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# **See3CAM\_CX3RDK**

## **Firmware Build Manual**

Revision 1.5  
25-June-2014



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## See3CAM\_CX3RDK\_e-CAM59CX3

### 1 Revision History

Rev No	Date	Major Changes	Author
Initial Draft	07-October-2013	Initial Draft	Shanthakumar
1.1	08-October-2013	Reviewed and modified	Subbarao
1.2	10-October-2013	Modified section 7	Shanthakumar
1.3	13-February-2014	Modified section 5.2	Shanthakumar
1.4	11-June-2014	Modified section 7	Shanthakumar
1.5	25-June-2014	Added Section 4.1 (Referring Cypress Application Note)	Shanthakumar



## 2 Introduction

Denebola (See3CAM\_CX3RDK) is a USB3.0 UVC Reference Design Kit (RDK) developed by e-con Systems using the EZ-USB® CX3 USB3.0 Peripheral controller from Cypress Semiconductors. The Cypress EZ-USB® CX3 is a USB 3.0 peripheral controller that enables developers to add USB 3.0 connectivity to any image sensors compliant with Mobile Industry Processor Interface (MIPI) Camera Serial Interface Type 2 (CSI-2) standard. The Denebola Reference Design Kit developed using EZ-USB® CX3 is a complete Reference Design Kit and has OmniVision OV5640 CMOS image sensor interfaced to it through 2-lane MIPI CSI-2 interface. This is a fully functional camera reference design kit that can stream uncompressed 720p60, 1080p30 and full 5MP@15fps. e-con Systems, a Silver level partner of Cypress Partner program, has developed the reference design kit for EZ-USB® CX3 from Cypress Semiconductors and this kit can be purchased directly from our web store.

Based on the proven EZ-USB FX3 Platform, CX3 comes with an ARM9 CPU and 512KB SRAM that provides 200 MIPS of computational power. The CX3 supports MIPI CSI-2 version 1.01, up to 4 data lanes with data speed up to 1Gbps per lane, for a total bandwidth of 4 Gbps. CX3 is ideally suited for high-definition or high-speed image-capturing applications. CX3 supports multiple peripheral interfaces such as I2C, SPI, and UART, which can be programmed to support Pan, Tilt and Zoom or other camera control functions.

Denebola RDK is a two-board solution containing base board designed around Cypress CX3 USB3.0 Peripheral controller and the Camera daughter board (part number: e-CAM59CX3) designed using OmniVision OV5640 CMOS image sensor based Autofocus camera module. e-con also plans to support multiple camera sensor daughter boards in the future that can be used to evaluate CX3 performance and also other CMOS Image sensors.

See3CAM\_CX3RDK with e-CAM59CX3 is a UVC compliant device and does not require any drivers to be installed on the PC. The native UVC drivers of Windows and MAC Operating Systems shall be compatible with this camera. E-con also provides the sample application that demonstrates some of the features of this camera. However, this camera can be utilized any DirectShow application such as Skype etc.

## 3 Scope

e-con Systems provide the complete firmware source code that is running on CX3 performing a full-featured USB Video Class (UVC) camera functionality. The 5MP Autofocus camera is exposed as a UVC device to the PC and the exposes some of the common UVC controls. This UVC stack firmware is provided to the customers in source code form allowing customers to extend the features or use the same as the base to develop their own UVC cameras. The scope of this document is to explain about how to build the firmware source code provided by e-con Systems as part of the Denebola RDK.

## 4 Pre-Requisites

It is assumed that the user is familiar with USB firmware and USB protocol, specifically the Video Class. It is also assumed that the customer is familiar with the UVC device enumeration, DirectShow framework (or V4L2 frame work in case of Linux) and how to use DirectShow framework to develop applications.



It is assumed that the user has hands-on experience with Cypress EZ-USB FX3 SDK and has developed applications using Cypress FX3 SDK on Eclipse Integrated Development Environment (Eclipse IDE).

## 4.1 Firmware Design

This document does not provide detailed design flow of the UVC firmware as this firmware flow is same as the example UVC project provided by Cypress in the FX3 SDK. Please refer the Cypress Application Note “[AN90369 - How to Interface a MIPI CSI-2 Image Sensor With EZ-USB® CX3](#)” which explains the firmware flow of the example project provided in the SDK. This firmware flow for this example project provided by e-con Systems is also same as the cypress example project and the Cypress Application Note can be used as reference to understand the firmware design.

## 5 Description

The See3CAM\_CX3RDK with e-CAM59CX3 is a USB 3.0 device capable of streaming camera frames VGA @ 60 fps, 720p @ 60 fps, 1080p @ 30 fps and 5MP @ 15 fps when connected to USB3.0 host port by leveraging the full throughput of USB3.0. In USB3.0, the UVC implementation is through BULK transport.

Supported Preview format:

- YUV2

Supported Preview resolutions:

- VGA @60 fps
- 720p @ 60 fps.
- 1080p @ 30 fps.
- 5MP @ 15fps

Supported still image formats:

- YUV2

Supported still image resolutions:

- 5MP

### 5.1 UVC Controls

The See3CAM\_CX3RDK with e-CAM59CX3 has the following UVC Camera controls:

- Brightness
- Contrast
- Hue
- Saturation
- Sharpness
- White Balance (Manual and Automatic)
- Exposure (Manual and Automatic)
- Focus (Manual and Automatic)



Source code provided for See3CAM\_CX3RDK\_e-CAM59CX3, implements all the above mentioned features. Camera settings are given as library which is need to be linked to the source code and need to call the required function to configure the camera as per the requirement.

## 5.2 USB2.0 Support

It also supports all the features with a USB 2.0 interface when connected to a USB2.0 High Speed host port. However, in USB 2.0, See3CAM\_CX3RDK with e-CAM59CX3 can stream only in VGA resolution and at about 30 fps only. In USB2.0, the UVC implementation is through BULK transport.

Supported Preview format:

- YUV2.

Supported Preview resolutions:

- VGA @30 fps.

## 6 FX3 SDK

Since CX3 is based on EZ-USB FX3 Platform, the same FX3 SDK (version 1.3 or later) can be used for CX3 also and FX3 SDK will be provided by Cypress and it can be downloaded from Cypress website. Please note that SDK version 1.3 or later should be installed to work with CX3.

### 6.1 Downloading & Installing FX3 SDK

FX3 SDK can be downloaded from the Cypress website.

Please check the following link: <http://www.cypress.com/?rID=57990>

In the above link FX3 SDK is available for both Windows and Linux operating systems. In this section installation process is explained for Windows operating system.

To download the SDK for windows operating system, Click on “EZ-USB FX3 SDK v1.3 for windows”.

Please note that, to download the SDK user should register and log in with Cypress.

To install the downloaded SDK run the exe file, then the following window will appear on the screen. Do the following things to complete the installation successfully.

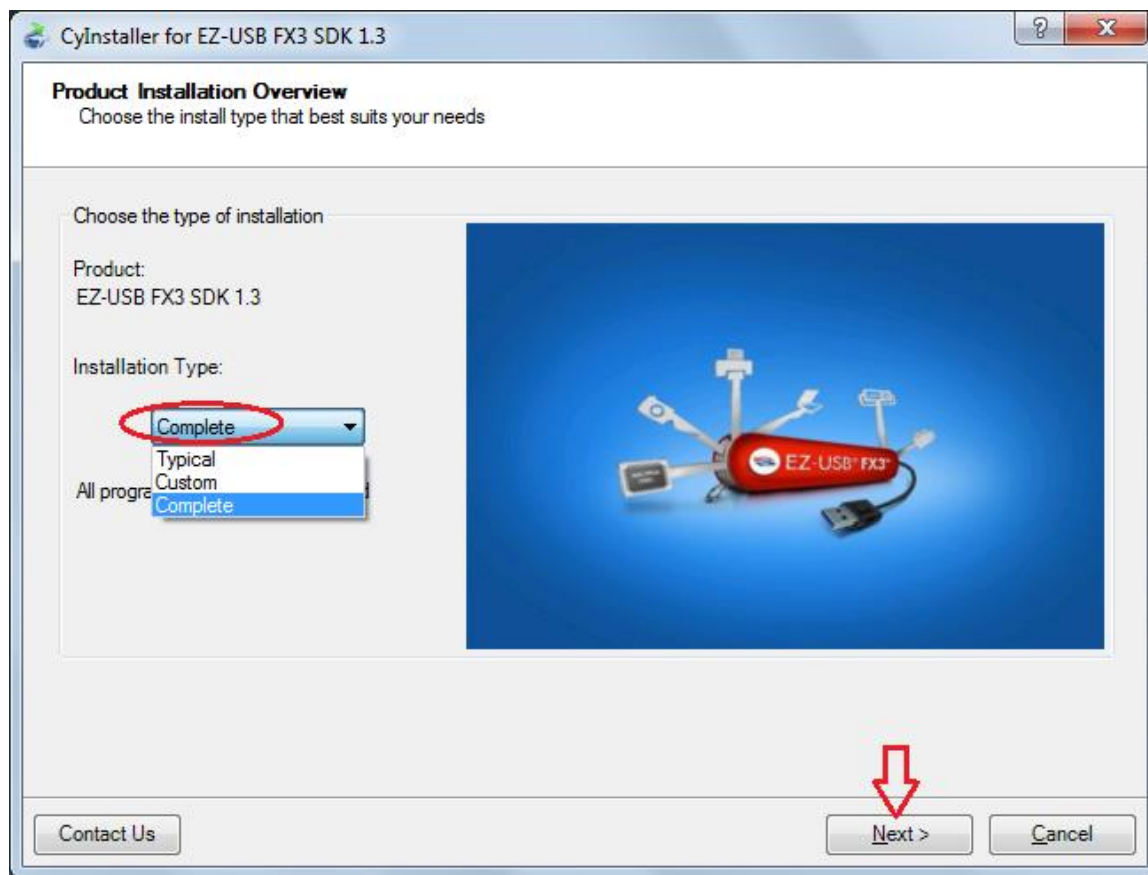




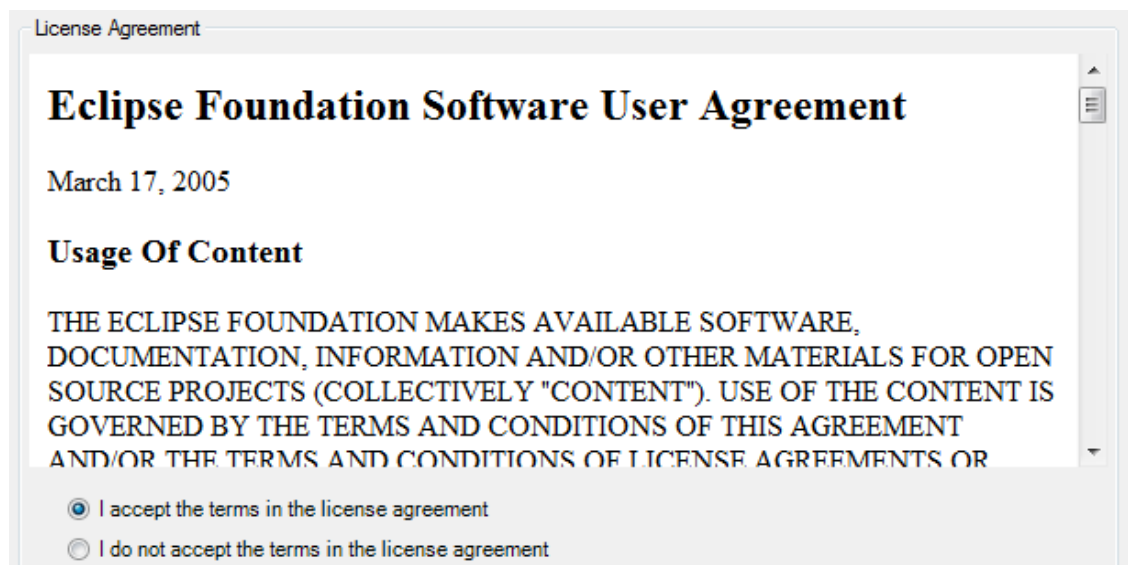
By default SDK will be installed to the following path "C:\Program Files\Cypress". This document assumes that the user has chosen to install the SDK at the default location "C:\Program Files\Cypress".

In the next window change the Installation type to "Complete" and click "Next". So it will install all the components (see the section 5.2) of FX3 SDK. It is highly recommended to choose the installation type as "Complete".



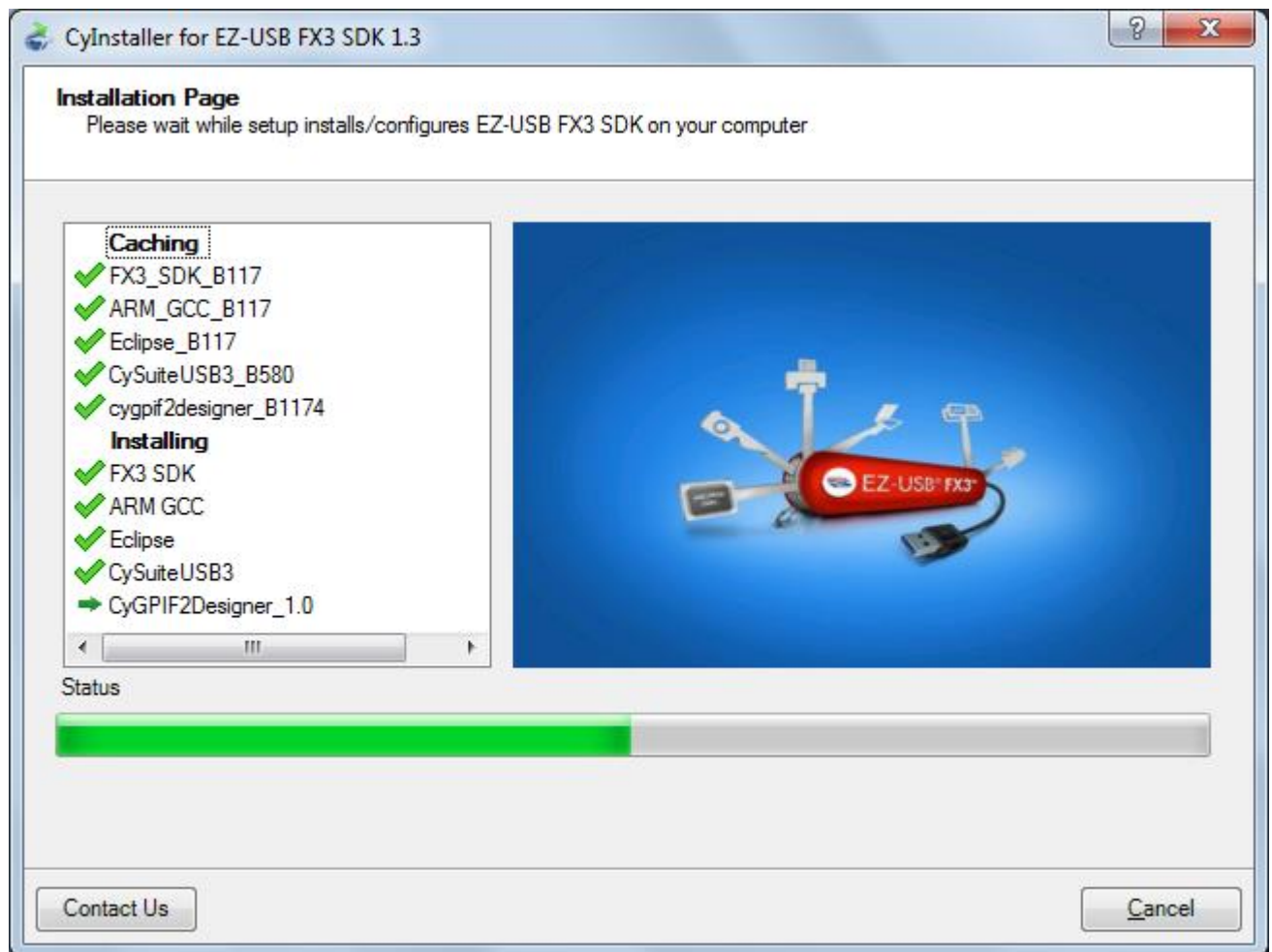


Click I accept the terms in the license agreement in all the following windows. For every component "License Agreement" window will be appeared.





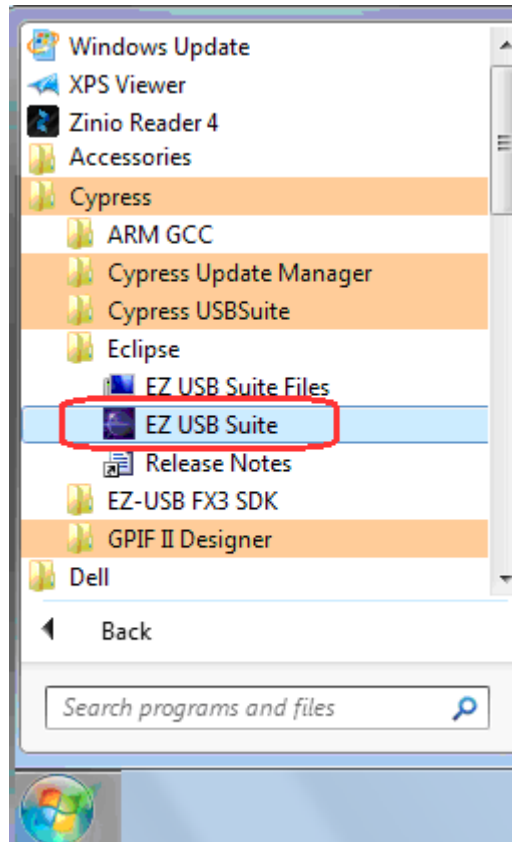
Installation progress of the components will be shown in the following window.



After installation of all the components is finished the below window will appear, Click the Finish button.



User can access the FX3 SDK components from “Start Menu -> All Programs -> Cypress”



## 6.2 Components of SDK installation

The following are the software components that will be installed during the SDK installation, when you choose “Complete” installation option.

1. FX3 Firmware – This contains the FX3 Firmware libraries, Header files, Example Code and firmware conversion utility.
2. ARM GCC – This contains the GNU Toolchain for ARM processors.
3. Eclipse – The eclipse IDE with the required plug-ins.
4. USB Suite – the windows host driver, C++ & C# API libraries, and the Control center, Bulkloop and Streamer applications.
5. GPIF II Designer – Windows based tool for configuring the GPIF II port of the FX3 device.

Note: To know in detail about the above components, please refer the documents which are installed during SDK installation.



## 6.3 How to build and test SDK example firmware

Building and Testing the SDK examples are explained in “FX3 Programmers Manual.pdf” at Section: 12.2.2 Eclipse Projects.

## 7 See3CAM\_CX3RDK\_e-CAM59CX3 Project package

The See3CAM\_CX3RDK\_e-CAM59CX3 Source project package can be downloaded from the e-con Systems website. Please use the following link to download.

Link: <http://www.e-consystems.com/CX3-Reference-Design-Kit.asp>

See3CAM\_CX3RDK\_e-CAM59CX3 Source project package contains the below two folders.

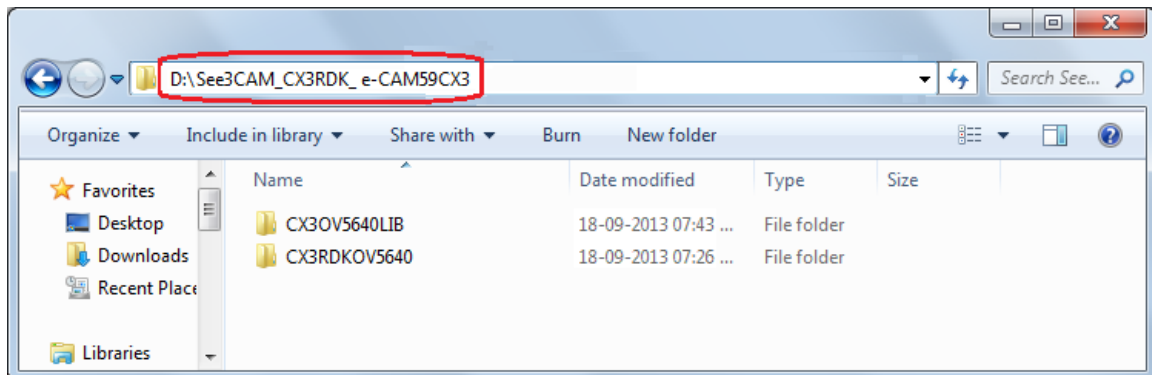
- CX3RDKOV5640 – This folder contains the source code of the UVC device side implementation. This also contains the USB descriptor initialization for UVC.
- CX3OV5640LIB – This folder contains the sensor specific library files and header files. The OV5640 sensor register settings for sensor initialization, video preview initialization, UVC controls/configuration etc are all included in this folder as library files. The library files are available for “Debug” and “Release” formats. In the example firmware file, these libraries and header files are already linked with project source.

Note: To get the Source code of the sensor library, please contact [sales@e-consystems.com](mailto:sales@e-consystems.com).

### 7.1 How to build the See3CAM\_CX3RDK\_e-CAM59CX3

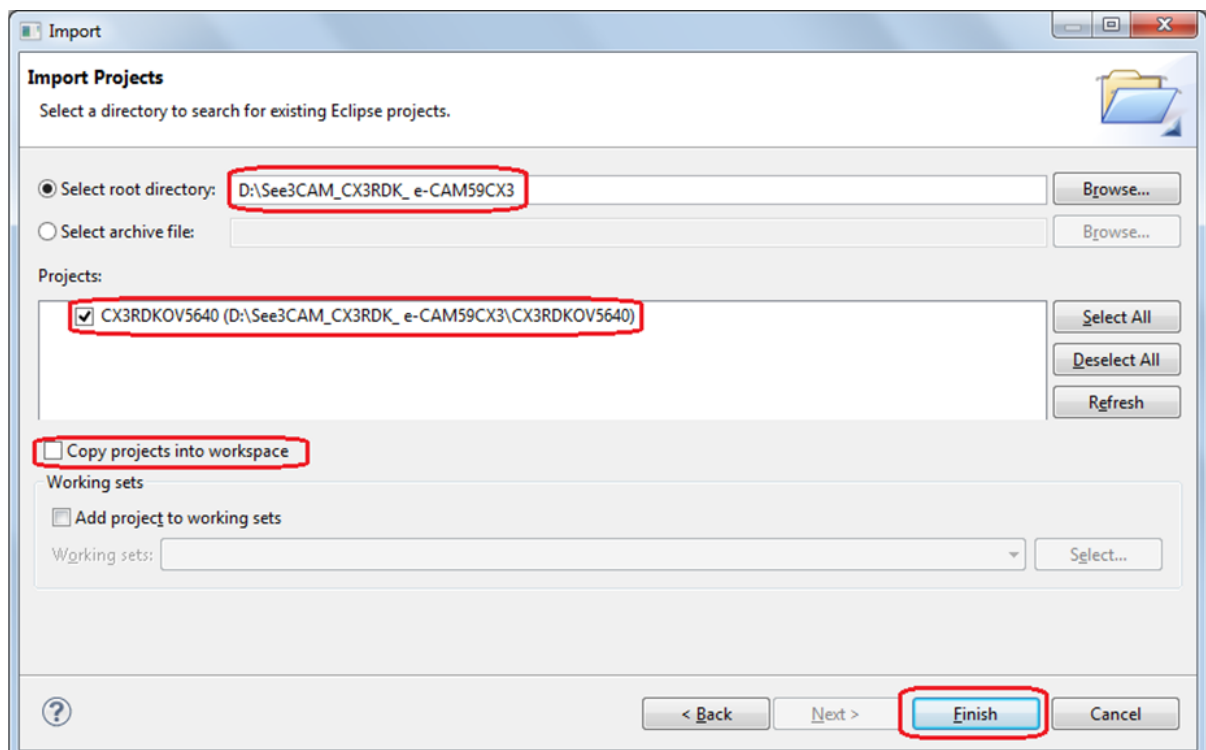
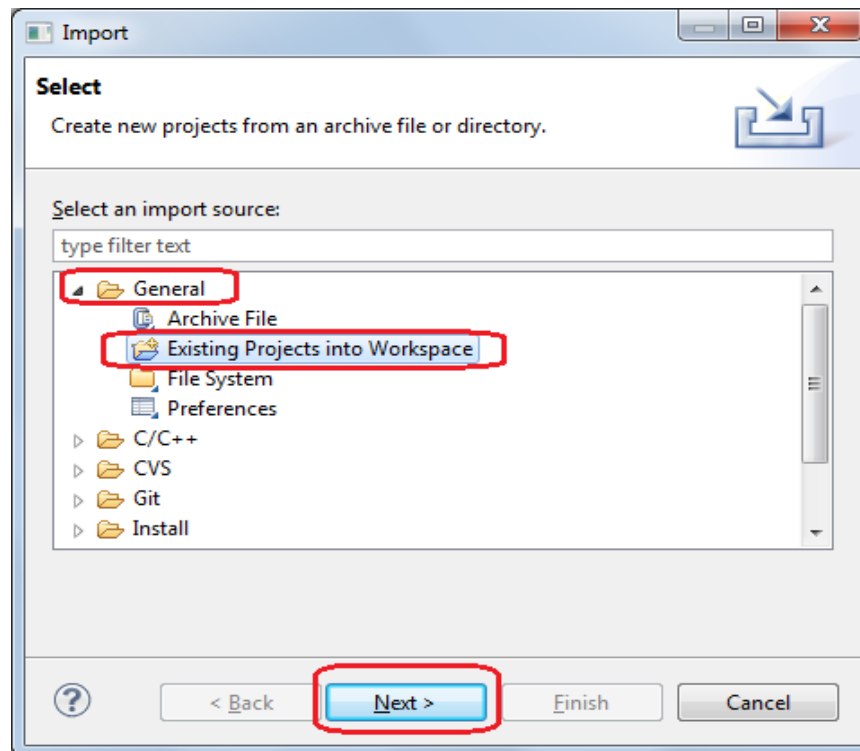
Please follow the below procedure to build the See3CAM\_CX3RDK\_e-CAM59CX3.

1. Copy the See3CAM\_CX3RDK\_e-CAM59CX3 folder into following path “D:\See3CAM\_CX3RDK\_e-CAM59CX3” or any user specified path.



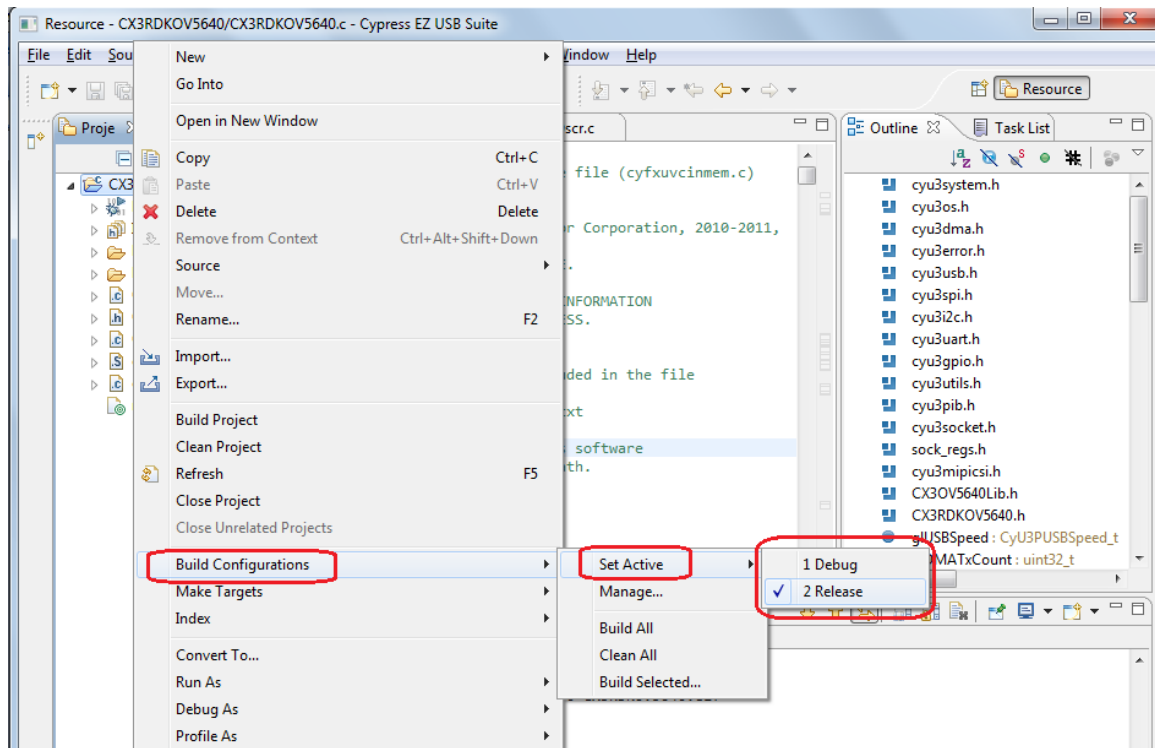
2. Open Eclipse, create a new workspace or you can use the existing workspace.
3. Import the project under “General-> Existing Projects into Workspace”, browse the project path and select the project.



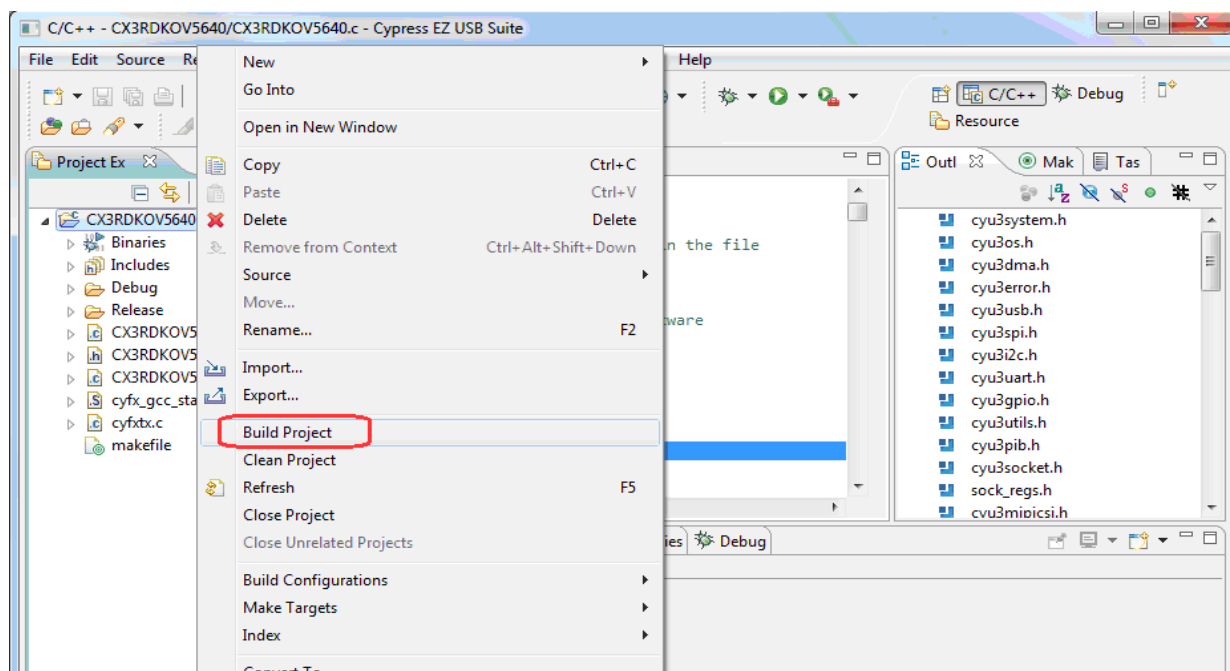


4. To select the required Build configuration right click on project, "Build Configuration->Set Active-> then select either "Debug" or "Release".





5. Click "Build project"



The project will be built and the corresponding firmware binary files will be created in the respective folders.

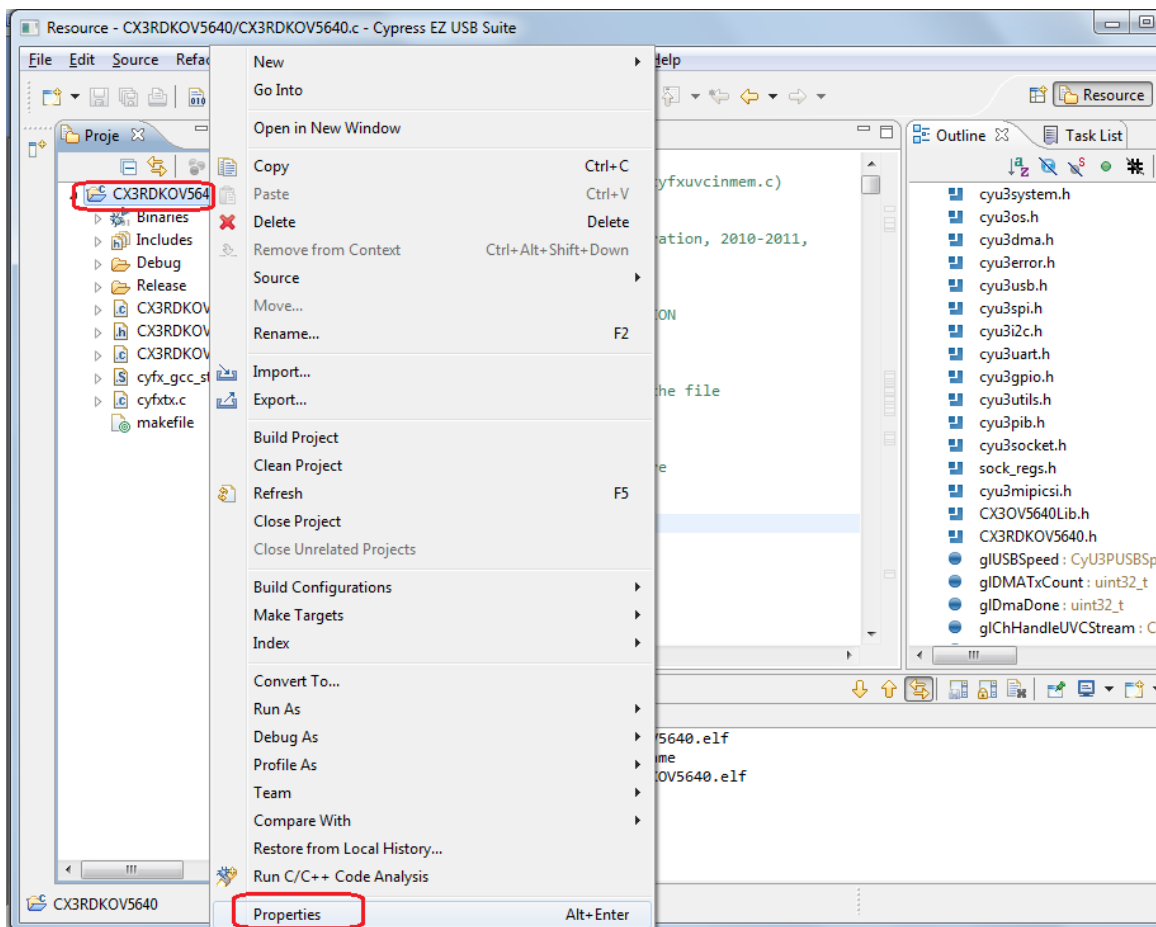


- Debug mode binary will be located in “D:\See3CAM\_CX3RDK\_e-CAM59CX3\CX3RDKOV5640\Debug\CX3RDKOV5640.img”.
- Release mode binary will be located in “D:\See3CAM\_CX3RDK\_e-CAM59CX3\CX3RDKOV5640\Release\CX3RDKOV5640.img”.

### 7.1.1 Project Properties

This section explains about the project properties, especially the linking of sensor specific libraries and header files.

The project properties can be accessed by Right Clicking the Project and select the “Properties”.



After selected the properties the following window will be opened. In that the user can modify the project properties & link the sensor related libraries & header files to the project.



## 7.1.2 Including Sensor Header file

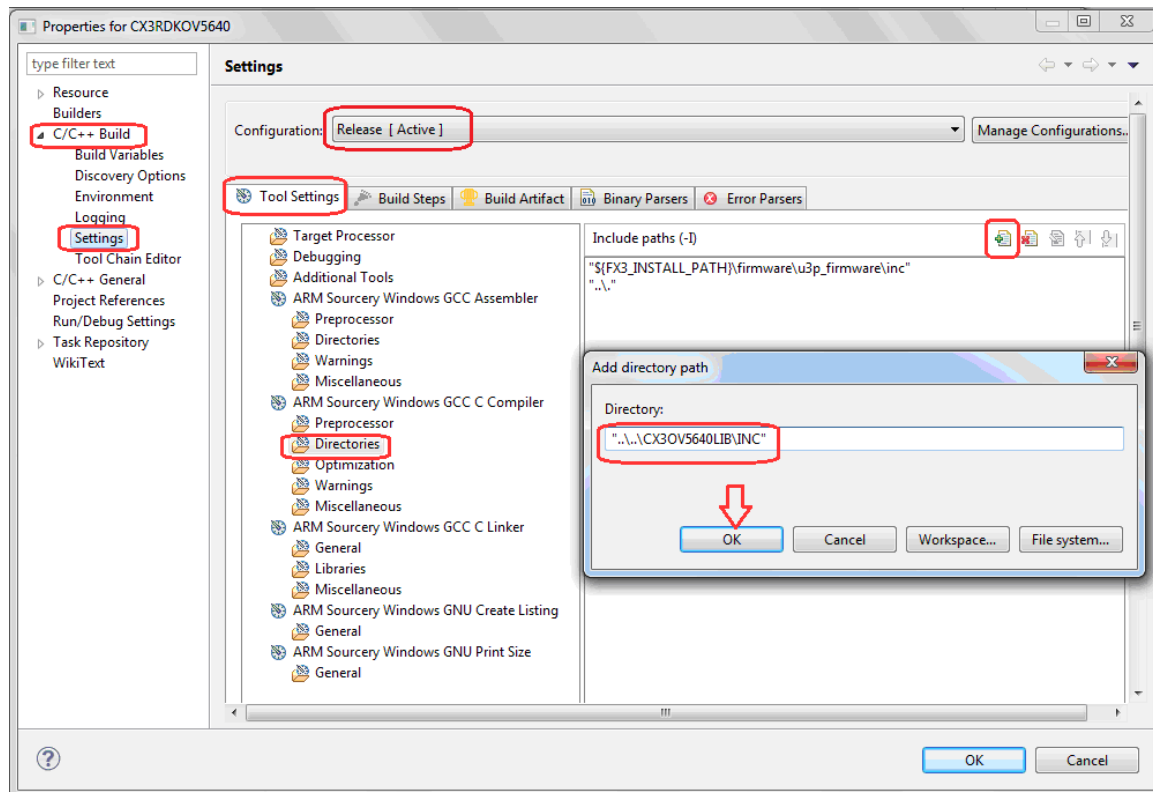
The user should include the sensor header file to access the sensor APIs in the source project

To include the header file directory in the project properties. Select “C/C++ Build -> Settings -> Tool Settings -> ARM Sourcery Windows GCC C Compiler -> Directories -> Add Button”

The Add directory path window will be opened, in that add the path of the header file as shown “..\..\CX3OV5640LIB\INC” & Click “OK”

Then the Directory will be added to the project. The same process should be repeated for “Debug” configuration also.

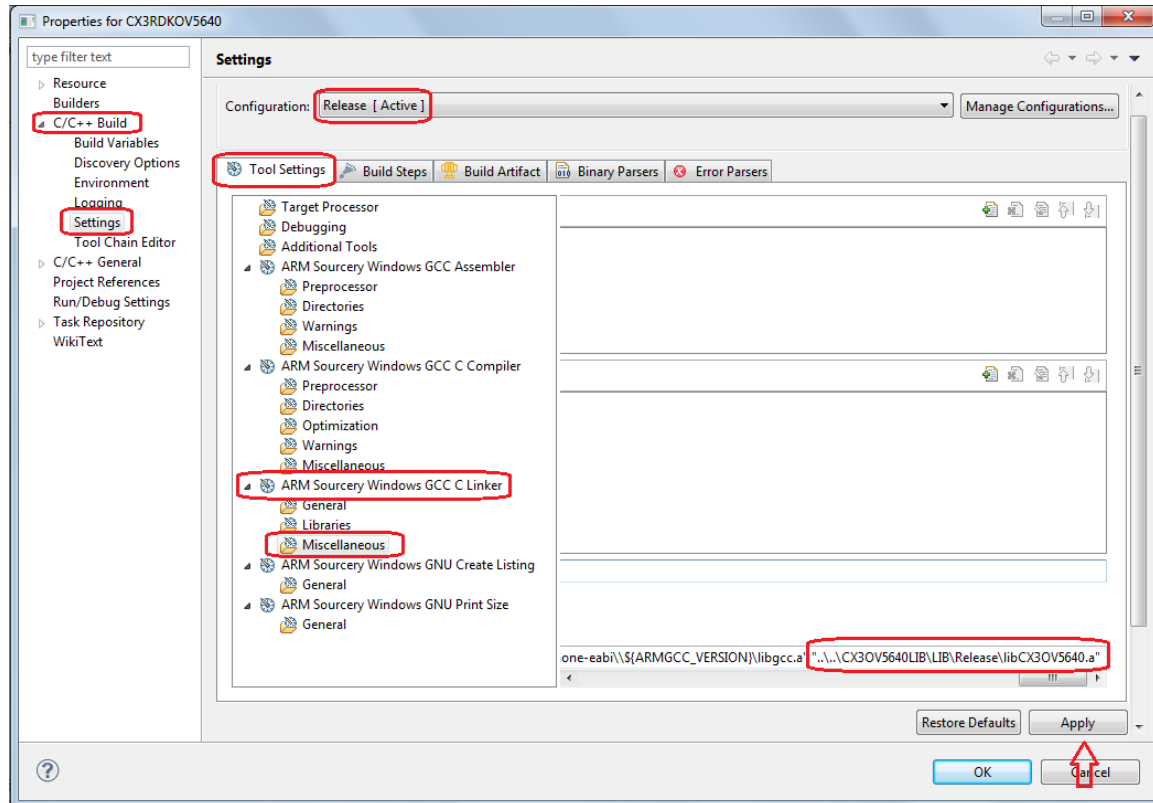
Note: The sensor library folder “CX3OV5640LIB” should be in the same folder which has the project folder that is “CX3OV5640”.





### 7.1.3 Linking the Sensor Library

The user should link the Sensor library to the project before building. That can be done by adding the “..\..\CX3OV5640LIB\LIB\Release\libCX3OV5640.a” string to the end of the string listed in the “C/C++ Build -> Settings -> Tool Settings -> ARM Sourcery Windows GCC C Linker -> Miscellaneous -> Other flags”.



- For Debug Configuration the string should be added is as follows,  
“..\..\CX3OV5640LIB\LIB\Debug\libCX3OV5640.a”
- For Release Configuration the string should be added is as follows,  
“..\..\CX3OV5640LIB\LIB\Release\libCX3OV5640.a”

NOTE: This example will only work correctly and stream at mentioned frame rates in Release configuration.

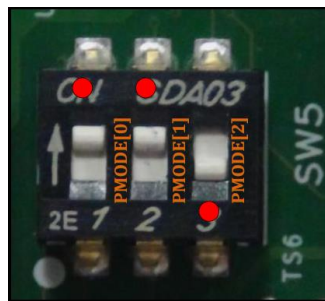


## 7.2 How to load & test the firmware

For loading the binary image to the CX3 RDK kit, you need to use the Cypress tool called USB Control Center. This tool is automatically installed during the SDK installation. This tool allows you to download the firmware in to RAM or I2C EEPROM or SPI Flash. The CX3 RDK supports all the storage locations. The following sections explain loading the firmware image to these locations and how to run the firmware from there.

### 7.2.1 Load into RAM

Before connecting the CX3 RDK, the Boot Mode Switch (SW5) position should be in USB boot mode (Refer the Figure below).

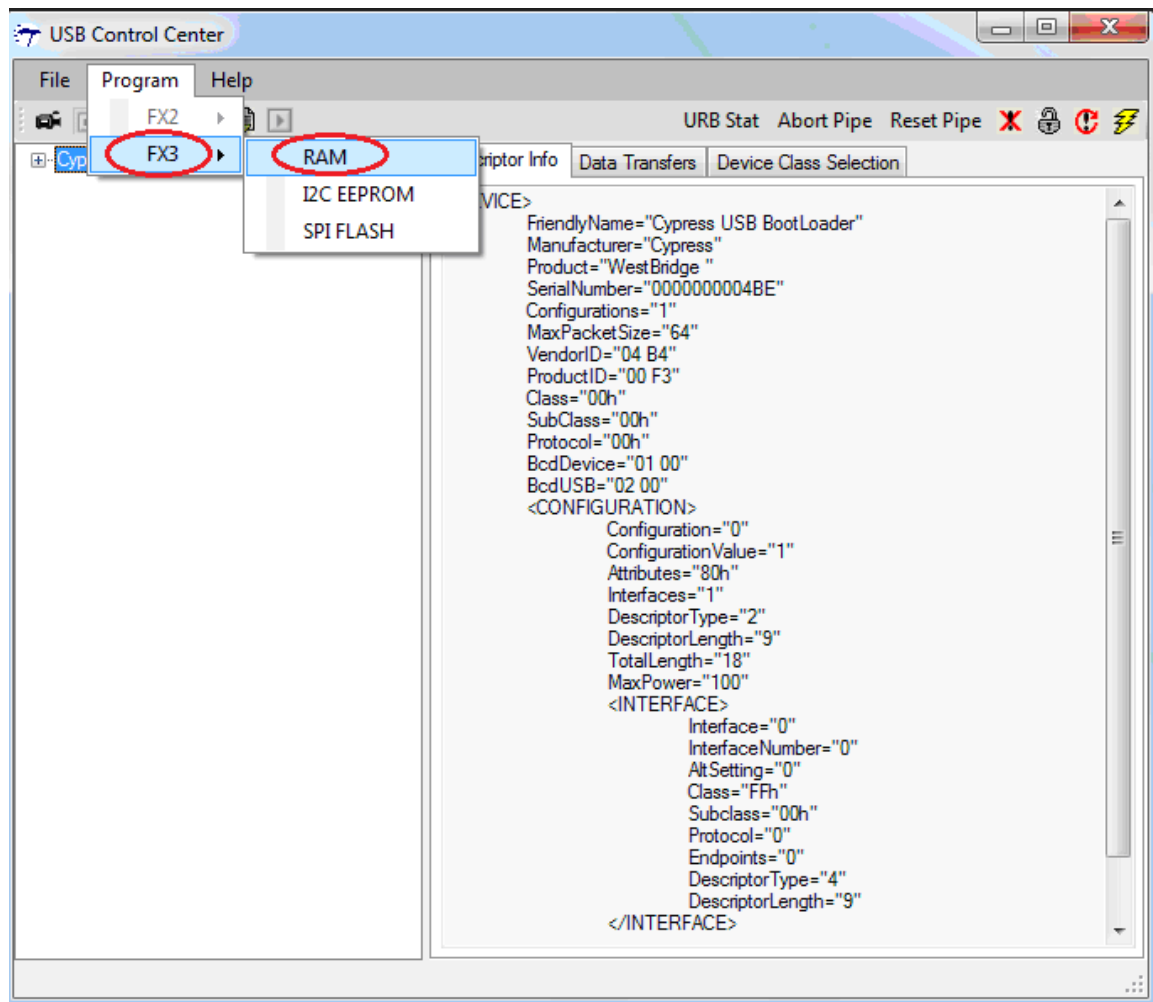


Firmware binary can be loaded into RAM and it can be tested. Open Cypress control center. Connect the device, if you are connecting the device for the first time host PC will prompt for the drivers, so user should select the driver's path to install.

If the drivers installed successfully, the device will be listed in the Control Center as "Cypress BootLoader".

Select Menu option Program->FX3->RAM

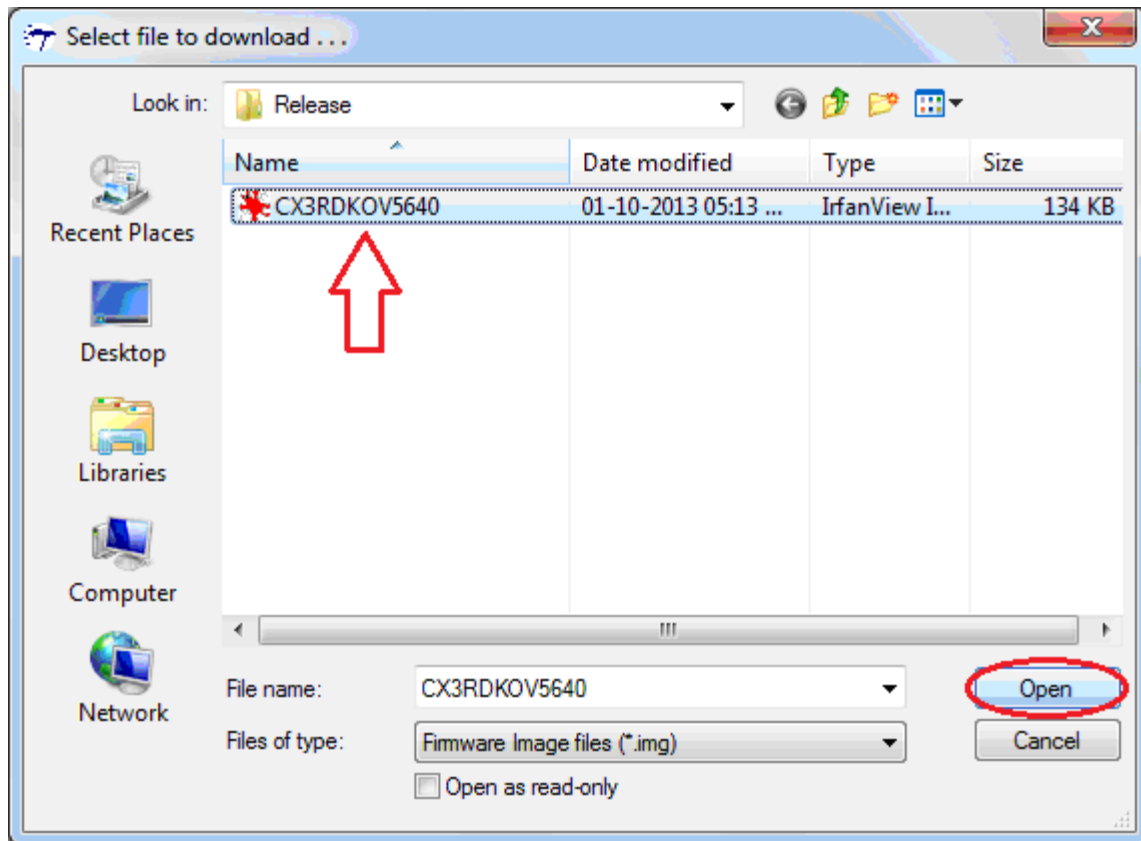




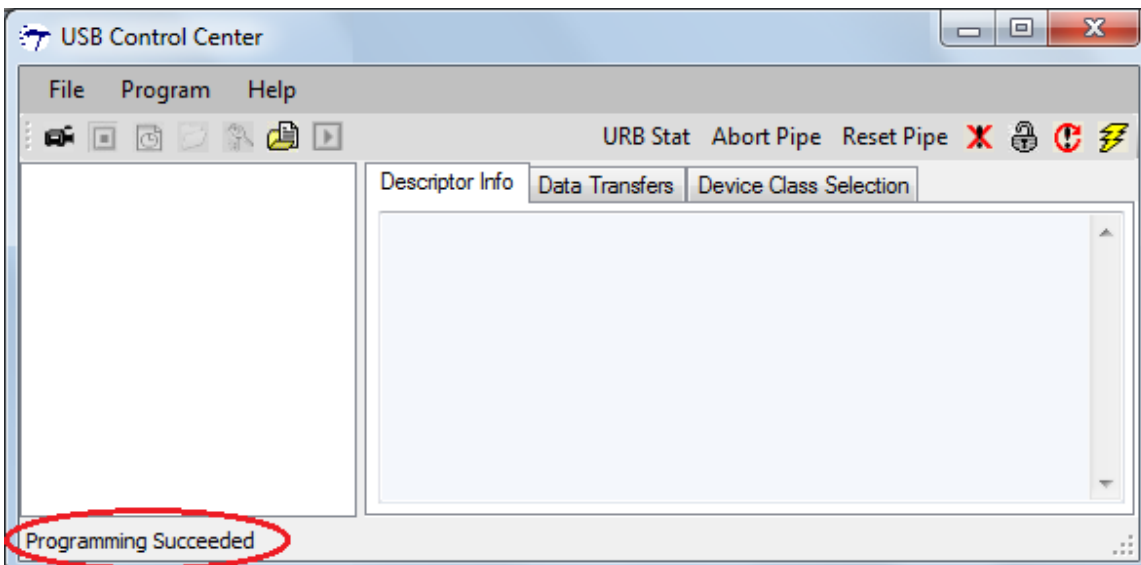
A browse window will appear in that window browse for the firmware path, by default which is "D:\See3CAM\_CX3RDK\_e-CAM59CX3\CX3RDKOV5640\Release", then select the Binary file and click "Open" button to load the firmware binary.

After that the firmware binary will be loaded in the RAM & the CX3 will automatically starts to execute the firmware.



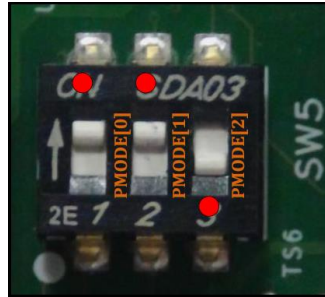


Now the binary file will be loaded and it will show a message like “Programming Succeeded” at the left bottom side of the control center.



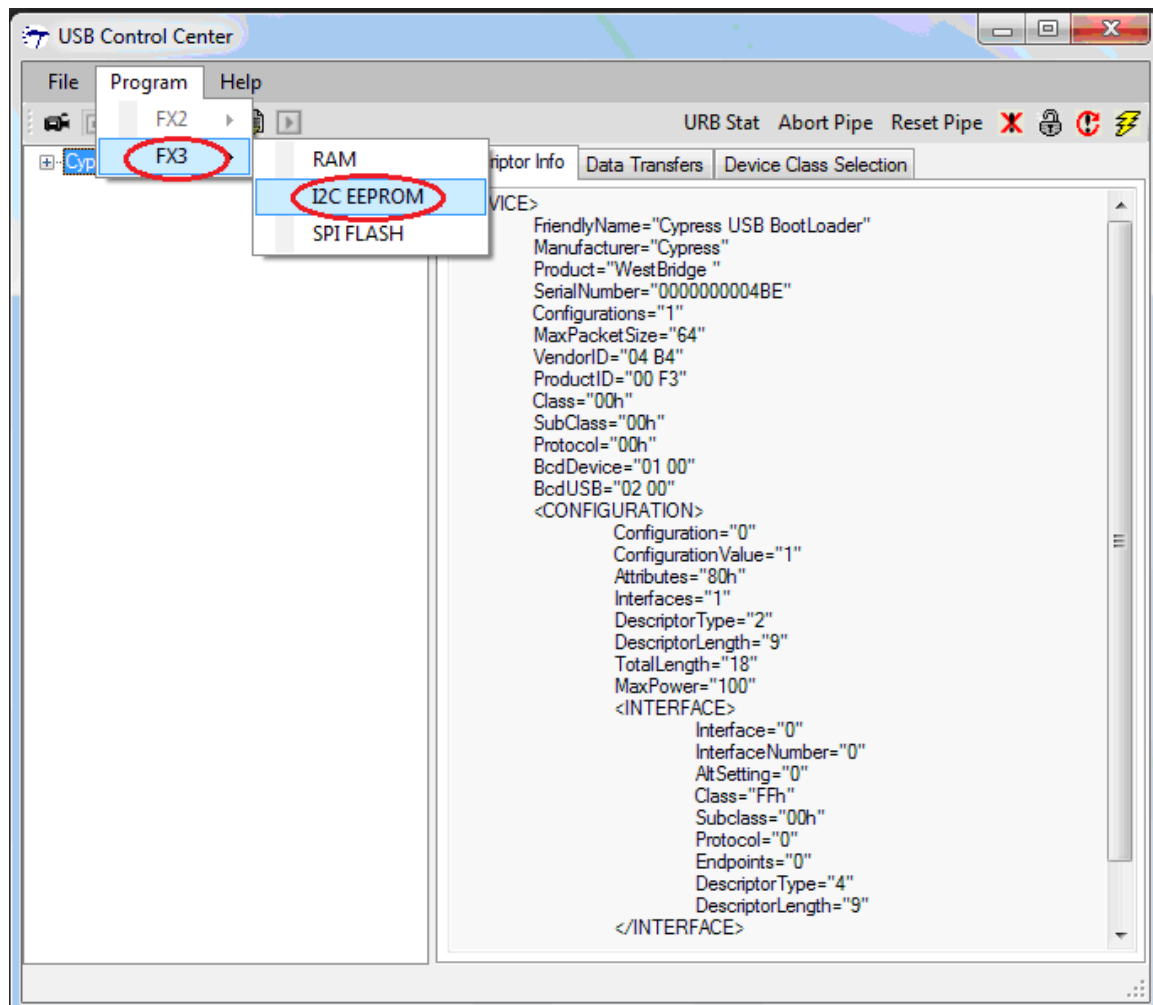
## 7.2.2 Load into I2CEEPROM

Before connecting the CX3 RDK, the Boot Mode Switch (SW5) position should be in USB boot mode (Refer the Figure below).



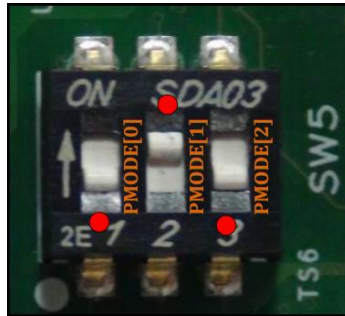
Firmware binary can be loaded into EEPROM via I2C. Once we have loaded the firmware into EEPROM means it will be there until it's erased or reloaded. Open Cypress control center. Connect the device,

Open Control Center , select "Cypress BootLoader" and then select Menu option Program->FX3->I2C EEPROM, and then browse the firmware binary to load into I2C EEPROM.



If the firmware programming to I2C EEPROM is successful it will show a message as "Programming Succeeded"

To boot from I2C EEPROM, Switch off the CX3 RDK, then Change the Boot Mode Switch (SW5) position according to the I2C boot (Refer the Figure below) & Switch On the CX3 RDK.

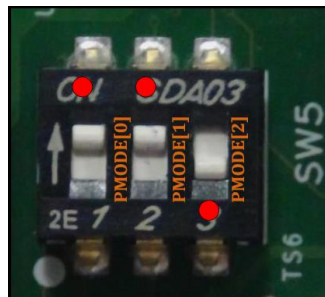


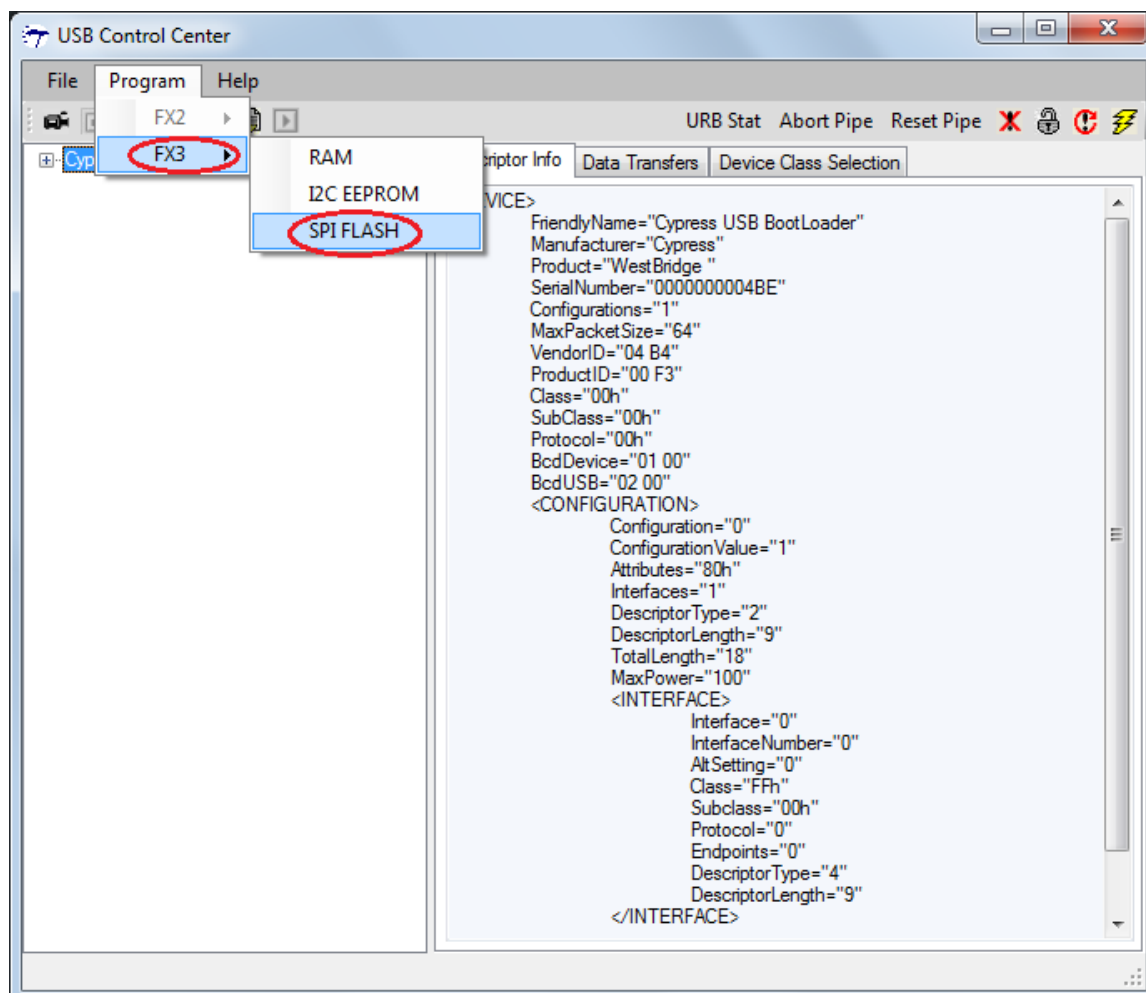
### 7.2.3 Load into SPI FLASH

Firmware binary can be loaded into FLASH via SPI. Once we have loaded the firmware into Flash means it will be there until it is erased or replaced. Open Cypress control center. Connect the device,

Open Control Center , select "Cypress BootLoader" and then select Menu option Program->FX3->SPI FLASH, and then browse the firmware binary to load into SPI FLASH.

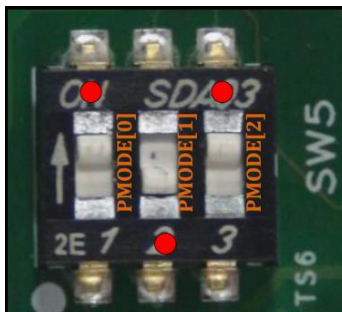
Before connecting the CX3 RDK, the Boot Mode Switch (SW5) position should be in USB boot mode (Refer the Figure below).





If the firmware programming to SPI FLASH is successful it will show a message as "Programming Succeeded"

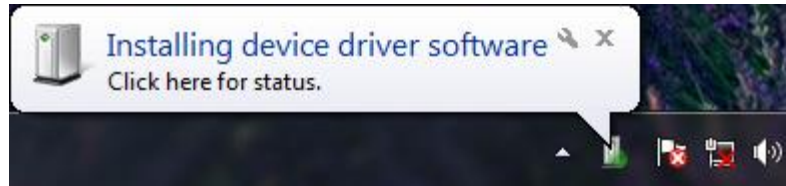
To boot from SPI FLASH, Switch off the CX3 RDK, then Change the Boot Mode Switch (SW5) position according to the SPI boot (Refer the Figure below) & Switch On the CX3 RDK.



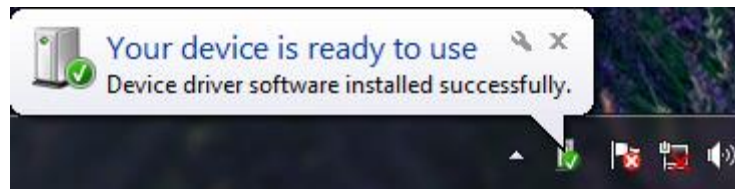
## 7.2.4 How to test the firmware

After loading the firmware binary to the See3CAM\_CX3RDK with e-CAM59CX3, device will be detected by the host PC as UVC device.

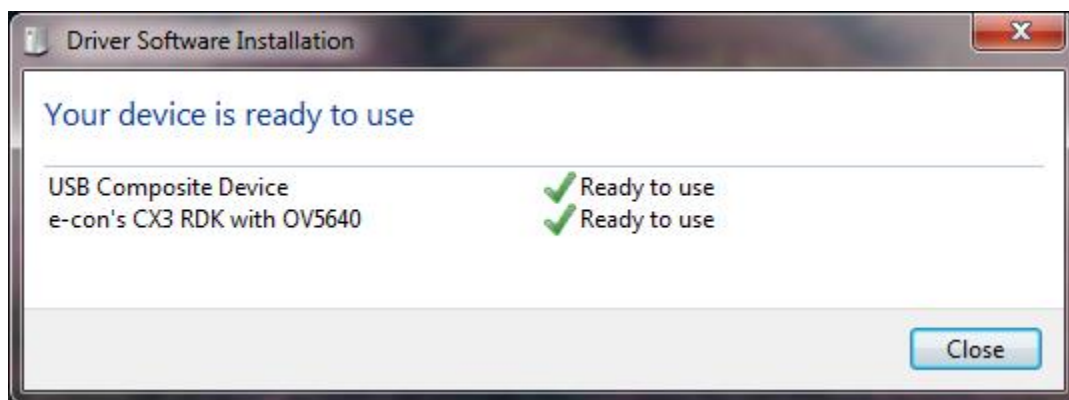
The driver will be installed automatically, there is no need to install any external drivers. A popup message will be displayed like "Installing device driver software" in the right bottom side of the screen.



Wait for the driver installation to finish. After the drivers have been successfully installed it will display the message like "Your device is ready to use".

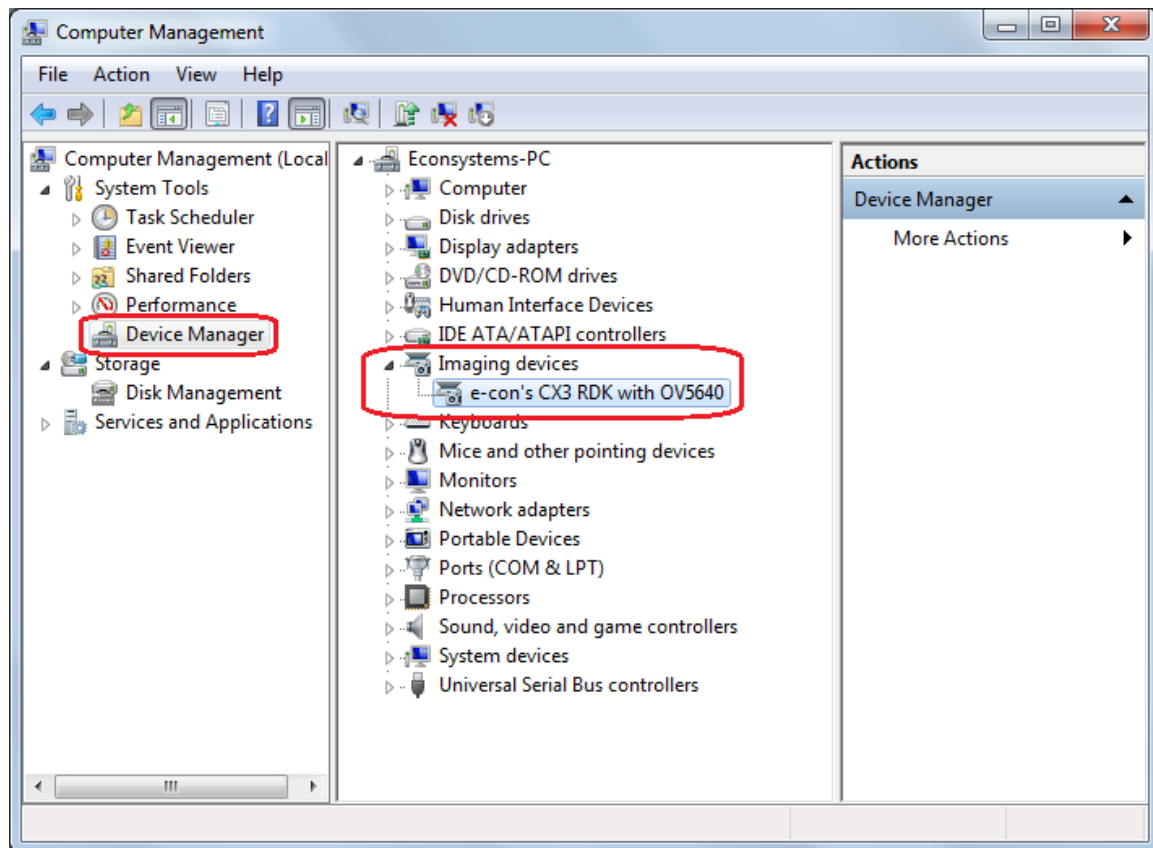


If this message was clicked then a window will be opened and it will show the status of the driver's installation.

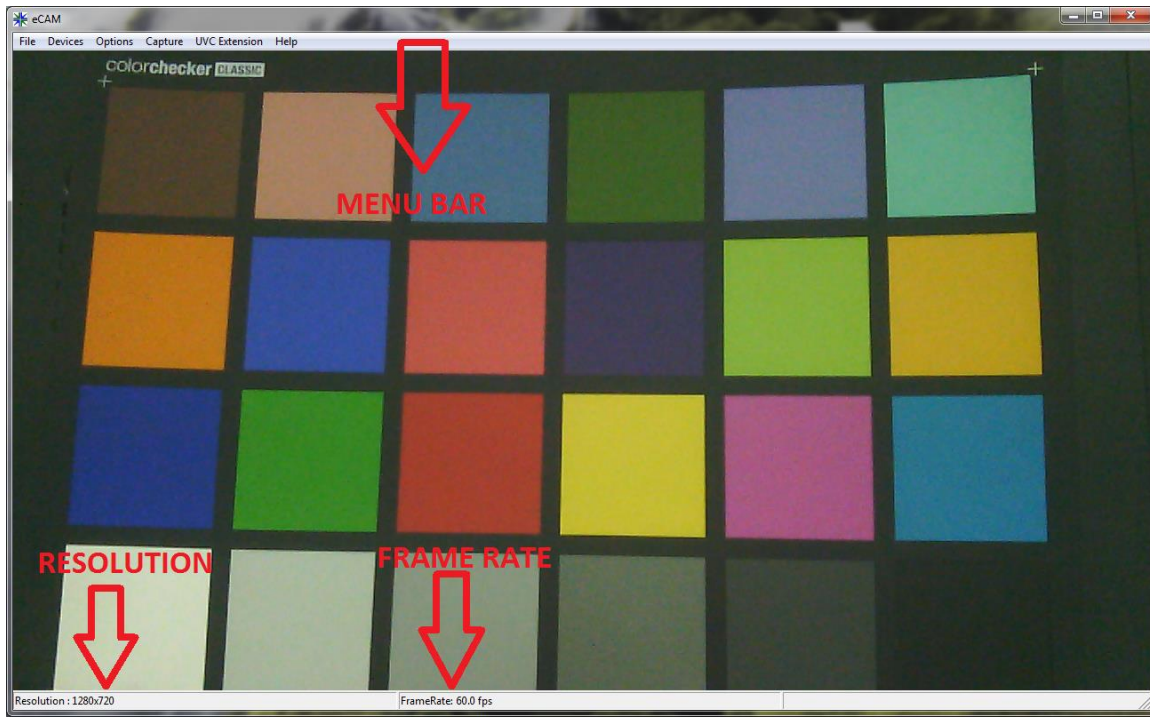




After Successful driver installation the See3CAM\_CX3RDK\_e-CAM59CX3 will be listed in the "Device manager" under the "Imaging Devices" category as **"e-con's CX3 RDK with OV5640"**.



To check the preview, open the sample direct show application “e-CAM View” which should be installed on host PC. The e-CAMView will show the preview from the camera.



Now the e-CAMView will show the camera preview, please refer “e-CAMView Application User Manual for See3CAM\_CX3RDK\_e-CAM59CX3\_1\_2.doc”.

To get the e-CAMView application source code please contact [sales@e-consystems.com](mailto:sales@e-consystems.com).

## 8 Conclusion

This document explains how to install the FX3 SDK, how to build and test the See3CAM\_CX3RDK\_e-CAM59CX3 firmware.

