GPMX002 XMC E9171 Graphics/Compute Processor
DO-254/ED-80 Certifiable GPU Module IP

FEATURES AND BENEFITS

- Part of the COTS-D family of safety certifiable modules

- A compact Graphics Processing Unit (GPU) module providing up to five independent display outputs

- Single conduction-cooled rugged module XMC (VITA 61) solution design for harsh environments

- A complete hardware solution with data package to support certification to RTCA DO-254/EUROCAE ED-80

- The provision of all IP and data to enable manufacture, support, and repair of the module

- Availability of certifiable OpenGL® graphics libraries for CoreAVI's VkCore® SC Vulkan®-based graphics and compute driver, with data packages to support DAL A certification to RTCA DO-178C/EUROCAE ED-12C

INTRODUCTION

The GPMX002 AMD Embedded Radeon™ E9171 compact GPU module (GPM) is ideal for avionics and defense applications requiring optimal balance of performance and power efficiency from a safety certifiable graphics solution for up to five simultaneous displays.

The E9171 graphics design comes with all the data needed to support, manufacture, and repair, as well as data to support DO-254/ED-80 hardware certification.

The GPMX002 is also supported with graphics and video driver libraries complete with data to support DO-178C/ED-12C software certification. The available data kits support both FAA and EASA certification authority needs.
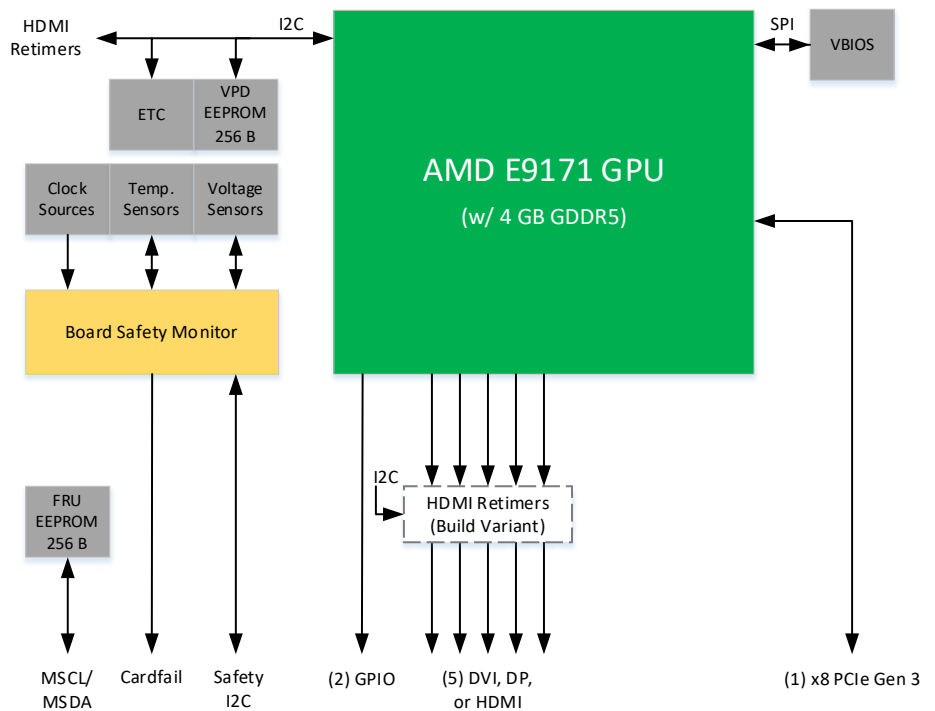

Figure 1: GPMX002 XMC Module Block Diagram

PROCESSING

The GPU is the CoreAVI extended temperature screened AMD Embedded Radeon E9171, which is a discrete GPU in a multi-chip-module (MCM) format with integrated memory providing a smaller, power-efficient solution. The E9171 is the latest Embedded Radeon GPU from AMD offering 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 (HVEC), H.265.

With integrated 4 GB of dedicated graphics memory and support for up to five simultaneous displays, the E9171 GPU module virtually eliminates the need for additional processors and duplicate hardware to drive multiple displays with powerful applications.

MEMORY

The GPMX002 GPU module includes 4 GB of dedicated 128-bit wide GDDR5 SDRAM, accessible from the PCIe interface through a 128 MB aperture, simplifying the mapping of one or more modules into an SBC PCI address space.

The dedicated graphics memory is used by the GPU and graphics driver libraries to store the frame buffers (the rendered images), Vertex Buffer Objects (VBO), and textures (application data such as moving map data or decoded video streams).

OUTPUTS

The following table summarizes the maximum supported data rates on GPMX002 interfaces.

INTERFACE	QUANTITY
DisplayPort 1.4 (up to five)	Up to 4096 x 2160 @ 60 Hz, 24 bpp, CVT-RBv2
Dual-link DVI (up to two - contact factory)	Up to 2560 x 1600 @ 60 Hz, 24 bpp, CVT-RB (maximum pixel rate: 330 MP/s for dual-link DVI)
Single-link DVI (up to five)	Up 1920 x 1200 @ 60 Hz, 24 bpp, CVT-RB (maximum pixel rate: 165 MP/s for single-link DVI)
HDMI 2.0b (up to five)	Up to 3840 x 2160 @ 60 Hz, 24 bpp, CVT-RBv2
PCIe	Supports x1, x2, x4 and x8 lane widths Supports 8.0 GT/S (PCIe Gen 3) per lane

Table 1: Maximum Supported Data Rates

LOCAL FUNCTIONS

Local functions include video decode acceleration and video encode acceleration.

The dedicated Unified Video Decoder (UVD) hardware 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).

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.

SAFETY AND SECURITY FEATURES

In addition, the module provides a suite of safety monitors to support safety requirements. These include temperature, voltage, and clock monitors. The temperature monitor, E9171 internal thermal sensor, is under application control, while voltage and clock out-of-range would result in the module being shut down. A failure of any of the monitors results in the assertion of a CardFail indicator to the I/O connector.

SOFTWARE

RTOS Board Support

The GPMX002 E9171 GPU module is fully supported by a suite of Vulkan-based graphics, compute, and video libraries with support for leading RTOS and Single Board Computer hosts, like CoreAVI's SBC0003 LX2160A SBC. CoreAVI is able to provide a complete DO-178C/ED-12C certifiable software package including the Real Time Operating System and its artifacts, certifiable Built-In-Test (BIT) software, and certifiable graphics drivers—all pre-integrated and ready to go. As the single provider of the entire software suite, support is easy to obtain and CoreAVI's expertise in software certification ensures the lowest risk. Please contact CoreAVI for additional RTOS support.

- DDC-I Deos™

- Lynx Software LynxOS®-178

- SYSGO PikeOS®

CoreAVI also provides support for Green Hills® INTEGRITY® and Wind River® VxWorks® RTOS. Please contact CoreAVI for more details.

The following diagram provides an overview of the available driver libraries that are described in the following sections. Further information and data sheets are available on CoreAVI's website.
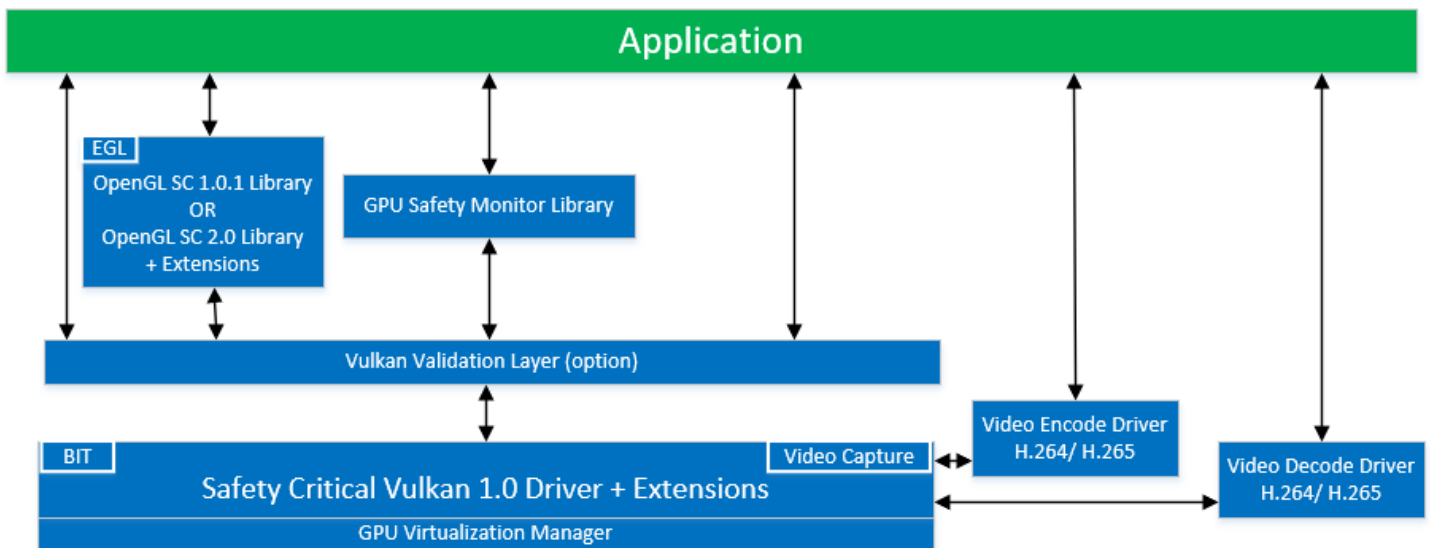

Figure 2: E9171 Software Overview

VULKAN

The foundation for the E9171 graphics support is CoreAVI's VkCore® SC safety critical Vulkan-based graphics and compute driver. VkCore SC provides programmable graphics pipeline rendering, enabling application flexibility by making use of the programmable units within the E9171 GPU. Vulkan is a thin, 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. CoreAVI supports Vulkan with graphics and compute libraries for common tasks and algorithms, allowing customers to focus on the application. In addition, CoreAVI provides VkCoreGL® SC1 and VkCoreGL SC2 application libraries for our VkCore SC driver, enabling customers to take advantage of Vulkan for existing applications to address performance-bound areas and add new capabilities.

The included compositor extension in the VkCoreGL SC libraries, EGL_EXT_compositor, composites and displays multiple off-screen graphics frame buffers. VkCore SC and the EGL_EXT_compositor provide an aligned solution for all Future Airborne Capability Environment (FACE™) profiles.

CoreAVI's VkCore SC Vulkan-based solution also supports multi-partition and multi-threaded applications.

VIDEO

The dedicated Unified Video Decoder hardware (UVD) is supported by CoreAVI's DecodeCore® driver library. DecodeCore supports H.264 and H.265 video decoding of up to ten streams, placing the decoded video data directly into OpenGL textures ready for complex hardware accelerated image manipulation and integration with 2D or 3D graphics. The driver architecture and API ensure high efficiency and low latency between the video decode hardware and the graphics hardware.

The dedicated Video Codec Engine (VCE) hardware is supported by CoreAVI's EncodeCore® driver library. EncodeCore can encode video data on the SBC host, or directly encode a frame buffer within the GPU providing either an H.264 or H.265 raw encoded video stream available on the SBC host. The encoding of a frame buffer is particularly useful for distributing and/or recording the data being presented on a display.

CoreAVI also includes a video capture API with the graphics driver library. VkCore SC works with DMA engines to provide a semi-autonomous mechanism to directly capture video input to GPU memory as an OpenGL texture, minimizing latency.

GPU SOFTWARE SAFETY MONITOR

To address safety requirements with respect to preventing or detecting the potential display of Hazardously Misleading Information (HMI), CoreAVI's TrueCore™ GPU safety monitor provides a software approach to detecting E9171 failures that may lead to HMI.

LIFECYCLE

AMD has planned a seven-year availability of the E9171 to the end of 2024, making it one of the longest available GPUs on the market today. 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.

COMPONENT SUPPLY

Similar to the successfully qualified and deployed CoreAVI extended temperature screened E4690 and E8860 GPUs, the E9171 is also extended temperature screened by CoreAVI to enable applications to use the GPU in harsh operating conditions.

SPECIFICATIONS

The GPMX002 dimensions are per ANSI/VITA 42.0-2008 for single-width XMC, conduction-cooled module.
The weight is TBD.

MECHANICAL FORMAT	CONDUCTION-COOLED		
PARAMETER	VALUE	VITA 47 CLASS 3	DO-160G
Temperature (C)			
Storage	-55 to 105	CC4	4.5.1, 4.5.3
Operating	-40 to 85[1]		4.5.1[3], 4.5.2[3], 4.5.3, 4.5.4, 5.0[3]
Vibration (all axes)			
Random	0.1 g2/Hz (maximum) from 5 to 2000 Hz for high performance aircraft (~12g RMS)	V3	8.5, 8.7, 8.6
Shock (all axes)			
Half Sine/Sawtooth	40 g / 11 ms	OS2	7.2, 7.3.1
Altitude (ft)			
Operating Maximum	60,000		4.6.1[3]
Relative Humidity			
Operating (non-condensing)	0-95%[2]		6.3.1, 6.3.2, 6.3.3
Electrostatic Discharge (ESD)			
Air discharged electrostatic pulse immunity	15,000 V		25.5
Fire, Flammability			
Comply with Flammability requirements	N/A		26.6

Table 2: Environmental Specifications

1.   Operating Carrier Card card edge temperature.

2.   95% with acrylic conformal coating, 100% could be achieved (not tested) with urethane or silicone conformal coating.

3.   Module is not intended for installation in non-pressurized and non-controlled temperature locations on an aircraft.

The E9171 graphics and compute engine is designed to run from a universal +5 V or +12 V VPWR with maximum typical current as set out in the following table, based on executing a representative application at the highest rated operating temperature.

VOLTAGE	TYPICAL CURRENT (AMPS)
VPWR (universal +5 V/+12 V)	+5 V: 4.45 A +12 V: 1.85 A
+3.3 V	Not used
+12 V	Not used
-12 V	Not used
+3.3 V Auxiliary	.05 A

Table 3: GPMX002 Voltage and Current Requirements

COTS-D DATA KIT

The COTS-D Data Kit provides all the data to enable support, manufacture, and repair of the E9171 graphics and compute engine. Key elements of the data package include:

- Theory of Operations
- Bill of Materials including full manufacturers part numbers
- Schematics
- Mechanical drawings and assembly diagrams
- Printed Circuit Board (PCB) drawings and data
- Manufacturing data
- Qualification data

The technical transfer also includes training and support for the product introduction process at your manufacturing facility or chosen contract manufacturer. Please request the COTS-D application note, which provides further details on the data items and support provided for the technical transfer.
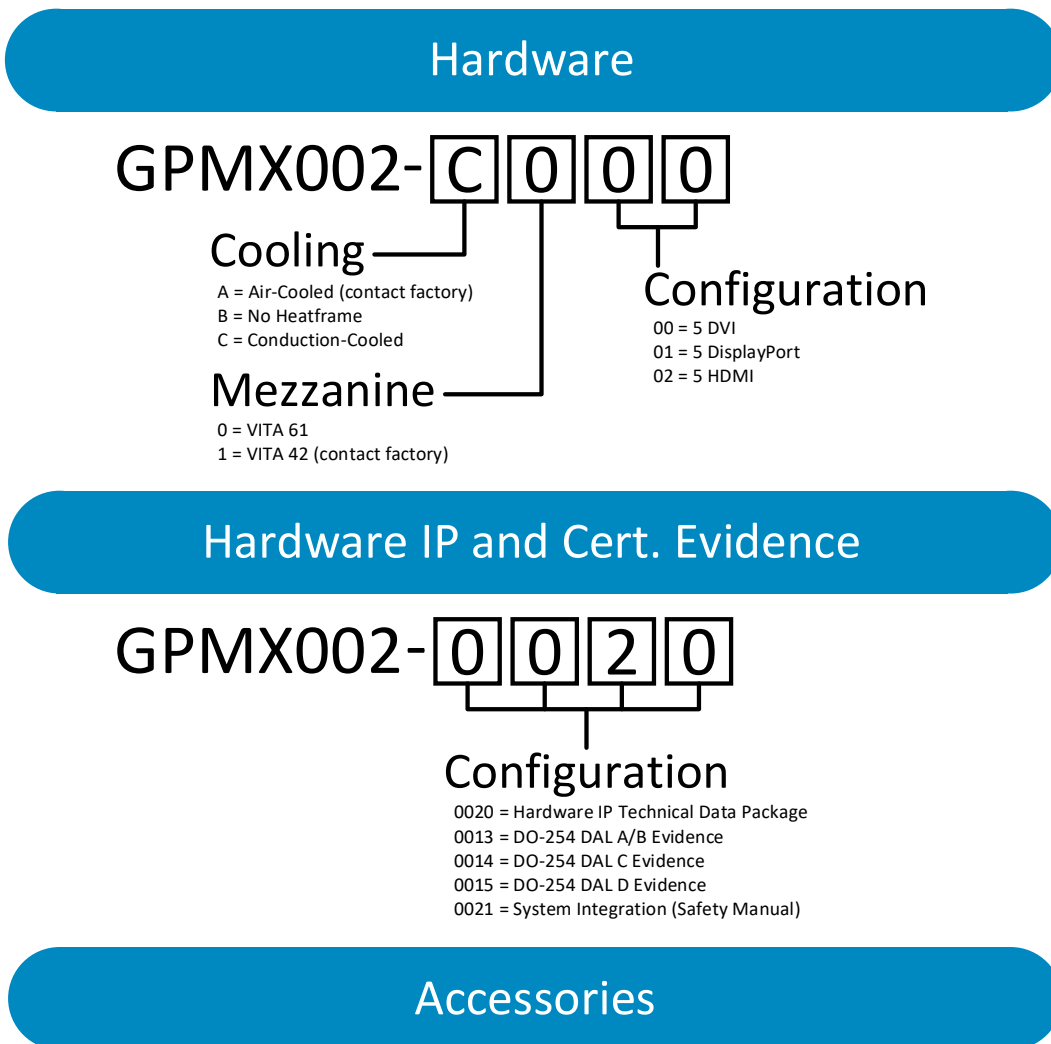
DO-254/ ED-80/ ARP4761 DATA KIT

The DO-254/ED-80/ARP4761 Data Kit provides documentation and evidence to support FAA and EASA certification requirements of the hardware elements, as well as Failure Modes and Effects Analysis (FMEA) and other documentation to support ARP4761 safety assessments for the E9171 GPU module—specifically, data for the E9171 to support Design Assurance Level (DAL) A.

DO-178C/ ED-12C DATA KIT

The DO-178C/ED-12C Data Kit provides documentation and evidence to support FAA and EASA certification requirements of the software elements up to and including Level A.

ORDERING

The following graphic provides the ordering information for the GPMX002 XMC module products available from CoreAVI.

Hardware

GPMX002- C 0 0 0

Cooling
A = Air-Cooled (contact factory)
B = No Heatframe
C = Conduction-Cooled

Mezzanine
0 = VITA 61
1 = VITA 42 (contact factory)

Configuration
00 = 5 DVI
01 = 5 DisplayPort
02 = 5 HDMI

Hardware IP and Cert. Evidence

GPMX002- 0 0 2 0

Configuration
0020 = Hardware IP Technical Data Package
0013 = DO-254 DAL A/B Evidence
0014 = DO-254 DAL C Evidence
0015 = DO-254 DAL D Evidence
0021 = System Integration (Safety Manual)

Accessories

RTMX002-1000: XTM, 5 mini-HDMI (DVI)

RTMX002-1001: XTM, 5 DisplayPort

Figure 3: GPMX002 Ordering Information

Related products from CoreAVI:

- VkCore SC graphics and compute driver.
- VkCoreGL SC 1.0.1 and VkCoreGL SC 2.0 application libraries with EGL_EXT_compositor
- DecodeCore library
- EncodeCore library
- TrueCore library
- DO-178C/ED-12C Level A Data Kit for each of the driver libraries

Contact Sales@CoreAVI.com to discuss your requirements and obtain a quote.