Getting started with PSoC™ 64 security

About this document

Scope and purpose

This document demonstrates how to build and execute a simple blinky application on a PSoC™ 64 secured MCU. Additionally, it provides a basic understanding on provisioning the process, secure boot validations, key generation, and image signing.

Intended audience

This document is intended for developers who are using the PSoC™ 64 secured MCU.

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1 Introduction

The PSoC™ 64 secured MCU line, based on the PSoC™ 6 MCU platform, features out-of-box security functionality. At a high level, PSoC™ 64 consists of two cores: Cortex®-M0+ and Cortex®-M4. The bootloader runs on the Cortex®-M0+ core and is considered as a secure core and the user application runs on the Cortex®-M4 core. The authenticity of the user application on Cortex®-M4 is always validated by the Cortex®-M0+ bootloader before handing over the control to the user application on this secured MCU. In a secure boot functionality, Infineon provides an immutable boot code programmed in a factory that launches an Infineon bootloader. The bootloader is itself signed, so that the boot code can verify the integrity of the bootloader. This bootloader then verifies the signature of user application software that should run on the device before launching it. The device fails to boot in case of failed authentication, as shown in Figure 1. For more details, see the "Secure Boot" SDK user guide.

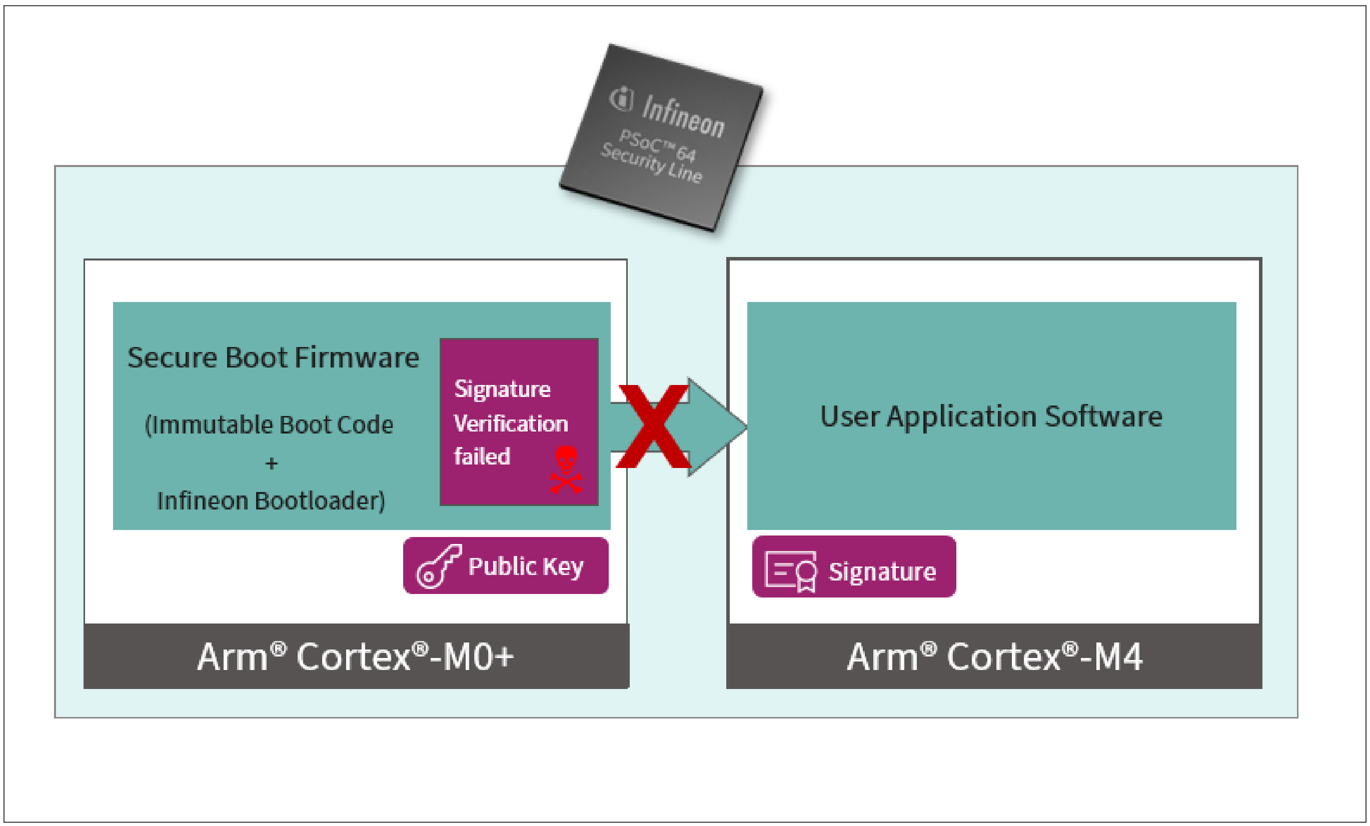


Figure 1 Secure boot validation (failure)

On successfully validation the signature of the user application software, the Infineon bootloader passes the control to the user application on the Cortex®-M4 core.

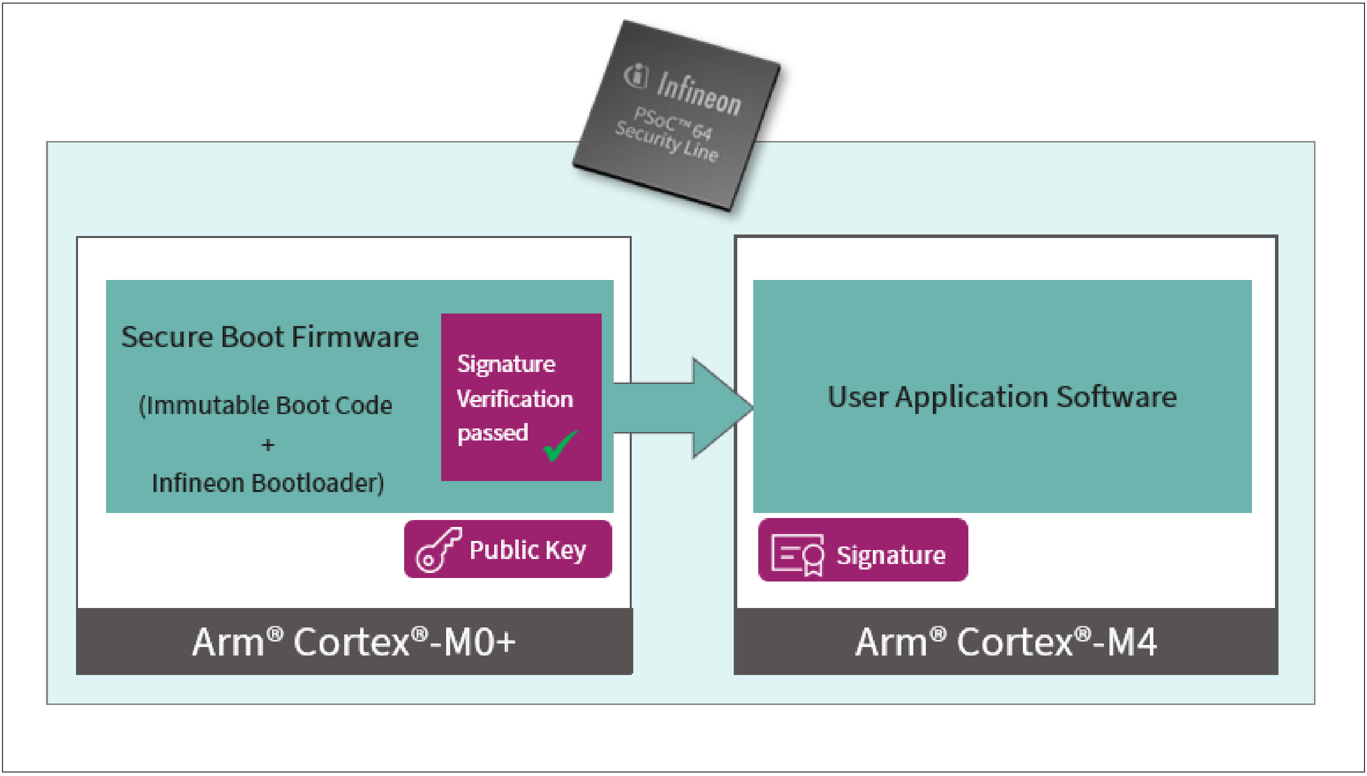


Figure 2 **Secure boot validation (success)**

To develop with a PSoC™ 64 secured MCU, firstly, you must provision the device with keys and policies, and then program the device with signed firmware. The policies are a set of rules to be enforced on the device such as defining the flash partitions, setting protection rules for debug ports, and so on. The keys are used to validate the signed firmware on the device as a part of the secure boot process. The device fails to boot if the firmware validation fails.

1.1 Terms definition

- ModusToolbox™: The ModusToolbox™ software is a modern, extensible development environment supporting a wide range of Infineon microcontroller devices
- Root of trust (RoT): This is an immutable process or identity used as the first entity in a trust chain. No ancestor entity can provide a trustable attestation (in digest or other form) for the initial code and data state of the RoT
- JSON: It is a lightweight format for storing and transporting data
- JWT: JSON Web Token is an open industry standard that defines a compact and self-contained way for securely transmitting information
- Policy: A set of rules that are enforced on a device
- Keys: Key is a P-256 ECC key-pair used by the encryption and decryption algorithms to encrypt and decrypt data
- Provisioning: It is the process of injecting secure assets (for example, keys, policies, and certificates) into the device

2 Getting started

This section demonstrates a quick hands-on exercise on how to create a basic security project, program, and execute it. This helps you to get started with the secured application without going deep into the security concepts of the PSoC™ 64 device.

Prerequisites

To provision the assets and keys, and setting up the development environment on the device for the blinky code example, install the following:

1. ModusToolbox™ software, v3.0 or later. For more details, see the ModusToolbox™ installation guide

   ***Note**: Python is no longer bundled with ModusToolbox™ 3.2 or later on Windows. In most cases, install Python version 3.8.10 to 3.11. See Using Python with a ModusToolbox™ application to set it up in Python with ModusToolbox™ 3.2. This content has been tested with ModusToolbox™ 3.2 with Python 3.8.10*

2. “Secure Boot” SDK package ("CySecureTools" v6.0.0 or later). For more details, see the cysecuretools on GitHub page
3. ModusToolbox™ Edge Protect Security Suite package, v1.0.0 or later. For installation and more details, see the ModusToolbox™ Setup program user guide

2.1 Create ModusToolbox™ secure application (Secure Blinky App)

After installing the ModusToolbox™ software, do the following to create a new project under a new workspace or existing workspace.

1. Launch the Eclipse IDE for ModusToolbox™
2. Click **File** > **New** > **ModusToolbox™ Application**
3. Select the suitable kit in the Project Creator (for example, **CY8CKIT-064B0S2-4343W**) and click **Next >**

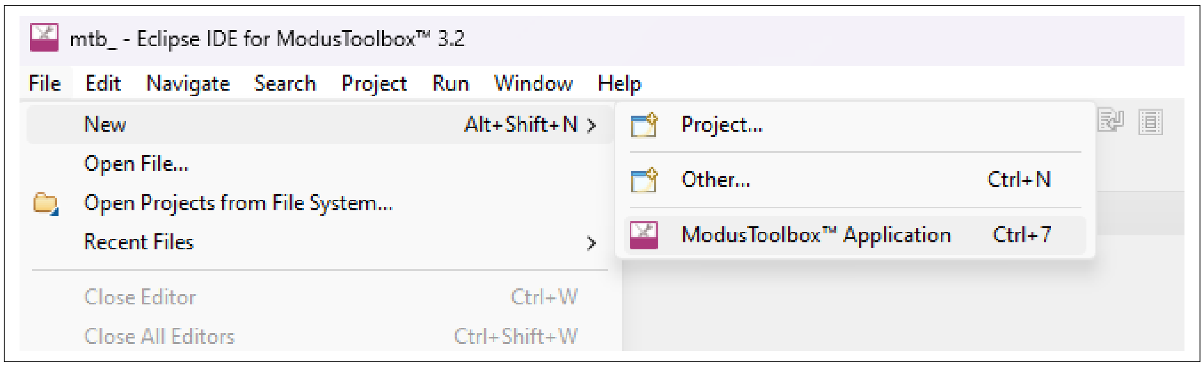
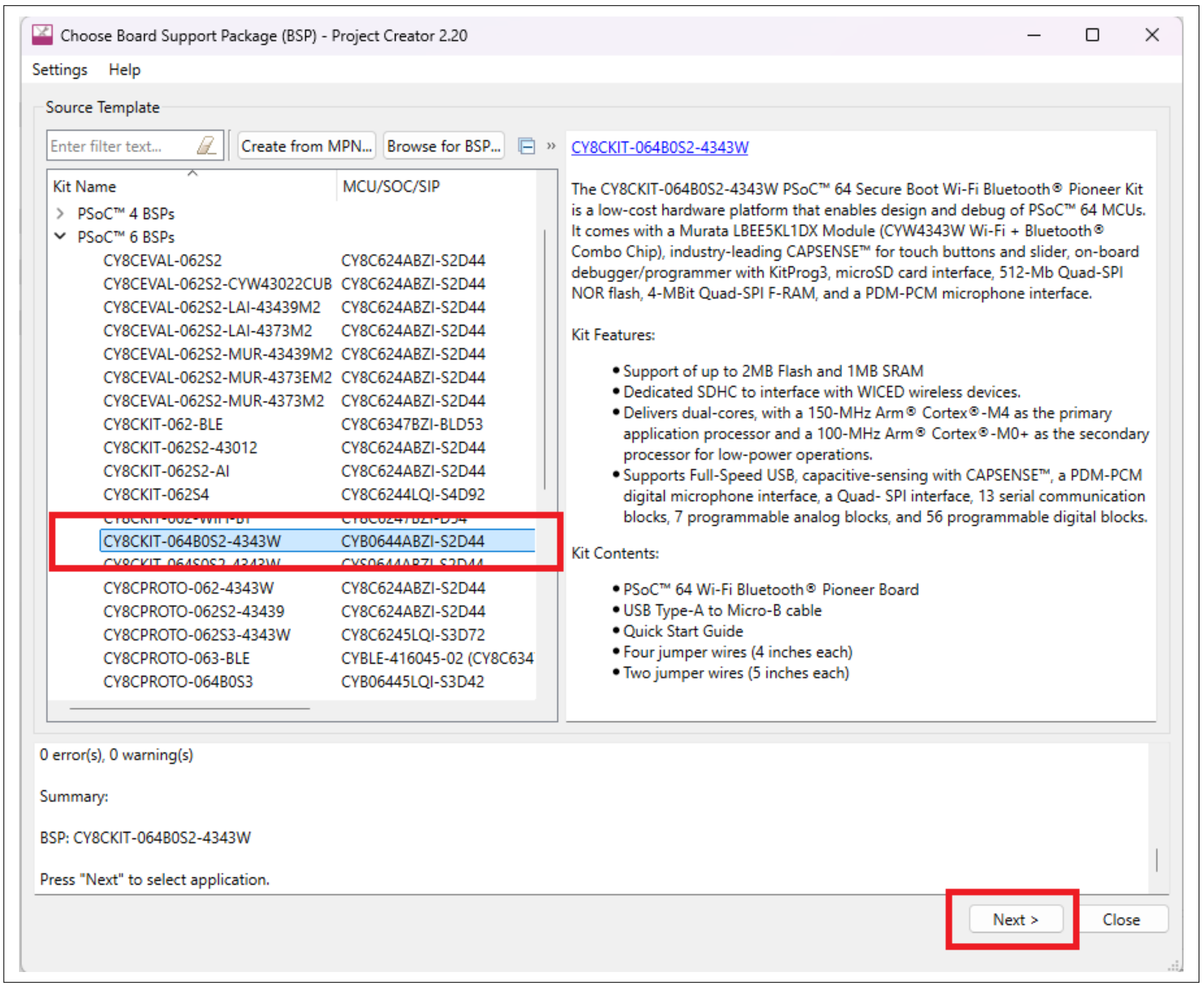

mtb_ - Eclipse IDE for ModusToolbox™ 3.2
File
Edit
Navigate
Search
Project
Run
Window
Help
New Alt+Shift+N >
Open File...
Open Projects from File System...
Recent Files >
Close Editor Ctrl+W
Close All Editors Ctrl+Shift+W
Project...
Other... Ctrl+N
ModusToolbox™ Application Ctrl+7

Figure 3 **Create a new ModusToolbox™ Application**



Kit Name	MCU/SOC/SIP
PSoC™ 4 BSPs	
PSoC™ 6 BSPs	
CY8CEVAL-062S2	CY8C624ABZI-S2D44
CY8CEVAL-062S2-CYW43022CUB	CY8C624ABZI-S2D44
CY8CEVAL-062S2-LAI-43439M2	CY8C624ABZI-S2D44
CY8CEVAL-062S2-LAI-4373M2	CY8C624ABZI-S2D44
CY8CEVAL-062S2-MUR-43439M2	CY8C624ABZI-S2D44
CY8CEVAL-062S2-MUR-4373EM2	CY8C624ABZI-S2D44
CY8CEVAL-062S2-MUR-4373M2	CY8C624ABZI-S2D44
CY8CKIT-062-BLE	CY8C6347BZI-BLD53
CY8CKIT-062S2-43012	CY8C624ABZI-S2D44
CY8CKIT-062S2-AI	CY8C624ABZI-S2D44
CY8CKIT-062S4	CY8C6244LQI-S4D92
CY8CKIT-064B0S2-4343W	CYB0644ABZI-S2D44
CY8CPROTO-062-4343W	CY8C624ABZI-S2D44
CY8CPROTO-062S2-43439	CY8C624ABZI-S2D44
CY8CPROTO-062S3-4343W	CY8C6245LQI-S3D72
CY8CPROTO-063-BLE	CYBLE-416045-02 (CY8C634
CY8CPROTO-064B0S3	CYB06445LQI-S3D42

CY8CKIT-064B0S2-4343W

The CY8CKIT-064B0S2-4343W PSoC™ 64 Secure Boot Wi-Fi Bluetooth® Pioneer Kit is a low-cost hardware platform that enables design and debug of PSoC™ 64 MCUs. It comes with a Murata LBEE5KL1DX Module (CYW4343W Wi-Fi + Bluetooth® Combo Chip), industry-leading CAPSENSE™ for touch buttons and slider, on-board debugger/programmer with KitProg3, microSD card interface, 512-Mb Quad-SPI NOR flash, 4-MBit Quad-SPI F-RAM, and a PDM-PCM microphone interface.

Kit Features:

- Support of up to 2MB Flash and 1MB SRAM
- Dedicated SDHC to interface with WICED wireless devices.
- Delivers dual-cores, with a 150-MHz Arm® Cortex®-M4 as the primary application processor and a 100-MHz Arm® Cortex®-M0+ as the secondary processor for low-power operations.
- Supports Full-Speed USB, capacitive-sensing with CAPSENSE™, a PDM-PCM digital microphone interface, a Quad- SPI interface, 13 serial communication blocks, 7 programmable analog blocks, and 56 programmable digital blocks.

Kit Contents:

- PSoC™ 64 Wi-Fi Bluetooth® Pioneer Board
- USB Type-A to Micro-B cable
- Quick Start Guide
- Four jumper wires (4 inches each)
- Two jumper wires (5 inches each)

0 error(s), 0 warning(s)

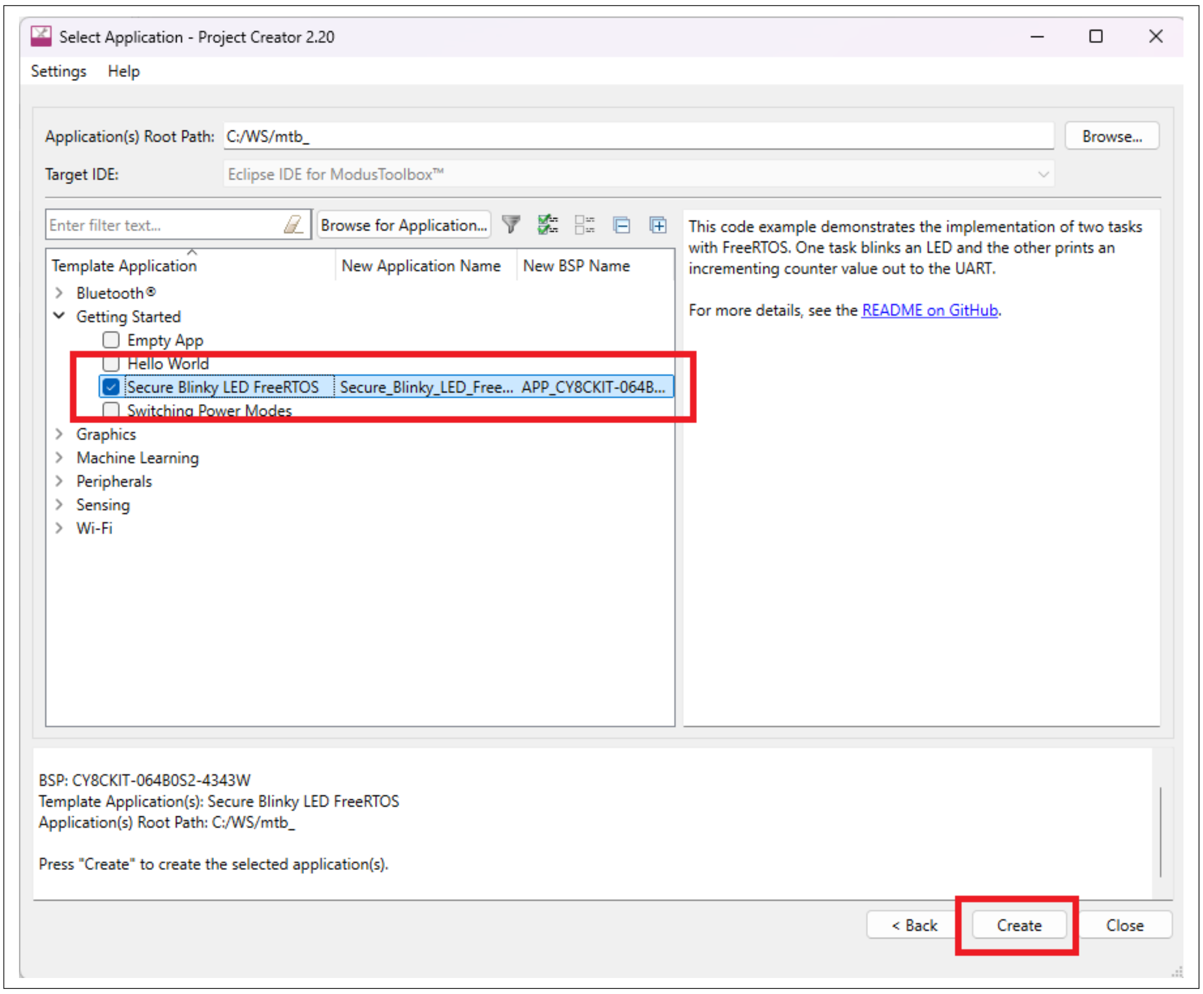
Summary:

BSP: CY8CKIT-064B0S2-4343W

Press "Next" to select application.

Figure 4 Selecting the kit

4. Select the **Secure Blinky LED FreeRTOS** application under **Getting Started** and click **Create**. This may take a while as it pulls all required sources from respective repositories



Application(s) Root Path: C:/WS/mtb_

Target IDE: Eclipse IDE for ModusToolbox™

This code example demonstrates the implementation of two tasks with FreeRTOS. One task blinks an LED and the other prints an incrementing counter value out to the UART.

For more details, see the README on GitHub.

BSP: CY8CKIT-064B0S2-4343W
Template Application(s): Secure Blinky LED FreeRTOS
Application(s) Root Path: C:/WS/mtb_

Press "Create" to create the selected application(s).

Figure 5 Selecting the application

The earlier step creates a blinky application that executes on CM4 core and CM0+ core hosts the bootloader.

2.2 Connecting the kit

Connect the kit to the PC using the provided USB cable through the KitProg3 USB connector. Ensure that you remove the jumper shunt from J26 to change the VCC_3V3 voltage to 2.5 V and the jumper shunt on J14 is placed in the VCC_3V3 position (between pin 2 and 3) before plugging in the kit to the PC. The 2.5 V supply is necessary for provisioning, where PSoC™ 64 eFuses are blown. KitProg3 must be in the DAPLink mode for provisioning. The Status LED (LED2) will be ramping ON/OFF (~2 Hz) in this mode. Press and release the Mode button (SW3) one or more times until the KitProg3 is in the DAPLink mode.

Table 1 Voltage configuration details

PSoC™ 64 VTARG	J14 position	J26
1.8 V	VCC_1V8	X
2.5 V	VCC_3V3	Not loaded
3.3 V	VCC_3V3	Loaded

2.3 "CySecureTools" setup

"CySecureTools" is a command-line tool that contains all the necessary scripts for generating the policies, creating key pairs, provisioning the device, signing the user application, and creating the certificate. After installing the "CySecureTools", generate the policies and keys to be provisioned into the device using any of the following:

- Command-line interface
- Secure Policy Configurator (GUI)

2.3.1 Command-line interface

1. Open the **modus-shell** program provided as part of ModusToolbox™ installation, which can be accessed from the Windows search box
2. Navigate to the `%WORKSPACE%/Secure_Blinky_LED_FreeRTOS/` directory in the workspace
3. Run the following command in modus-shell:

   ***Note**: This example uses the CY8CKIT-064B0S2-4343W kit. You can use any of the PSoC™ 64 kits.*

```
cysecuretools -t <target_parameter> init
```

The `<target_parameter>` for "CySecureTools" can either be the kit name or the device family name, as shown in Table 2. In this document, the device family name is used in the example. A user with a custom board will most likely use the device family name too. The following two commands are the same:

```
cysecuretools -t cyb06xxa init
(or)
cysecuretools -t cy8ckit-054b0s2-4343w init
```

This command provides default policies generated in the `/policy` folder and other secure assets that can be used to set up the chip with development parameters, such as leaving the Cortex®-M4 Debug Access Port (DAP) open to reprogram the chip.

Based on the selected target, this step sets up all the necessary files in the workspace that are used for subsequent steps and generates multiple policy files in the `%WORKSPACE%/Secure_Blinky_LED_FreeRTOS/policy` folder.

Table 2 "CySecureTools" target parameters

Kit	"CySecureTools" target parameter		Description
	Kit name	Device family name	
CY8CKIT-064B0S2-4343W	cy8ckit-064b0s2-4343w	cyb06xxa	Device with 2 MB flash
CY8CPROTO-064B0S3	cy8cproto-064b0s3	cyb06xx5	Device with 512 KB flash

2.3.1.1 Device policy

As mentioned earlier, a policy is a JSON file that defines the device's operating modes, debug access, code updates, and so on. The policy is injected into the device during the provisioning. The `CySecureTools init` command generates multiple default device policies in the `/policy` folder and you can pick any policy to proceed further to create the keys and provision the device. In this example, `policy_single_CM0_CM4_swap.json` is chosen as the device policy.

This policy is for applications that need to have a single signature for two combined applications, that is, secure Cortex®-M0+ and user app on Cortex®-M4.

Table 3 shows a high-level overview of a policy. For a detailed description of policy parameters, see the "Secure Boot" SDK user guide.

Table 3 Sample policy template

Feature	Policy setup
“Secured” coprocessor debug port	Open
CM4 debug port	Open
SysAP debug port	Open
CM4 (application) flash size	1152 KB
External memory enabled for update?	Yes
Re-provisioning enabled?	Yes

2.3.1.2 Creating new public and private key pair for signing

After creating the policy, generate the keys to provision the device. An asymmetric key pair consists of a public and private key. It is used to generate and verify the signature over a chunk of data (bootloaders, user images, and so on). In an asymmetric cryptography, the sender shares the public key with everyone in the system and keeps the private key with the self. Whenever the sender wants to send any data securely, they sign the data with the private key and the receiver verify the data with a public key. The message encrypted with the private key cannot be decrypted without the corresponding public key. Therefore, ensuring the security of the data exchanged.

To generate a key pair, ensure that you are in the `%WORKSPACE%/Secure_Blinky_LED_FreeRTOS/` directory and run the following command in the modus-shell:

```
cysecuretools -t cyb06xxa -p policy/policy_single_CM0_CM4_swap.json create-keys
```

“CySecureTools” reads the provided policy and generates the keys as defined in the policy file. The keys are generated in the `/Keys/` folder. By default, only one key, the USERAPP_CM4_KEY, a P-256 elliptic curve key pair, is generated with this command. The tool generates keys in two formats: PEM and JSON. Both the PEM and JSON files represent the same key. This key is used to sign the application software image.

Figure 6 shows the key generation and provisioning flow.

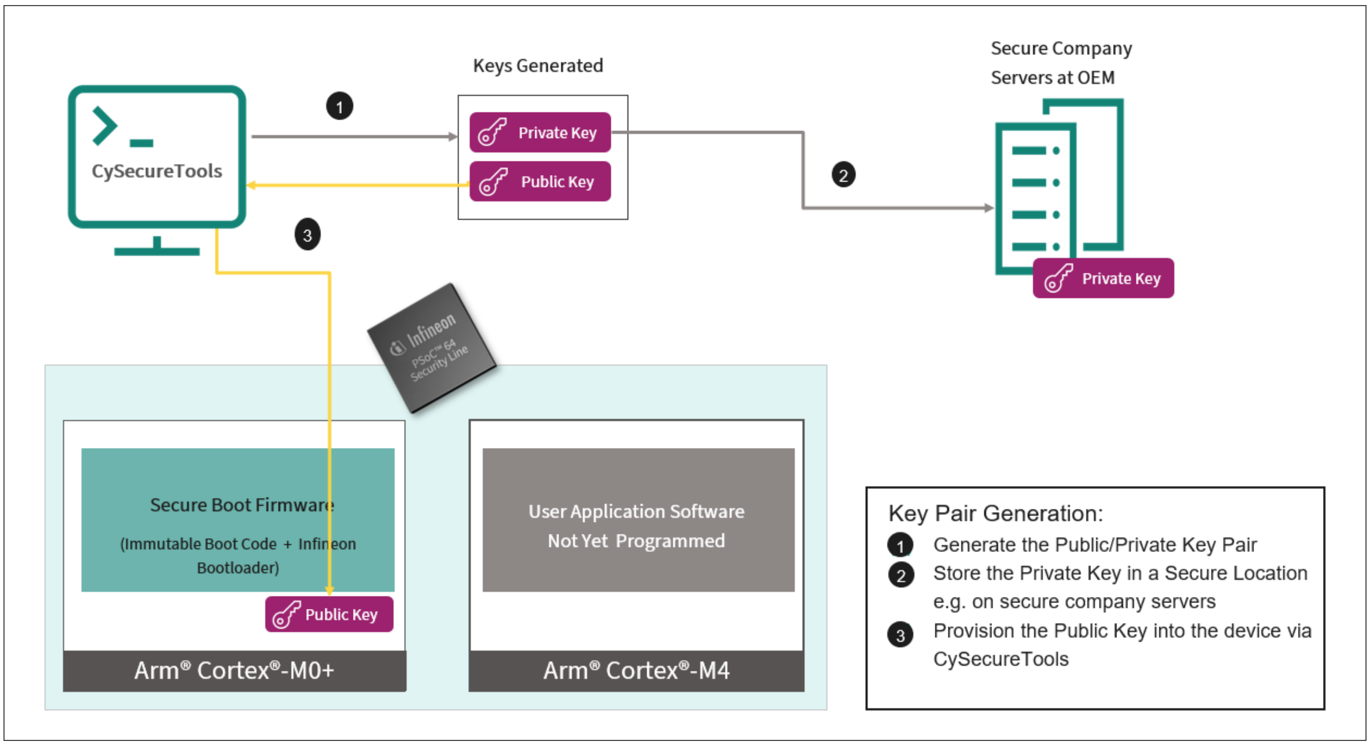

Keys Generated
Secure Company Servers at OEM
CySecureTools
Private Key
Public Key
Private Key
Secure Boot Firmware
(Immutable Boot Code + Infineon Bootloader)
Public Key
User Application Software Not Yet Programmed
Arm® Cortex®-M0+
Arm® Cortex®-M4
Key Pair Generation:
1 Generate the Public/Private Key Pair
2 Store the Private Key in a Secure Location e.g. on secure company servers
3 Provision the Public Key into the device via CySecureTools

Figure 6 **Flow diagram of key pair generation**

2.3.1.3 Provisioning the device

Provisioning is a process of injecting the keys, certificates, and bootloader image to the device. Do the following to provision the device:

1. Connect the PSoC™ 64 kit to the host machine where the "CySecureTools" is installed via the provided USB cable through the KitProg3 USB connector (J6)
2. Once connected, put the device in DAPLink mode by pressing the mode select SW3 switch provided on the kit.

   In this mode, the Status LED (LED2) will be ramping ON/OFF fast (~2 Hz). The kit supply voltage must be 2.5 V in this step. For voltage configurations, see the Connecting the kit
3. Ensure that you are in the `%WORKSPACE%/Secure_Blinky_LED_FreeRTOS/`directory. In the command-line, run the following command for provisioning the assets to the device:

```
cysecuretools -t <target_parameter> -p policy/policy_single_CM0_CM4_swap.json provision-
device
```

```
E.g.: cysecuretools -t cyb06xxa -p policy/policy_single_CM0_CM4_swap.json provision-device
```

Note: *Ensure that you pass the correct target parameter in the command. For more details, see* Table 1

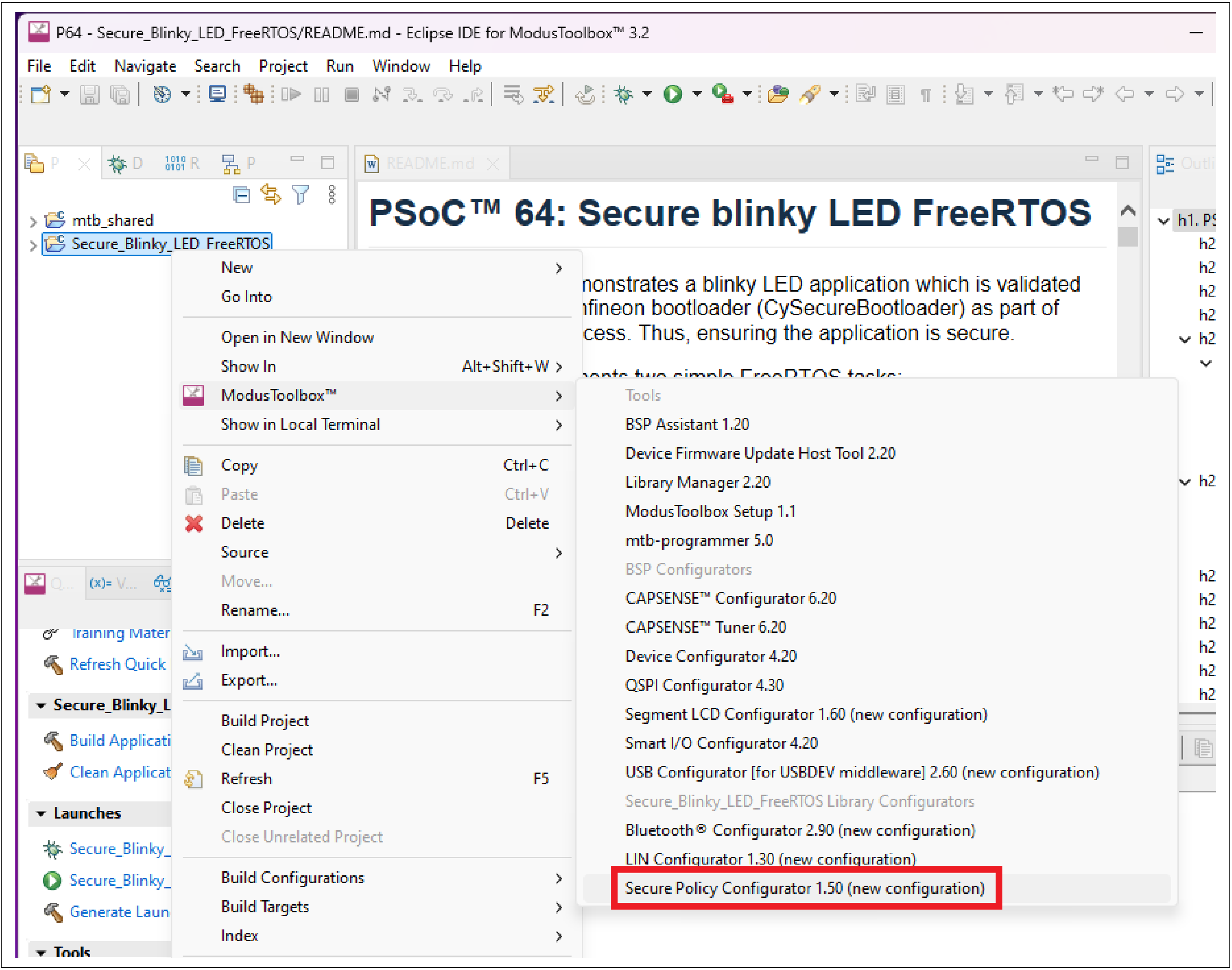
4. To see the progress of the device provisioning, open the device serial COM port over Tera Term or Putty in the host machine with a 115200 baud rate. On successful provisioning of the assets, see the "PROVISIONING PASSED" message on the serial terminal

As mentioned earlier, the policies, keys generation, and provisioning can also be done via a GUI tool called “Secure Policy Configurator” to be discussed in the following section. For more details on provisioning, see PSoC™ 64 provisioning specification.

2.3.2 Secure Policy Configurator

The “Secure Policy Configurator”, which is available with the ModusToolbox™ Edge Protect Security Suite package as mentioned in Prerequisites. For more details, see the Secure Policy Configurator user guide. Use the "Secure Policy Configurator" to create a new or edit existing policy configuration files for the PSoC™ 64 "Secure Boot" MCU devices and provision devices. The "Secure Policy Configurator" provides easy execution of the configuration without using the command line. Additionally, it provides editing a policy file via a GUI without editing the XML policy file. This configurator internally uses "CySecureTools" for generating policies, keys, and provisioning.

In the Command-line interface section, the command line is used to send the provisioning command to provision the device. This section explains how to provision a device via the "Secure Policy Configurator". To open the Configurator, go to the ModusToolbox™ Project Explorer and right click on the project and traverse as shown in Figure 7. Alternatively, you can also launch it from the Quick Panel, scroll down, and click on the "Secure Policy Configurator" tool in Library Configurators.

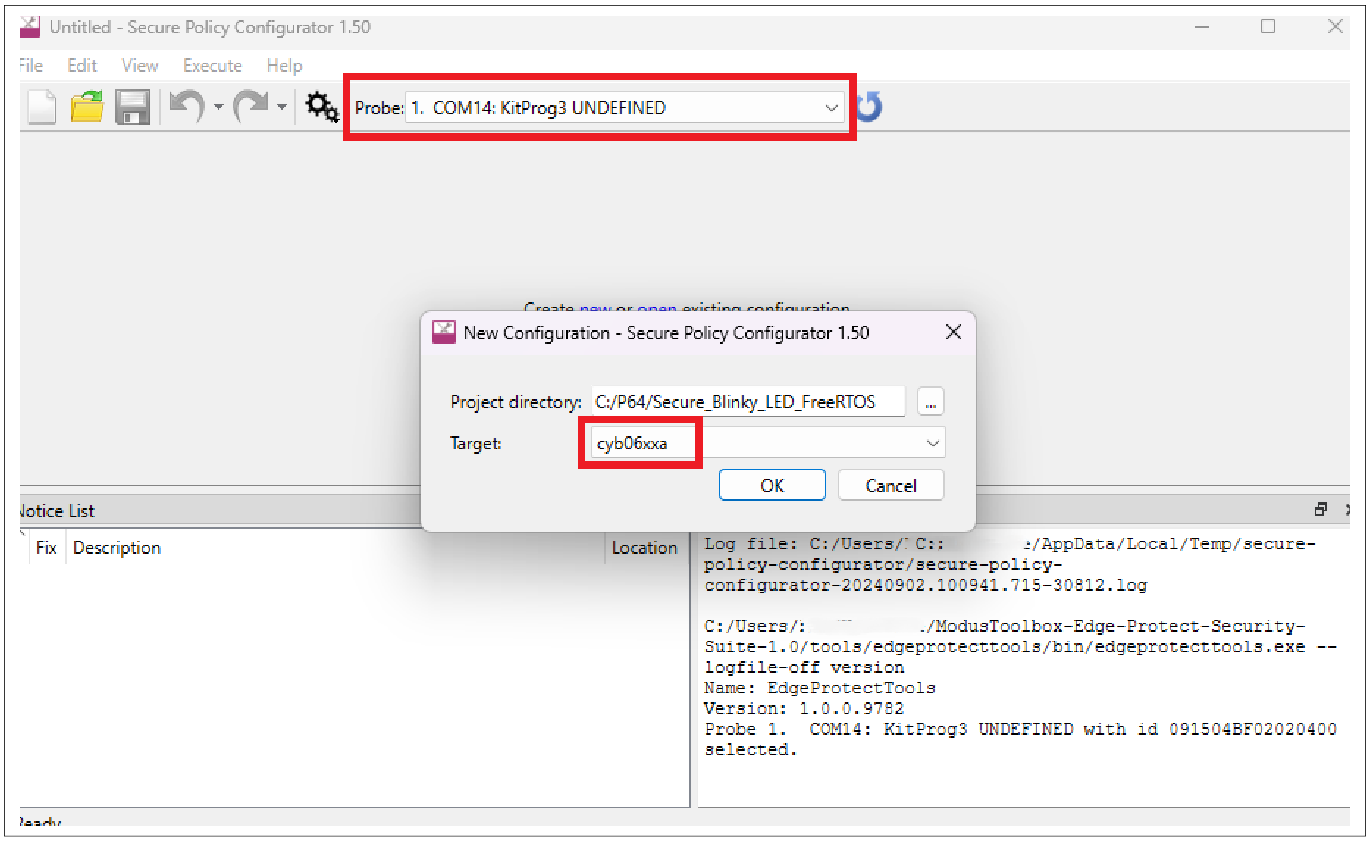


PSoC™ 64: Secure blinky LED FreeRTOS

nonstrates a blinky LED application which is validated
nfineon bootloader (CySecureBootloader) as part of
cess. Thus, ensuring the application is secure.

Figure 7 **Secure Policy Configurator**

Once the "Secure Policy Configurator" tool is launched, go to **File** > **New**, probe the appropriate kit (CY8CKIT-064B0S2-4343W in this case), Project directory and Target, as shown in Figure 8 and click **OK**. This step creates the default policies and keys in `/policy` and `/keys` folder inside `%WORKSPACE%/Secure_Blinky_LED_FreeRTOS`.


Untitled - Secure Policy Configurator 1.50
File Edit View Execute Help
Create new or open existing configuration
New Configuration - Secure Policy Configurator 1.50
...
OK
Cancel
Notice List
Fix
Description
Location
Ready

Probe: 1. COM14: KitProg3 UNDEFINED

Project directory: C:/P64/Secure_Blinky_LED_FreeRTOS

Target: cyb06xxa

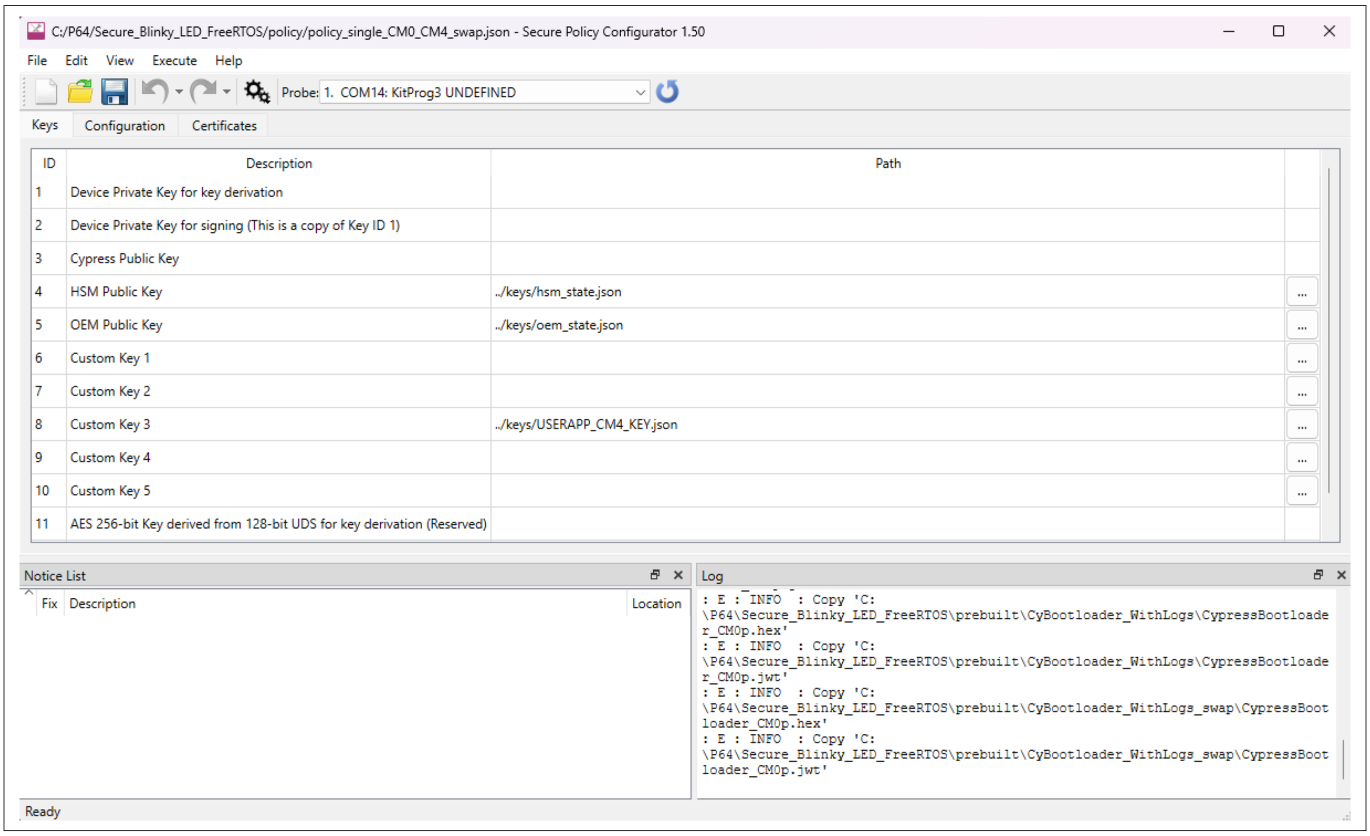
```
Log file: C:/Users/: C:: [redacted]e/AppData/Local/Temp/secure-
policy-configurator/secure-policy-
configurator-20240902.100941.715-30812.log

C:/Users/: [redacted]./ModusToolbox-Edge-Protect-Security-
Suite-1.0/tools/edgeprotecttools/bin/edgeprotecttools.exe --
logfile-off version
Name: EdgeProtectTools
Version: 1.0.0.9782
Probe 1.  COM14: KitProg3 UNDEFINED with id 091504BF02020400
selected.
```

Figure 8 **Select Target**

By default, the tool does not generate the user keys. Therefore, generate the user application keys explicitly in the `/keys` folder via the command line before provisioning the device. See Creating new public and private key pair for signing for generating USERAPP_CM4_KEY.

After generating the policies and keys, it opens the generated policy, as shown in Figure 9. By default, the generated policy is `policy_single_CM0_CM4_swap.json`.



C:/P64/Secure_Blinky_LED_FreeRTOS/policy/policy_single_CM0_CM4_swap.json - Secure Policy Configurator 1.50

ID	Description	Path
1	Device Private Key for key derivation	
2	Device Private Key for signing (This is a copy of Key ID 1)	
3	Cypress Public Key	
4	HSM Public Key	../keys/hsm_state.json
5	OEM Public Key	../keys/oem_state.json
6	Custom Key 1	
7	Custom Key 2	
8	Custom Key 3	../keys/USERAPP_CM4_KEY.json
9	Custom Key 4	
10	Custom Key 5	
11	AES 256-bit Key derived from 128-bit UDS for key derivation (Reserved)	

```
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs\CypressBootloade
r_CM0p.hex'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs\CypressBootloade
r_CM0p.jwt'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs_swap\CypressBoot
loader_CM0p.hex'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs_swap\CypressBoot
loader_CM0p.jwt'
```

Figure 9 **Policy**

You can see the policy fields displayed in the Policy Configurator. You can either provision the device as mentioned in the Provisioning the device section or edit and provision the policy as explained in the following sections.

2.3.2.1 Editing a policy

Edit the policies as per your requirement. An example is demonstrated to edit the policy and provision the device. Under the **Configuration** tab, disable the Cortex®-M4 debug port by selecting the `Disable` option, and save the changes, as shown in Figure 10. This generates a new policy file overwriting the old file in the`/policy` folder and provisioned to the device.

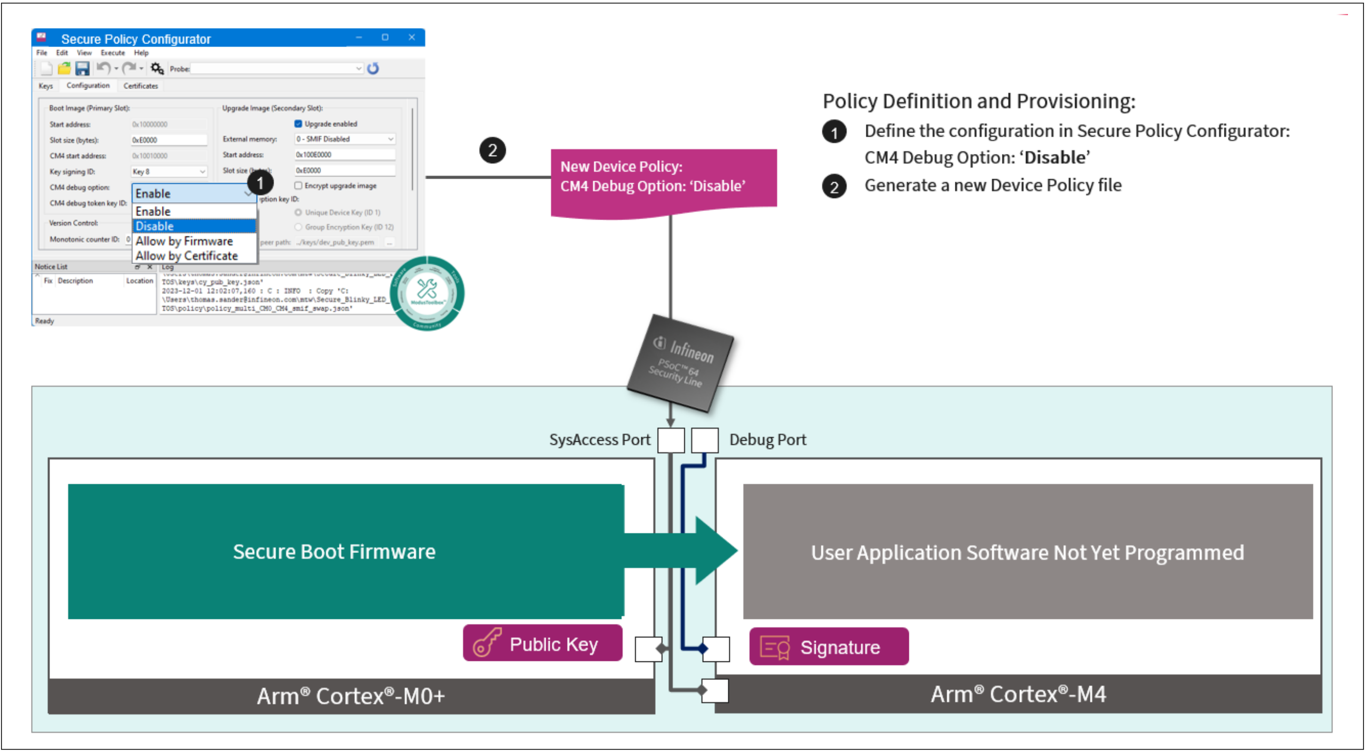

Secure Policy Configurator
Enable
Disable
Allow by Firmware
Allow by Certificate
New Device Policy:
CM4 Debug Option: 'Disable'
Policy Definition and Provisioning:
1 Define the configuration in Secure Policy Configurator: CM4 Debug Option: 'Disable'
2 Generate a new Device Policy file
SysAccess Port
Debug Port
Secure Boot Firmware
User Application Software Not Yet Programmed
Public Key
Signature
Arm® Cortex®-M0+
Arm® Cortex®-M4

Figure 10 **Secure Policy Configurator**

***Note**: The previous example is just a demonstration. It is not advisable to disable the debug ports during the development stage because you will be unable to debug any application on the Cortex®-M4 core.*

Once the policy is provisioned to the device, the debug policy is enforced on the device and the debug port of Cortex®-M4 is disabled, as shown in Figure 11.

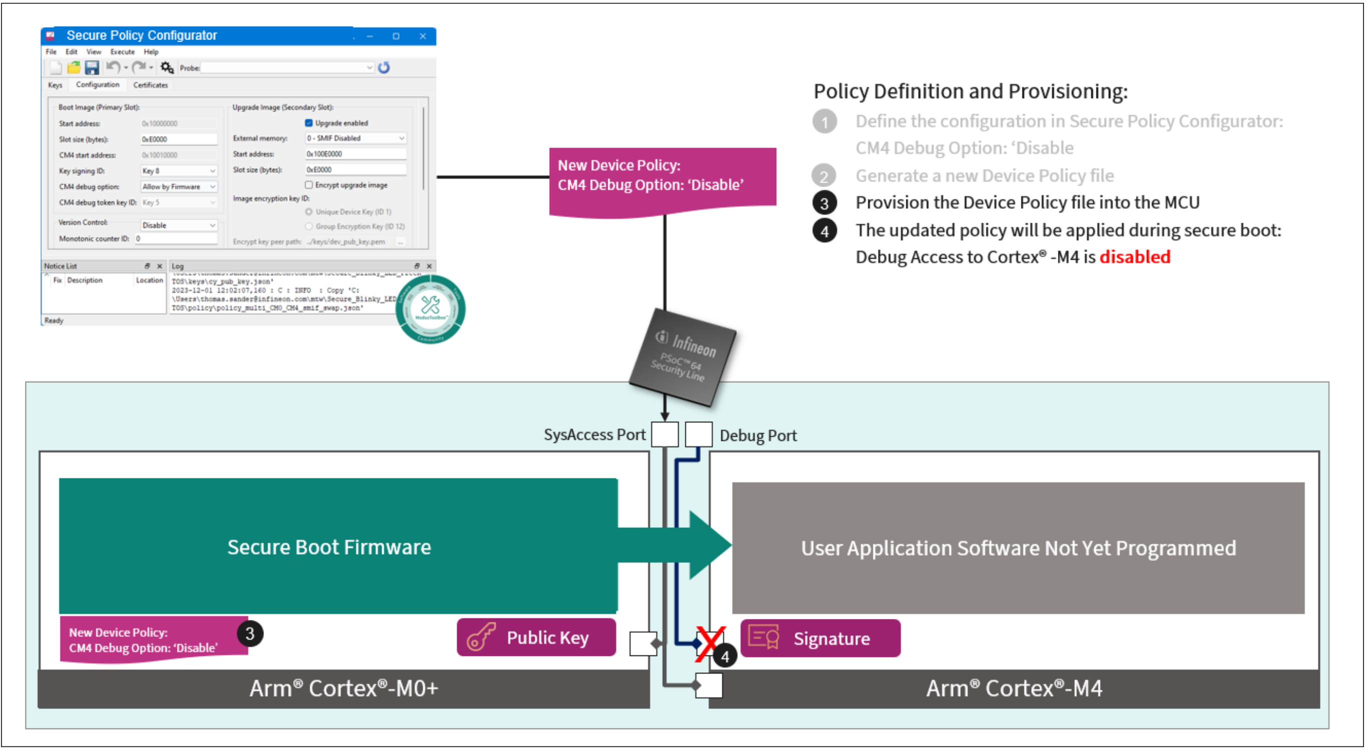
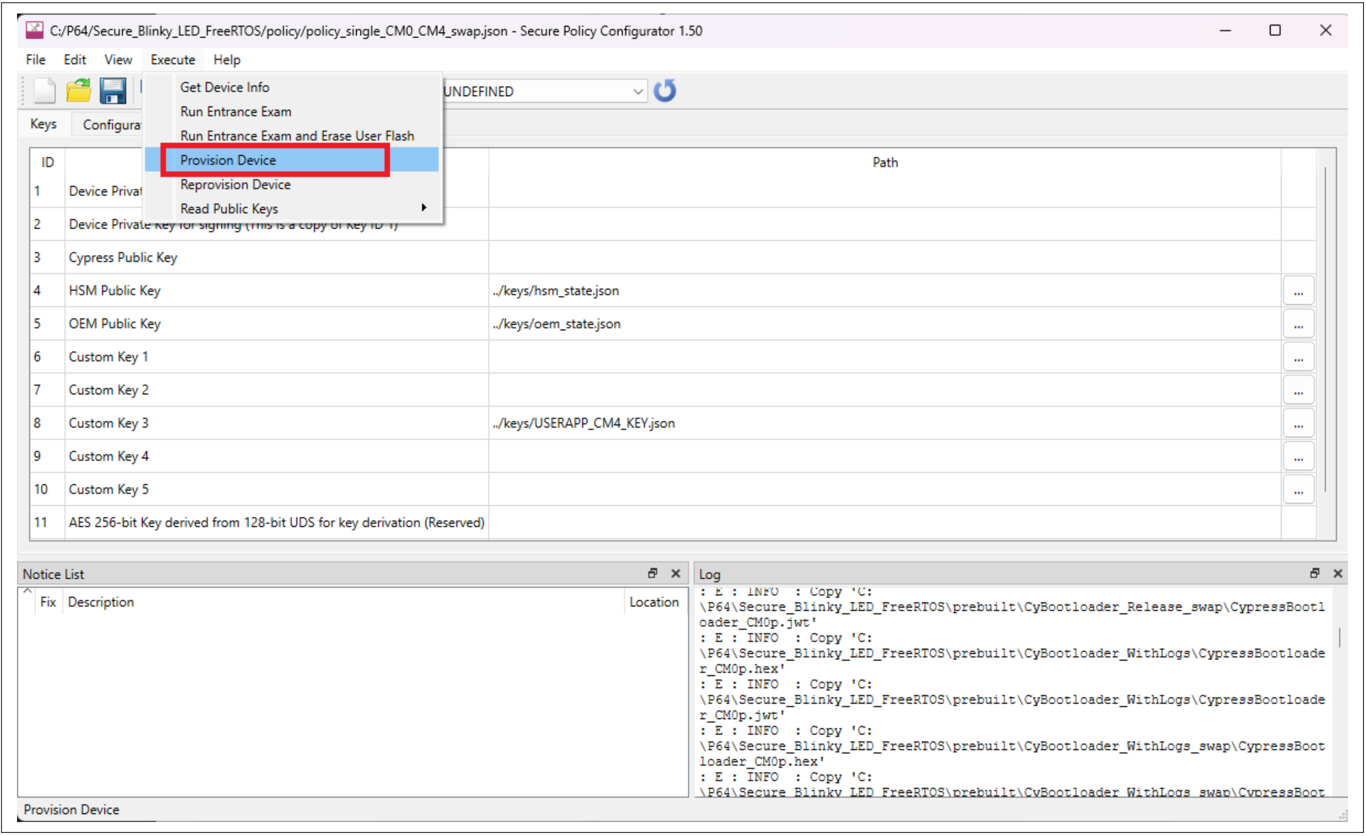

Secure Policy Configurator
New Device Policy:
CM4 Debug Option: 'Disable'
Policy Definition and Provisioning:
1 Define the configuration in Secure Policy Configurator: CM4 Debug Option: 'Disable
2 Generate a new Device Policy file
3 Provision the Device Policy file into the MCU
4 The updated policy will be applied during secure boot: Debug Access to Cortex® -M4 is disabled
SysAccess Port
Debug Port
Secure Boot Firmware
User Application Software Not Yet Programmed
New Device Policy: CM4 Debug Option: 'Disable'
Public Key
Signature
Arm® Cortex®-M0+
Arm® Cortex®-M4

Figure 11 **Secure Policy Configurator**

For more information on this tool and options, go to **Help** > **View Help** in the tool window.

2.3.2.2 Provisioning the device

Provision the device as shown in Figure 12.



ID		Path
1	Device Privat	
2	Device Private Key for signing (This is a copy of Key ID 1)	
3	Cypress Public Key	
4	HSM Public Key	../keys/hsm_state.json
5	OEM Public Key	../keys/oem_state.json
6	Custom Key 1	
7	Custom Key 2	
8	Custom Key 3	../keys/USERAPP_CM4_KEY.json
9	Custom Key 4	
10	Custom Key 5	
11	AES 256-bit Key derived from 128-bit UDS for key derivation (Reserved)	

```
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_Release_swap\CypressBootl
oader_CM0p.jwt'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs\CypressBootloade
r_CM0p.hex'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs\CypressBootloade
r_CM0p.jwt'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs_swap\CypressBoot
loader_CM0p.hex'
: E : INFO  : Copy 'C:
\P64\Secure_Blinky_LED_FreeRTOS\prebuilt\CyBootloader_WithLogs_swap\CypressBoot
```

Figure 12 Provisioning the device

The status of provisioning can be seen in the log window.

2.4 Build and run the secure application

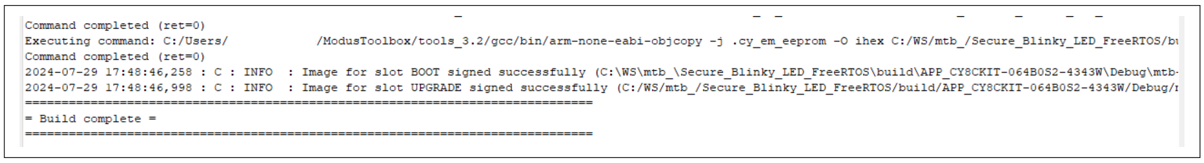
Ensure that the device is provisioned before executing the secured application on the device. Put the MiniProg4 or KitProg back into CMSIS-DAP Bulk mode before attempting to program or debug the device. Now, reconnect the kit to power then press and release the Mode button (SW3) one or more times until the KitProg3 is in the CMSIS-DAP Bulk mode. The Status LED (LED2) will be solid in this mode.

Additionally, if the voltage is set to 2.5 V for provisioning, it should be changed back to the normal operating voltage before programming the application. Do the following to build and run the secured application:

1. In the Project Explorer, right-click on the **Secure_Blinky_LED_FreeRTOS** project and select **Build Project**
2. Ensure that the device is connected to the host machine over USB
3. Right-click on **Secure_Blinky_LED_FreeRTOS** project and select **Run As** > **Run Configurations**
4. On the dialog, select **GDB OpenOCD Debugging** > **Secure_Blinky_LED_FreeRTOS Program (KitProg3_MiniProg4)** and click the **Run** button
5. Once the build is complete, you will see in the ModusToolbox™ console that "CySecureTools" has signed the image with the keys you generated in the Creating new public and private key pair for

signing section. The following messages are shown in the build console window before the memory consumption table, as shown in Figure 13:

- "Image for slot BOOT signed succesfully"
- "Image for slot UPGRADE signed succesfully"



```
Command completed (ret=0)
Executing command: C:/Users/           /ModusToolbox/tools_3.2/gcc/bin/arm-none-eabi-objcopy -j .cy_em_eeprom -O ihex C:/WS/mtb_/Secure_Blinky_LED_FreeRTOS/bu
Command completed (ret=0)
2024-07-29 17:48:46,258 : C : INFO  : Image for slot BOOT signed successfully (C:\WS\mtb_\Secure_Blinky_LED_FreeRTOS\build\APP_CY8CKIT-064B0S2-4343W\Debug\mtb-
2024-07-29 17:48:46,998 : C : INFO  : Image for slot UPGRADE signed successfully (C:/WS/mtb_/Secure_Blinky_LED_FreeRTOS/build/APP_CY8CKIT-064B0S2-4343W/Debug/r
==============================================================================
= Build complete =
==============================================================================
```

Figure 13 ModusToolbox™ console after build is complete

As part of the build process mentioned above, the signature of the application software image is generated by the "CySecureTools" (part of the post build scripts) using the Private key generated from Creating new public and private key pair for signing and appends to the end of the application software image.

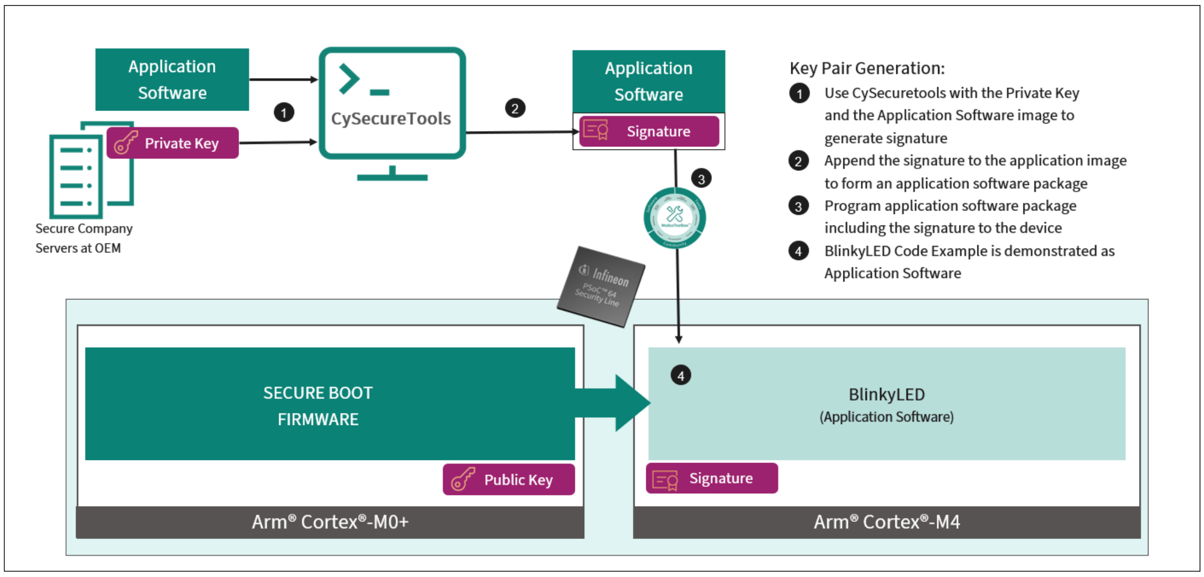
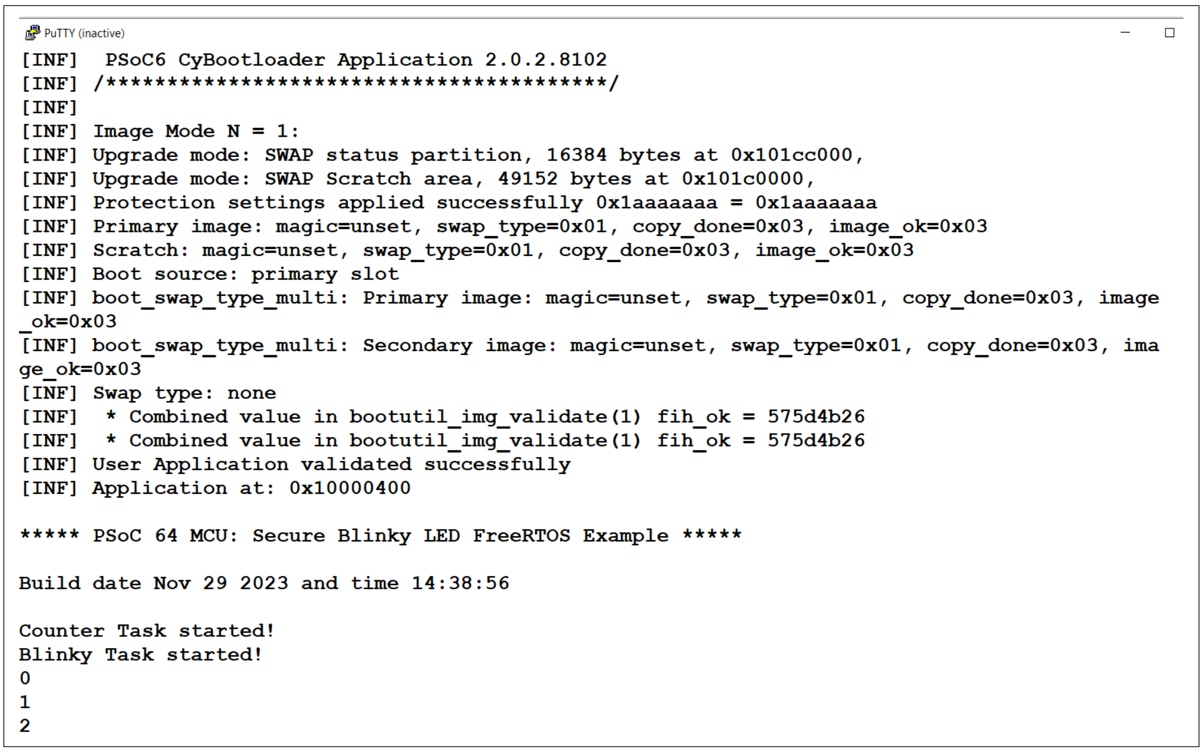

Application Software
Private Key
Secure Company Servers at OEM
1
CySecureTools
2
Application Software
Signature
3
Key Pair Generation:
1 Use CySecuretools with the Private Key and the Application Software image to generate signature
2 Append the signature to the application image to form an application software package
3 Program application software package including the signature to the device
4 BlinkyLED Code Example is demonstrated as Application Software
SECURE BOOT FIRMWARE
Public Key
Arm® Cortex®-M0+
4
BlinkyLED
(Application Software)
Signature
Arm® Cortex®-M4

Figure 14 Application software image signature generation

6. Immediately after the build, it flashes the images to the device and boots the application. Observe LED8 (Orange) blinking every second. Open a serial terminal with a baud rate of 115200 to see the application logs, as shown Figure 15. This confirms that the application is loaded successfully and running


PuTTY (inactive)

```
[INF]  PSoC6 CyBootloader Application 2.0.2.8102
[INF] /*******************************************/
[INF]
[INF] Image Mode N = 1:
[INF] Upgrade mode: SWAP status partition, 16384 bytes at 0x101cc000,
[INF] Upgrade mode: SWAP Scratch area, 49152 bytes at 0x101c0000,
[INF] Protection settings applied successfully 0x1aaaaaaa = 0x1aaaaaaa
[INF] Primary image: magic=unset, swap_type=0x01, copy_done=0x03, image_ok=0x03
[INF] Scratch: magic=unset, swap_type=0x01, copy_done=0x03, image_ok=0x03
[INF] Boot source: primary slot
[INF] boot_swap_type_multi: Primary image: magic=unset, swap_type=0x01, copy_done=0x03, image
_ok=0x03
[INF] boot_swap_type_multi: Secondary image: magic=unset, swap_type=0x01, copy_done=0x03, ima
ge_ok=0x03
[INF] Swap type: none
[INF]  * Combined value in bootutil_img_validate(1) fih_ok = 575d4b26
[INF]  * Combined value in bootutil_img_validate(1) fih_ok = 575d4b26
[INF] User Application validated successfully
[INF] Application at: 0x10000400

***** PSoC 64 MCU: Secure Blinky LED FreeRTOS Example *****

Build date Nov 29 2023 and time 14:38:56

Counter Task started!
Blinky Task started!
0
1
2
```

Figure 15 **Application logs**

Note: *When using the CY8CKIT_064B0S2_4343W target, the ModusToolbox™ BSP has a post build image signing command located in `/bsps/TARGET_APP_CY8CKIT-064B0S2-4343W/bsp.mk`. This post build script uses the policy file to find the private key path used to sign the application. If a different or invalid key is used, the secure boot process will fail.*

2.5 Debugging the application

1. Right-click on **Secure_Blinky_LED_FreeRTOS** project and select **Debug As** > **Debug Configurations…**
2. On the dialog, select **GDB OpenOCD Debugging** > **Secure_Blinky_LED_FreeRTOS Debug** and click **Debug** button

A breakpoint is set at the main function with default launch configurations. After step 3, the debugger breaks at the main function of the blinky application. Now you can start debugging the code starting from the main function.

References

This section contains various links to the resources that can be useful when working with the application note.

Document	Name/description
Application notes	
AN227860	"Secure Boot" SDK user guide
AN228571	Getting started with PSoC™ 6 MCU on ModusToolbox™ software
PSoC™ 64 provisioning specification	PSoC™ 64 Provisioning specification guide
Code examples	
CE228684	PSoC™ 64 MCU: Secure blinky LED with FreeRTOS
PSoC™ 6 code examples	PSoC™ 6 MCU code example list
Device documentation	
PSoC™ 6 MCU datasheets	PSoC™ 64 MCU datasheets
PSoC™ 6 reference manuals	PSoC™ 64 MCU reference manual
Libraries (on GitHub)	
mtb-pdl-cat1	PSoC™ 6 Peripheral Driver Library (PDL)
mtb-hal-cat1	Hardware Abstraction Layer (HAL) library
retarget-io	A utility library to retarget the standard I/O (STDIO) messages to a UART port
p64-utils	PSoC™ 64 “Secure Boot” utilities middleware library
PSoC™ 6 middleware	PSoC™ 6 middleware libraries
Tools	
ModusToolbox™	ModusToolbox™ software installation
CySecureTools	"CySecureTools" installation

Revision history

Document revision	Date	Description of changes
**	2023-12-15	Initial release
*A	2024-09-11	Updated the Python version and Secure Policy Configurator section

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