

High-Quality Analog Video Transmission Over Fiber Optic Cable

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1. Introduction

As industries continue to modernize, many legacy systems still rely on analog video formats such as PAL and NTSC for surveillance, industrial monitoring, and defense applications. However, traditional coaxial cables introduce signal degradation and interference over long distances.

This white paper introduces an FPGA-based analog video transmission system over fiber optic cable, ensuring long-distance, low-latency, and interference-free video transport while maintaining compatibility with existing analog video infrastructure.

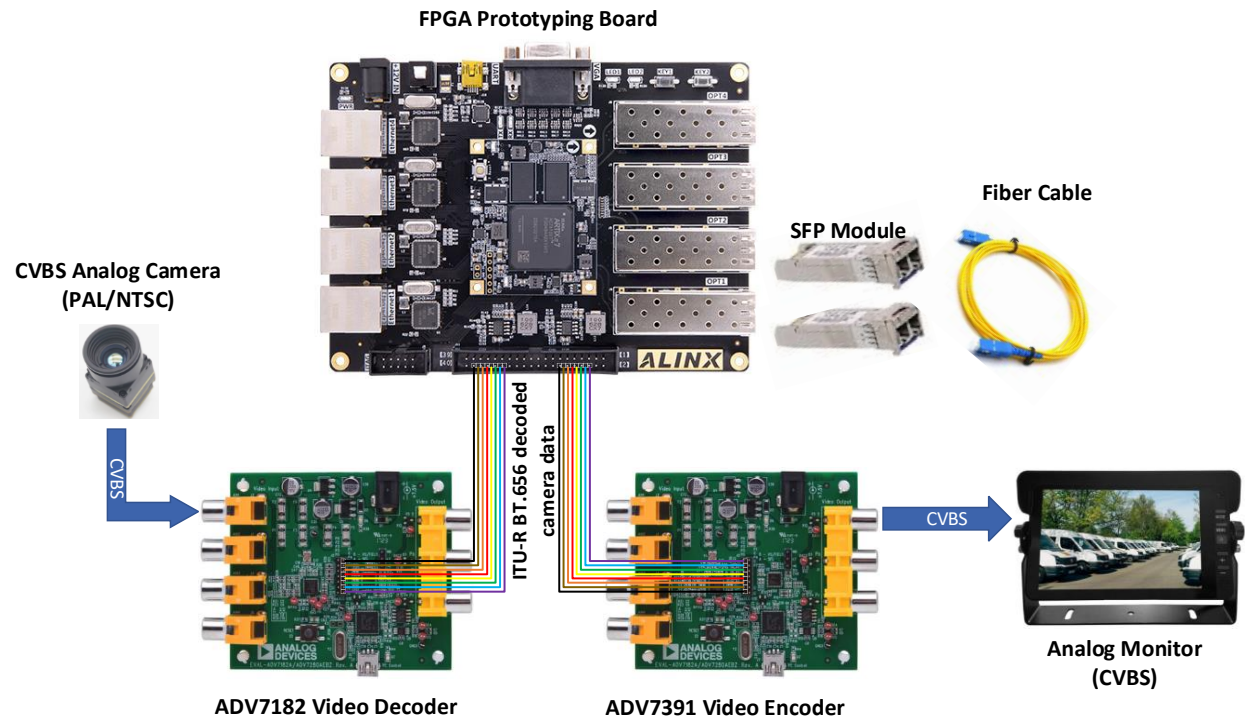
2. System Overview

The proposed solution digitizes PAL/NTSC analog video signals using the Analog Devices ADV7280 encoder, transmits the video stream over fiber optic cable via an FPGA, and reconstructs the original analog signal using a video decoder.

System Components:

- Analog Video Input: PAL/NTSC signal from cameras
- Video Encoder: ADV7280 converts analog to ITU-R BT.656 digital format
- FPGA Processing: 8-bit data + pixel clock processing and fiber optic transmission
- Fiber Optic Communication: Lossless transmission over long distances
- Video Decoder: Converts digital back to analog for display on legacy monitors

Block Diagram of the prototyping demo:



3. Key Features & Advantages

- Long-Distance Transmission: Fiber optic cables enable video transport over several kilometers without quality loss
- Low Latency: FPGA-based real-time processing ensures minimal delay
- Interference-Free: Immune to electromagnetic interference (EMI) compared to coaxial cables
- Compact & Scalable: Custom FPGA implementation allows optimization for various use cases
- Cost-Effective Upgrade Path: Supports existing PAL/NTSC analog infrastructure without requiring a full digital overhaul
- Customizable for Industry Needs: Can be tailored for defense, industrial and medical applications

4. Technical Specifications

Table 1: Technical Specifications of the System

Parameter	Specification
Input Video Format	PAL/NTSC (CVBS)
Digital Encoding	ITU-R BT.656 (8-bit YCbCr)
Transmission Medium	Fiber Optic Cable
FPGA Interface	8-bit video data + pixel clock for video data – Aurora for fiber cable
Output Video Format	PAL/NTSC (CVBS)
Latency	< 23us (Tested for 5-meter fiber cable loopback)

5. FPGA Resource Utilization

The system is implemented on an FPGA, ensuring efficient video data handling with minimal resource usage. Below is an estimated breakdown of FPGA resource utilization:

For AMD 7 series FPGAs with default synthesis options of Vivado 2021.1, the project includes both the transmitter and the receiver sides:

Table 2: Resource Utilization for Transmitter and Receiver

Resource	Utilization
LUT	1059
LUTRAM	37
FF	1963
BRAM	2
GT	2
BUFG	6
MMCM	2

Only transmitter, where the decoded ITU-R BT.656 video stream is taken as input and sent through fiber cable:

Table 3: Resource Utilization for Transmitter Only

Resource	Utilization
LUT	546
LUTRAM	22
FF	995
BRAM	1
GT	1
BUFG	6
MMCM	2

Only receiver, where serial data is received from fiber cable and encoded ITU-R BT.656 video stream is sent to video encoder system:

Table 4: Resource Utilization for Receiver Only

Resource	Utilization
LUT	521
LUTRAM	22
FF	970
BRAM	1
GT	1
BUFG	6
MMCM	2

6. Applications & Use Cases

A. Surveillance & Security

- Analog **CCTV** systems requiring long-distance transmission without quality degradation.

B. Industrial & Legacy Systems

- Manufacturing environments where **older analog cameras** are used for process monitoring.

C. Aerospace & Defense

- **UAVs, military vehicles, and aircraft** using legacy analog video systems for situational awareness.

D. Medical & Automotive Applications

- Transmission of **medical imaging video** over fiber for low-latency diagnostics.
- Automotive **rear-view and parking camera systems** in large transport vehicles.

7. Deliverables

Our deliverables are tailored to meet the specific needs of our customers. We offer flexible options, including:

1. Vivado Project with Source Code & IP Configurations

We provide a fully functional Vivado project, including all source code and IP configurations, ensuring complete transparency and flexibility. As part of our service, we offer:

- A comprehensive online training session covering project architecture and functionality.
- Detailed explanations of design blocks and their operation.
- A real-time demonstration of the working system.

2. Complete System Design with Custom PCBs

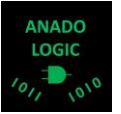
For customers requiring a turnkey solution, we deliver a complete hardware system, including:

- Custom PCB design tailored to the project requirements.
- Manufacturing options, including prototype assembly and mass production support.
- A dedicated online training session covering system architecture and integration.
- A live demonstration showcasing system performance and functionality.

3. Custom Configuration & Design Modifications

We offer fully customizable solutions beyond our standard prototyping demo. Our team can:

- Modify FPGA configurations and PCB layouts to meet specific needs.
- Integrate pre- or post-processing blocks for enhanced image or signal processing.
- Implement feature enhancements based on customer requirements.



As with all deliverables, we provide an online training session, a detailed technical briefing, and a real-time system demo.

8. Conclusion

This FPGA-based Analog Video Transmission Over Fiber system provides a reliable, interference-free, and low-latency solution for industries that still rely on PAL/NTSC video. It enables seamless integration with existing infrastructures while leveraging the benefits of fiber optic transmission.

For inquiries, customization requests, or potential partnerships, contact:

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