Application Note

Building Automotive 360-Degree Surround View Systems Using FPD-Link High-Speed SerDes

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ABSTRACT

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With the development of Advanced Driver Assistance Systems (ADAS), surround-view camera data must be transmitted to ADAS to achieve assisted parking, while also being transmitted to In-Vehicle Infotainment (IVI) systems for 360-degree surround view display. Therefore, the hardware coupling between the surround view system and automotive ADAS increases the complexity of automotive 360-degree surround view systems. This application note first introduces common application scenarios and display requirements of current automotive 360-degree surround view systems, and then details how to use FPD-Link to meet system requirements for different application scenarios, thereby helping users more rapidly design automotive 360-degree surround view systems that fulfill display requirements.

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1 Introduction

The automotive 360-degree surround view system mainly captures 360-degree images around the vehicle in real time through four cameras and synthesizes a panoramic top-down view, providing the driver with an all-around field of vision, thereby helping them better understand the environment surrounding the vehicle. The system typically includes key components such as four surround-view cameras, an image processing unit (IVI SoC), and a display. The cameras are installed at the front, rear, and both sides of the vehicle respectively, capturing images from different angles. With the rapid development of Advanced Driver Assistance Systems (ADAS), surround-view camera data must be transmitted to Advanced Driver Assistance Systems (ADAS) to achieve assisted parking, and also needs to be transmitted to In-Vehicle Infotainment (IVI) systems for automotive panoramic display, causing the automotive 360-degree surround view system to be deeply coupled with automotive ADAS, which makes the scenarios of automotive 360-degree surround view systems relatively complex.

2 Application Scenarios and Requirements

2.1 Application Scenarios

With the development of Advanced Driver Assistance As shown in Figure 2-1, an automotive 360-degree surround view system is typically composed of front, rear, left, and right four-channel surround-view cameras transmitted to the In-Vehicle Infotainment (IVI) system via a first-stage SERDES, and the IVI SoC performs stitching and image optimization on the multiple camera images. When the vehicle is equipped with ADAS applications, the surround-view camera data needs to be transmitted to the IVI system to achieve panoramic applications, and also needs to be transmitted to the ADAS system to achieve assisted parking. Depending on whether the ADAS SoC and the IVI SoC constitute a single-board system, current automotive 360-degree surround view systems are mainly divided into the following two categories:

1. When the ADAS and IVI systems are non-single-board systems, the surround-view camera data is typically sent to the ADAS first, and the ADAS then sends the surround-view camera data to the IVI system through an additional serializer/deserializer, as shown in Figure 2-2.
2. When the ADAS and IVI systems are a single-board system (Cockpit-Driving Integration Solution), the surround-view camera data is output to different SoCs of ADAS and IVI respectively through different CSI output ports of the deserializer, as shown in Figure 2-3.

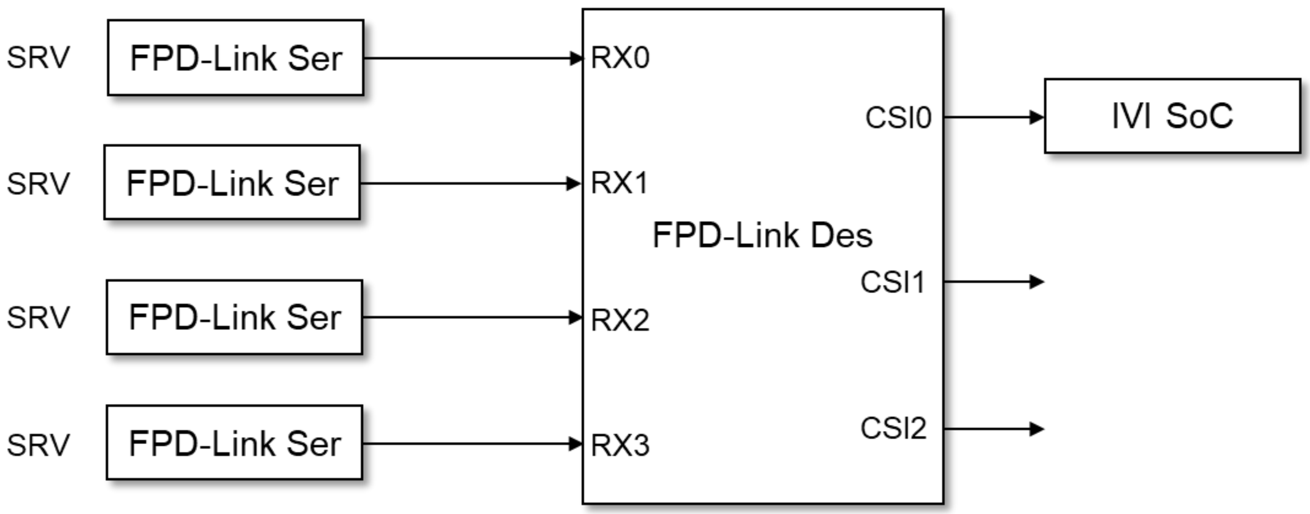


Figure 2-1. FPD-Link Serializer/Deserializer (SERDES) Transmission Schematic Diagram

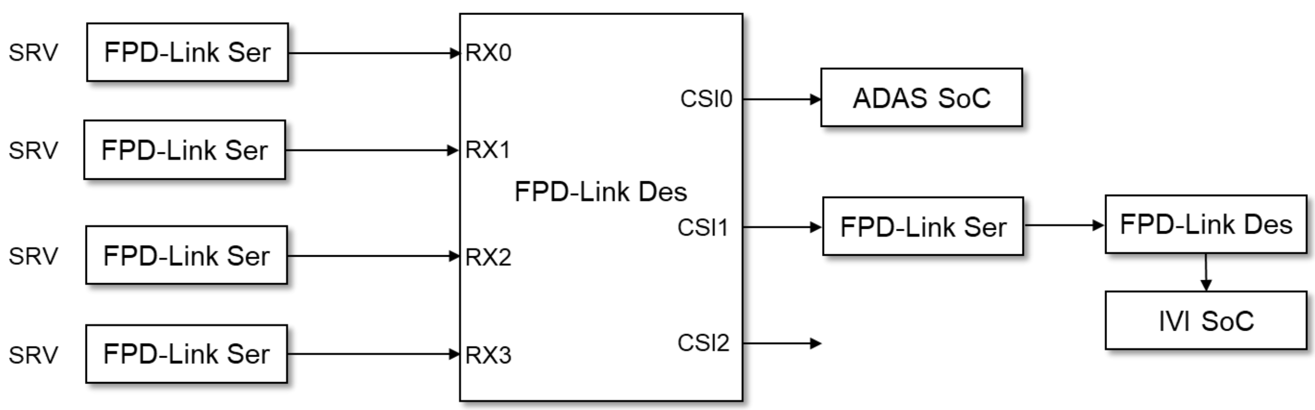


Figure 2-2. Typical Block Diagram of Dual-Stage SERDES Transmission for Automotive 360-Degree Surround View Systems

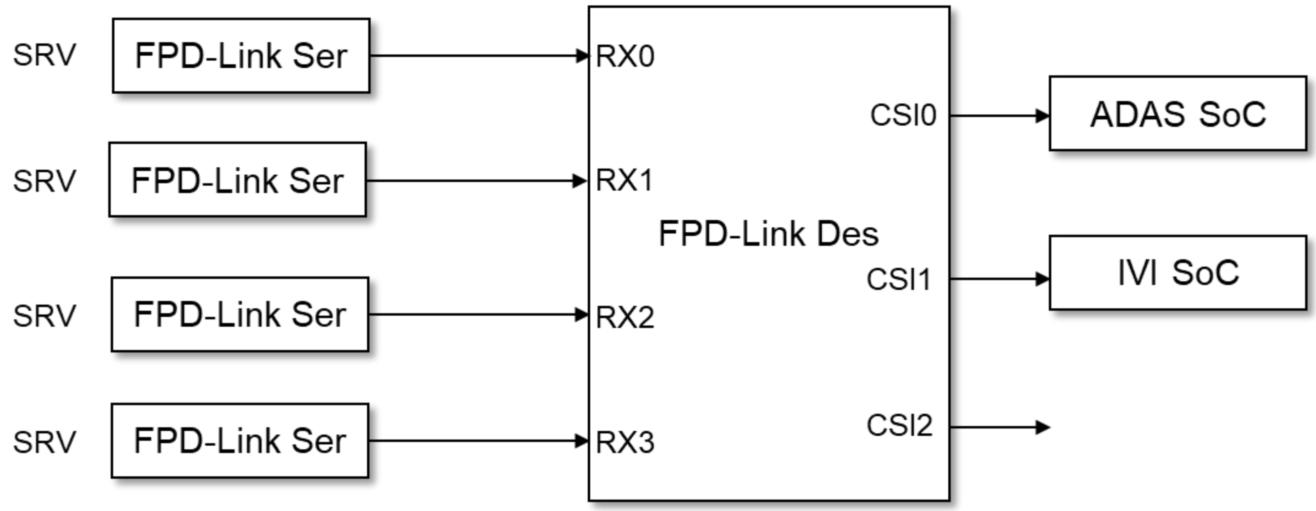


Figure 2-3. Typical Block Diagram of Single-Stage SERDES Transmission for Automotive 360-Degree Surround View Systems

2.2 Display Requirements

The automotive 360-degree surround view system needs to capture and display images around the vehicle in real time, so the data from the four-channel surround-view cameras must maintain synchronization to avoid display misalignment; furthermore, when a certain channel of the surround-view camera operates abnormally (such as a hot-plug event), the other channels of cameras must maintain normal display, as shown in Figure 2-4.

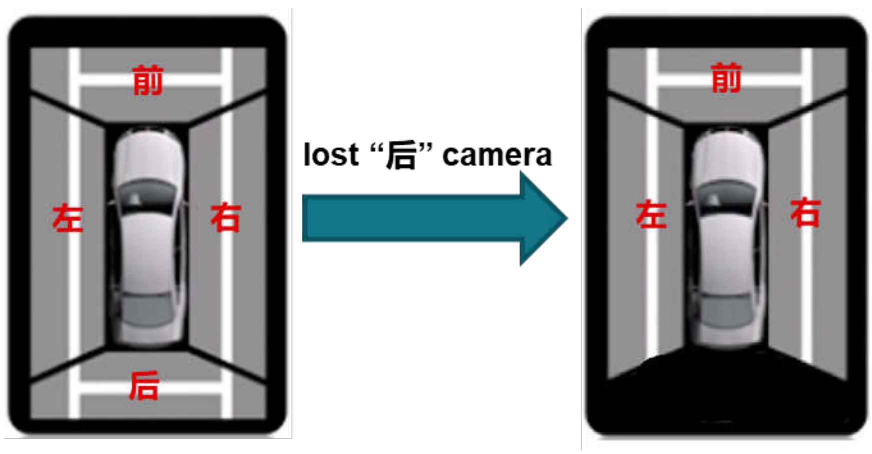


Figure 2-4. Display Requirements of Automotive 360-Degree Surround View Systems When an Input Camera Anomaly Occurs

3 Solutions

FPD-Link Des CSI output supports two aggregation modes: synchronous mode and non-synchronous mode. To maintain synchronous output of the four-channel surround-view camera data, the FPD-Link Des CSI output in automotive 360-degree surround view systems typically adopts the synchronous aggregation mode. However, when FPD-Link Des uses the synchronous aggregation mode and an anomaly occurs in a certain channel of the camera, the FPD-Link Des CSI port will stop outputting, resulting in a system black screen, as shown in Figure 3-1. To ensure that when an anomaly occurs in a certain channel of the camera, the other cameras can still display normally, the following operations are generally required. Solutions will vary for different application scenarios, please refer to the text below for more detailed operations.

1. Disable the forwarding of the abnormal input port of FPD-Link Des to resume CSI output.
2. The IVI SoC performs a black data padding operation for the abnormal input port.
3. During steps 1 and 2, the IVI SoC uses the previous frame image for display to guarantee that no black screen occurs in the display.

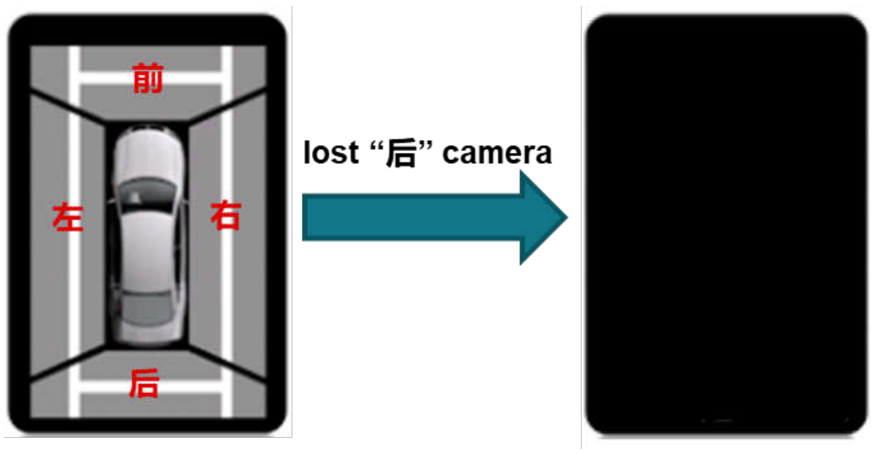


Figure 3-1. CSI Output Limitations of FPD-Link Des Synchronous Aggregation Mode When an Input Camera Anomaly Occurs

3.1 Panoramic Application with Single-Stage SERDES Transmission

For the application scenarios in Figure 2-1 and Figure 2-3, since the IVI SoC can learn which specific channel of the surround-view camera is abnormal by locally accessing the surround Des, it can fill the damaged camera with black data, making the solution relatively simple, as shown in the Figure 3-2 flowchart.

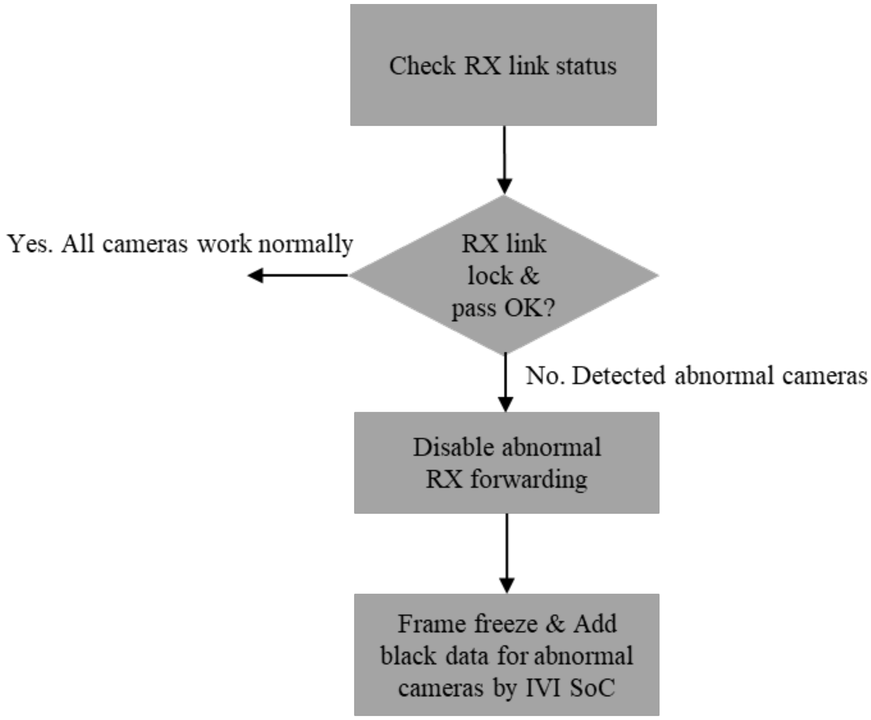


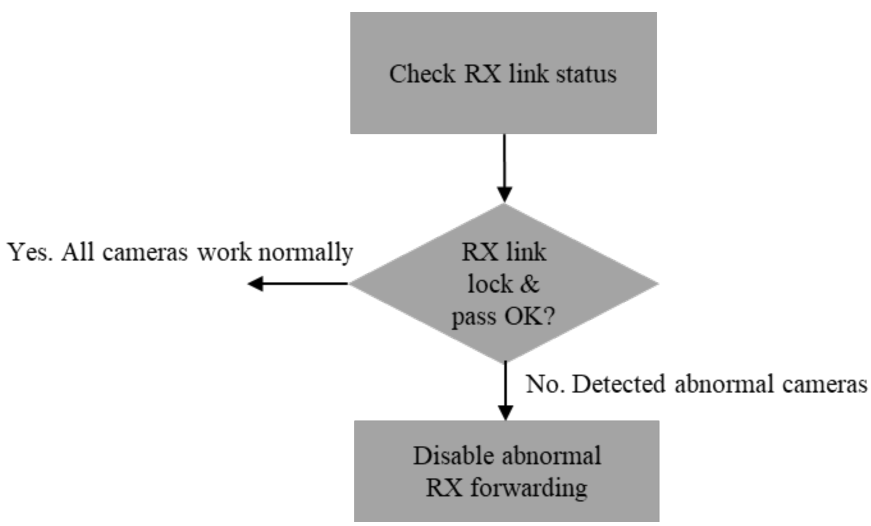
Figure 3-2. Solution for Panoramic Application with Single-Stage SERDES Transmission

3.2 Panoramic Application with Dual-Stage SERDES Transmission

3.2.1 IVI SoC Supports CSI-2 VCID Detection

When the IVI SoC supports CSI-2 Virtual Channel Identifier (VCID) detection, although the IVI SoC cannot learn which specific channel of the camera is damaged through the local Des, it can obtain this information through the FPD-Link Des output CSI-2 VCID detection, thereby padding the data of the damaged camera with black data. The solution is as follows.

ADAS SoC：



IVI SoC:

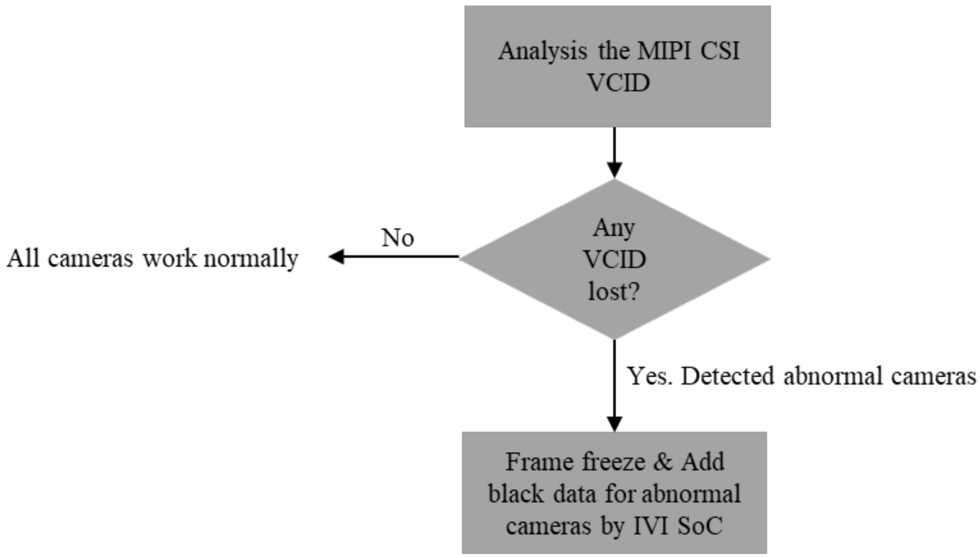


Figure 3-3. Solution for Dual-SERDES Transmission Panoramic Application When IVI SoC Supports VCID Detection

3.2.2 IVI SoC Does Not Support VCID Detection

When the IVI SoC does not support VCID detection, the IVI SoC needs to obtain information regarding which specific channel of the camera is damaged through the ADAS ECU. Therefore, the solution involves both software and hardware, and the recommended solution is as follows.

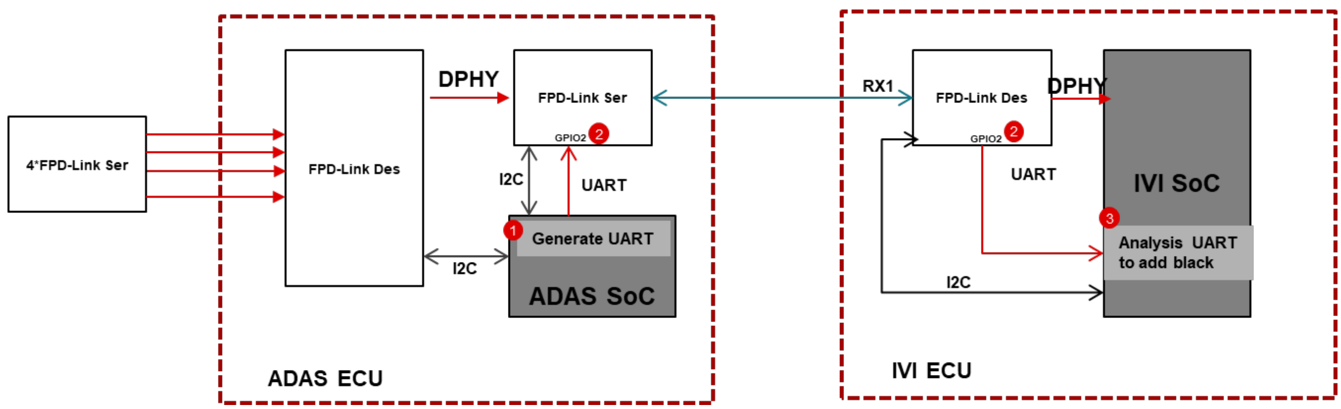
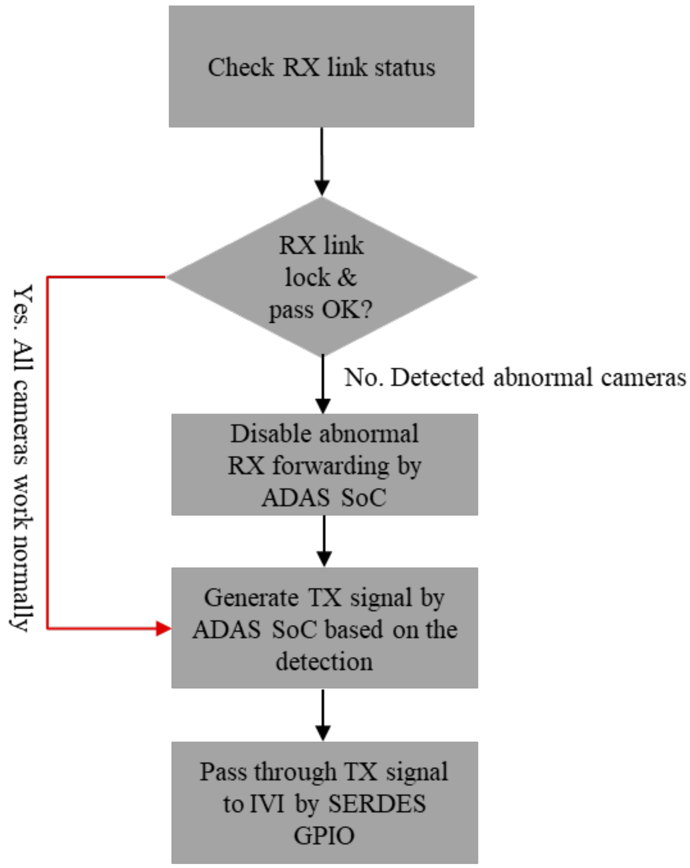


Figure 3-4. Hardware Part of Solution for Dual-SERDES Transmission Panoramic Application When IVI SoC Does Not Support VCID Detection

To ensure the software independence of the ADAS ECU and the IVI ECU, I2C communication is typically not allowed between the ADAS ECU and the IVI ECU. Therefore, FPD-Link GPIO pass-through is utilized to realize UART communication between the ADAS ECU and the IVI ECU, as shown in Figure 3-4. The software part is shown in Figure 3-5.

ADAS SoC:



IVI SoC:

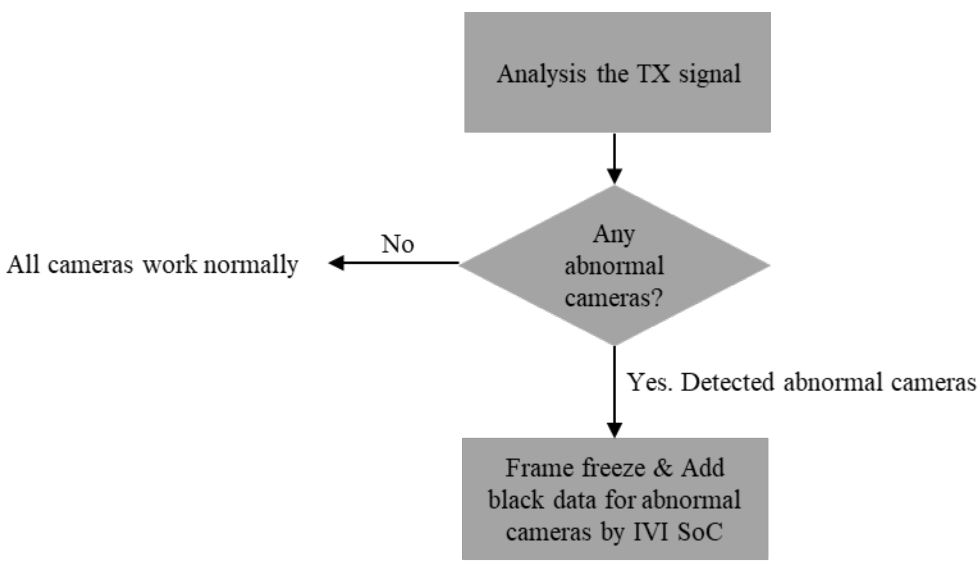


Figure 3-5. Software Part of Solution for Dual-SERDES Transmission Panoramic Application When IVI SoC Does Not Support VCID Detection

4 Summary

FPD-Link Des CSI-2 output supports synchronous and non-synchronous aggregation modes. Since the automotive 360-degree surround view system requires data from four channels of surround-view cameras to maintain synchronization, the FPD-Link Des CSI output needs to use the synchronous aggregation mode. However, when the FPD-Link Des CSI-2 output adopts the synchronous aggregation mode, it suffers from the pain point that FPD-Link Des will pause outputting if an anomaly occurs in a certain channel of the camera. This paper analyzes various automotive 360-degree surround view system scenarios in detail, providing system solutions for different application scenarios that satisfy the display requirements of automotive 360-degree surround view systems.

5 References

1. *DS90UB953A-Q1 datasheet*
2. *DS90UB960-Q1 datasheet*
3. *DS90UB9724-Q1 datasheet*

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