

Renesas Synergy™ Platform

PDC Web Camera Getting Started Guide

Introduction

This Getting Started Guide instructs users in how to install, build, and run a sample Parallel Data Capture (PDC) Web Camera application on a Renesas Synergy development board with the Renesas e² studio integrated software development environment (ISDE) and Renesas Synergy Software Package (SSP). This application project demonstrates how to use the SSP to capture images from a camera, encode images to JPEG using the JPEG hardware (HW) peripheral, and stream the resulting images via an HTTP webserver.

For this application project, the DK-S7G2 board is connected to the DHCP server to get an IP to display on the terminal via the COM port. The real-time image capture from the camera appears on a web page, and this display can be verified through a web browser using the address assigned by the DHCP server (IP printed on terminal).

The included project sample can be used as a reference in developing remote access control, video monitoring, and security camera applications.

Goals and Objectives

This application note is designed to help you install, build, and run the application example and demonstrates the interface of camera module (OV7670) to the DK-S7G2 board.

Time Needed

It should take no more than one hour to complete this guide, including the hands-on exercises.

Resources Required

To build and run the PDC Web Camera Application example, you need:

- Renesas Synergy™ DK-S7G2 Kit V3.1 or V4.1
- Omnivision OV7670 image sensor (camera module for DK-S7G2 Kit)
- e² studio ISDE v7.3.0 or greater, or IAR Embedded Workbench® for Renesas Synergy™ v8.23.3 or greater
- Synergy Software Package (SSP) v1.6.0 or greater, or Synergy Standalone Configurator (SSC) v7.3.0 or greater
- SEGGER J-Link® and associated USB driver
- Renesas Synergy USB CDC driver for Windows® 7 (included in the package)
- Windows® 7 or Windows® 10 test PC with a console application, such as Tera Term (or equivalent), installed.
- Micro USB cables
- Connection to local area network (LAN) with DHCP Server
- Download all the required Renesas (SSP) from the Renesas Synergy™ Gallery (www.renesas.com/synergy/ssp)

Prerequisites and Intended Audience

This document assumes you have some experience with the Synergy e² studio ISDE or IAR Embedded Workbench® for Renesas Synergy™ (IAR EW for Synergy) and the Synergy Software Package (SSP).

Before you use this application note, follow the procedure in the *SSP User's Manual* to build and run the **Blinky** project. Doing so enables you to become familiar with e² studio and the SSP, and ensures that the debug connection to your board functions properly.

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1. Connecting the board and importing the project into e² studio

This section instructs how to connect the camera module to the board.

Refer to the Out-of-Box Demo Programming Guide to set up the power connection and the J-Link debugger connection from your PC to the JTAG connector on the target board.

See the *Renesas Synergy™ Project Import Guide* (r11an0023eu0121-synergy-ssp-import-guide.pdf) in this package for instructions on importing the project into e² studio and building/running the application.

1. Connect the camera module as shown in the following figures:

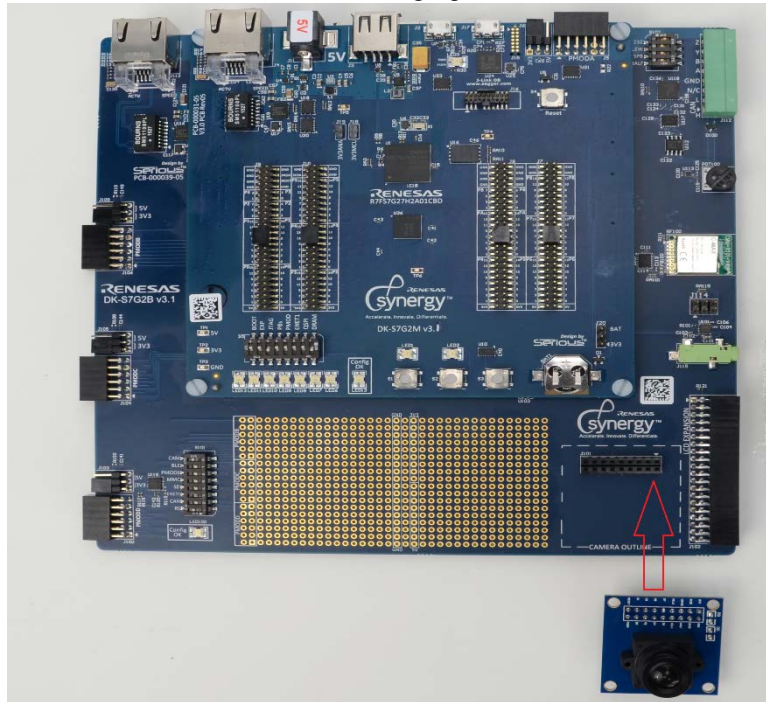


Figure 1. Camera Module before connecting to the main board

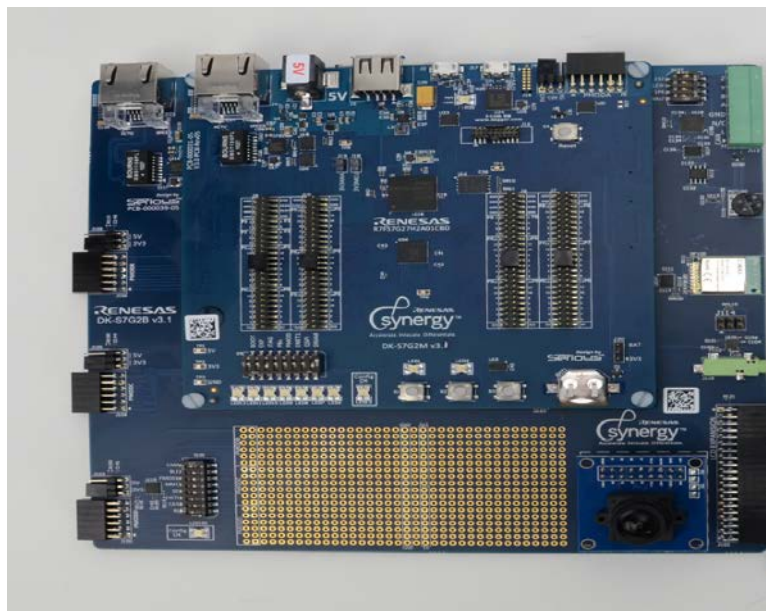


Figure 2. DK-S7G2 connected with Camera Module (OV7670)

- On the main board with the S5 DIP switch, set JTAG and DRAM to the ON position. On the base board, DIP switch S101, CAM and ENET0 is in the ON position; all other switches on S5 and S101 are OFF.

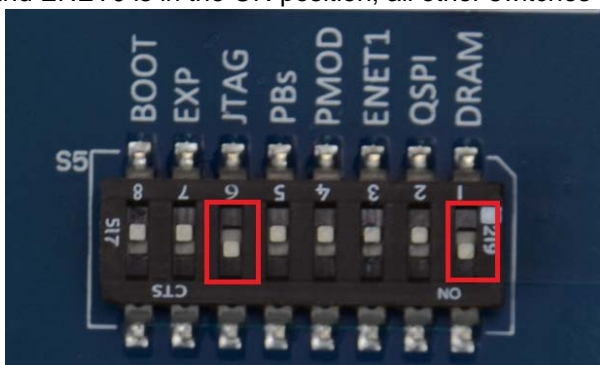


Figure 3. DIP Switch S5 configuration

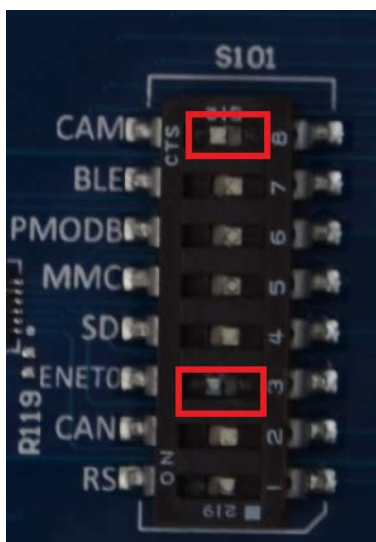


Figure 4. Dip Switch S101 configuration

3. Connect the Ethernet cable to the J113 port on the Base board. Make sure the other end of the cable is connected to the Local Area Network (which has the DHCP server on the network). (Connect the other end of cable in the same network where the host system is connected).

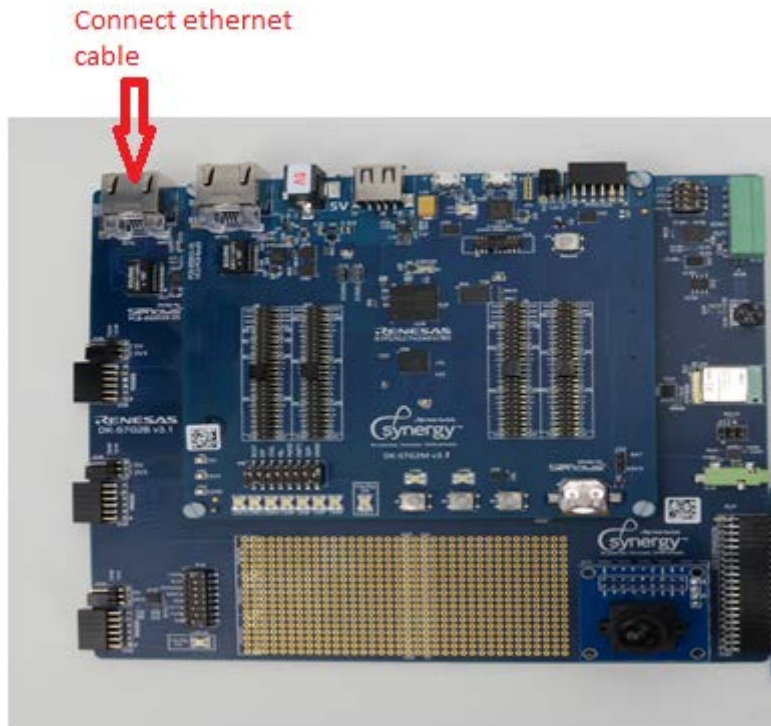


Figure 5. Connect Ethernet cable

4. On the DK-S7G2 V4.1 board the following settings are required
 - a. With the S7 and S9 DIP switch, set JTAG and DRAM to the ON position. all other switches on S7 and S9 are OFF.

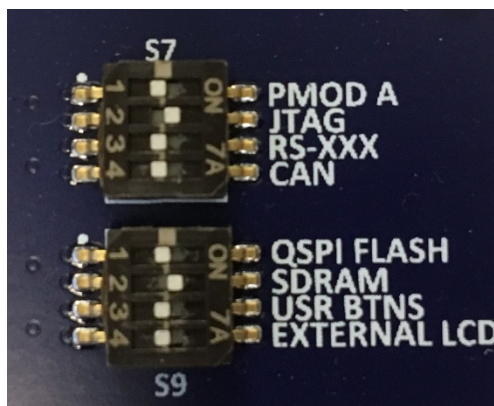


Figure 6. DIP Switch setting for S7 and S9

- b. With the S6 and S8 DIP switch, set ETHERNET 0, CAMERA and LCD to the ON position. all other switches on S6 and S8 are OFF.

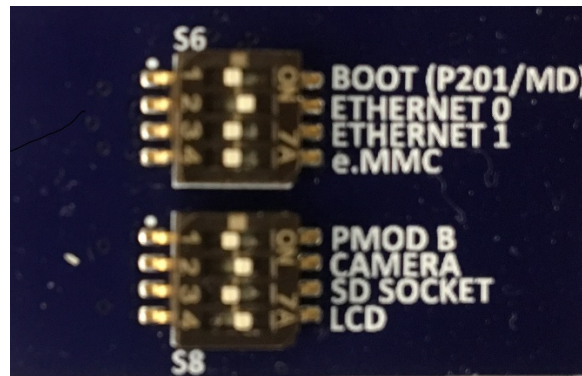


Figure 7. Dip Switch setting for S6 and S8

5. Connect the Ethernet cable to the J16 port on the board (ETHERNET 0). Make sure the other end of the cable is connected to the Local Area Network (which has the DHCP server on the network). (Connect the other end of cable in the same network where the host system is connected).

2. Determining you IP address

This section guides you through the process of determining the IP address of the board. The DHCP Client application running on the DK-S7G2 board will contact the local DHCP server (Sitting on the LAN) to obtain an IP address. Once this address is obtained, the program will send a text representation of the address over the USB connection to a terminal program (for example, HyperTerminal) on the PC. This USB connection is a standard CDC/ACM device which requires a driver file (.inf) to operate. 32-bit and 64-bit versions of these files can be found in src\cdc_inf directory included in the package.

The CDC/ACM device will show up in the Device Manager of your PC under the “Other devices” group as “EL Composite device.”

1. Right-click this device and select Update Driver Software.
2. When prompted for the location of the drivers, browse to the location of the two files from the package. Once the driver is updated, a new COM device will show up in the Device Manager.
3. Use a terminal program to open that COM device. Once your terminal program is open and operating, your IP address will be displayed in the terminal window.

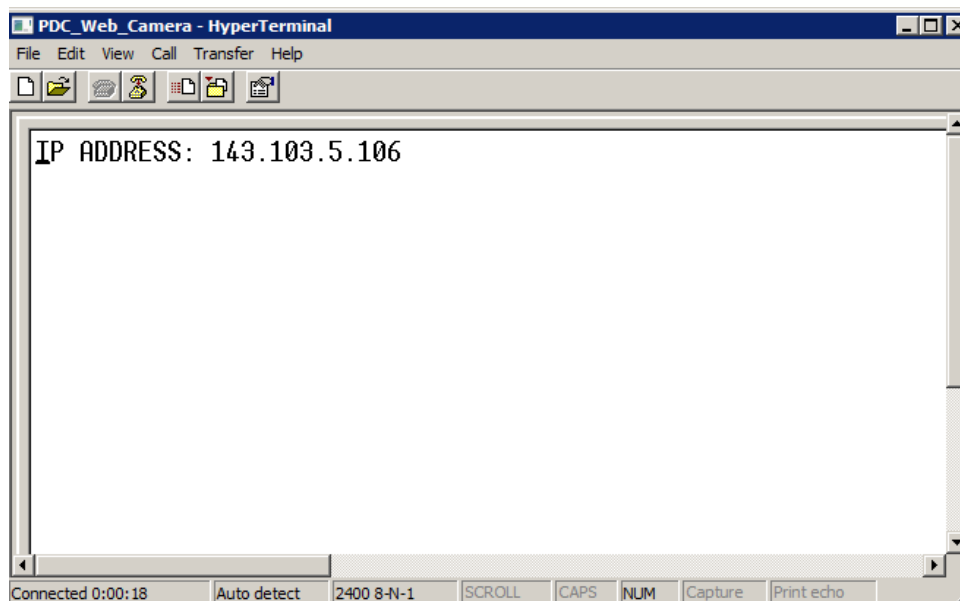


Figure 8. IP address

3. Observing the PDC Web Camera Application Output

When you first press the F8 key or the Resume button to start the application, the application stops at main(). Press **F8** or the **Resume** button again to run the code.



Figure 9. Resume button

1. Enter the IP address in a web browser address window. The camera window displays with the continuous capture from the modules.

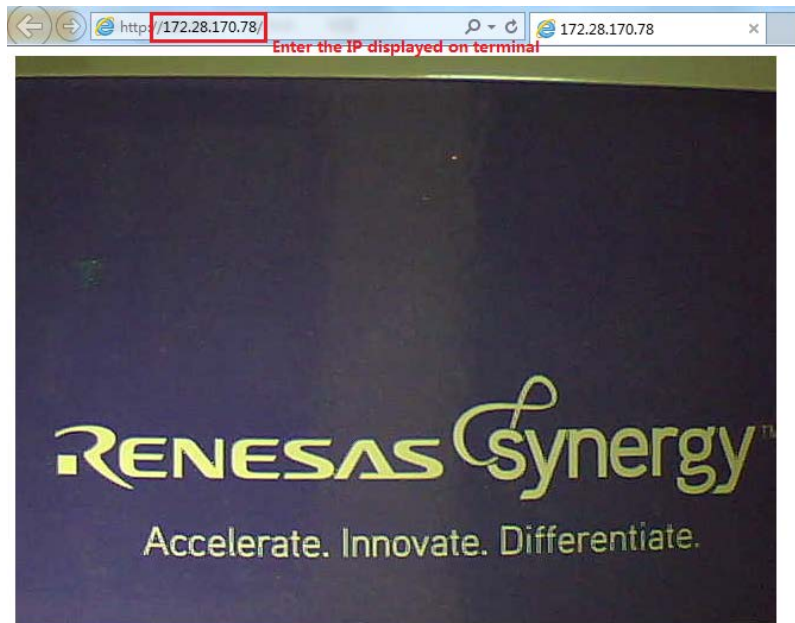


Figure 10. Browser view of the application

Once the application is resumed, you should see a real-time capture from the camera on the web address assigned by the DHCP. Changes in the orientation of the camera module will be reflected on the webpage. The view is like a video as the images are continuously displayed on the web page as soon as they are captured.

To end the debug session, press Ctrl + F2 or the Stop button.



Figure 11. Stop button

The webpage can be refreshed at any time when the image does not show correctly due to unstable network connection. In addition, multiple clients can be connected at the same time, which means two or more people can view the image simultaneously.

3.1 Application Design

3.1.1 Source Code Layout

Prior to using the application code, it's best to first understand the overall source code layout of a Synergy project. Synergy Applications generally consist of two different types of code; user created and auto generated.

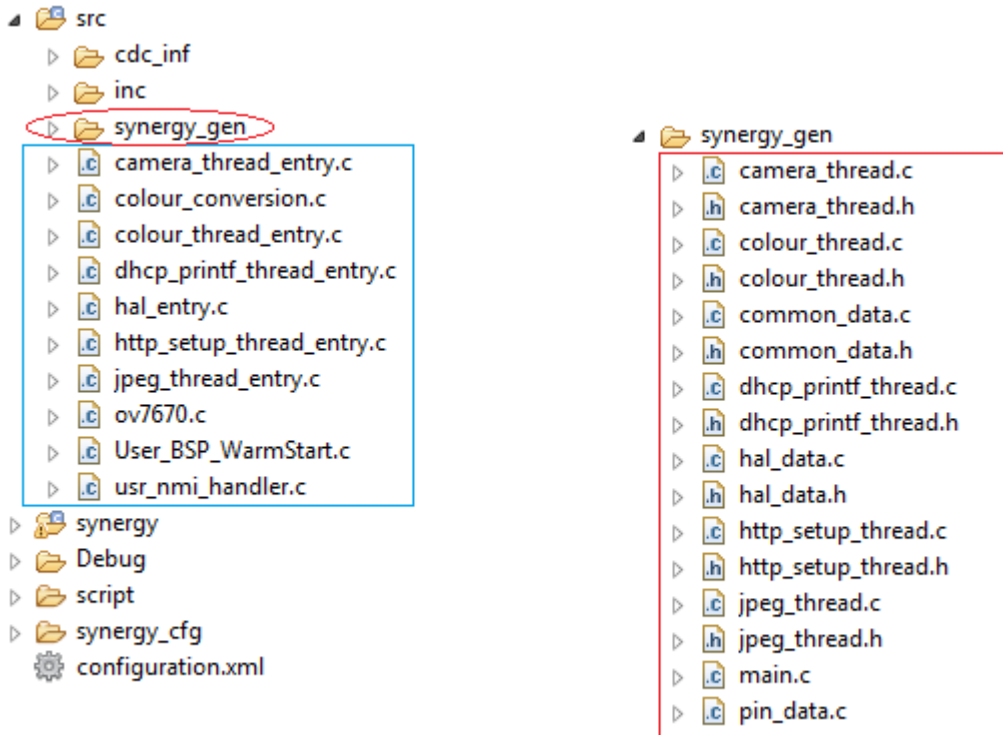


Figure 12. Source Code layout

The figure above shows the source code layout for the DK-S7G2 board. The framework auto-generated code is highlighted in a red block under the synergy_gen directory and the user created codes are highlighted in a blue. Note that the majority of the user created code resides in the src directory.

3.1.2 Thread Layout

The following figure illustrates the hierarchy and dependency of the modules belonging to each thread. The PDC Web Camera application has a separate thread for capturing image, color/jpeg conversion, http server thread and the DHCP diagnostic output.

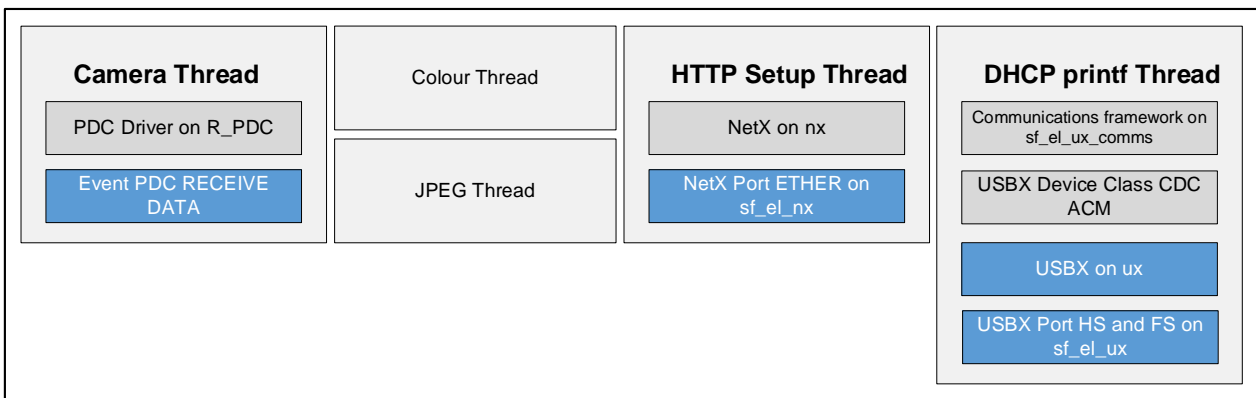


Figure 13. Module Hierarchy

3.1.3 Thread Modules and Objects

In addition to the core modules shown on Figure 13, the PDC Web Camera application employs additional ThreadX objects such as Queue and Semaphore. These objects enable thread synchronization and make more efficient utilization of the processor.

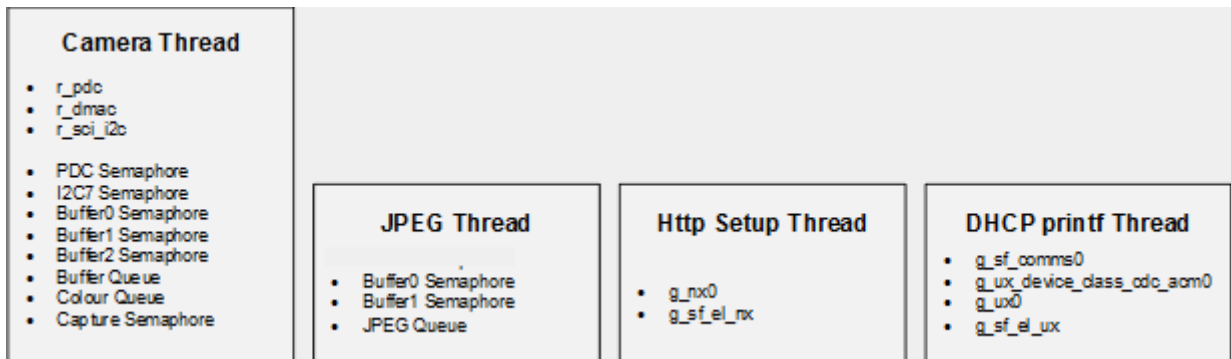


Figure 14. Thread Contents

3.1.4 Thread Flow

The following diagram shows the thread initialization flow:

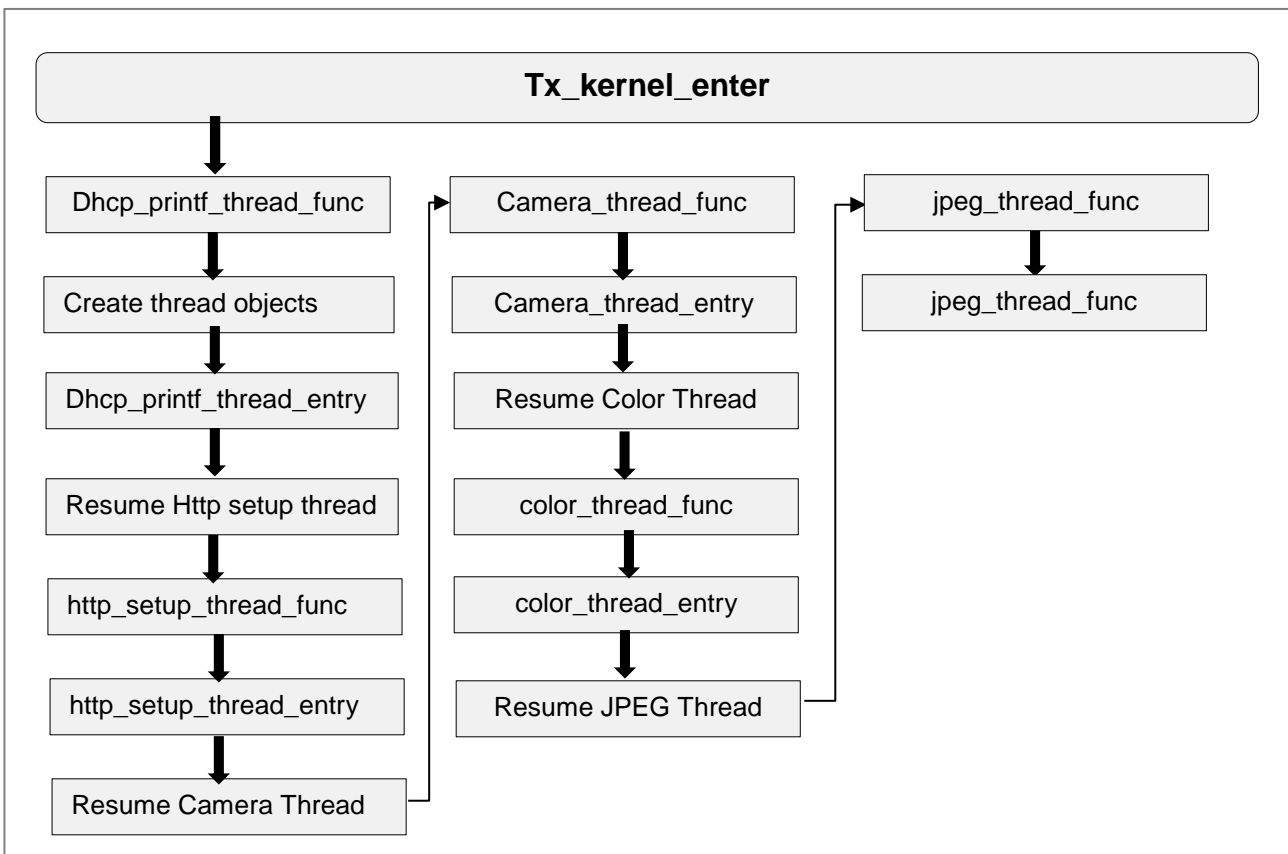


Figure 15. Thread Initialization

3.1.5 Camera Thread

The camera thread initializes the camera module, captures the images, and stores the images in a buffer. The data in the buffer is processed by color and jpeg thread. This thread runs in a permanent loop.

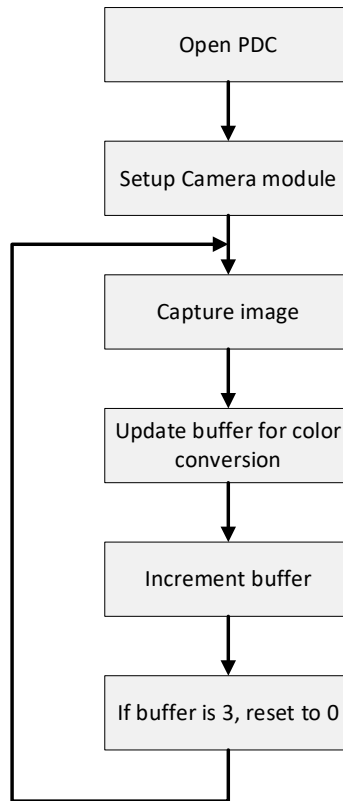


Figure 16. Camera Thread Flow

The DHCP printf thread starts the DHCP process. It contacts the DHCP server and obtains an IP address. The IP address of the DHCP server is not required to be known, as a DHCP client sends a broadcast query request that any DHCP server on the network may service. It waits until the IP address is assigned. Once the IP address is resolved, the thread will print out the IP address every 5 seconds. This can be seen by connecting the host system to J2 port on the board.

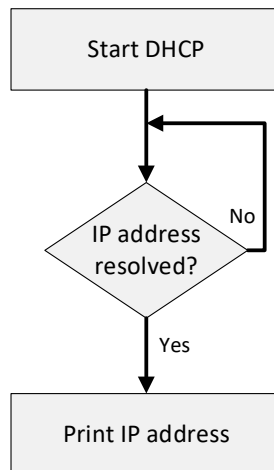


Figure 17. DHCP Thread Flow

4. Application Source Code Highlights

Some highlights of the PDC Web Camera application are in this section. The application demonstrates how to develop complex multi-threaded applications using ThreadX under the SSP. The key goal of the SSP is to abstract much of the complexity of interfacing with the myriad of ARM peripherals and, as quickly as possible, get you to the point where you can simply focus on constructing complex applications quickly.

4.1 Threads and Main

There are a few subtle differences between a standalone ThreadX application and an application that uses ThreadX under the SSP environment. In a typical ThreadX application `main()` calls `tx_kernel_enter()` which then calls `tx_application_define()`. If you've written ThreadX applications prior to working with Synergy, you may be used to creating the main application threads and defining other resources used by the application (e.g. queues, semaphores, etc.) in `tx_application_define()`.

Under the Synergy framework `main()` is an auto generated file which looks similar to the code listed below. In this case `tx_application_define()` calls thread entry functions for the threads specified during the framework configuration.

```
void tx_application_define(void * first_unused_memory) {
    http_setup_thread_create();
    dhcp_printf_thread_create();
    jpeg_thread_create();
    camera_thread_create();
    colour_thread_create();

#ifdef TX_USER_ENABLE_TRACE
    TX_USER_ENABLE_TRACE;
#endif

    g_hal_init();

    tx_application_define_user(first_unused_memory);
}

int main(void) {
    __disable_irq();
    tx_kernel_enter();

    return 0;
}
```

When you create a thread using the Threads tab, the framework will create several files. For example, when the Camera Thread was added, the framework created three files for you: `camera_thread.h`, `camera_thread.c` and `camera_thread_entry.c` as shown in the following figure.

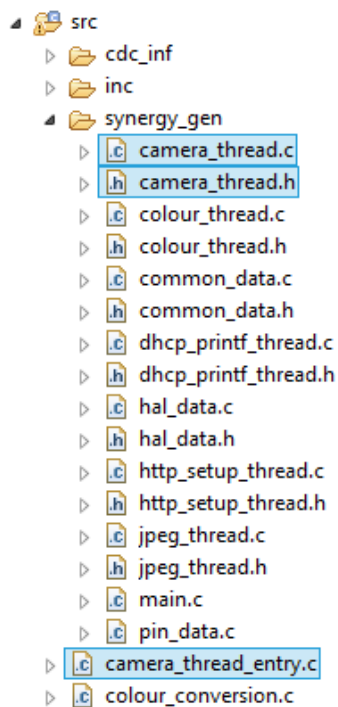


Figure 18. Three Camera Thread files

The first two files are auto generated and therefore put into the synergy_gen folder. The camera_thread_entry.c file is the entry point for the camera thread; this is where you put your application code. You should not update auto generated files since they will be re-generated every time you build the project or hit the Generate Project Content button. Auto generated files always contain some form of “Do Not Edit” message at the top of the file.

4.2 Limitations

In this application, an image is captured and converted only when there is a connection request from a client, so it allows client re-connection, and multiple clients to be connected. However, the frame rate will drop each time a new client is connected, as an image is captured and encoded for each GET request received from each client.

5. Reloading the Demonstration Program

See *DK-S7G2 Out-of-Box Demo Programming Guide* for instructions on reloading the demonstration on to the kit.

6. References

The following document is included with this application project:

- *Renesas Synergy™ Project Import Guide* (r11an0023eu01121-synergy-ssp-import-guide.pdf)

To download documents for a particular SSP release, visit the Synergy Gallery (www.renesas.com/synergy/ssp) or sign in to view additional versions.

- *SSP User's Manual* (r11um0124eu0101-synergy-ssp-v160.pdf)
- *X-Ware™ Component Documents for Renesas Synergy™* zip, which includes:
 - ThreadX User's Manual: Software (r11um0006eu0508-synergy-threadx)
 - NetX User Guide (r11um0004eu0511-synergy-netx.pdf)
 - NetX Dynamic Host Configuration Protocol for Clients User Guide (r11um0014eu0512_synergy_netx_dhcp.pdf)
 - NetX Hypertext Transfer Protocol (HTTP) User Guide (r11um0017eu0514_synergy_netx_http.pdf)
 - USBX Device Stack User's Manual: Software (r11um0007eu0584_synergy_usbx_device.pdf)

For all other documents, visit the Renesas.com website

- *DK-S7G2 Out-of-Box Demo Programming Guide* (r12an0024eu)

Website and Support

Visit the following vanity URLs to learn about key elements of the Synergy Platform, download components and related documentation, and get support.

Synergy Software	www.renesas.com/synergy/software
Synergy Software Package	www.renesas.com/synergy/ssp
Software add-ons	www.renesas.com/synergy/addons
Software glossary	www.renesas.com/synergy/softwareglossary
Development tools	www.renesas.com/synergy/tools
Synergy Hardware	www.renesas.com/synergy/hardware
Microcontrollers	www.renesas.com/synergy/mcus
MCU glossary	www.renesas.com/synergy/mcuglossary
Parametric search	www.renesas.com/synergy/parametric
Kits	www.renesas.com/synergy/kits
Synergy Solutions Gallery	www.renesas.com/synergy/solutionsgallery
Partner projects	www.renesas.com/synergy/partnerprojects
Application projects	www.renesas.com/synergy/applicationprojects
Self-service support resources:	
Documentation	www.renesas.com/synergy/docs
Knowledgebase	www.renesas.com/synergy/knowledgebase
Forums	www.renesas.com/synergy/forum
Training	www.renesas.com/synergy/training
Videos	www.renesas.com/synergy/videos
Chat and web ticket	www.renesas.com/synergy/resourcelibrary

Revision History

Rev.	Date	Description	
		Page	Summary
1.00	Aug.22.16	—	Initial version
1.10	Aug.30.16	—	Cleaned up Include Paths for the project, updated application note to include design limitation and added IAR EW for synergy in installed software section.
1.20	Feb.02.17	—	Improved the control method for images acquisition for clients. Javascript is used for webpage setting.
1.21	Nov.30.17	—	Updated for 1.3.1
1.22	Feb.06.18	—	Updated for 1.4.0
1.23	April.26.19	—	Updated for 1.6.0

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