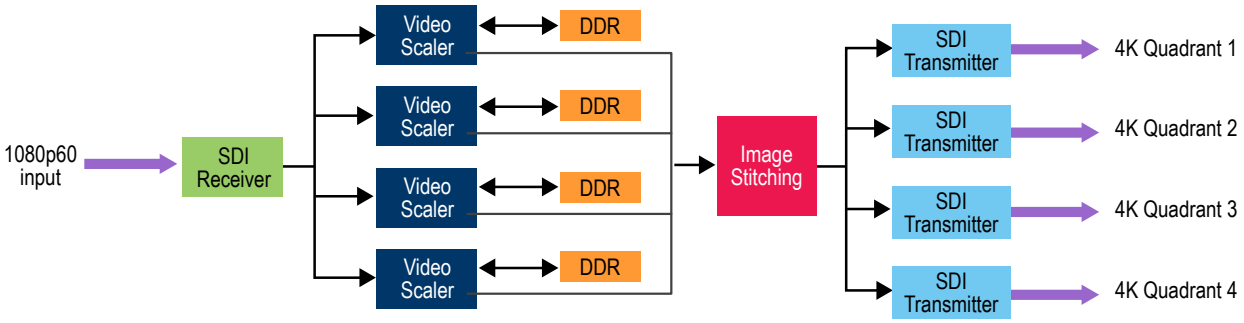
Single-Chip 4K Upscaling Solution With Integrated Video Interfaces

4K Ultra HD is the next major enhancement in professional video. A 4K video path can be constructed with four 1080p quadrants, each with their own video I/O, processing, and memory subsystem. An example of a 4K upscaling system is illustrated below. This seemingly straightforward approach poses challenges:

- The total memory available in the system can't be shared across quadrants
- Large board space needed to accommodate the number of components needed
- PCB layout difficulties with multiple wide parallel data busses between multiple devices
- Difficulty in merging and synchronizing across the four video pipelines

Diagram 1: Example ASIC-Based 4K UHD or QFHD Scaling System Block Diagram



Reduce Costs Using Altera's 4K Upscaler Reference Design

Altera has implemented a 4K upscaler design into a single device (diagram 1). Integrating these components into one FPGA lowers the overall cost, reduces design complexity, and simplifies board layout.

Altera's 4K upscaler design takes a PAL, 720p, 1080i, or 1080p input over a 3G-SDI interface and upscales it to QFHD resolution. The design offers a number of benefits:

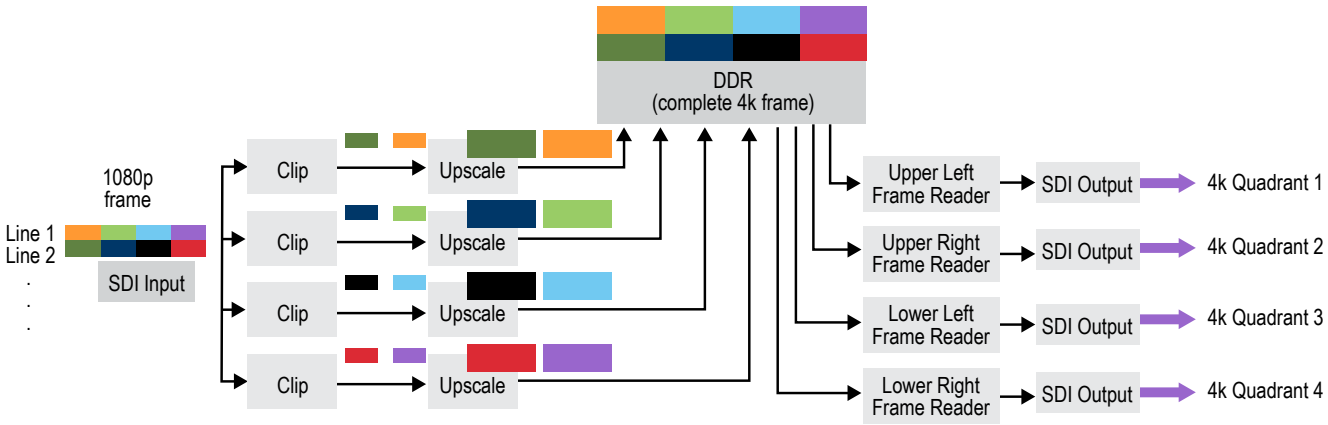
- Video processing pipelines operate at 148.5MHz, which is used in existing 1080p60 systems
- System initialization and run-time configuration in clear-text software code
- System is extensible to different number of video processing pipelines
- Highly parameterized and modular IP cores
- Standard interfaces makes it easy to integrate additional IP cores
- Hardware demonstrations of the 4K reference design is available on Stratix® IV and Stratix V

Table 1. Resource Usage

ALUTs	Logic Registers	Memory Bits	DSP Block 18-Bit Elements
51,810	60,616	4,824,456	190

The 4K reference design upscales each line from the source frame by splitting it into four vertical bands, where each band is passed to a separate processing pipeline. As the four upscaled vertical bands are written into external memory, they are recombined to form a seamless 4K UHD output frame. Four output frame readers then simultaneously retrieve the four quarters of the output frame from memory and send them over four 3G-SDI outputs (this is shown in diagram 2).

Diagram 2: Dataflow Diagram of Altera's 4K Upscaler Reference Design



The architecture shown in diagram 2 enables quick deployment of derivatives and variations. For example, extending to 16 video paths can support 4 channels of 4K UHD, 1 channel of 8K UHD, or 16 channels of HD. The I/O interface is decoupled from the video processing, so it can be swapped with other standards such as DisplayPort and HDMI. Because the design is migratable across FPGA families, there is ample headroom for integrating additional features such as video over IP, codec, additional processing, etc.

Accelerate Design Schedules With Altera's Video Infrastructure

Altera also provides a unique video design framework to significantly increase your productivity:

- **Video and Image Processing IP Suite:** a library of over 20 IP cores for video processing, all with a common open standard interface for ease of system integration
- **Video Verification Suite:** a free library of bus functional models and System Verilog functions for video system debug, supporting constrained random testing and video-RTL co-simulation
- **In-system Video Debug IP Cores:** you can generate video test patterns at any stage of your FPGA design to quickly troubleshoot source of issues. You can also monitor the video frames as they traverse through your FPGA design in hardware.
- **External Memory Performance Monitor:** a graphical utility that helps you analyze bandwidth and statistics so you can adjust bus arbitration and system performance

Want to dig deeper?

For more information about how Altera's video and image processing solutions can support your video processing applications, contact your local Altera sales representative or FAE, or download the application note *4K Format Conversion Reference Design* at http://www.altera.com/support/refdesigns/sys-sol/broadcast/ref-4k-video-upscaling.html.

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