# OPTIGA™ Trust Charge

## Product Version: V1

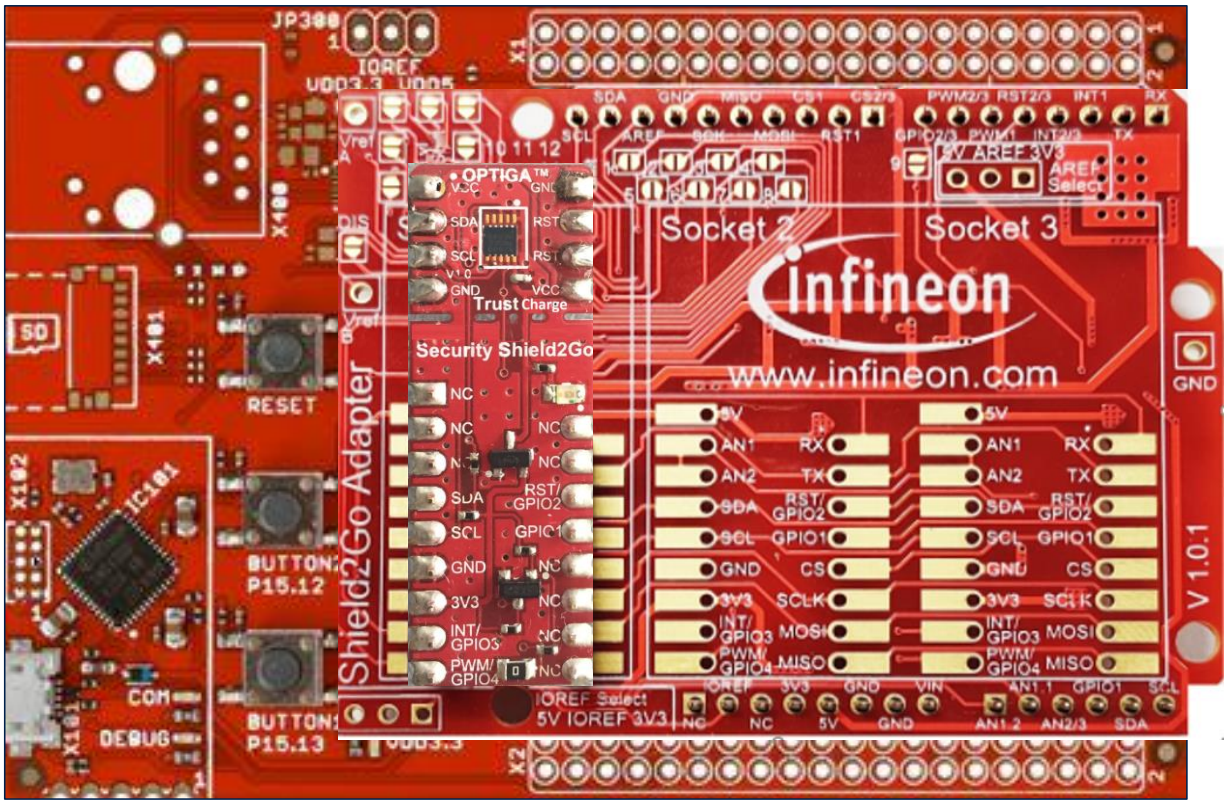
## About this document

### Scope and purpose

The purpose of this document is to guide a beginner to use the OPTIGA™ Trust Charge  XMC4700 Relax kit. The scope is limited to OPTIGA™ Trust Charge  XMC4700 Relax kit and its hardware and software components.

### Intended audience

This document addresses: customers, solution providers and system integrators.



# Table of Contents

# 1 Introduction

This document describes how to setup the environment to run OPTIGA™ Trust Charge application and use the provided binaries.

## 1.1 References

**Table 1 References**

| Definition | Source |
|---|---|
| [1] xmc4700_relaxkit_usermanual | Infineon |
| [2] Infineon_I2C_Protocol | Infineon |

## 1.2 Abbreviations

**Table 2 Abbreviations**

| Abbreviation | Definition |
|---|---|
| API | Application Programming Interface |
| CA | Certificate Authority |
| CHM | Microsoft Compiled HTML Help |
| CMOS | Complementary Metal Oxide Semiconductor |
| DAVE | Digital Application Virtual Engineer |
| ECC | Elliptic Curve Cryptography |
| HTML | Hyper Text Markup Language |
| HW | Hardware |
| I2C | Inter Integrated Circuit |
| IDE | Integrated Development Environment |
| IoT | Internet of Things |
| NIST | National Institute of Standards and Technology |
| OS | Operating System |
| PAL | Platform Abstraction Layer |
| PC | Personal Computer |
| RST | Reset |
| SCL | Serial Clock |
| SDA | Serial Data |
| SW | Software |
| TTL | Transistor Transistor Logic |
| USB | Universal Serial Bus |
| XMC | XMC4700 Relax Kit-V1.0 |

# 2 OPTIGA™ Trust Charge

OPTIGA™ Trust Charge is a security solution with a pre-programmed security controller built on Elliptic Curve Cryptography (ECC) with 256 and 384 bit curve length, SHA-256.

It supports secure data object update, hibernate and toolbox functionalities, which is used for secure communication, platform integrity, data store protection and lifecycle management for Connected Device Security.

## 2.1 OPTIGA™ Trust Charge XMC4700 Relax Kit

OPTIGA™ Trust Charge XMC4700 Relax Kit is designed to provide all the components required to setup the environment to demonstrate the features of the OPTIGA™ Trust Charge.

### 2.1.1 Evaluation Kit Components

**Table 3 Evaluation Kit contents**

| No. | Item | Description |
|---|---|---|
| 1 | XMC4700 board | Hardware Evaluation board for XMC4700 microcontroller from Infineon. More details can be found on Infineon website. |
| 2 | My IoT Adapter | Arduino compatible connector to add Shield2Go board on XMC4700 Relax Kit. |
| 3 | OPTIGA™ Trust Charge Security Shield2Go | Shield2Go board contains OPTIGA™ Trust Charge chip. It is compatible with Infineon's My IoT adapter. |
| 4 | Micro USB to USB cable | The cable provides DC supply to XMC4700 Relax Kit and to flash software. |

OPTIGA™ Trust Charge

## 2.2 Installed Software Components

The installed directory structure of OPTIGA™ Trust Charge setup software is shown below:

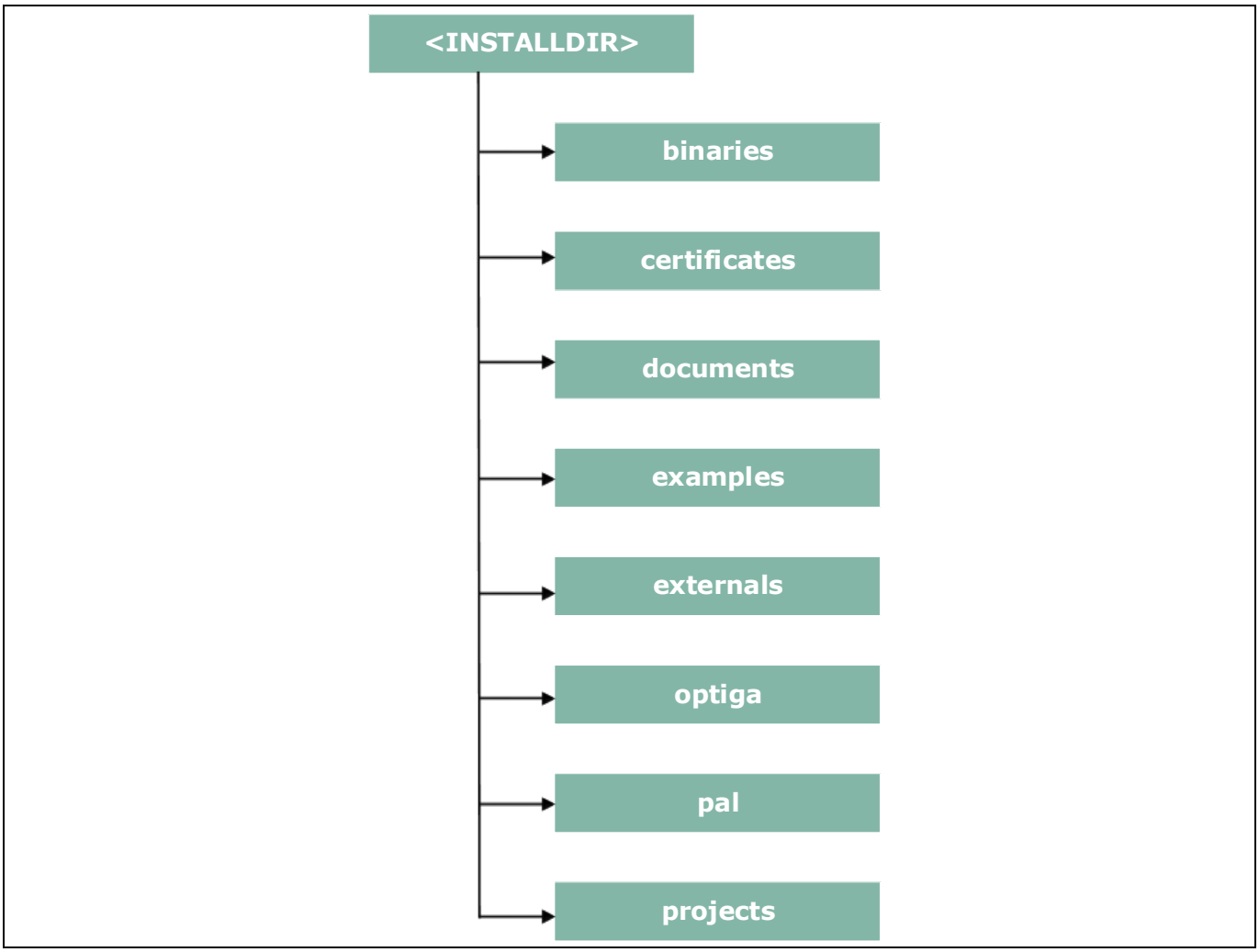



**Figure 1 Installed directory structure**

<*INSTALLDIR*> is the root directory to which the release package contents are extracted. The following section explains the contents of each subdirectory under installed directory:

1. **binaries --** binaries for OPTIGA™ Trust Charge example application.
2. **certificates** -- OPTIGA™ Trust Charge certificates.
3. **documents** -- Relevant OPTIGA™ Trust Charge documentation.
4. **examples** -- Example use cases for Toolbox features and a tool for generation of manifest for secure data object feature.
5. **externals** -- mbedTLS software crypto library.
6. **optiga --** OPTIGA™ Trust Charge libraries.
7. **pal** -- PAL for XMC4700 device and PAL for mbedTLS software crypto library.
8. **projects** -- XMC4700 device example project in DAVE workspace.

# 3 System Setup

This section explains the basic components required for system setup.

## 3.1 System Overview

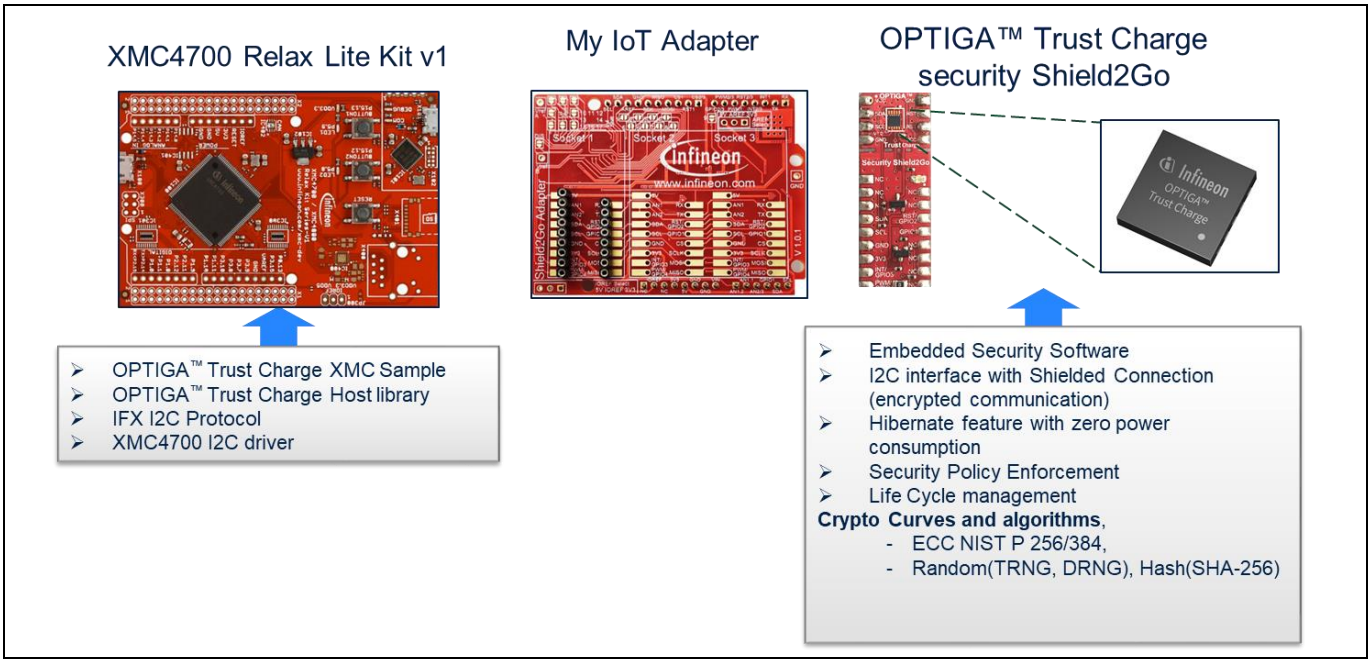



**Figure 2 System Overview**

This system consists of the following components:

1. XMC4700 Relax Kit v1.0 from Infineon
    - The XMC4700 Relax Kit is an evaluation board with XMC4700 Microcontroller from Infineon. For more information refer document [1].
    - It is used as a reference platform to simulate the Host.
    - It interacts with secure element via I2C.
2. My IoT Adapter
    - It acts as a gateway to add Shield2Go boards onto XMC4700 Relax Kit V1.0.
3. OPTIGA™ Trust Charge Security Shield2Go
    - Shield2Go board contains OPTIGA™ Trust Charge chip. It is compatible with Arduino Connector along with Infineon's My IoT adapter.

The following interface/connection is done among the above components:

- Micro USB data cable (with Data line) from PC is connected to XMC to supply power.

## 3.2 Hardware Setup

The hardware required to run OPTIGA™ Trust Charge setup is described in this section.

### 3.2.1 XMC4700 Relax Kit

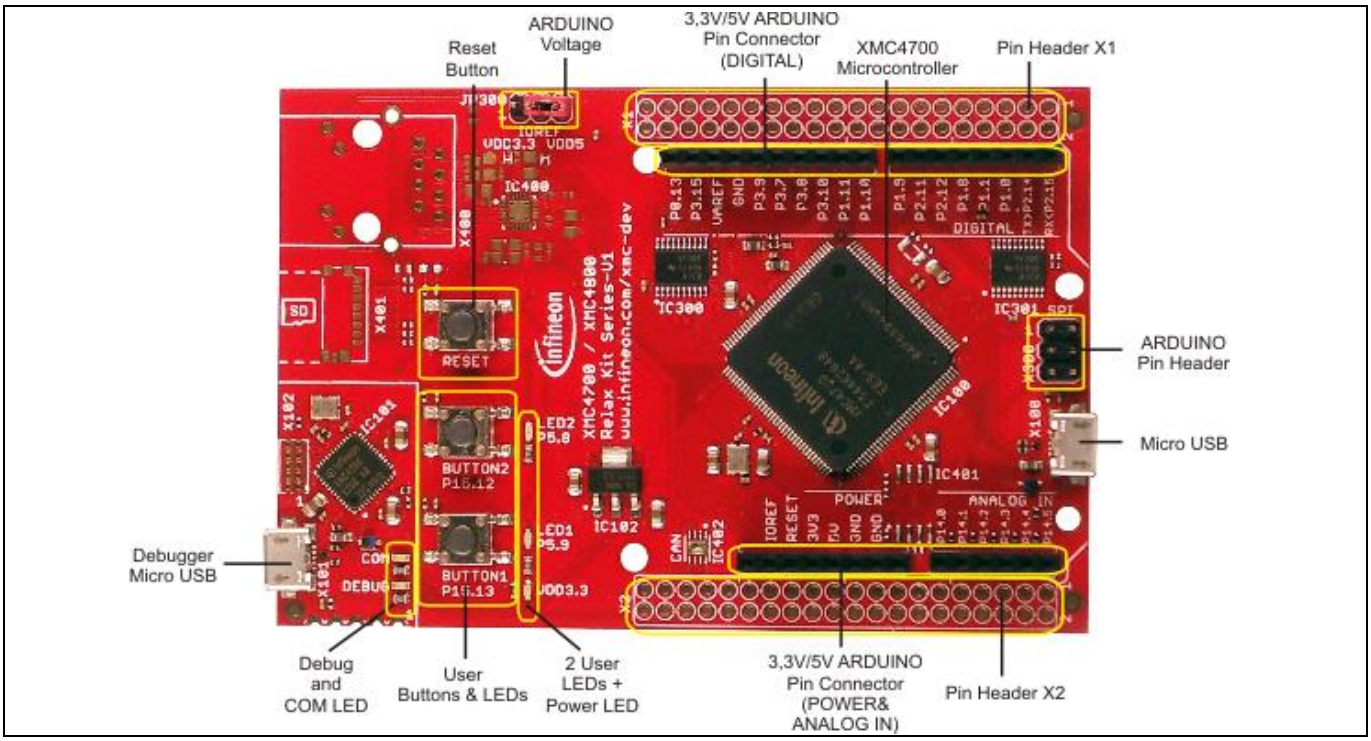



**Figure 3 XMC4700 Relax Kit**

**Table 4 XMC4700 Relax Kit Components**

| No. | Item | Description |
|---|---|---|
| 1 | DC Supply | Power supply of 5V is provided by connecting to Micro USB connector. |
| 2 | Arduino compatible connector | External interface to connect to Arduino Shields. |
| 3 | On-board debug probe | Supports Serial Wire Debug and UART communication for debugging and logging purposes. |

The pin headers for Arduino shields can be used for GPIOs or signal interface as well. Arduino compatible connector supports I2C, UART and SPI interfaces among others.

**Table 5 XMC4700 Relax Kit I2C Pin Information**

| No. | Description | Pin |
|---|---|---|
| 1 | I2C SCL | P0.13 |
| 2 | I2C SDA | P3.15 |
| 3 | RST | P1.11 |
| 4 | VCC | P2.12 |
| 5 | GND | GND |

For more information about pin details of Arduino shield, refer document [1].

For more information about the XMC Specification, Architecture and Design/Schematic, refer document [1]

### 3.2.2 My IoT Adapter

The My IoT adapter is an evaluation board that allows users to easily combine different Shield2Go boards to Arduino compliant ecosystem, for fast evaluation of IoT systems. With its solderless connectors, it allows users

to easily stack Shield2Go boards instead of soldering it. The shield design is derived from XMC2Go evaluation board.

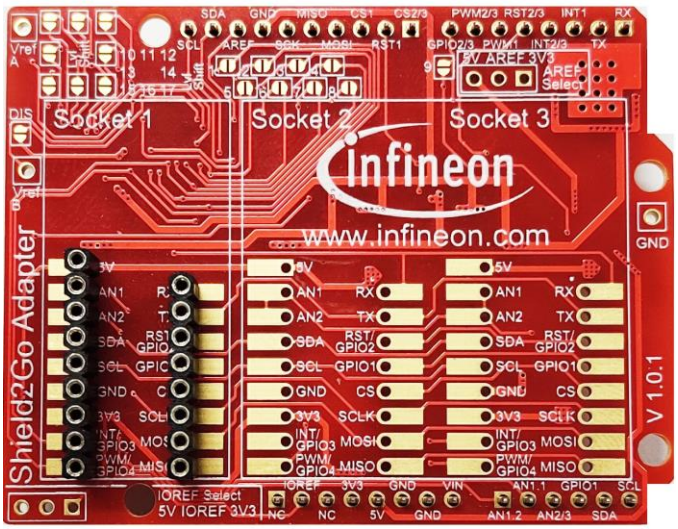



**Figure 4 My IoT adapter**

My IoT adapter features are as follows:

- Provide power supply and connectivity for Shield2Go boards.
- Level shifting handling capabilities between CMOS 3.3V and TTL 5V.
    - Solder bridges to selectively deactivate level shifting.
    - Additional pins enable setting the reference voltages for level shifting.
- Separate power control switches for Socket 1 and Socket 2. Socket 1 is independently controllable while Socket 2 and 3 share pins to underlying control board.

More information is available at Infineon website.

### 3.2.3 Shield2Go Security OPTIGA™ Trust Charge

Shield2Go boards are equipped with featured Infineon ICs and provide a standardized form factor and pin layout, allowing a ‘plug and play’ approach for easy prototyping.


**Figure 5 OPTIGA™ Trust Charge Shield2Go**

The OPTIGA™ Trust Charge Shield2Go is equipped with OPTIGA™ Trust Charge security chip. It allows users to develop system solutions by combining Shield2Go with My IoT adapter and XMC.

*Note: Ensure no voltage supplied to any of the pins exceeds the absolute maximum rating of $V_{cc}$ + 0.3 V.*

## 3.3 Software Setup

This section describes the software used in XMC to run the OPTIGA™ Trust Charge setup.

### 3.3.1 Software Components

All the software components required on XMC are explained in the following sections.

#### 3.3.1.1 XMC4700 Relax Kit

1. OPTIGA™ Trust Charge Host Library consists of the following:
   - Service Layer
     The layers (Util and Crypt) provide APIs to interact with OPTIGA™ for various use-case functionalities.
   - Access Layer
     This layer manages the access to the command interface of OPTIGA™ security chip. It also provides the communication interface to the OPTIGA™.
   - Platform Abstraction Layer
     This layer provides platform agnostic interfaces for the underlying HW and SW platform functionalities used by OPTIGA™ libraries.
   - Platform Layer
     This layer provides the platform specific components and libraries for the supported platforms.
2. IFX I2C Protocol
   This is an implementation as per document [2].
3. XMC4700 I2C Driver

These are low level I2C device driver for I2C communication from XMC to OPTIGA™ Trust Charge Security chip.

4. OPTIGA™ Trust Charge XMC Example
   This Example Application demonstrates Secure Data Object, Hibernate feature, Cryptographic ToolBox Functionalities and Read/Write General Purpose Data use cases.

*Note: The binaries and the example application provided with the application note are meant for the XMC4700 Relax Kit v1. These binaries may not work as expected if executed on a different platform.*

### 3.3.2 PC Requirements and Configurations

#### 3.3.2.1 PC Requirement

A 32-bit or 64-bit PC with Windows 7/10 Operating System with the below requirements need to be used for setting up the OPTIGA™ Trust Charge setup:

1. One USB port.
2. DAVE 4.4.2 and device feature 2.2.4, which can be downloaded from Infineon website.
   Link to download DAVE 4.4.2: Dave Download
3. Segger J-Link tool v6.00 or greater for flashing software on XMC.
   Link to download Segger: J-Link tool Download
   Link to download manual: J-Link manual Download

*Note: The path where DAVE tool is extracted is henceforth referred to as <DAVE_PATH> in the document.*

*Note: All the tools mentioned in the above list are intended to be used with the binaries or source code given in the release package.*

# 4 Using OPTIGA™ Trust Charge

## 4.1 Quick Setup

This section explains the steps to run OPTIGA™ Trust M example application.

### 4.1.1 Running OPTIGA™ Trust Charge Example Application

1. Make the connections among XMC4700 Relax Kit, My IoT Adapter and OPTIGA™ Trust Charge Shield2Go as shown below

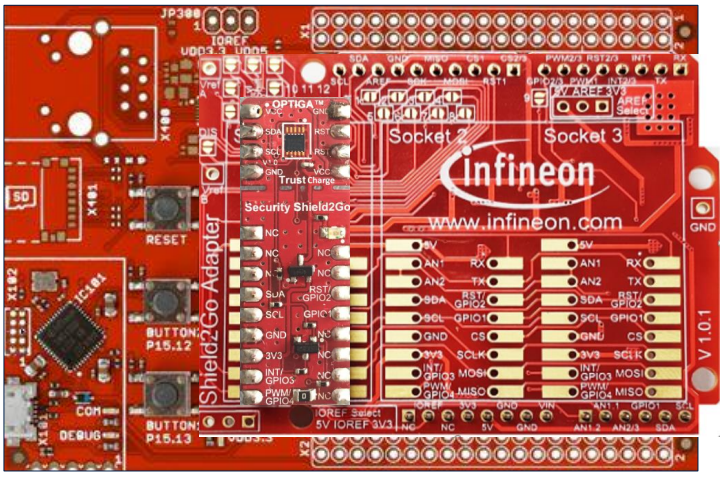



**Figure 6 XMC4700 Relax Kit, My IoT Adapter and OPTIGA™ Trust Charge Shield2Go connection**

2. Power up the kit by connecting Micro USB cable between PC and Debugger micro USB. For placement of Debugger micro USB refer Figure 3.
3. Download the OPTIGA™ Trust Charge example application using JFlashLite tool as described in section 4.1.2.1.

   Hex file location is <INSTALLDIR>\binaries\XMC4700_relax_kit\dave4\XMC4700_optiga_example.hex.
4. OPTIGA™ Trust Charge example application uses USBD_VCOM for logging, refer section 4.1.3 for logging details.

### 4.1.2 Steps to download example hex file to XMC4700 Relax Kit

#### 4.1.2.1 Using JFlashLite tool

1. Run JFlashLite.exe from JLink installation folder. It shows a notice window. Click OK.

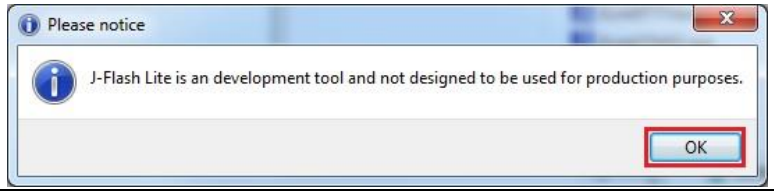



**Figure 7 JFlashLite launch window**

2. Click on Device to select a target device.

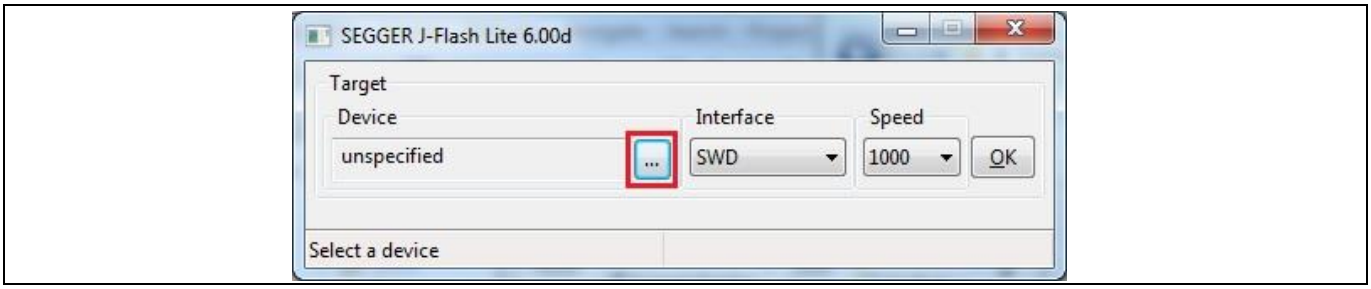



**Figure 8 JFlashLite select a device**

3. Select Infineon as Manufacturer and Device as XMC4700-2048, and then click OK.

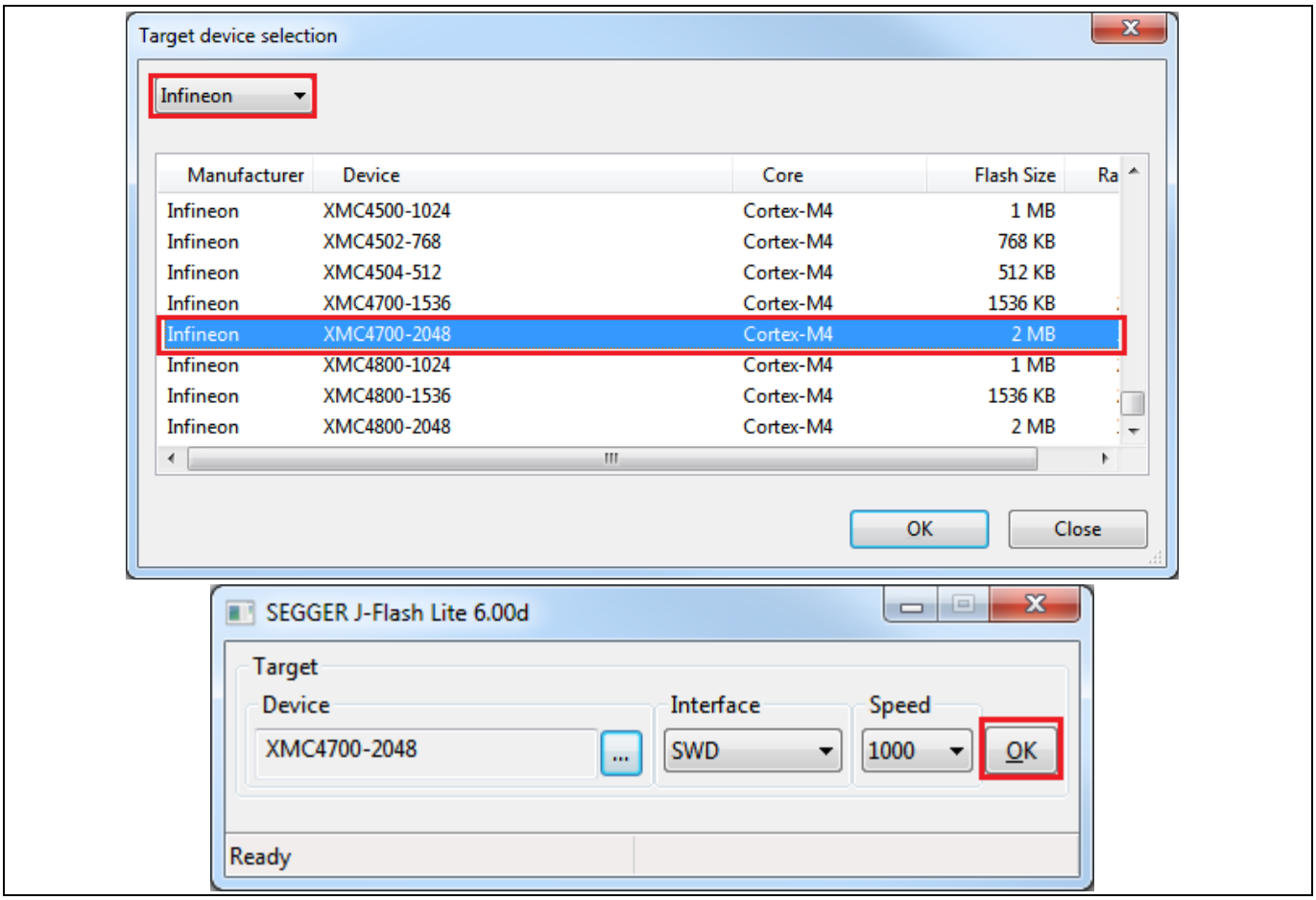



**Figure 9 JFlashLite Target device selection**

4. After target device selection, click OK on window shown in Figure 9.
5. Select hex file to be flashed under Data File and click on Program Device. It then shows the programming progress window.

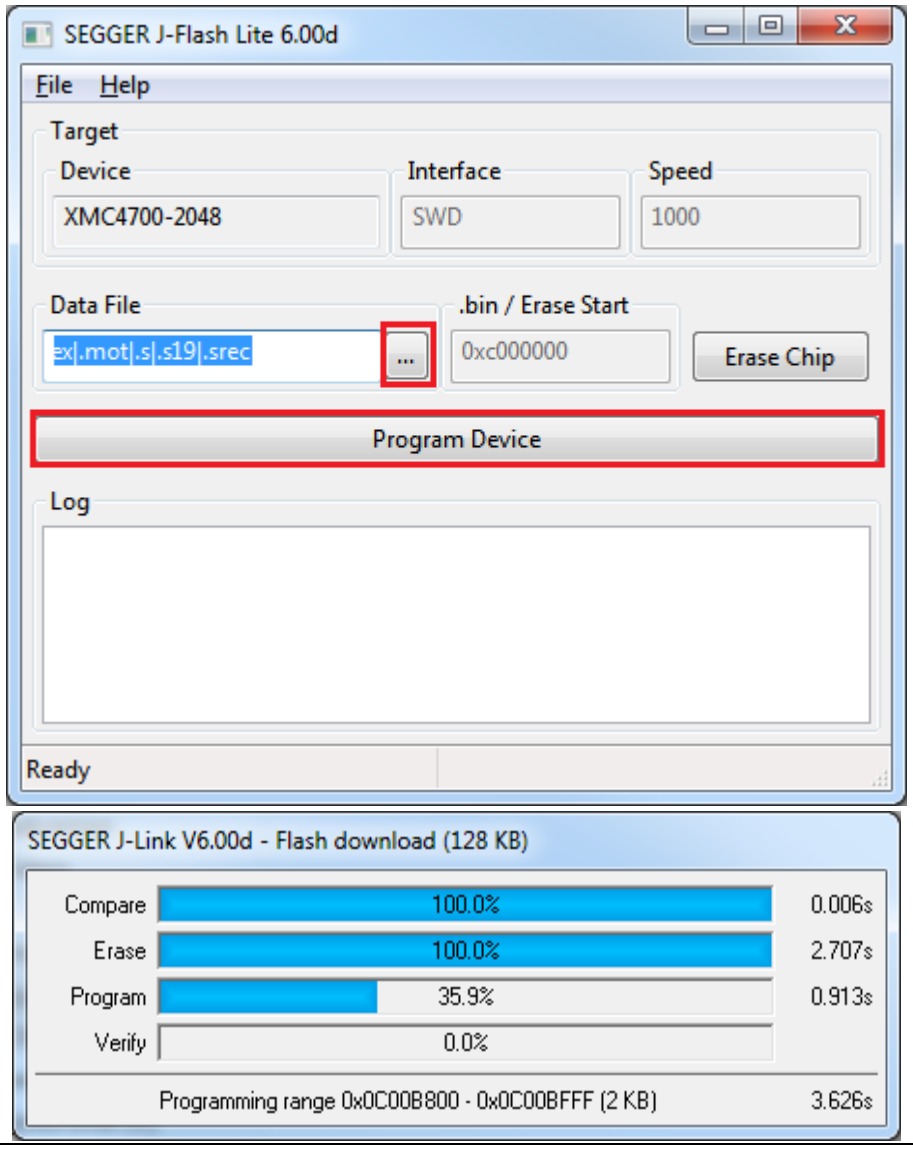



**Figure 10 JFlashLite Hex file selection and programming progress window**

6. Flash download completed.

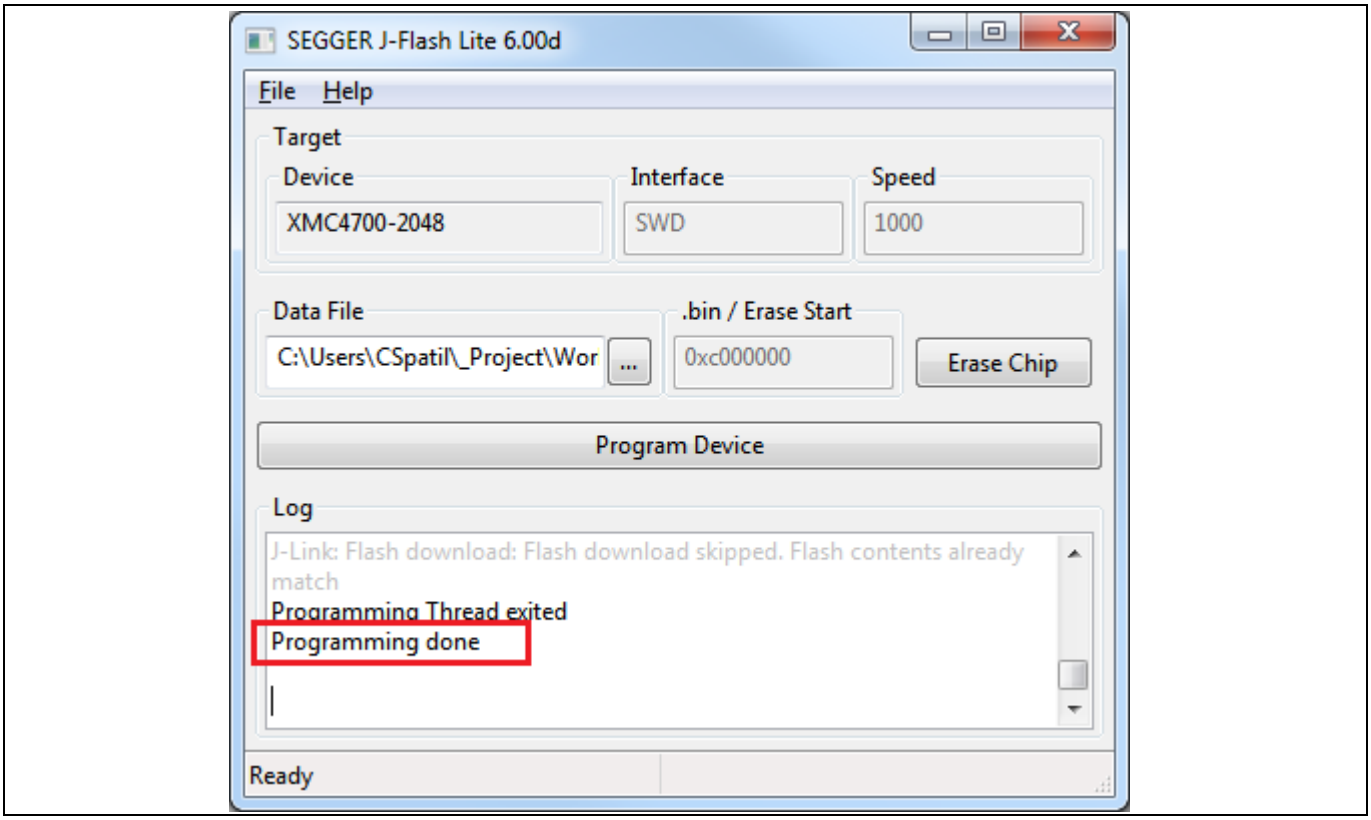



**Figure 11 JFlashLite programming completion window**

### 4.1.3 Logger

#### 4.1.3.1 Logger setup

1. Connect the micro USB cable between PC and micro USB. For placement of micro USB refer Figure 3.
2. Reset the XMC4700 by pressing the reset button.
3. Select the COM port with name “Communications Port” which gets detected after XMC4700 reset.

*Note: For binding the Windows serial driver(usbser.sys) with USBD_VCOM device user has to point to the driver.inf file in the folder path: <INSTALLDIR>\projects\XMC4700_relax_kit\common\Dave\Generated\USBD_VCOM\inf*

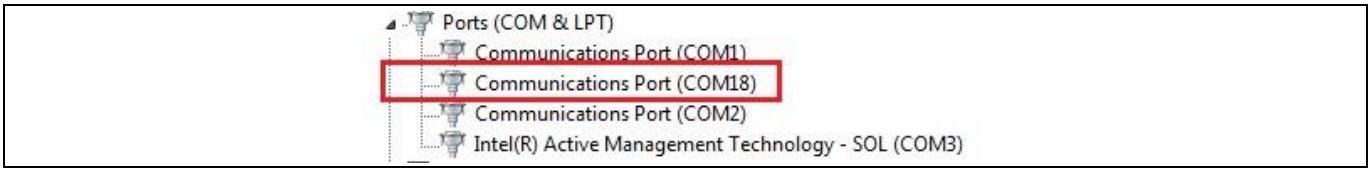



**Figure 12 Discovery of USB Serial Device COM port**

4. Configure COM port with 9600 8N1.

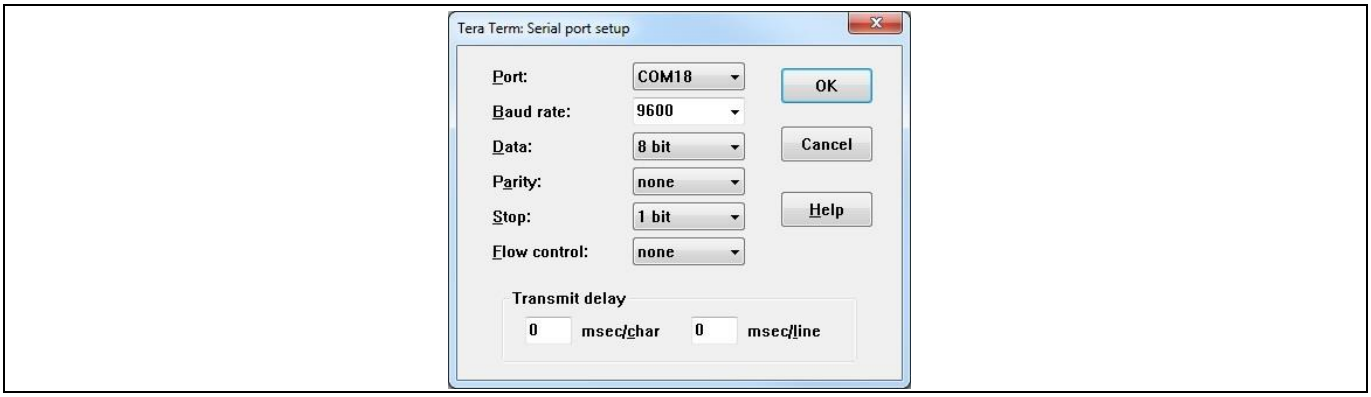



**Figure 13 TeraTerm terminal serial configuration**

5. Once connected, the terminal displays the text “Press any key to start optiga mini shell”.
6. It will list down the available optiga commands.

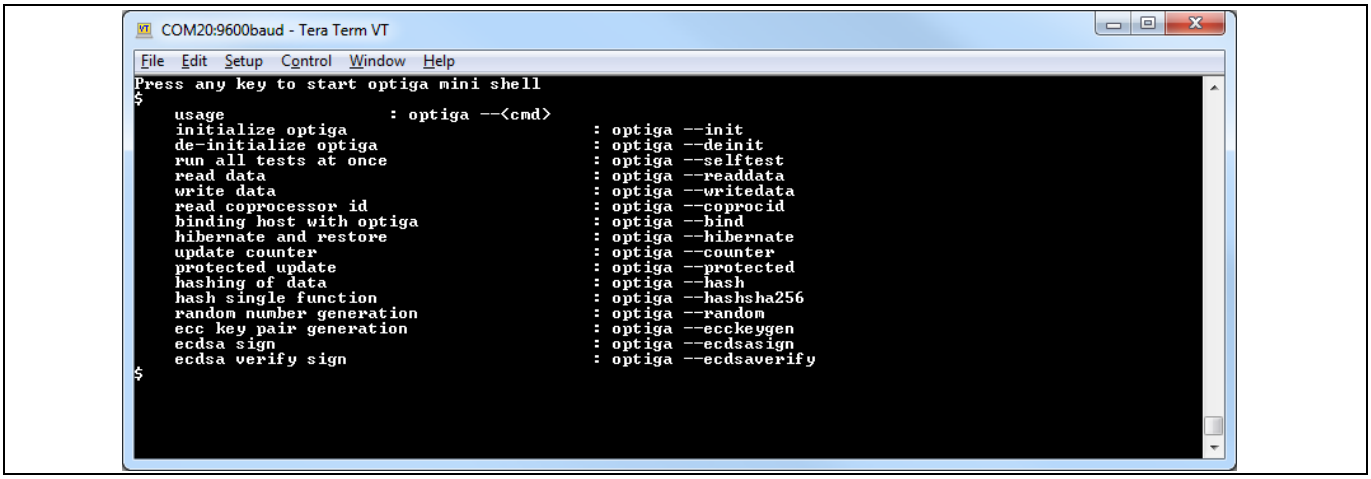



**Figure 14 TeraTerm log of example application**

7. Enter optiga command in format of “optiga --<cmd>”.

*Note: Execution of optiga --init is must before executing any other commands. Except for optiga --selftest command.*

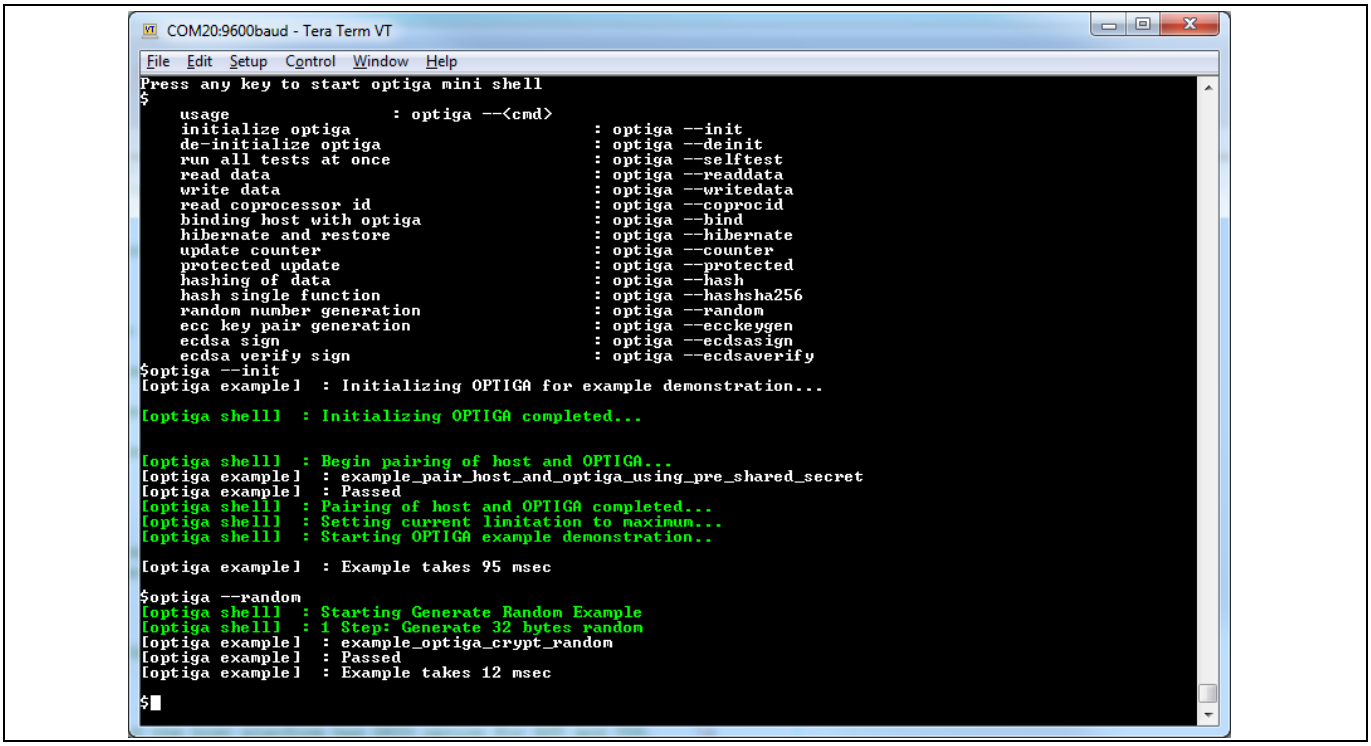



**Figure 15 Optiga random command execution using shell application**

8. The logs of the example execution are displayed along with status of each example as Passed or Failed.

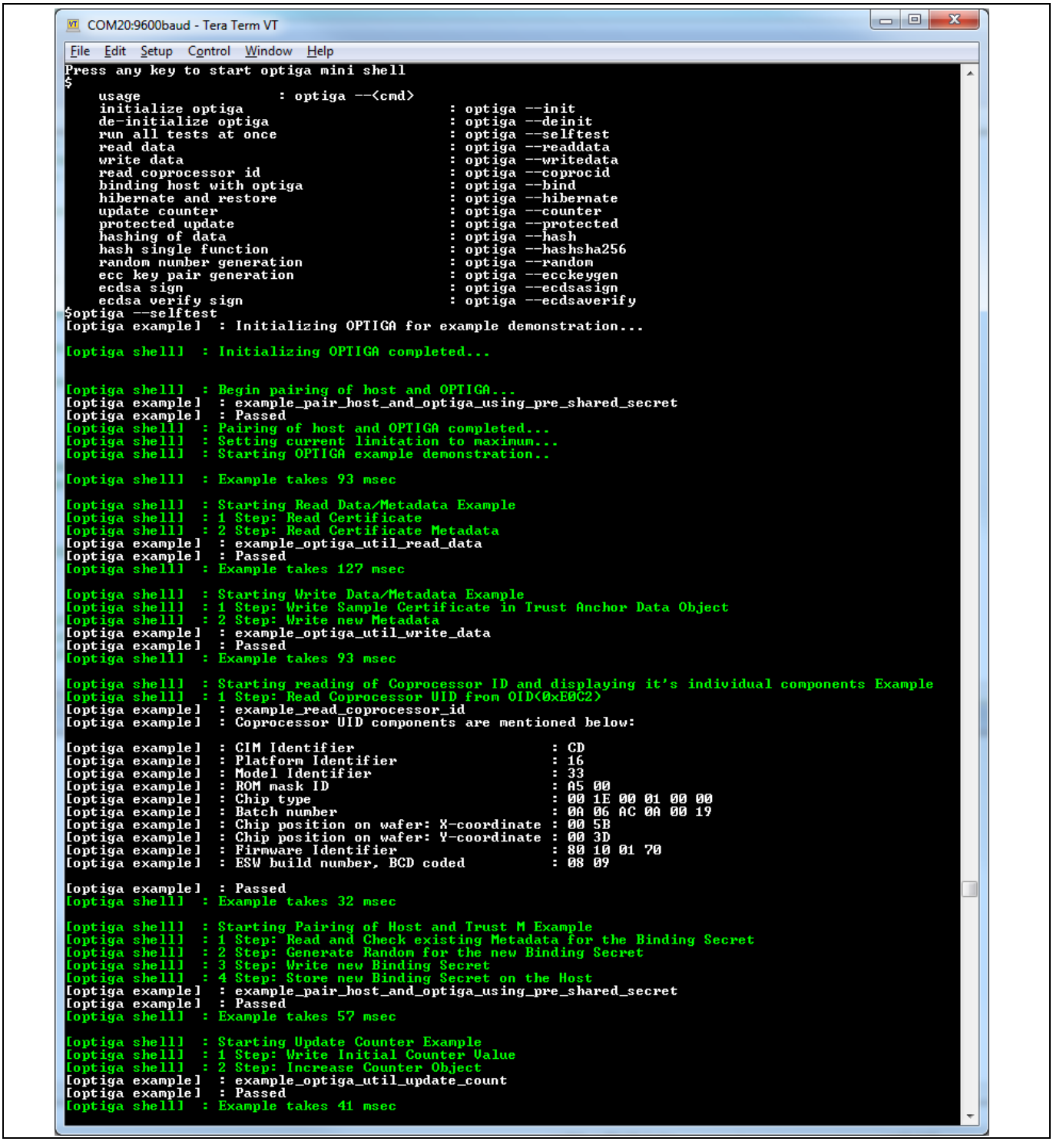



**Figure 16 TeraTerm log of example application**

### 4.1.3.2 Logger control

By default only logging from example is enabled in the release package.

Further control for OPTIGA™ Trust M host code logging is available in optiga_lib_config.h.

The macro OPTIGA_LIB_ENABLE_LOGGING provides complete control to enable/disable logging at host code. In addition, logging at UTIL, CRYPT, CMD and COMMS layer can be controlled using the following macros,

- OPTIGA_LIB_ENABLE_UTIL_LOGGING
- OPTIGA_LIB_ENABLE_CRYPT_LOGGING
- OPTIGA_LIB_ENABLE_CMD_LOGGING
- OPTIGA_LIB_ENABLE_COMMS_LOGGING

For Example,

1. To enable logging for only COMMS layer, enable OPTIGA_LIB_ENABLE_COMMS_LOGGING and disable rest all layer macros.
2. Build and run the project as described in section 4.1.1

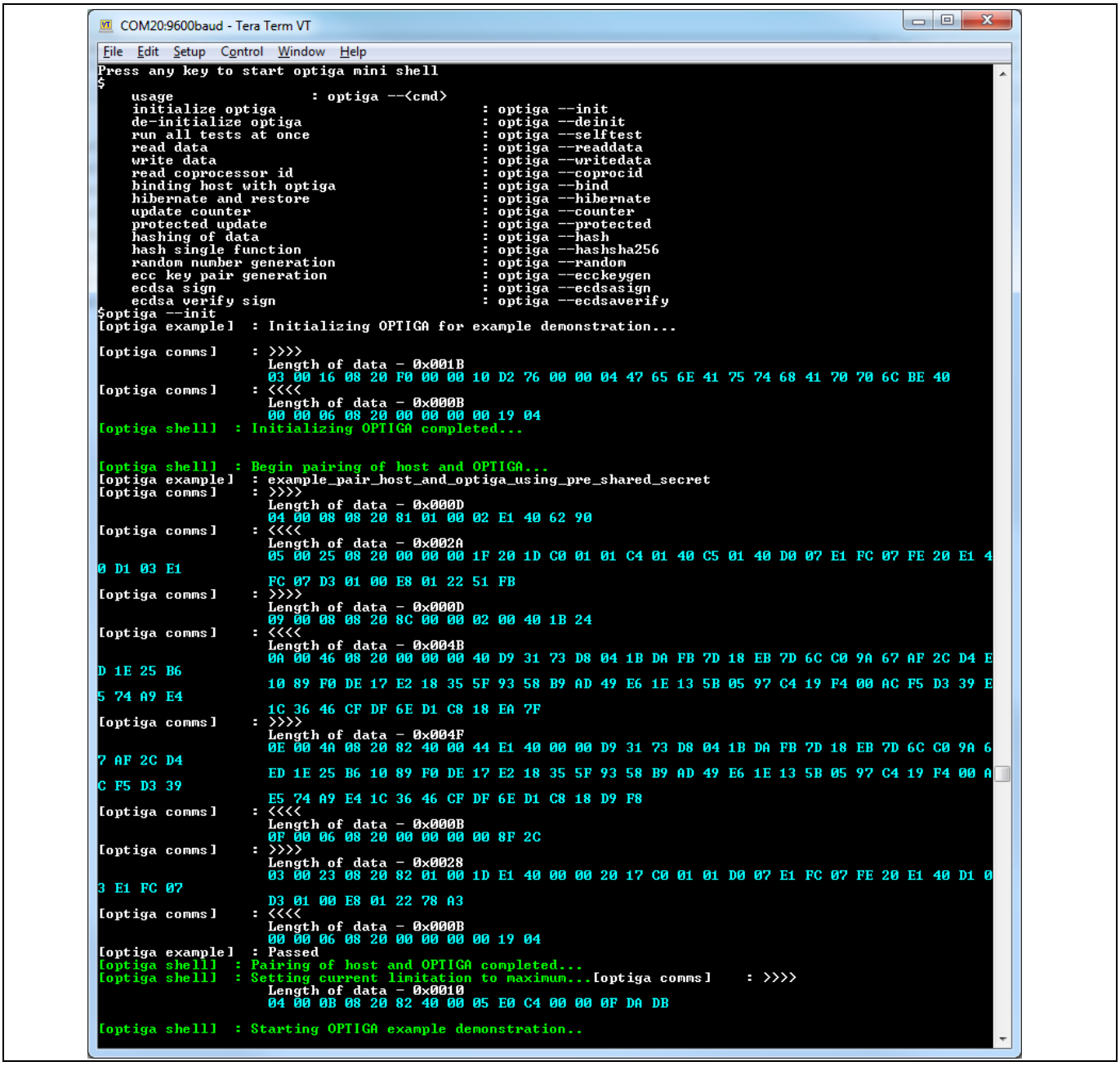



**Figure 17 Logging data with only COMMS layer enabled**

*Note: Execution time of example increase if more logging information is printed.*

## 4.2 Advanced Setup

This section explains the steps to build and run OPTIGA™ Trust Charge example application.

### 4.2.1 Setting up DAVE™ IDE on PC

1. Refer to the installation guide in <DAVE_PATH> to install DAVE™ on your PC.
2. Start DAVE™ from <DAVE_ PATH>\eclipse\DAVE.exe. The following splash screen will appear:

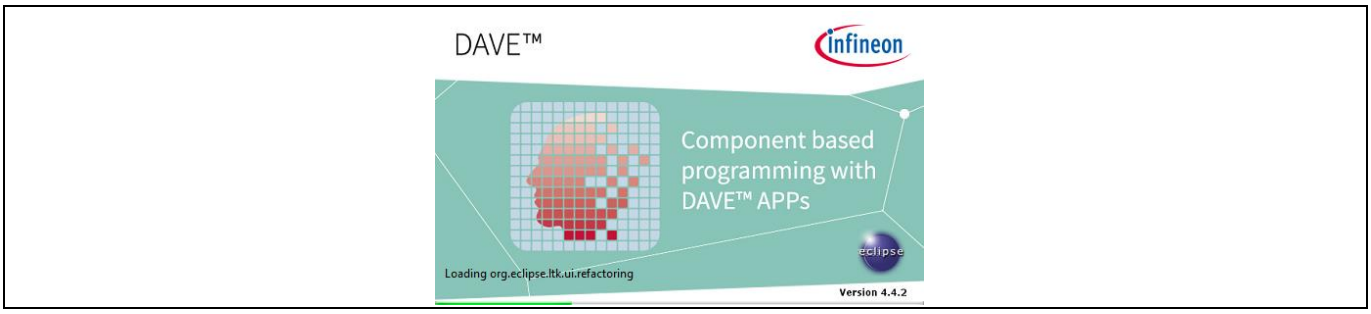



**Figure 18 Opening DAVE™**

3. Eclipse Launcher will pop-up. Select the workspace for DAVE™.

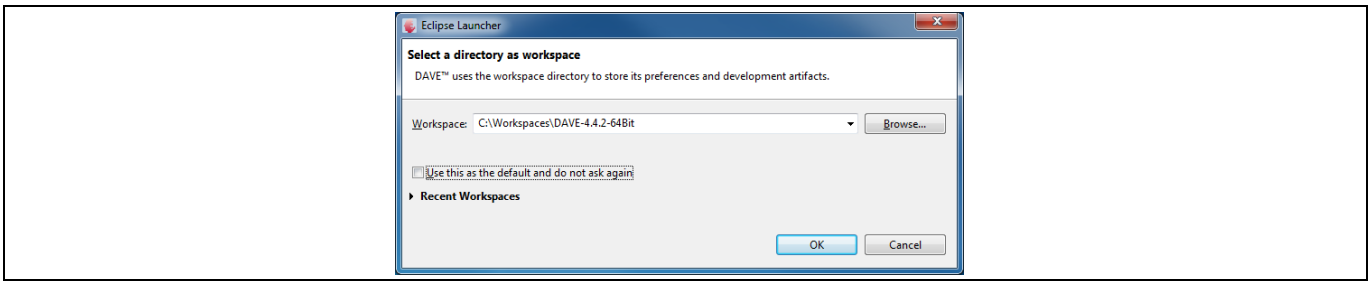



**Figure 19 Select workspace**

4. DAVE IDE enabled window.

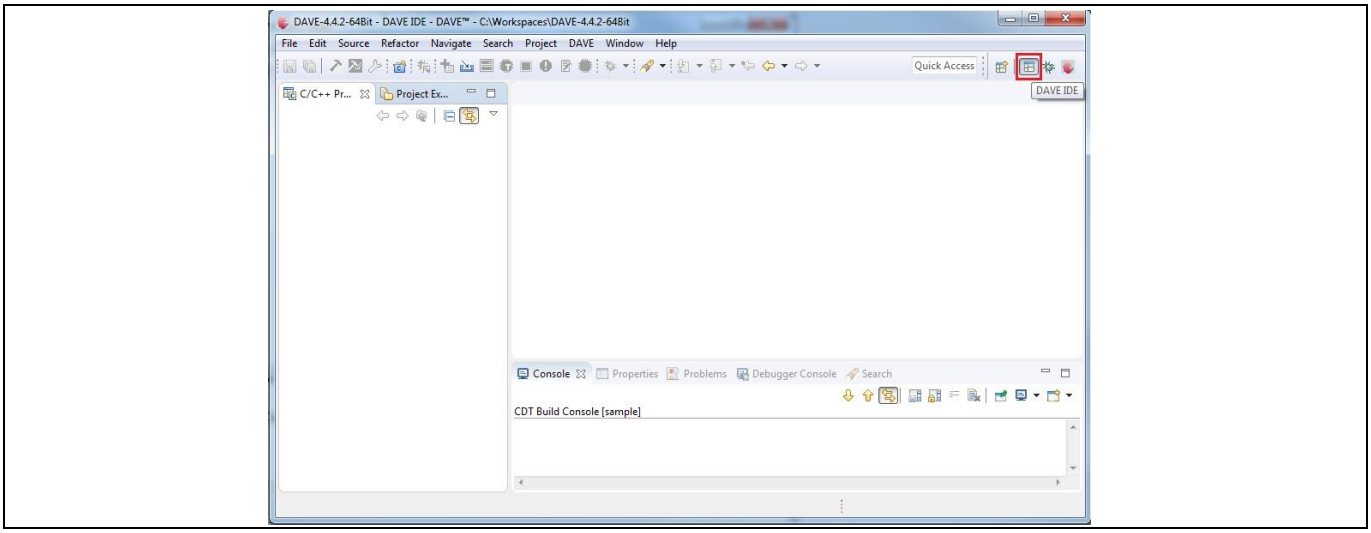



**Figure 20 DAVE IDE Perspective window**

### 4.2.2 Running OPTIGA™ Trust Charge Example Application Project with DAVE™

1. Make the connections among XMC4700 Relax Kit, My IoT Adapter and OPTIGA™ Shield2Go.
2. Power up the kit by connecting Micro USB cable between PC and Debugger micro USB. For placement of Debugger micro USB refer Figure 3.
3. Import example application project into DAVE IDE, by navigating through **File -> Import.** In Import pop-up, select Existing Projects into Workspace under General and then click **Next**.

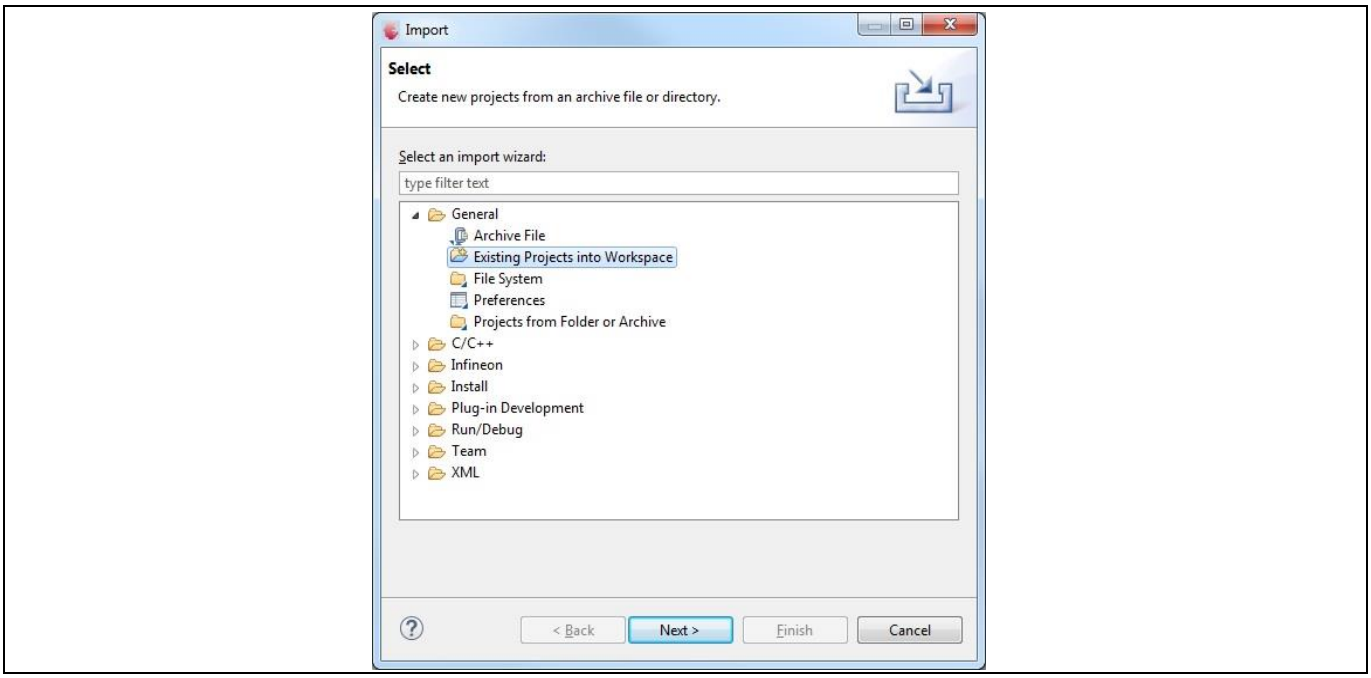



**Figure 21 Import DAVE project window**

4. Browse to <INSTALLDIR>\projects\XMC4700_relax_kit\dave4 for Select root directory, select XMC4700_optiga_example and then click Finish.

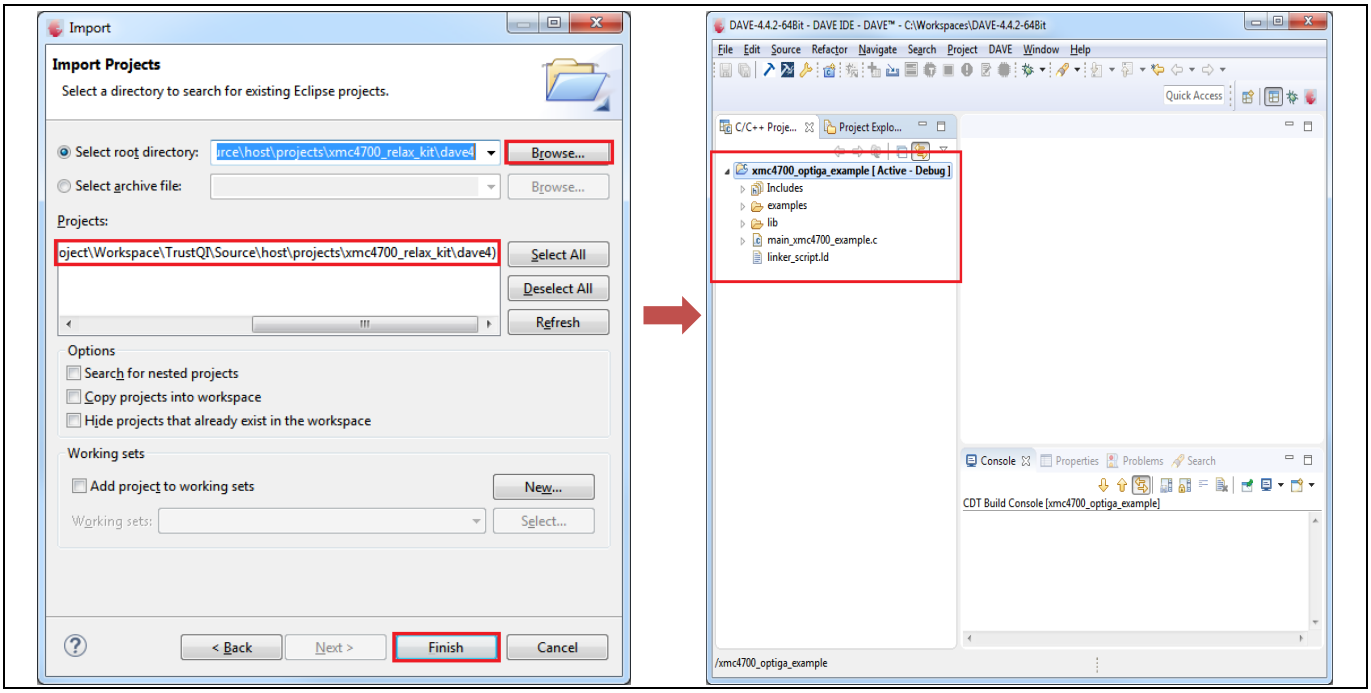


**Figure 22 Import a example project**

5. Set example project as an active project by right-click on project and select **Set Active Project**.

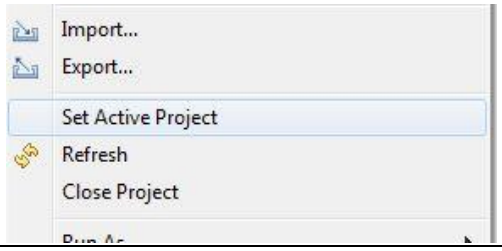



**Figure 23 Example project set as active project**

6. Select the build configuration by right-click on example project and then select **Build Configurations -> Set Active -> Debug.**

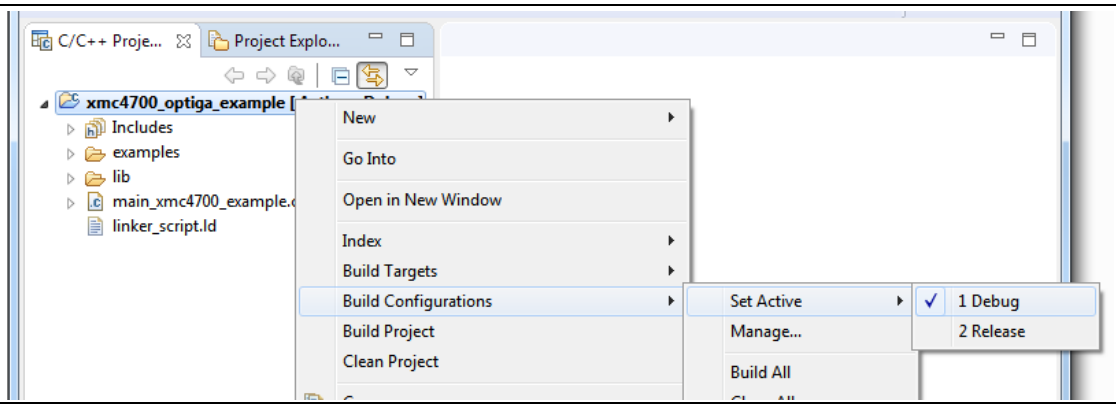



**Figure 24 Build configuration selection**

7. Build the project in debug configuration. It should be error free.

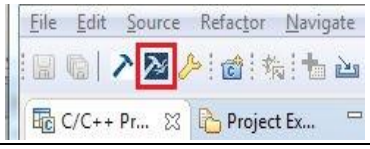



**Figure 25 Example build in debug**

8. Before launching the debugger, ensure that values are properly updated for variables like jlink_gdbserver and jlink_path. Navigate through **Window -> Preferences -> Run/Debug -> String Substitution** and update values as shown in the figure below:

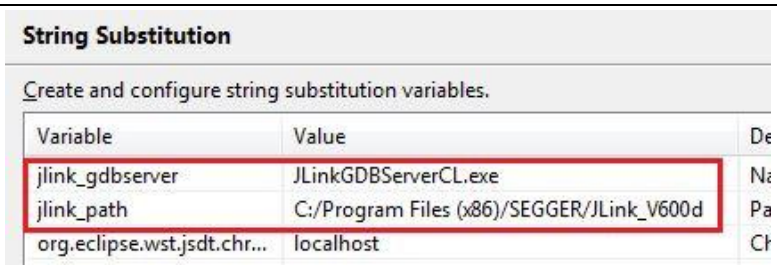



**Figure 26 J-Link variable mapping**

9. Launch debugger for debug of example application by clicking on bug symbol.

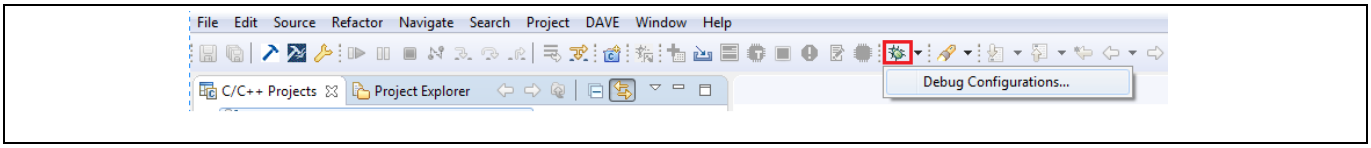



**Figure 27 Debugger launch**

10. Create a debug configuration and then click on Debug.

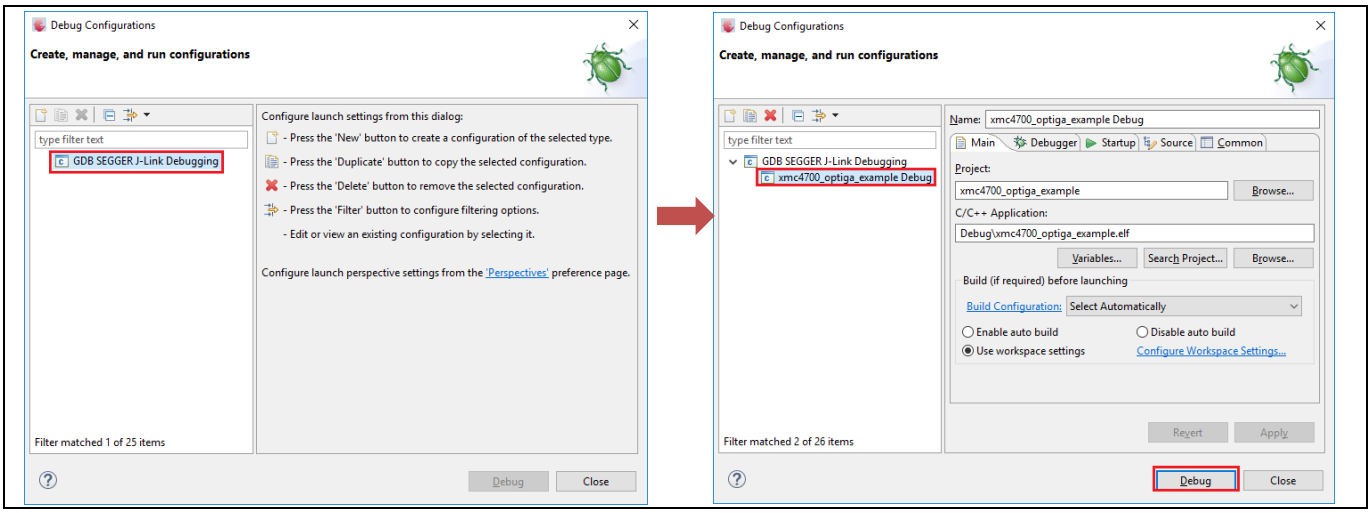



**Figure 28 Creating a example debug configuration**

11. If a window prompts to confirm the perspective switch, check the Remember my decision, and click yes.

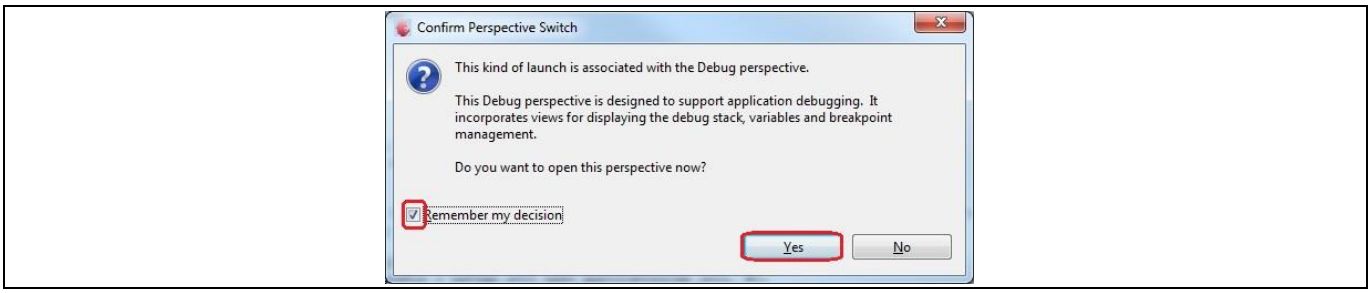



**Figure 29 Confirm perspective switch**

12. Start the debugger.

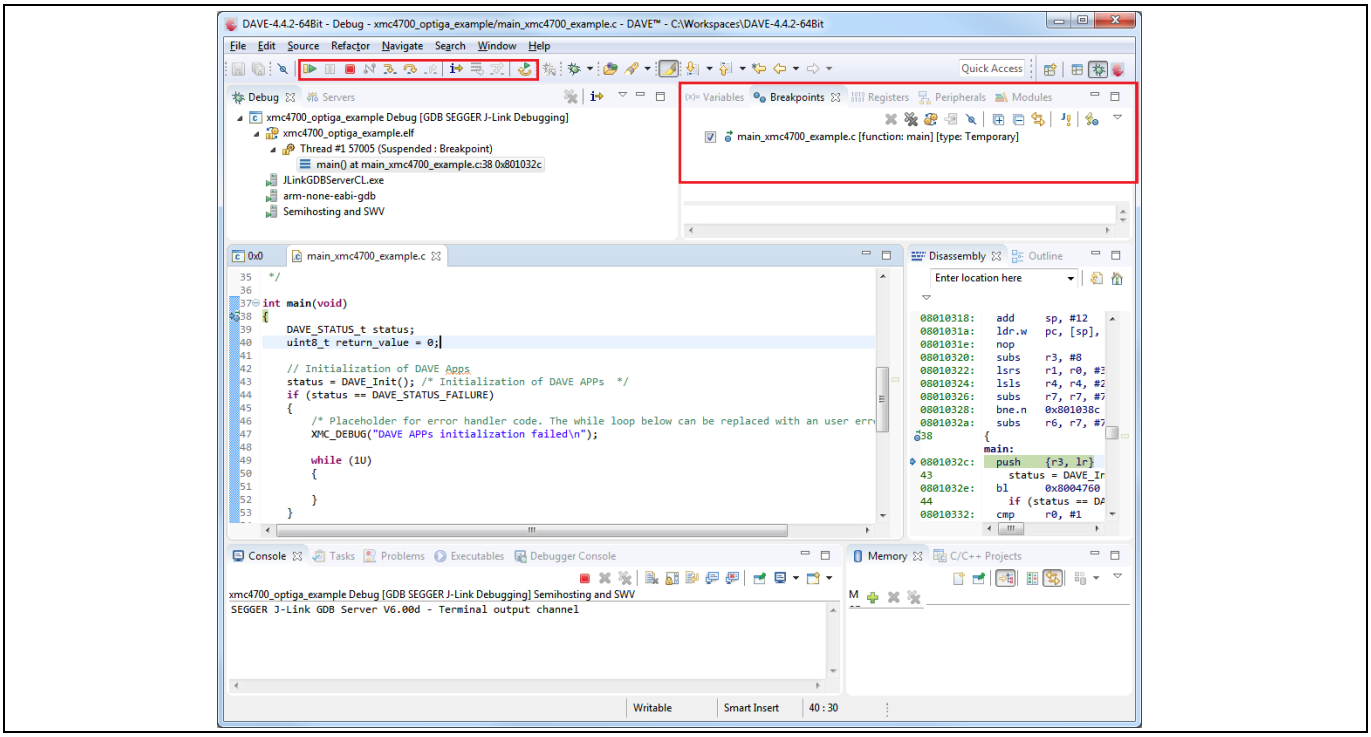



**Figure 30 Starting a debug session**

13. Refer section 4.1.3.1 to setup USBD_VCOM for logger.
14. Example logs can be seen on terminal as shown in Figure 14.
15. To build project in release configuration, select the build configuration as **Release** as shown in Figure 24 and build the project again.
16. Create a new configuration by right-click on example project and **Run As -> Run Configurations.** Double-click on GDB SEGGER J-Link Debugging and select Release configuration then click on Run. The logs of the executing example can be seen on the terminal as shown in Figure 14.

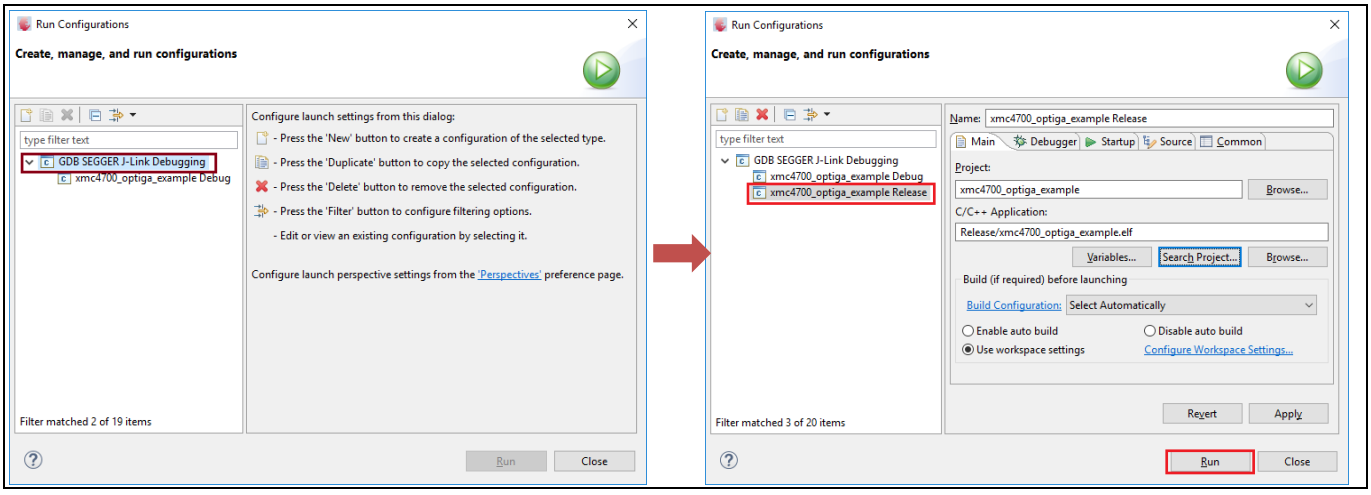



**Figure 31 Run example with release configuration**

17. To execute the example without shielded connection, disable the macro OPTIGA_COMMS_SHIELDED_CONNECTION in file optiga_lib_config.h.

```
/** @brief OPTIGA COMMS shielded connection feature.
 *         To disable the feature, undefine the macro
 *
 */
//#define OPTIGA_COMMS_SHIELDED_CONNECTION
```

**Figure 32 OPTIGA_COMMS_SHIELDED_CONNECTION disable**

18. To run example application with logging for different layers refer to section 4.1.3.2.

# 5 Troubleshooting

**Table 6 Troubleshooting**

| No | Problem | Reason | Solution |
|---|---|---|---|
| 1 | The Green LED light is “Not on” on XMC4700 Relax kit | No power supply | Verify that power supply is connected to XMC4700 Relax kit. |
| 2 | CDC port not detected | SW not correctly installed | In device manager, click on the malfunctioning CDC port and select to manually install the driver. Provide directory as C:\ for path to install the driver. |
| 3 | Problem occurred during debugger launch | Debug session is not terminated | Go to Debug perspective and remove all terminated launches. |

# Revision History

**Table 7**

| Document version | Date of release | Description of changes |
|---|---|---|
| 1.30 | 27-07-2020 | Engineering Sample Release |
| | | |
| | | |
| | | |
| | | |

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