TEXAS INSTRUMENTS

Application Report
SPRAC43 – June 2016

TDA3xx ISS Tuning and Debug Infrastructure

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ABSTRACT

A camera system has many components including image sensor, optics and an Image Signal Processor (ISP). To get the best image quality, each subsystem must be configured to operate at the optimal level. The interdependencies between different subsystems must be utilized to get the best results. Additionally, there are many tradeoffs to be made while determining the best sensor and ISP configuration. This makes image quality tuning a long and complex process, requiring many rounds of data collection, calibration and validation.

TDA3xx ISS offers a powerful and feature rich Image Pipe for processing RAW sensor data and generating a high quality output stream. Image pipe is configurable allowing the users to adjust image quality based on sensor properties and individual preferences. To enable this, TI delivers example processing pipelines in Vision Software Development Kit (SDK) and PC-based graphical tool for image quality tuning. This application report explains the tuning infrastructure present in the Vision SDK for TDA3xx ISS imaging pipeline and other debug infrastructure.

Contents

1 Dynamic Camera Configuration (DCC)

DCC application is a PC-based tool designed to automate and simplify ISP tuning for RAW sensors. This tool has built-in support for all TDA3xx ISS modules. The tuning is achieved by passing captured RAW images through various ISS blocks for getting desired output quality. The raw images are captured from the sensor and connected to the TDA3xx ISS block. The output of the DCC is set of tuned values for each ISS module in xml and binary format. These tuned parameters can be later on parsed and used in the ISS usecase to get the desired output quality from the ISS. The tool also provides a live connection to target board using Ethernet that allows capturing RAW/YUV images, probe sensor registers, ISP register and view/tweak 2A algorithm parameters real time.

Vision SDK 2.6 (and later) offers DCC framework providing support for some of the most common tuning tasks including:

- Parsing the output of tuning tool and converting to ISP register settings
- Maintaining a database of per-photospace parameter set and dynamic switching based on 2A output
- Support for reading DCC database from QSPI flash OR compile time header files

In addition, Vision SDK 2.6 (and later) has networking support that enables:

- Capturing RAW frames (pre ISP) and YUV frames (post ISP)
- Reading ISP registers and other TDA3 memories
- Sending one or more DCC files from PC to target for “quick testing”
- Sending DCC database from PC to target for persistent QSPI flash

To be able to use the tuning tool effectively, setup the EVM and configure the Vision SDK to interact with the tuning tool. This document explains the necessary steps for the right configuration.

The tuning tool installation notes and usage are documented separately. Those topics are not covered in this document.

1.1 Prerequisites

Windows 7 PC with the following programs installed:

- DCC Tuning Tool
- Vision SDK 2.6 (or later)
- TDA3 EVM + Ethernet cable: PC and EVM must be on the same network. Corporate firewall can sometimes prevent TDA3 EVM from getting an IP address. It is recommended to use a router with EVM and PC connected physically to the router.
- Vision SDK build with Networking support, see “VisionSDK_NetworkTools_UserGuide.pdf” in the Vision SDK/docs folder

1.2 DCC Usage

The output of the DCC, tuned ISS configurations, is stored in a fixed xml and binary format. This xml/binary file is also known as the DCC profile for a given sensor. The DCC profile for each supported sensor is stored in the BSP sensor driver. ISS usecase in VisionSDK parses this DCC profile and applies this configuration to the ISS modules based on the given lighting condition. ISS usecase gets the current lighting condition form the AEWB algorithm.

Vision SDK supports DCC profile for few sensors. To get the list of supported sensors with DCC support, see the *Vision SDK User's Guide*. This is a part of the Vision SDK release that can be found under the 'docs' folder in the vision sdk package, which is available for download at http://bangsdowebsvr01.india.ti.com/VISION_SDK/02_09_00_00/.

The steps needed to use DCC are shown in the following sections.

1.2.1 Enabling DCC Support

DCC profile can be enabled or disabled in the Vision SDK by modifying sensor capabilities. To enable or disable DCC for the sensor, set the flag isDccCfgSupported to TRUE or FALSE in the SensorFeatures variable in driver ti_components\drivers\bsp_01_02_04_06\src\devices\<sensor_name>\src\bspdry_<sensor>Api.c, respectively.

Changing it to FALSE disables DCC support for this sensor and the ISS usecase uses the default configuration from the ISS sensor layer, (for example, from iss_sensor_<sensorname>.c file).

1.2.2 DCC Profile Usage in ISS Usecase

When DCC is enabled, ISS usecase checks for the DCC profile’s availability in the order below:

- The usecase first tries to get the valid DCC profile from the QSPI. If valid profile is found, usecase parses the profile and configures the ISS.
- If there is no valid profile in the QSPI (user did not flash DCC in QSPI), the BSP sensor driver provides DCC profile that was specified at the time of compilation.
- If the BSP sensor driver also does not have DCC profile, usecase uses the default configuration from the ISS sensor layer. The same folder contains a script “generate_dcc.bat” that:

1.2.3 Compiling DCC Profile

DCC profile for all the supported sensors is stored in ti_components\drivers\bsp_01_02_04_06\src\devices\<sensor_name>\src\dcc_xml in XML format.

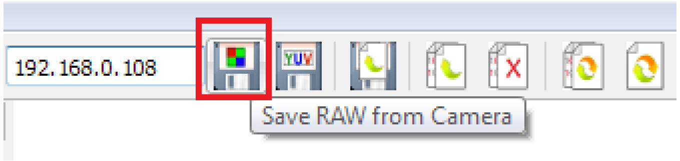
- Loops across XML files in the folder and converts them to binary format.
- Appends all binary files to a single file (*sensor.bin*)
- Converts *sensor.bin* to C style header file format
- Compiling the driver includes DCC database in the firmware build
- *sensor.bin* can also be flashed to QSPI for updating tuning parameters without code compilation.

1.2.4 Runtime Updates

ISP tuning parameters can be updated while the ISS usecase is running on the TDA3xx EVM. This allows to quickly check the output quality with the tuned parameters on actual hardware. Vision SDK supports changing of the tuning parameters at runtime. It also supports many other features like reading and writing memory block, AEWB algorithm state and sensor registers etc. These runtime features make use of DCC tool utility to send and receive commands to the TDA3xx EVM.

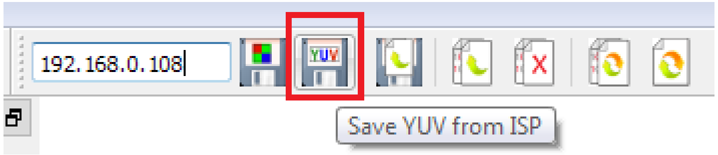
Vision SDK 2.7 and later has networking support integrated with DCC Tuning Tool, which provides an easy mechanism to save RAW/YUV frames, flash/save/delete DCC profiles, and so forth. The following sections explain the details about each of these options in DCC tool.

1.2.4.1 Save RAW Frame



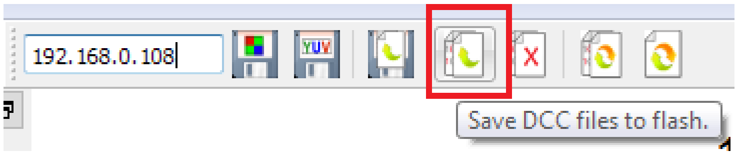
Captures a RAW frame from the sensor and allows you to save to a location on PC.

1.2.4.2 Save YUV Frame



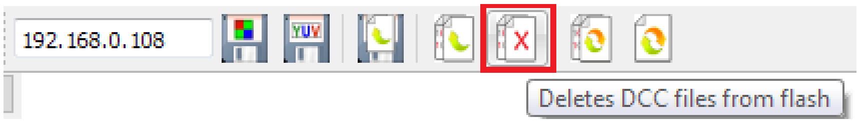
Captures a YUV frame from ISP output queue and allows you to save to a location on PCa.

1.2.4.3 Flash DCC Files



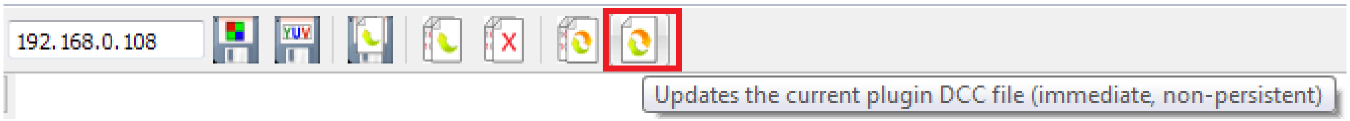
Write selected DCC files and write to QSPI Flash on the EVM. The change is persistent and will be applicable on next reboot.

1.2.4.4 Delete DCC Database From Flash



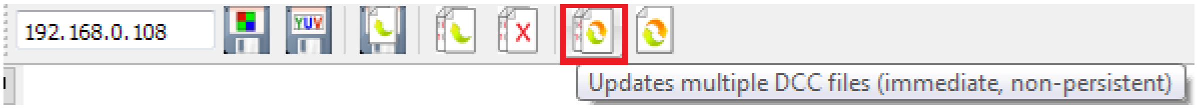
Clears DCC database for the selected sensor only. The change is persistent and will be applicable on next reboot.

1.2.4.5 Update the Current DCC Plugin in Memory


192.168.0.108
Updates the current plugin DCC file (immediate, non-persistent)

Updates current DCC plugin in RAM (not QSPI flash). The effect of the change is visible immediately without rebooting the system. However, the change is not persistent and will be lost on next reboot, unless saved to Flash.

1.2.4.6 Update Multiple DCC Plugins in Memory



Same as the previous command, but allows you to select multiple DCC files that can all be pushed together to target board and updated in real-time.

2 Capturing ISP Output at Various Stages

One of the important steps in debugging ISS quality issues is to capture output images at various processing stages and verify that it matches with the expected reference images. Vision SDK provides a method to capture images at the output of various ISS blocks and the captured images can be compared offline with the reference images.

2.1 Pre-Requisites

To enable this feature, vision sdk must be built with the debug macro ISS_ENABLE_DEBUG_TAPS enabled. Set the ISS_ENABLE_DEBUG_TAPS macro to yes in the Rules.make file and rebuild the vision sdk.

2.2 Usage

ISS links in vision sdk supports storing outputs of Resizer, IPIPE, IPIPEIF and GLBCE modules. In addition to this, when running two pass wdr flow, the intermediate output can also be captured.

Note that only one module's output can be captured at a time.

There are two steps required to capture the output of the ISS module: enable tap point and store/capture the output.

2.2.1 Enable ISS Tap Point

ISS links in vision sdk supports IOCTL ISSM2MISP_LINK_CMD_SET_TAP_PARAMS to enable tap points in ISS. This IOCTL enables tap point for the given module and bypasses all subsequent modules in the path, so the output from the ISP is actually the output from the given module. This output may or may not be in a display format, so display may not be correct.

This IOCTL takes pointer to the structure IssM2mIspLink_IspOutputTapParams as an argument.

```
struct IssM2mIspLink_IspOutputTapParams_t {
    char                             chId;
    /**< Id of the channel for which this config need to be applied*/
    IssM2mIspLink_IspOutputTapPoints outputTapModule;
    /**< Enable frame capturing for given output  */
};

enum IssM2mIspLink_IspOutputTapPoints {
    ISSM2MISP_LINK_ISP_TAP_RESIZER_OUTPUT = 0,
    /**< Enable Resizer Output for Frame capturing */
    ISSM2MISP_LINK_ISP_TAP_IPIPE_OUTPUT = 1,
    /**< Enable IPIPE Output for Frame capturing */
    ISSM2MISP_LINK_ISP_TAP_GLBCE_OUTPUT = 2,
    /**< Enable GLBCE Output for Frame capturing */
    ISSM2MISP_LINK_ISP_TAP_IPIPEIF_OUTPUT = 3,
    /**< Enable IPIPEIF Output for Frame capturing */
    ISSM2MISP_LINK_ISP_TAP_INTERMED_OUTPUT = 4
    /**< Enable Intermediate Output for Frame capturing for 2 pass wdr */
};
```

2.2.2 Saving Output

ISS link in vision sdk supports IOCTL ISSM2MISP_LINK_CMD_SAVE_FRAME for saving the ISP output. It essentially copies current ISP output to a temporary buffer, which can be capture via CCS console or via network tool.

3 References

- *TDA3xx Vision SDK User's Guide*: This is a part of the Vision SDK release that can be found under the 'docs' folder in the vision sdk package, which is available for download at http://bangsdowebsvr01.india.ti.com/VISION_SDK/02_09_00_00/.
- *TDA3xx Vision SDK Network Tool User's Guide*: This is a part of the Vision SDK release that can be found under the 'docs' folder in the vision sdk package, which is available for download at http://bangsdowebsvr01.india.ti.com/VISION_SDK/02_09_00_00/.

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