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Helping man use images to communicate.

Application Note: Image/Video Processing/Compression Using A436 Video Digital Signal Processors DSP Chip

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Oxford Micro Devices' **A436 Video DSP Chip** is an extremely efficient and flexible, image/video processing/compression device. It dramatically reduces system size, cost and power dissipation compared to competitive devices.

It has many unique capabilities that make it ideal for building very fast, low power, low cost, compact, flexible, embedded and autonomous image/video processing/compression devices such as Still and Motion, Smart Cameras, and Video Editing Systems. It provides single chip (plus memory), user software-programmable, broadcast quality, video compression in ***real-time***. It supports multi-format / standards-based / non-standards based, image/video compression/decompression. Please contact us for additional information about our A436 VDSP Chip.

The A436 Chip is in development. Specifications are subject to change without notice. A limited number of partnering opportunities is available to give you a head start in developing products using it. Please contact us for more information on our partnering program.

Here are some of the many ways the A436 Chip helps you build small, low cost, very fast, flexible, embedded image/video processing/compression systems:

1) **Simple architecture -** The A436 Chip is specifically intended for ***real-time*** image/video processing/compression applications. It has an open architecture that can be understood quickly, greatly helping hardware and software engineers to use the A436. It is a very efficient processor for imaging and obtains very high performance with a relatively low clock rate. This reduces its complexity, cost and power dissipation.

2) **Many speed-ups built in** - The A436 Chip has many built-in features to accelerate image/video processing/compression. See below.

3) **Compact and low cost** - An autonomous (no PC, microcontroller or other processor required)

image/video processing/compression system can be built from only **four chips**: a digital image sensor, an A436 Chip, one 32b SDRAM and a small non-volatile memory. The A436 is very economical in quantity.

4) **Support for any type of sensor** - The A436 Chip can be used with any type of monochrome or color, digital image sensor. A variety of sensor interfaces is provided to initialize the sensor and read data from it. A flexible, glueless interface is provided to the digital output of the sensor. Data from the sensor is automatically loaded into a user-defined circular buffer in RAM in the A436 via a programmable DMA controller in the A436. To minimize power dissipation in applications with a low frame rate, data can be read from the sensor and stored in the A436's memory while the A436 is in a low power mode, then the A436 can immediately switch to a fully active mode to process the data. Or, a continuous video data stream can be read from the sensor and processed simultaneously. In addition, multiple image sensors can be connected to the same A436 for use in applications requiring multiple types or resolutions of image sensors.

5) **Fully software programmable** - The A436 Chip is fully and efficiently software programmable *by the customer* in our ANSI-compatible, parallel-enhanced version of C. The instruction set of Oxford's proven A236 Chip has been extended to provide additional performance in image/video processing/compression and fingerprint applications. Customers can port their code and algorithms to the A436 Chip using software tools we provide on our web site. The 32-bit instruction set of the A436 is simple enough, with little or no pipelining, that the assembly-language output of our C compiler can easily be viewed, analyzed and modified if desired.

6) **Optimized imaging data types** - The manipulation of image/video data requires the use of a variety of imaging-specific data formats such as YUV and SRGB. The A436 provides direct, instruction-level support for a variety of parallel data types to handle these data formats very efficiently.

7) **Highly flexible** - Any type of image/video compression algorithm can be implemented, whether standard (e.g., jpeg) or special (e.g., motion wavelets). The A436 is NOT hardwired to any particular form of compression; it has built-in instruction-driven building blocks that support all forms of compression.

8) **Fast time to market** - With the widespread use of the Internet, new demands for image processing occur everyday. Standards cannot be written fast enough. A single hardware design can be made with the A436 and its functionality changed as needed, or in the field, by reprogramming the A436 and storing the code in an external Flash EEPROM. The A436 is pin-compatible (with the exception of some power pins) with our current A236, which can be used now for initial system development.

9) **Large built-in caches** - A large, wide Data Cache with an efficient page replacement algorithm is provided in the A436 Chip to provide efficient implementation of critical image/video processing/compression applications. The Data Cache is large enough to efficiently support wide-area searches for motion estimation.

10) **Series / parallel use** - Highly modular image/video processing/compression systems can be built easily by using multiple A436 Chips in series and/or parallel. The A436 Chip's three DMA ports support both video and packet modes of operation to enable data to be moved among multiple A436 Chips and other processors easily.

11) **Low power dissipation** - The caches and parallel arithmetic units have all been designed to minimize power dissipation. An internal SRAM enables the A436 to perform rapid interrupt service, and to boot and perform power management operations while the external SDRAM is completely turned off.

12) **Power management** - Extensive chip- and system-level power management features are provided by the A436 Chip. Quiescent power dissipation is virtually zero. Long battery life is provided. Management of the power of external SDRAMs is provided for battery-powered and other low power applications.

13) **Full-featured I/O**

a) **Serial I/O** - The A436 Chip has three serial ports, a UART (RS-232) port for serial communications with a remote system, a programmable 2-wire/3-wire high speed / low speed, DMA serial bus port for control of local chips such as image sensors, infrared interface and flash memory cards, and a full-duplex stereo audio port.

b) **Parallel I/O** - The A436 Chip has three parallel I/O ports, each with its own dedicated DMA controller. One port is typically used to read data from a sensor, one port is used to interface to an external Flash EEProm, and the third port is typically used to interface to a video display device such as an LCD. The ports support streaming (e.g., live image and video) and packet modes of operation.

c) **Programmable I/O Lines** - The A436 Chip has software-programmable I/O lines that can easily be connected to a variety of devices including keypads, indicators, actuators, and switches. These lines can also be used to reset devices and provide chip selects to peripheral devices.

14) **Fast start-up and mode change** - The A436 can start up very quickly after being reset and can change operating modes very quickly. Thanks to its internal SRAM, the A436 can boot with the external SDRAM turned completely off.

15) **Small size** - The A436 Chip is being housed in both standard and small, chip-scale, packages for use in miniature portable devices.

16) **Multipurpose** - The A436 Chip is optimized for wireless image/video processing/compression applications AND fingerprint applications. A single DMA port of the A436 Chip can support both a fingerprint image sensor AND a color visual image sensor at the same time. As a result, a single low cost miniature system can have BOTH fingerprint and video compression / conferencing capability within it, or separate devices can be built.

17) **Image display** - Image/video processing/compression involves the capture and processing of images, and, depending upon the application, the display of images for a graphical user interface. Multiple double-buffered DMA ports are built into the A436 Chip to acquire and display live images, reducing system size and cost.

18) **Lens correction in real time** - The A436 can be programmed to correct geometric and chromatic aberrations, and modulation transfer function (MTF) variations in low cost lenses in real

time, before processing or compressing the images, reducing system size, cost and weight. Increased depth of field and light sensitivity can also be provided easily.

Some of the many ways that the A436 Chip greatly speeds up image/video processing/compression are:

1) **Motion estimation / pattern recognition coprocessor** - The A436's tightly coupled internal *Motion Estimation / Pattern Recognition Coprocessor* can perform a 64-point motion estimation calculation every CPU clock, delivering the equivalent of more than **50,000 MIPS**, orders of magnitude faster than any other processor. This co-processor can also be used to align color planes to one another and make distance measurments on vectors.

2) **Fast multiplier / adders** - The A436 can perform 3.2 billion, 16b x 16b, multiply/adds per second, greatly accelerating image processing/compression. Parallel matrix-vector and convolution computations are supported.

3) **Fast matrix transpose** - The A436 can transpose matrices instantly, as the data is being accessed for some other operation, greatly accelerating image processing/compression such as 2-D DCTs.

4) **Sliding window addressing** - The A436 can access and process parallel operands in a single cycle regardless of the alignment of the parallel operands in memory, greatly accelerating filtering, convolution, motion estimation, etc.

5) **Reduction of memory size** - The A436 can operate upon images in the native, SRGB color filter dot format from digital image sensors, reducing the size of image buffers by one-half compared to the storing of images in Y-U-V format.

6) **Gain adjustment** - The A436's parallel arithmetic units can quickly adjust the gain of individual pixels in a sensor.

7) **Linear and non-linear filtering** - The A436's parallel arithmetic units can quickly implement small and large, linear and non-linear 2-D filters upon the images. Uses include convolution, contrast enhancement, erosion, dilation, line-thinning, edge-enhancement, etc.

8) **Thresholding** - The A436's parallel arithmetic units can quickly convert gray-scale images to binary. This can be done using a map of the defects in a given fingerprint image sensor if desired.

9) **Multiple image formats** - The A436 can efficiently operate on image data in Y-U-V (e.g., TV) or SRGB color filter dot (e.g., Bayer 2G) format.

10) **Equalization** - The A436's parallel arithmetic units can quickly perform multiple histogram measurement and equalization operations in parallel. FFTs and other algorithms can be sped up, too.

11) **Histograms, table look-ups and DCT read-outs** - The A436's parallel arithmetic units can perform eight table look-up / histogram operations in parallel to quickly perform non-linear pixel transformations and compute histograms. This same capability can be used to quickly read out DCT results having a diagonal placement in memory.

12) **Efficient pyramidal / hierarchical processing** - The A436 can efficiently implement pyramidal or hierarchical image processing to reduce the scale of images and reduce the amount of memory to store them and the amount of time spent matching patterns.

13) **Orientation normalization** - The A436's parallel arithmetic units can quickly scale, rotate and translate images and feature vectors to normalize image size, position and orientation.

14) **Distance measurement** - The A436's parallel arithmetic units can quickly perform multiple distance measurements between feature vectors in parallel. This is useful in applications where it is desired to find the best match among many candidates.

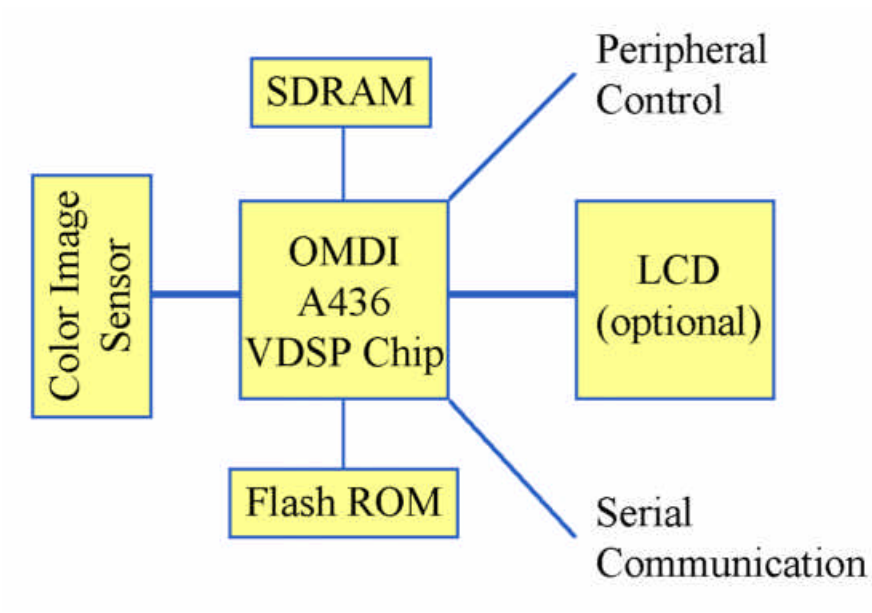
15) **Bit-packing** - The A436 has enhancements that provide fast bit-packing for image/video compression.

16) **Encryption** - The A436's parallel arithmetic units can quickly implement encryption / decryption algorithms.

Applications

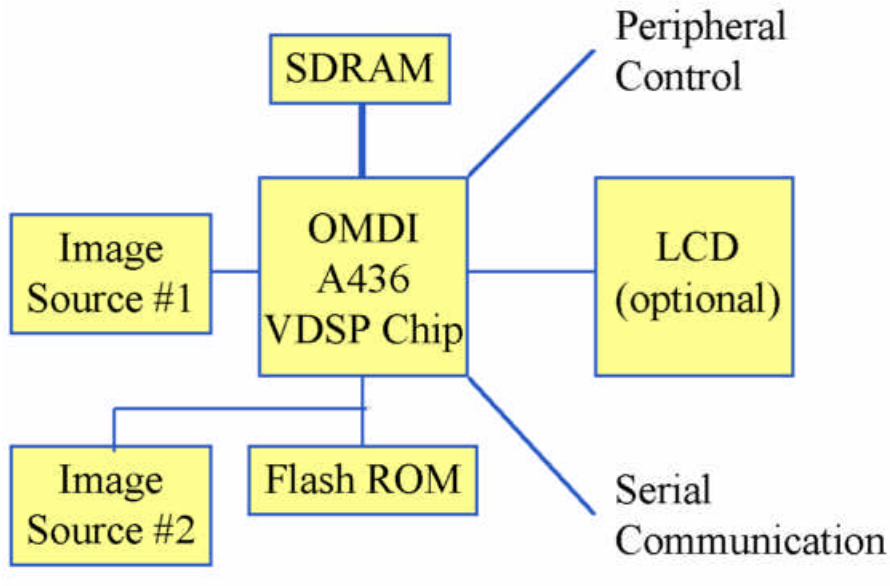
Smart web cameras	**Smart digital cameras**	**Vehicle blindspot elimination systems**
Video compression cameras	**Digital cameras with high frame rates**	**Single- and multi-sensor, professional, still and video cameras**
Handheld video conferencing systems	**Smart surveillance cameras**	**Stereo cameras**
Programmable inspection cameras	**Extremely high resolution imaging and personal identity authentication systems**	**Smart video monitoring systems and color quad/octal processors**
Smart fax machines and scanners	**Smart 1-D and 2-D barcode scanners**	**Video editing systems**

Block Diagrams of Typical Applications



Block Diagram #1: Flexible, fully software programmable, high frame rate, *Smart Still, Video or Web Camera*

Five-chip (including an image sensor and two SDRAM chips) multi-purpose, *Smart Camera* using OMDI A436 Video DSP Chip, shown with optional LCD for image / video display.



Block Diagram #2: Flexible, fully software programmable, *Smart Professional Camera or Video Editing System*

Six-chip (including two image sensors, video decoders or other image sources/interfaces, and two SDRAM chips) multi-purpose *Smart Professional Camera* or *Video Editing System* (with external hard drive) can combine live or stored images from two image sources to form composite images. It can also be used as a stereo camera.

Please contact us to discuss your application in detail.

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Ax36 Parallel Video Digital Signal Processors DSP Chips

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