

# Safety Certifiable Platform Components for AMD's Embedded Radeon™ E9171 GPU

## INTRODUCTION

The E9171 Platform for Safety Certifiable Applications available from CoreAVI comprises temperature screened GPUs, safety certifiable COTS-D hardware IP, development hardware, safety certifiable Vulkan® drivers, OpenGL® SC libraries, and safety certifiable GPU tools that have been pre-integrated and validated together to significantly de-risk the integration challenges typically faced when integrating hardware and software components from multiple suppliers. The platform is an off-the-shelf foundation upon which safety certifiable applications can be built with confidence.

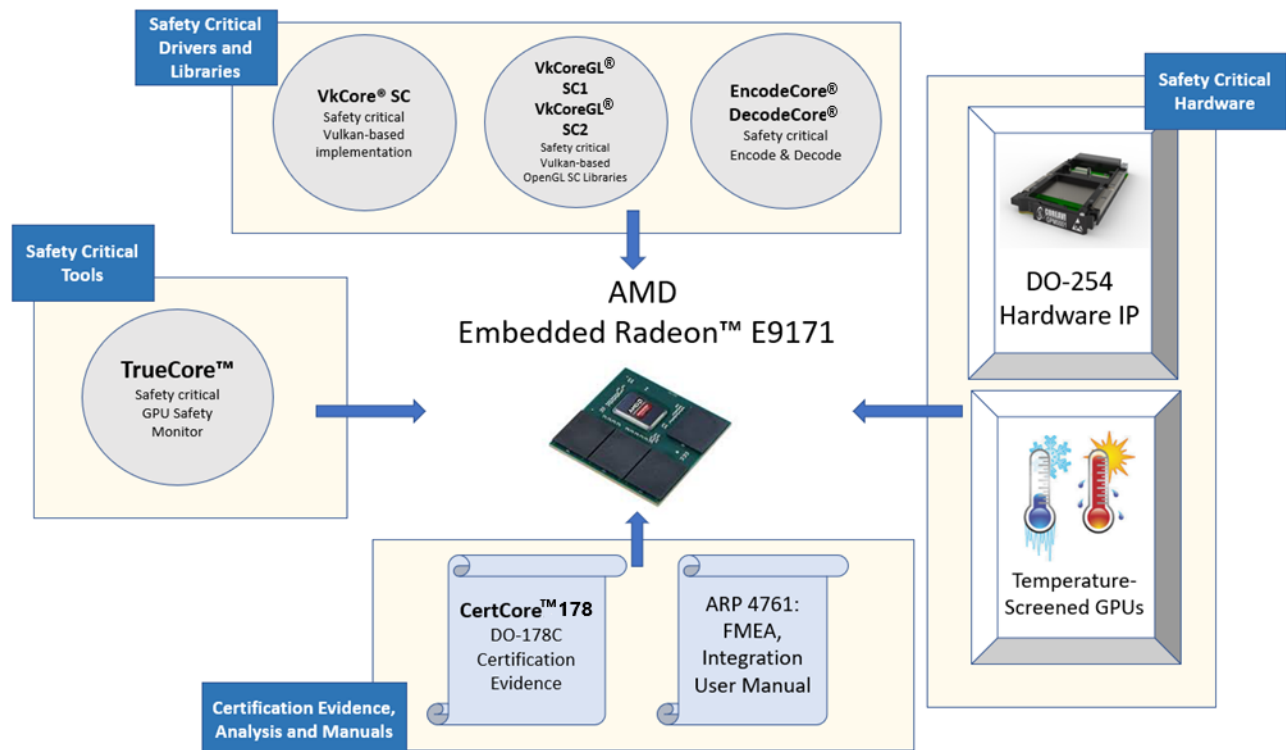


Figure 1: E9171 Platform for Safety Certifiable Applications

## EXTENDED TEMPERATURE RANGE

CoreAVI provides extended temperature versions of the E9171 GPU to facilitate its use in rugged embedded applications. CoreAVI functionally tests the E9171 over  $-40\text{C Tj}$  to  $+95\text{ Tj}$ , increasing the manufacturing yield for hardware suppliers while reducing supply delays to end customers.

## GPM3001 – AMD E9171 GPU PROCESSING MODULE

The GPM3001 is the latest generation of CoreAVI standard product COTS-D 3U VPX graphics module based on the AMD E9171 GPU. Like all COTS-D solutions, the GPM is supported with certification evidence to support system certification up to DAL A.

The CoreAVI 3U VPX E9171 hardware IP is offered as a high-performance compute/graphics solution in which the E9171 GPU is operated at full clock speeds to maximize performance.

With the E9171 mounted directly to a 3U VPX module, thermal power can be dissipated easily to the card edge, allowing the module to run at its full capability, maximizing its compute performance, and allowing the full shader processing capabilities to be exploited.

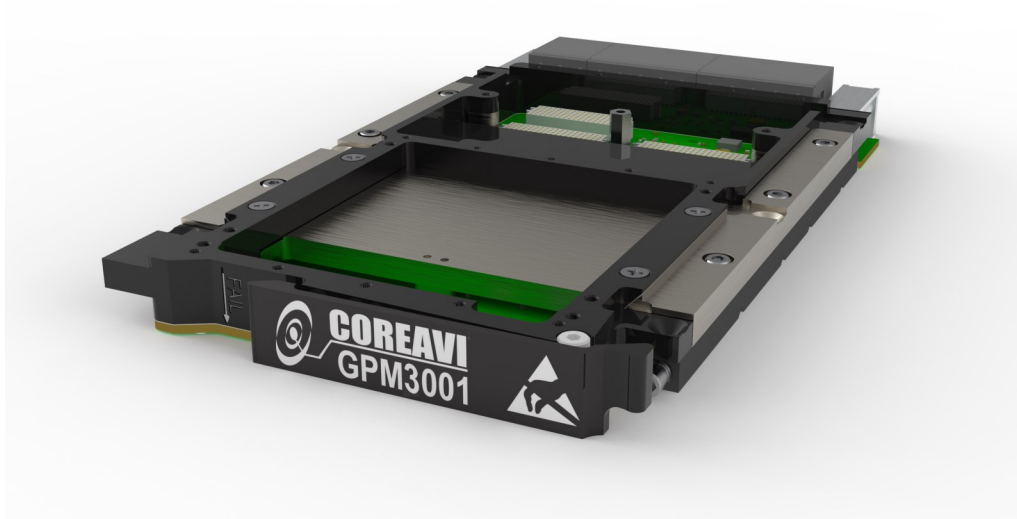
The module design can be used with any standard 3U VPX Single Board Computer, such as the companion SBC3003 offered by CoreAVI.

## HARDWARE FEATURES

The key features of the 3U VPX E9171 module are:

- Designed to DO-254/ED-80 requirements
- Standard VITA 65 OpenVPX 3U form factor
- Supported with DO-254/ED-80 COTS certification evidence
- High-performance PCIe Gen 3 backplane, GPU, and mezzanine support
- A VITA 61 XMC 2.0 mezzanine site supporting video output conditioning, video capture direct to the GPU memory, or generic XMC support
- PCIe switch to support high bandwidth direct coupling to the mezzanine site
- Safety monitors
- Conduction-cooled, AFT option
- Operating card edge temperature range of -40 to +71°C (full performance), and -40 to +85 C (core clock step down)
- 3U VPX powered from +5 V

Refer to the preliminary datasheet for the GPM3001 for more details on the card features.



*Figure 2: GPM3001 Module*

## E9171 GPU LONG-TERM SUPPLY AND SUPPORT

CoreAVI has provided consistent and dedicated support for the supply and use of the AMD embedded GPUs within the rugged Mil/Aero/Avionics market segment for over a decade. With the E9171, CoreAVI will continue that focused support to ensure that the software, hardware, and long-life support are provided to meet the needs of customers' system lifecycles.

CoreAVI has extensive environmentally controlled storage facilities that are used to store the GPUs supplied to the Mil/Aero/Avionics market place, ensuring that a ready supply is available for the duration of any program.

CoreAVI also provides the post Last Time Buy storage of GPUs and is often able to provide additional quantities of components when COTS hardware partners receive increased volume for existing products/systems requiring additional inventory.

## EVALUATION SUPPORT

CoreAVI provides evaluation hardware for all its COTS-D Hardware IP designs to enable customers to get started early on platform development. To support customers in the development of their E9171-based graphics/compute applications, CoreAVI offers a standard commercial AMD E9171 development board, compatible with an industry standard PCIe interface.

VkCore® SC drivers as well as VkCoreGL® SC1 and VkCoreGL® SC2 application libraries are available for Windows 10. These products are available on a 12-month evaluation license that includes support. Please refer to the VkCore SC and VkCoreGL SC datasheets for more detailed information on these products.



*Figure 3: PCIe Development Board*

## VKCORE SC DRIVER AND VKCOREGL SC LIBRARIES

Vulkan is a thin but wide, low-overhead graphics and compute API, targeting high-performance applications by offering higher performance than OpenGL, as well as a more balanced CPU/GPU usage. The Vulkan API enables programmers to access the hardware efficiently through a common API that can be used to support both graphics and compute needs.

CoreAVI supports the GPM3001 with a safety certifiable graphics and compute driver solution for the AMD E9171. The E9171 is supported by CoreAVI's safety critical Vulkan implementation, named VkCore SC, as well as OpenGL SC 1.0.1 and SC 2.0 certifiable graphics driver library suites, named VkCoreGL SC1 and VkCoreGL SC2. The drivers are available as standard product, developed by CoreAVI as part of its roadmap R&D investments. The OpenGL driver library operates through the Vulkan API and allows legacy applications to run on the E9171. Supported shaders include Vertex, Fragment, and Geometry.

The drivers are available with certification evidence to support certification to RTCA DO-178C and EUROCAE ED-12C, up to DAL A.

## TRUECORE™

TrueCore is a GPU safety monitor library designed to interoperate with CoreAVI GPU drivers.

TrueCore uses a patented approach to provide a suite of highly engineered Initiated Built-In-Tests (IBIT). These provide test coverage of the intended function of the GPU's graphics rendering pipeline (graphics command to framebuffer memory). Through the use of several tests, each with a unique test pattern that is verified independently by the CPU, applications are provided with flexibility in optimizing test execution and result filtering that may not be present with FPGA-based approaches. In testing the graphics rendering pipeline, TrueCore is testing one or more instances of each functional IP block, thereby providing test coverage for design errors, common-mode failures, and incorrect function caused by unused and undocumented functions.

## CERTIFICATION SUPPORT

CoreAVI provides support for DO-254/APR-4761 processes with a CoreAVI developed Failure Modes & Effects Analysis (FMEA), which is used to determine BIT routines required for fault detection coverage. Each safety critical product offered by CoreAVI is also provided with a User Integration Manual to support the user in integrating the generic, safety certifiable COTS-D module into the specific system/application into which it is being deployed and certified.

## VBIOS SUPPORT

CoreAVI GPU and graphics driver customers work directly with CoreAVI to obtain a new VBIOS image. With this process, CoreAVI provides its customers with a VBIOS service that best meets their needs and expectations, eliminates reliance on AMD, and significantly reduces the complexity of obtaining a new VBIOS. In addition, customers will benefit from a rapid turnaround for urgently needed VBIOS versions, will be able to use their existing points of contact at CoreAVI, and will receive support for product development phases, as well as for their VBIOS for the full term of their extended lifecycle support program.

## E9171 GPU

### *Features and Benefits*

- Compact, power efficient GPU module from AMD's Embedded Radeon series of GPUs:
  - Up to five independent display controller outputs
  - 4GB of dedicated memory
  - Eight compute units, each containing 64 shaders providing:
    - 1,248 GFLOPS FP32 (float) performance/ 78.02 GFLOPS FP64 (double) performance
    - Pixel fillrate of 19.5 Gpixels/second and Texel fillrate of 39.01 Gtexels/second
  - Upgraded encode and decode to support 4K at 60 Hz and High Efficiency Video Coding (HEVC), H.265
- Available with extended temperature range to meet the needs of rugged embedded systems
- Featured in CoreAVI's COTS-D family of safety certifiable hardware IP modules, such as the GPM3001
- Supported with CoreAVI's VkCore SC Vulkan-based graphics and compute driver, VkCoreGL SC OpenGL libraries, encode and decode capabilities
- Data to support DO-254/ARP-4761 processes:
  - GPU functional block level (gray box) Failure Modes and Effects Analysis (FMEA)
  - User Integration Manual (Safety Manual)
- TrueCore GPU safety monitor
- VBIOS image services

The AMD Embedded Radeon E9171 is the next generation high-performance graphics processor from AMD that is targeted towards the embedded market space and the rugged Mil/Aero/Avionics market.

Similar to the existing E8860 and E4690 GPUs, the E9171 is a 37.5mm x 37.5 mm multi-chip module (MCM) comprising the GPU with integrated graphics memory on a single substrate. The embedded memory makes it a very compact, power efficient solution, ideal for embedded applications and for use on space constrained modules.

The E9171 offers twice the dedicated video memory and more than 2x the performance of the previous generation E8860 in the same power envelope. The E9171 also upgrades the video decode and encode for 4K support at 60 Hz and High Efficiency Video Coding (HEVC), H.265.

With an integrated 4 GB of dedicated graphics memory and support for up to five simultaneous displays, the E9171 graphics module can drive multiple displays with powerful applications.

The many feature and performance benefits offered by the E9171 make it a compelling solution for any embedded application that is in development now, and that has a long lifecycle requirement. With the E9171 just being introduced to the market it offers the longest lifecycle of any embedded, high-performance graphics/compute solution.

The E9171 is a natural replacement for any system currently using the E4690 or where an E8860 solution is being considered. Table 1 provides a comparison between the E9171 and previous generation GPU solutions.

FEATURE	AMD E4690	AMD E8860	AMD E9171
<b>Chip Process</b>	55nm	28nm	14nm
<b>Package Size</b>	35mm x 35mm	37.5mm x 37.5mm	37.5mm x 37.5mm
<b>Bus Interface</b>	PCIe 16x Gen2	PCIe 16x Gen3	PCIe 8x Gen3
<b>Bus Bandwidth</b>	8 GB/sec (full duplex)	16 GB/sec (full duplex)	8 GB/sec (full duplex)
<b>Video Memory</b>	128-bit GDDR3	128-bit GDDR5	128-bit GDDR5
	512MB	2GB	4GB
<b>Max GPU Clock Speed (MHz)</b>	600	625	1,124
<b>Max Memory Clock Speed (MHz)</b>	700	1,125	1,500
<b>Video Memory Bandwidth (GB/sec)</b>	22.4	72.2	96
<b>Pixel Fillrate (Gpixels/sec)</b>	4.8	10	19.5
<b>Texel Fillrate (Gtexels/sec)</b>	19.2	25	39.01

Table 1: GPU Comparison Chart

FEATURE	AMD E4690	AMD E8860	AMD E9171
Floating Point Performance (GFLOPS)	384	760	1248
Display Controllers	2	6	5
Video Decode	H.264	H.264	H.264, H.265
Video Compression Encoder	--	H.264	H.264, H.265
TDP (W)	30	37	31
Last Time Buy(1)	2014	2020	2024

## DEDICATED GRAPHICS MEMORY

The E9171 graphics module includes 4 GB of dedicated 128-bit wide GDDR5 SDRAM accessible from the PCIe interface through a 256 MB aperture, simplifying the mapping of one or more modules into an SBC PCI address space. The size of the aperture may be changed through a VBIOS configuration.

The dedicated graphics memory is used by the GPU and graphics driver libraries to store Vulkan images, buffers, descriptors, shaders, and textures including application data such as moving map data or decoded video streams.

## MEMORY MANAGEMENT UNIT (MMU)

CoreAVI's drivers utilize the E9171's Memory Management Unit hardware protection mechanism to protect the memory space of each application, in a similar manner to how it is performed on CPUs. The E9171 MMU supports 16 virtual memory spaces with one being used by the driver, leaving support to virtualize and protect 15 applications.

- H.264 encoding is based on the ISO/IEC 14496-10 specification:
  - Up to Main Profile @ level 4.1 I & P-frame (no B-frame) encode

## E9171 PCIE INTERFACE

### Lane Width

The E9171 GPU supports the following PCIe interface lane widths:

- x1
- x2
- x4
- X8

Should the very high bandwidth provided by 8 lanes of PCIe Gen 3 not be required, by reducing the lane utilization, power savings can be achieved.

(1) Based on AMD lifecycle dates. CoreAVI offers a long-term supply program to extend the availability of our supported GPUs past the Last Time Buy date set by the manufacturer. Please contact CoreAVI for more details.

### *PCIe Interface Speed*

The E9171 GPU supports the following PCIe interface speeds:

- PCIe Gen 1 – 2.5 GT/s
- PCIe Gen 2 – 5.0 GT/s
- PCIe Gen 3 – 8.0 GT/s

## VIDEO ENCODER

The dedicated Video Codec Engine (VCE) hardware provides the following video encoding features:

- H.264 encoding is based on the ISO/IEC 14496-10 specification:
  - Up to Main Profile @ level 5.1 (3840 × 2160p @ 30 fps) I & P-frame (no B-frame) encode
  - Multi-stream support with total throughput up to 1080p @ 120 fps
  - Constant bit rate and variable bit rate controls
- H.265 (HEVC) encoding based on the ISO/IEC 23008-2 specification:
  - Up to Main Profile @ level 5.0 High-Tier (4096 × 2160p @ 30fps) I and P frame (no B-frame) encode
  - Multi-stream support with total throughput up to 1080p @ 120 fps
  - Constant bit rate and variable bit rate controls

CoreAVI's EncodeCore® is a real-time and safety critical H.264/H.265 video encode driver that enables the hardware video encoder that is built-in to the E9171. The driver architecture and API ensure high efficiency and low latency between a frame buffer and the video encode hardware to capture the graphics output being sent to a display. The resulting compressed video is made available on the host SBC as raw H.264/H.265 data. The raw encoded data can then be packaged by the application into a desired format that can be transmitted, recorded, and played back on video players supporting the packaged format.

## VIDEO DECODER

The dedicated Unified Video Decoder hardware (UVD) provides the following video decoding features:

- H.264 decoding based on the ISO/IEC 14496-10 specification:
  - Up to HP@L5.1 decoding with a maximum bit rate of 160 Mbps. Support for constrained Baseline profile only (no FMO or ASO)
  - Resolution support up to 4096 × 2160 (maximum 4K @ 60 fps)
- H.265 (HEVC) decoding based on the ISO/IEC 23008-2 specification:
  - Up to Main/Main10 L5.1 decoding with a maximum bit rate of 160 Mbps
  - Resolution support up to 4096 × 2176 (maximum 4K @ 60 fps)



CoreAVI's DecodeCore® is a real-time and safety critical H.264/H.265 video decode driver that enables the hardware video decoder that is built into the E9171. The driver architecture and API ensure high efficiency and low latency between the video decode hardware and the graphics hardware. The decompressed video is made available as a texture, enabling complex hardware accelerated image manipulation and integration with 2D or 3D graphics.

## APPLICABILITY

This document is applicable to the following part number.

*Table 2: Part Number Applicability*

ORDER PART NUMBER	GPU IDENTIFICATION	DESCRIPTION
100-CG3135E-RT	216-0905150	Temperature screened CoreAVI RADEON™ E9171 GPU with Run-time License.

For more information on CoreAVI's support for the E9171 GPU, contact [Sales@CoreAVI.com](mailto:Sales@CoreAVI.com).

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