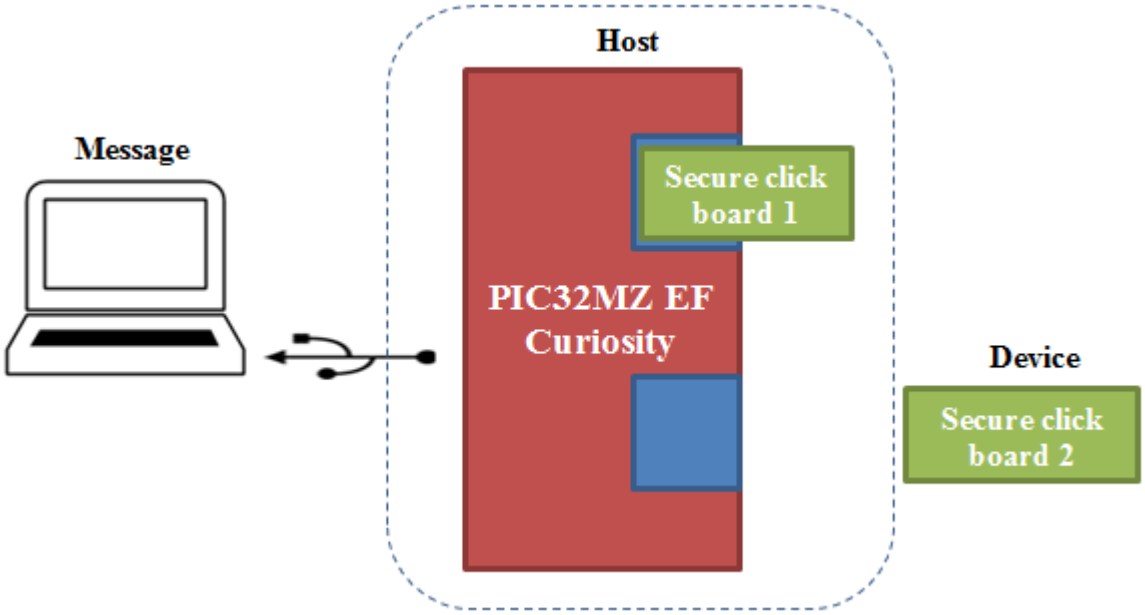
This application demonstrates the use of the ATECC508A module to authenticate the security of the connected device. The authentication method used is Symmetric.

Symmetric authentication uses a challenge and response process. The host challenges a remote device to assure that it is authentic and can be trusted. The challenged device responds with the expected results. This method requires that both the host and the remote devices *share the same key.* Additionally the remote device can send a *unique serial number* so the responses are unique from other remote devices.

In this application, a secure hardware key storage device (ATECC508A on a Secure click board) is used to contain the shared key and unique serial number, in the host and remote device.

The following figure represents a functional block diagram of the application.

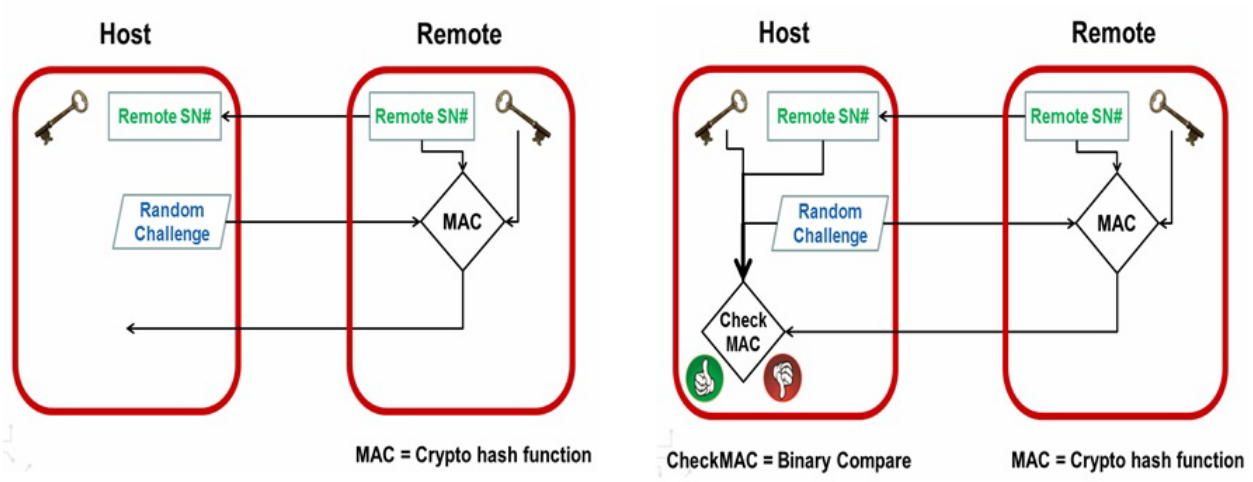
Figure 4-1. Functional Block Diagram



Authentication Process

The authentication begins with the host asking for the serial number of the remote device. The host sends a random number, which it expects the remote device to hash with the shared secret key. This is called a challenge because it challenges the remote device to provide a correct answer. This challenge process is shown in the following figure.

Figure 4-2. Authentication Process



The remote device hashes the random number with the *shared key* and the *unique serial number*, then sends back the resulting output of the hash, which is referred to as a Message Authentication Code (MAC).

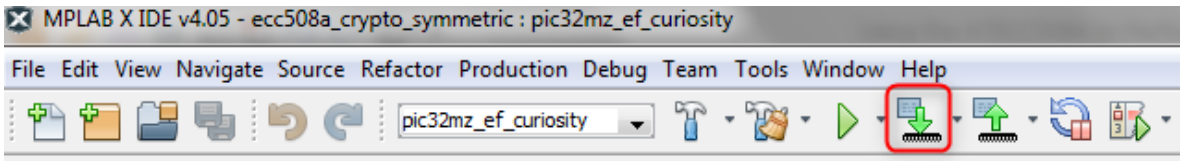
The host checks the returned MAC by repeating the same operation. It hashes the *shared key* with the random number and the unique serial number of the remote device. The host compares the two results.

A matching result indicates that the challenge has been successfully responded to by the remote device and the host can trust the external device.

The following steps are used for running the demonstration:

1. Open the project in MPLAB X IDE and select the pic32mz_ef_curiosity project configuration.
2. Build the code and program the device by clicking on the program button as shown below.

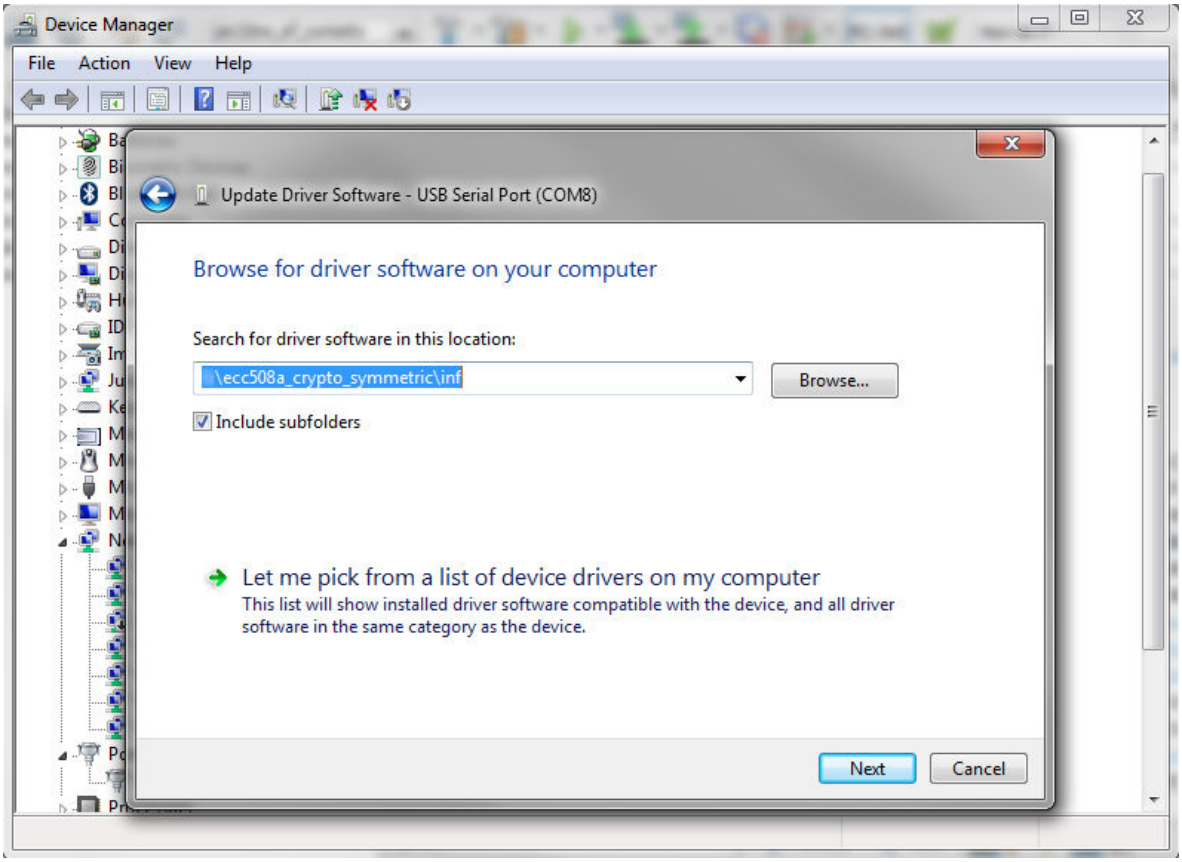
   Figure 4-3. Building the Code

3. After power up, the demonstration is active. This is indicated by a yellow LED (LED3) on the board.
4. Plug in a USB cable with a Micro-B type connector to the Micro-B port (J12), of the Curiosity board, then plug the other end into the computer.
5. If this is the first time using this device with a personal computer, the computer may prompt for a `.inf` file.
6. Select the *Install from a list or specific location (Advanced)* option. Specify the path from */ecc508a_crypto_symmetric/inf directory.*

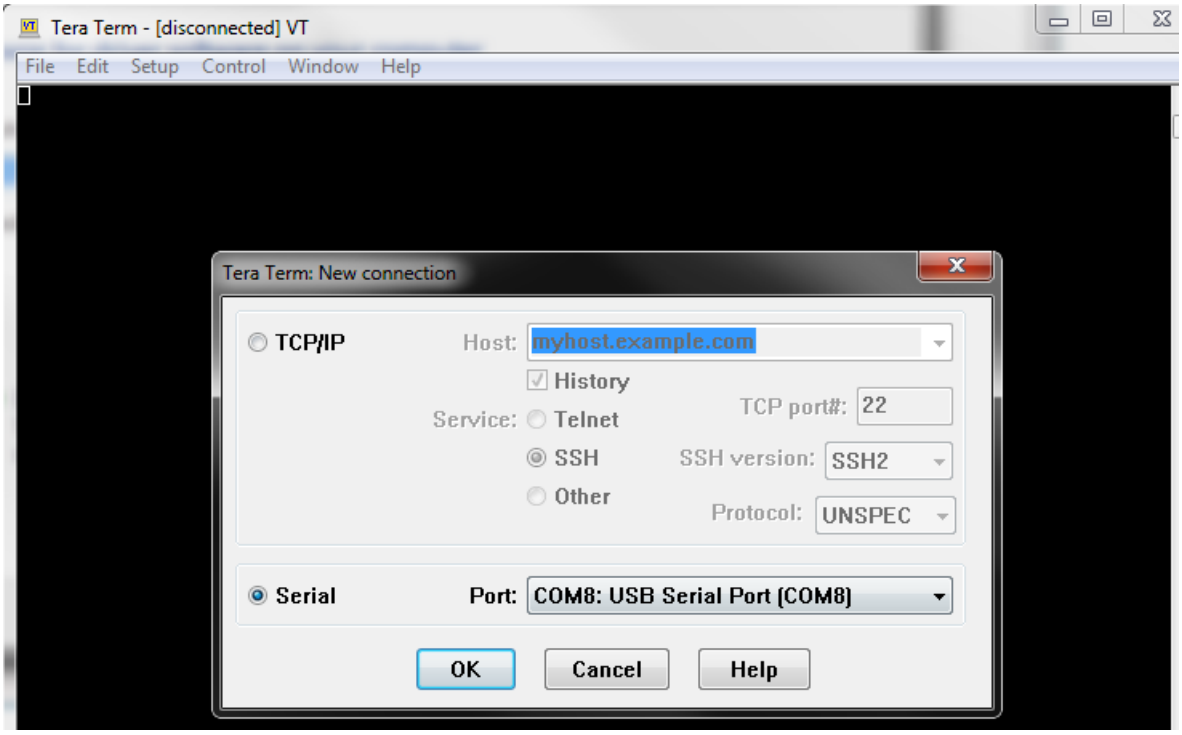
   Note: To specify the driver, you may open the device manager and expand the Ports (COM & LPT) tab, then right click on *Update Driver Software*.

Figure 4-4. Updating Driver Software



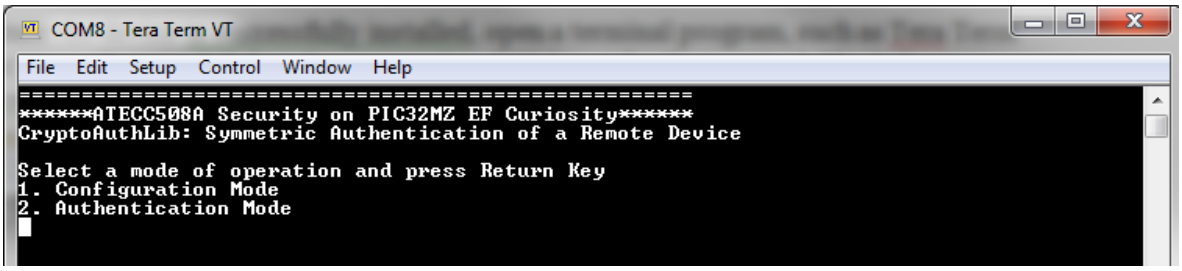
7. Once the device is installed, open a terminal program, such as Tera Term or Hyper Terminal. Select the appropriate COM port for the terminal. The following figure shows the COM port selection for the Tera Term terminal program.

Figure 4-5. COM Port Selection



8. Once the Tera term screen is displayed, Press the *Enter* key. The following modes of operation will be displayed:

Figure 4-6. Selecting a Mode of Operation



9. The application demonstration offers the following two modes of operation.
   - **Configuration Mode:** This mode is used to configure the blank ATECC508A module with the configuration data and keys to be stored. A blank ATECC508A device is in an unlocked state. This operation performs a lock (on Configuration Zone and Data Zones) on the ATECC508A device. The locking operation is one time operation and irreversible.
   - **Authentication Mode:** This mode performs the secured authentication of the Remote ATECC508A device
10. **Selecting option 1 - Configuration Mode**
    - The display prompts the user to select an action

```
------In Configuration Mode------
Plug in host Secure Click board in Mikro Bus Interface 1 and press S1
```

    - When the Secure click board is plugged-in, the application enters Configuration Write mode and prints the existing or default configuration

Note: The existing or default configuration may be different from that shown in the following figure.

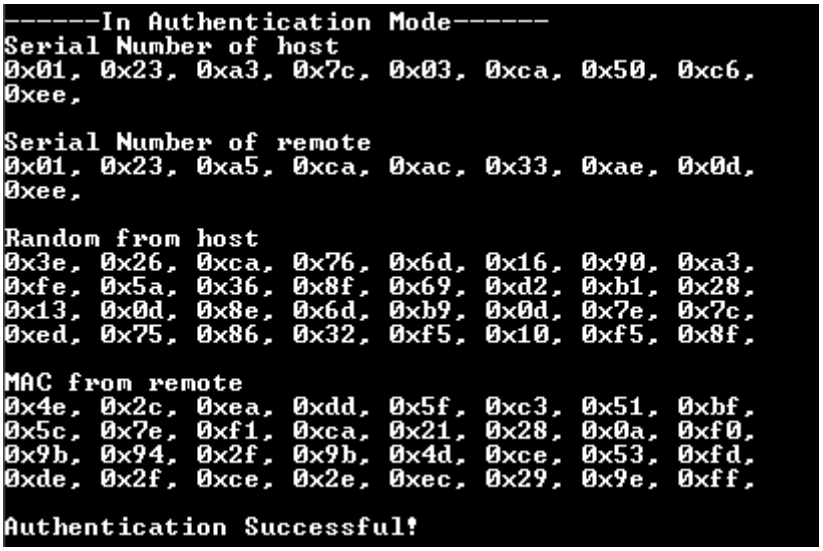
– If the plugged-in board is a brand new Secure click board, the application will write the new configuration to the configuration zone and lock it. The application will display the following messages:
  - **Configuration Write Complete**
  - **Locking Configuration Zone**
  - **Configuration Zone Lock Complete**
– This would be followed by the writing of new data such as, data slot contents and new keys, to the data zone and locking it. It would display the following messages:
  - **Writing Data Zone**
  - **Data Zone Write Complete**
  - **Locking Data Zone**
  - **Data Zone Lock Complete**
  - ****Host board Configuration Done****
– If the plugged-in board is already configured, the application displays the following message: ATCA is already configured.
– Once the host configuration is completed, The display prompts the user for further action with the following message: Plug in remote Secure Click board in Mikro Bus Interface 2 and press S1.
– When the Secure click board is plugged-in, the application enters the configuration write mode, and prints the existing or default configuration
  Note: The existing or default configuration could be different from what is shown in the following figure.

Figure 4-7. Writing Configuration

- If the plugged-in board is a brand new Secure click board, the application will write the new configuration to the configuration zone and lock it. It will display the following messages:
  - **Configuration Write Complete**
  - **Locking Configuration Zone**
  - **Configuration Zone Lock Complete**
- This would be followed by writing of new data such as, data slot contents and new keys, to the data zone and locking it. It would display the following messages:
  - **Writing Data Zone**
  - **Data Zone Write Complete**
  - **Locking Data Zone**
  - **Data Zone Lock Complete**
  - ****Remote board Configuration Done****
- If the plugged-in board is already configured, the application displays the following message: ATCA already configured.
- The application then provides the user an option to return to main menu with the following message: Press a key followed by 'enter' key to return to Options Menu.

11. **Selecting Option 2 - Authentication Mode**
    - Pass Case:
      - By default, the application performs successful authentication of the Remote Secure click (plugged in J10). The successful authentication will be indicated by a green LED (LED2) on the board

Figure 4-8. Successful Authentication Mode



- The Remote Secure click successfully authenticates as it shares the secret key with the host.
  Note: In configuration mode, both the host and device (ATECC508A) are programmed with four identical keys. Refer to the function,`ECC508A_ATCA_CONFIGURE_WriteData` in `ecc508a_atca_configure.c`.
- In the implementation of the function `_ECC508A_CRYPTO_SYMMETRIC_APP_Handle_Authentication`, the MAC is computed and verified for Slot 0, which corresponds to Key 0 being used to compute the MAC on the remote device. The same Key 0 is used to verify the MAC on the host device. Since the key is same, the MAC verification on the host is successful.

  Figure 4-9. MAC Verification

```
status = atcab_checkmac(mode, slot, (const uint8_t*)&nonce,
                                    (const uint8_t*)&mac, (const uint8_t*)&otherdata);
```

– Fail Case:

- To test the Authentication Failure case, uncomment or comment the below lines of code in the function `_ECC508A_CRYPTO_SYMMETRIC_APP_Handle_Authentication` in the file `ecc508a_crypto_symmetric_app.c`.

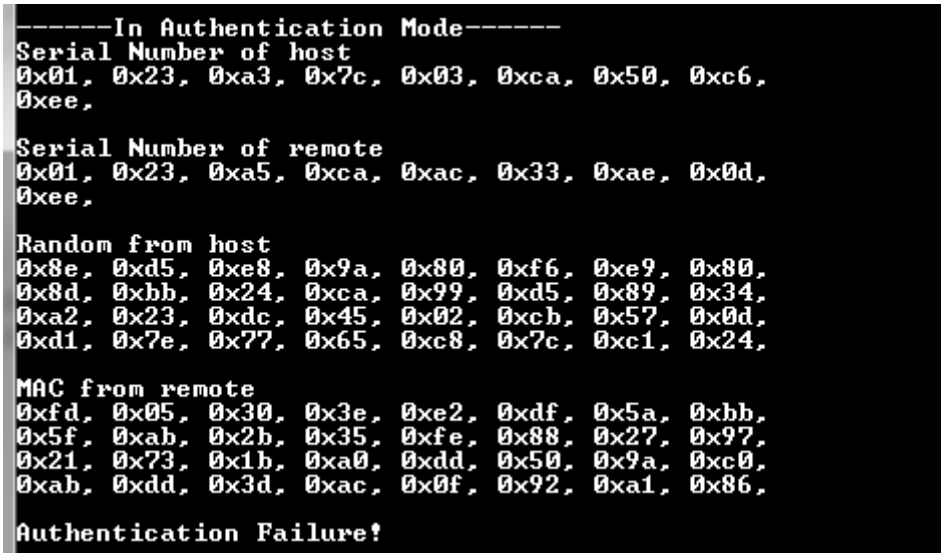
  Figure 4-10. Fail Case

```
/* CheckMac API Call for Testing Authentication Fail Case. Uncomment and build
 * the below code to verify the Authentication Fail case. */
slot = 1; // Using a different slot
status = atcab_checkmac(mode, slot, (const uint8_t*)&nonce,
                                    (const uint8_t*)&mac, (const uint8_t*)&otherdata);


/* CheckMac API Call for Testing Authentication Pass Case. To test fail case
 * comment the below atcab_checkmac API call and uncomment the above one */
//status = atcab_checkmac(mode, slot, (const uint8_t*)&nonce,
//                                    (const uint8_t*)&mac, (const uint8_t*)&otherdata);
```

- Build and program the code. Repeat the user actions to select *Authentication Mode*. The application will fail to authenticate the Remote Secure click (plugged in J10). The failure is indicated by a red LED (LED1) on the board.

  Figure 4-11. Authentication Mode Failure



- The remote Secure click failed to authenticate because the secret key used to compute the MAC by the remote, and the secret key used to verify the MAC from the remote by the host are different. The remote used the Key 0 to compute the MAC, while the host used Key 1 to verify the computed MAC. Since the Keys are not identical, the MAC verification fails, indicating that the host and the remote do not share a key.
- The application then provides the following message to return to the main menu: Press a key followed by 'enter' key to return to Option Menu.

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	E	= -40°C to +125°C (Extended)
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