Active Silicon LONG-REACH VIDEO TRANSMISSION

WHITE PAPER

# HIGH-DEFINITION LONG-REACH VIDEO TRANSMISSION

Active Silicon


*Headquarters:*

Active Silicon Ltd
1 Waterside Court, Waterside Drive,
Langley, Berks, SL3 6EZ, UK.

Tel: +44 (0)1753 650600
Email info@activesilicon.com
Website: www.activesilicon.com

*North America:*

Active Silicon, Inc.
479 Jumpers Hole Road, Suite 301,
Severna Park, MD 21146, USA.

Tel: +1 410-696-7642

Email: info@activesilicon.com
Website: www.activesilicon.com

## Executive Summary

This white paper looks at high-definition, real-time image acquisition using long cables and how it is possible to transmit video digitally over twisted pair cables up to 150m and coax cables up to 700m, with fiber optic offering the option of many kilometers.

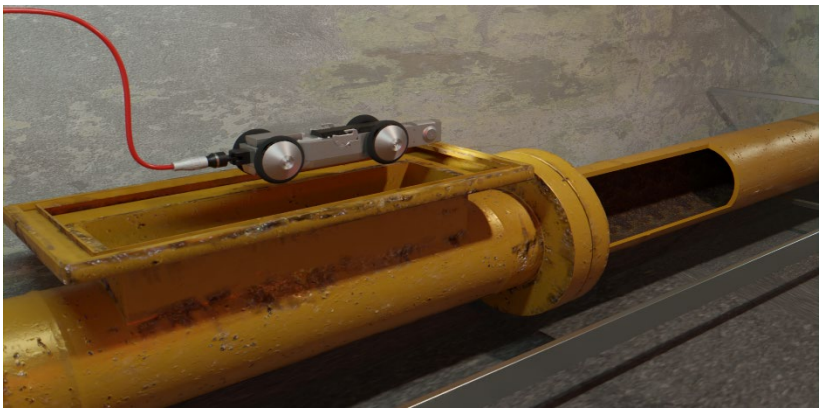
Maintaining image quality when receiving analog and digital video over extended distances has proved to be challenging. Various technology solutions and hardware have been explored and developed to address latency, resolution and cost issues. This paper will look at these options, and which solutions best address these challenges.

## Applications using long-reach video transmission

High-definition image acquisition for long-reach video is a particularly important aspect of **pipe inspection**, where small cameras are used in enclosed spaces, under limited lighting conditions. Applications include sewer inspection, pipe repair and industrial pipe inspection in the **wastewater, energy, telecoms and manufacturing sectors**. In pipe inspection, cameras are generally built into pushrod systems, which are mechanically operated, or pipe crawlers, which have varying amounts of remote control. These systems may include a number of slip rings, which allow cables to rotate in the pipe without twisting, and crawlers to turn or spin in excess of 360 degrees.

Clearly, it is important that images are of a suitable high resolution since operators are searching for tiny cracks and imperfections in the pipe structure. It is also imperative that pushrods and crawlers can operate at length to enable as much pipe work as possible to be inspected with the minimum amount of surface disruption.

**Surveillance and security** applications also benefit greatly from this technology. Defense systems, surveillance, ROVs and robotics all use compact cameras with long cables and/or slip rings to allow cameras to bend and turn, changing the direction of viewing.



## Introduction to long-reach video technology

The optimum way to receive high-quality digital video is to acquire raw uncompressed data, but this of course, results in a very high data rate. Compressing the video to reduce the data rate can result in reduced resolution and/or image artefacts. High Definition (HD) video is normally transmitted at a serial data rate of 1.485 Gb/s or 2.97 Gb/s. While these rates work well over short cable runs, it is not possible to use these data rates over long cable lengths without significant cost.

High-Definition Serial Digital Interface (HD-SDI) and 3G-SDI (2.97 Gb/s) are progressive scan formats which are typically transmitted uncompressed over a single coaxial cable. These formats benefit from low latency and can handle uncompressed data, but cable lengths are limited depending on the system hardware.

Historically, long-reach vision systems have been limited to SD analog transmission up to several hundred meters, often with supplementary amplifiers. However, requirements for long-reach video transmission in HD video applications are becoming more prevalent and new technologies are emerging to enable video transmission at lower data rates whilst preserving image quality.

## IP Compression

One established method of transmitting high-definition video is IP Compression using Motion-JPEG, or M-JPEG, format. In this process, each video frame is compressed separately as a JPEG image. The standard is common in gaming consoles and digital cameras developed for the consumer market. H.264, or MPEG-4, is a more commonly used standard as it allows a higher compression ratio but at the expense of latency (and quality on a per frame basis). To cope with recent 4K video, this has been developed further, resulting in H.265, or High Efficiency Video Coding (HEVC), but this method currently requires additional hardware in the system to enable encoding/decoding of HEVC video. However, while these Ethernet solutions benefit from using mature compression standards that are widely supported, they incur latency, require large data storage facilities or bandwidth capacities, additional (often expensive) hardware and inevitably result in inferior image quality.

## Alternative technologies

- High-Definition Composite Video Interface, or **HD-CVI**, is an analog solution offering artificial higher analog image resolution by manipulation of the standard analog image signal. It requires minimal installation requirements and is targeted at the mid to low-end surveillance market.
- High-Definition Transport Video Interface, **or HD-TVI**, was developed by Techpoint in 2012 and supports 1080p video resolution over cable lengths up to 500m. It is focused at the high-volume surveillance market and provides limited support or information for the industrial sector.
- **EX-SDI** is a technology encompassing Visually Lossless CODEC (VLC) which can be encoded at both 270 Mb/s and 135 Mb/s; however, purchase of the encoder chips generally incurs a minimum order value. This, like HD-TVI, is also a solution for high-volume security customers with little support for industrial applications.
- Analog High Definition, **AHD**, supports 720p and 1080p over coax cables, connecting CCTV cameras to DVRs. Downsides are the limitation in camera compatibility and configurability, plus the quality degrades with distance, since it is not a digitally-based system. While cost is competitive, image quality is not as good as that available with other technologies.

These options are all viable over shorter cable lengths but have not proven to provide the high-quality image results required by many applications over longer cable lengths. Furthermore, hardware is bulky and often expensive.

## HD-VLC™ - a preferred choice

High-Definition Visually Lossless CODEC (HD-VLC™) is an innovative technology, developed by Semtech Corporation, which works over cable lengths of at least three times that of HD-SDI products. This involves a unique CODEC which encodes HD data to the same rate as standard definition video, i.e. 270 Mb/s or 540 Mb/s serial data rate. The technology is easily accessible from a well-established supplier and is a dependable and consistent option. The advantages to using HD-VLC™ include:

- Ability to use coax cables up to 700m, twisted pair cables up to 150m and fiber optic cables over many kilometers.
- Hardware is compact, allowing the smallest possible components to be produced.
- No additional latency is introduced to the system, so images are transmitted in real-time.
- Superior image quality.
- Multiple slip rings can be used.


## Solutions from Active Silicon

Active Silicon has developed an interface solution to support HD-VLC™ and enable long-reach high-definition digital video transmission. This solution has been tailored to the pipe inspection sector but applies equally to many other application areas.

Harrier 10x AF-Zoom 3G-SDI Camera (Tamron MP3010M-EV)

Harrier 10x AF-Zoom 3G-SDI Camera

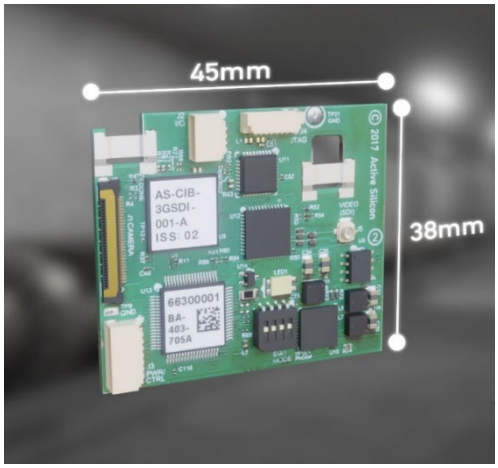
The solution comprises the Harrier 3G-SDI Camera Interface Board (shown above mounted on the side or on the back of a camera), compatible with autofocus-zoom cameras including the Tamron cameras (e.g. MP1010M-VC), Sony EV-series (e.g. FCB-EV7520) and Harrier series cameras (10x, 40x and the 36x with global shutter). The BlueBird SDI Adapter provides options for conversion from HD-VLC back to 3G/HD-SDI, USB 3.0 and HDMI.

Hardware has been tested using 75 Ohm coaxial cable and 100 Ohm twisted pair cable, as well as including a number of slip rings. Results are shown below[1].

| Cable type | HD-VLC 270Mb/s | HD-SDI 1.48Gb/s |
|---|---|---|
| Belden 1694A (RG6) | 700m | 230m |
| Belden 543945 (RG59) | 550m | 150m |
| KE-Link SYV 75-5 | 500m | 140m |
| Canare L-3C2V | 300m | 80m |
| Cat-5e/6 UTP | 150m | - |

## Harrier 3G-SDI Camera Interface Board

Active Silicon's Harrier interface board provides a cost-effective solution to take full advantage of the high-definition digital video provided by the camera, connecting directly to the camera's digital output to provide superior image quality and supporting all the HD-SDI modes of the camera up to 1.5 Gb/s and 3G-SDI up to 2.97 Gb/s. In addition, the interface board can provide simultaneous analog output in Standard Definition (SD) video in 720p50/60 modes and supports full screen 4:3 and 16:9 monitors.




Other features include a built-in test pattern which conforms to the SMPTE RP-219-2002 specification, and HD Visually Lossless Compression allowing much greater cable lengths. Additionally, it is programmed to enable activation of crosshairs and other application-specific overlays in the image data.

This board revolutionizes the transmission of digital video, allowing cable lengths not reached before, and complements our existing interface board and digital interface kit range. Harrier is the smallest and coolest-running board available on the market today.

[1] Test results according to Semtech Corp.

## BlueBird SDI Adapter

When using HD-VLC™ compression technology, the digital signal is encoded for long-distance, high-quality transmission. Active Silicon provides the BlueBird SDI Adapter, which converts the signal back into 3G/HD-SDI, USB or HDMI, ready for viewing on a monitor or processing via computer.


## Harrier 3G-SDI Series

Harrier allows crawler systems to transmit images over cable set-ups, including multiple slip rings, of up to 700m and pushrod systems up to 150m. It provides real-time imaging with low-latency, superior image quality and fits the smallest cameras available in the market.

Due to its compact size, the Harrier board is the only video interface board available to date which, in combination with small autofocus-zoom cameras, can replace legacy Sony FCB camera systems without requiring any significant mechanical changes to the existing enclosure. Therefore, it is an ideal component in the replacement of Sony FCB modules which have reached end-of-life status.

To find out more about the Harrier series of interface boards, and our other world-class vision system components, view product details on our website or contact us at the address overleaf.

## About Active Silicon

Active Silicon is a leading manufacturer of imaging products and embedded vision systems. We provide camera electronics for image data transmission, frame grabbers for data acquisition and embedded systems for image processing and machine control.

Founded in 1988, Active Silicon has a proven track record in providing reliable, high-quality products for a variety of industries world-wide. Our products have applications in many areas of science and industry including manufacturing, life sciences, medical imaging, security and defense. From space missions to large scale deployment of industrial vision systems, we have provided imaging components and embedded systems that help our customers provide world-class solutions.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