

Industrial Imaging

Applications of the K2H and K2E platforms in high-end imaging



TI's K2E and K2H System-on-Chip (SoC) platforms, based on the KeyStone II multicore architecture, are 28-nm high-performance platforms that deliver power-efficient processing solutions for high-end imaging applications. These devices are the first to integrate ARM® Cortex™-A15 MPCore™ processors with high-performance TMS320C66x DSP cores, providing heterogeneous processing at industry-low power-consumption levels.

The integration of the Cortex-A15 processors greatly reduces system cost and design complexity by removing the need for a high-end general-purpose processor. With full support of SMP Linux™, the Cortex-A15 processors enable developers to quickly and easily migrate existing software designs to the low-power, high-performance K2E and K2H platforms.

| | ARM® Cortex™-A15 | C66x DSP | 5-Port 1 GbE Switch | 3-Port 10 GbE Switch | NetCP |
|------------|------------------|----------|---------------------|----------------------|-------|
| K2E | | | | | |
| AM5K2E02 | 2 | 0 | 1 | 0 | 1 |
| AM5K2E04 | 4 | 0 | 2 | 2 | 2 |
| 66AK2E05 | 4 | 1 | 2 | 2 | 2 |
| 66AK2E02 | 1 | 1 | 1 | 0 | 1 |
| K2H | | | | | |
| 66AK2H12 | 4 | 8 | 1 | 0 | 1 |
| 66AK2H06 | 2 | 4 | 1 | 0 | 1 |

Table 1 – Devices in the KeyStone II architecture

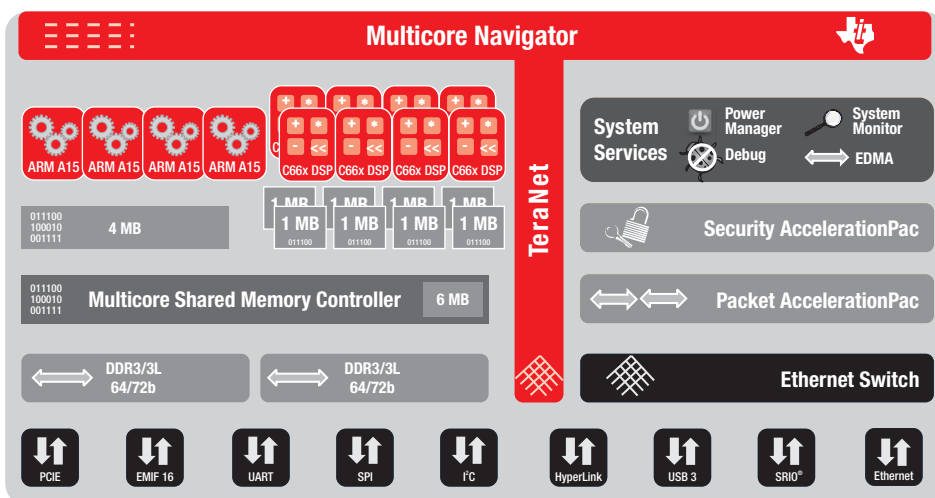
Many high-end imaging applications require powerful real-time processing as well as the need to run operating system and control code. With the K2H platform, developers of applications will have for the first time, a full

ARM-based Linux device integrated with the industry's highest-performing DSP cores in a single power-efficient package that can deliver up to 352 GMACS, 198 GFLOPS and 19,600 Dhrystone MIPS. Coupled with industry-best development tools and multicore software support for OpenMP® and OpenCL™, developers can easily parallelize code and run it on the ARM or DSP cores and quickly create code that scales across the different devices within the K2H and K2E platforms, allowing for the most cost- and power-efficient designs.

Application Segments

Industrial Automation: Industrial automation systems are implemented to increase production throughput and productivity and to improve the quality and consistency of a product or process. These systems perform a wide array of functions including:

- Image location and enhancement
- 1D/2D code reading



▲ Figure 1 – TI's 66AK2H12 SoC with four Cortex-A15 processors and eight C66x DSP cores

- 2D/3D pattern matching
- Background modeling and subtraction
- Object feature extraction
- Edge detection
- Dilation and erosion
- Thresholding
- Image warping
- Optical character recognition (OCR)
- Edge- and surface-based inspection
- Defect identification and classification
- Feature and tolerance verification
- Color identification

The combination of these functions in an industrial automation system requires significant real-time processing. These processing functions can be implemented in a smart industrial imaging camera with a low-power, high-performance processor like TI's TMS320C665x multicore DSPs which provide enough processing power to do many industrial automation functions while remaining within the power limitations of the camera.

Where more processing is needed or post processing analysis is desired, a multi-headed processing unit taking input from several cameras in a centralized vision processing unit as part of a comprehensive industrial automation system is deployed, as shown in Figure 2. This central system typically is responsible for most of the analytic processing. The K2E and K2H SoC platforms provide an elegant, scalable solution for this type of

centralized processing in industrial automation systems.

With the Cortex-A15 processors in the K2H and K2E devices and the development tools and programming models available from TI, developers have the ability to support full ARM-based Linux™ systems while offloading the real-time processing to the high-performance C66x cores. The offloading of real-time processing enables a more power-efficient, high-performance centralized processing unit. For more complex systems requiring additional processing capacity, TI's HyperLink can be used to connect multiple KeyStone devices adding additional C66x DSP cores and/or Cortex-A15 processors.

Because the processing elements of the KeyStone SoCs are programmable and scalable, the system has maximum flexibility, allowing the same processing system to be used across different product lines. The scalability is further expanded because the C66x cores in the K2H platform are the same as those in the C665x platform. Therefore, code developed for the C66x core that is used in the central processing unit can migrate to the smart automation camera and vice versa, allowing maximum reuse and scalability.

Video Surveillance: Video surveillance applications will also benefit from TI's K2H and K2E platform of devices. This is particularly true in the popular network video recorder (NVR) and digital video recorder (DVR) hybrid, known as an NVR/DVR, and the standalone analytics servers.

These end equipments get their video content through a network connection and may have to encode/transcode the video before storing it. Video can then be retrieved, decoded/transcoded when necessary, and have various analytics algorithms run on all or parts of the video stream. Common analytic algorithms used in surveillance are:

- Tamper detection
- Motion detection
- Trip zone/boundary crossing
- Object detection/removal
- Object identification
- Object counting
- Object tracking
- Behavior analysis
- Facial recognition
- License plate recognition

TI's KeyStone II SoCs are well equipped to handle the combination of the NVR/DVR functionality and the need for processing the analytics algorithms listed above.

KeyStone II devices feature a network coprocessor AccelerationPac. This AccelerationPac consists of a packet accelerator and a security accelerator that work in tandem to offload the DSP and ARM cores. This enables high-performance network application processing while freeing the C66x DSP and Cortex-A15 processors for other functions like analytics, video encode/decode, running the operating system (OS)



▲ Figure 2 – Example of 66AK2H06 SoC used as the main processor in a multi-head vision controller used to control multiple cameras and run analytics in an industrial automation system

and executing control code. The security accelerator provides security processing for a number of popular encryption and decryption modes and algorithms, including IPsec, SCTP, SRTP, 3GPP and SSL/TLS.

The C66x DSP cores in the K2H platform are ideal for running advanced analytics algorithms. Providing both fixed- and floating-point capability and high-speed device interconnectivity through HyperLink to connect multiple KeyStone devices, the K2H platform provides a scalable solution to fit the processing needs of any NVR/DVR system, including software implementations of advanced codecs like HEVC.

With the Cortex-A15 processors integrated into the same K2H platform, or available stand alone in the K2E platform, developers have a full ARM-based Linux system allowing quick and easy migration to the low-power, high-performance KeyStone II devices while eliminating the need for an additional general-purpose CPU.

Other Applications for High-End Imaging Include:

- High-end inspection systems
- PLC in industrial automation
- Industrial printers/scanners
- Currency/counterfeit detection

Development Support

Texas Instruments' investment in heterogeneous software tools makes programming and development simpler than ever. TI provides a free, downloadable Multicore Software Development Kit (MCSDK) which includes highly-optimized libraries and platform-specific drivers. TI also provides optimized single and multicore libraries for FFTs, image and video analytics, matrix math, and many other commonly used functions and algorithms.

The multicore software development tools include support for OpenMP[®], making it easier than ever to repurpose complex application software, and OpenCL[™] which

simplifies offloading tasks to the C66x DSP cores. Algorithm and system developers can recompile OpenMP code with TI's Code Composer Studio[™] Integrated Development Environment to run in supported KeyStone devices with little modification, substantially reducing the traditional porting time to embedded architectures.

TI has numerous demonstration systems available to help developers see a complete system and to get up and running quickly. These include an industrial imaging demonstration and an image-processing demonstration that is incorporated into TI's MCSDK.

TI also provides free video codecs for the C66x DSP which come with production licensing and are available for download. Additional codecs are available via TI's Design Network.

To download TI's multicore software, libraries and tools please visit www.ti.com/multicore.

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