

# CV2AQ

## Automotive Computer Vision SoC

### Key Features

#### Computer Vision Engine CVflow®

- Convolutional neural network (CNN)- / deep neural network (DNN)-based monocular processing to enable classification, tracking, and more
- Tools for high- and low-level algorithm development
- CNN toolkit for easy porting with Caffe, TensorFlow, and ONNX

#### Stereo Processing Engine

- Enabling generic obstacle detection, terrain modeling, and more

#### High-Efficiency Video Encoding

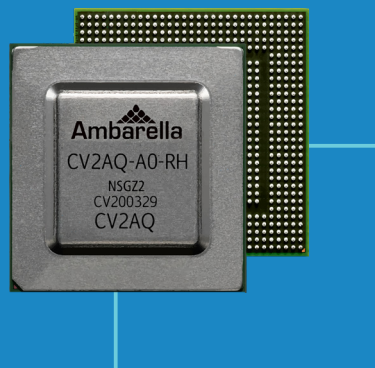
- H.265 and H.264 video compression
- Flexible multi-streaming capability
- 12MP30 video performance
- Multiple constant bit rate (CBR) and variable bit rate (VBR) control modes
- Smart H.264 and H.265 encoder algorithms

#### Ambarella Cutting Edge Imaging Pipeline

- Advanced imaging for low-light conditions
- Dynamic range (HDR and WDR) engine
- Automotive multi-channel smart auto exposure (AE) and auto white balance (AWB)

#### Target Applications

- Multi-channel drive recorders
- AVM / surround view with auto parking assist (APA)
- Single- / multi-channel electronic mirrors
- Advanced driver assistance systems (ADAS)
- Driver / in-cabin monitoring systems (DMS / CMS)
- Short-range / long-range depth perception camera

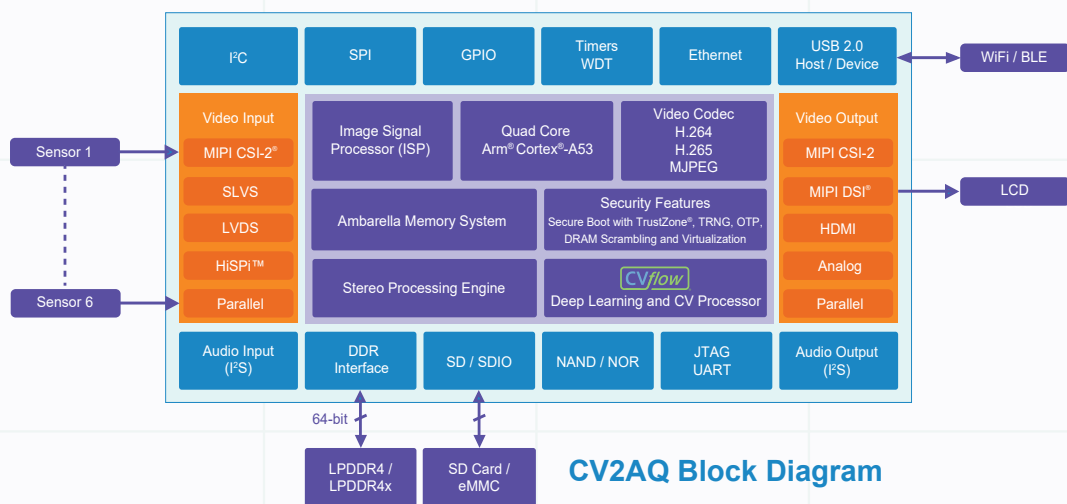


## Overview

Ambarella's AEC-Q100 Grade 2-qualified CV2AQ system on chip (SoC) combines image processing, 12MP30 video encoding / decoding, and CVflow® computer vision processing in a single, low-power design. The CV2AQ's CVflow DNN engine and a dedicated stereo vision accelerator enable efficient implementation of mono and stereo algorithms for the next generation of intelligent automotive cameras. Fabricated in advanced 10 nm process technology, CV2AQ achieves an industry-leading combination of low power and high performance in both human and computer vision applications.

The CV2AQ's CVflow architecture provides computer vision processing at full 12MP resolution, enabling image recognition over long distances and with high accuracy. It includes efficient 4K encoding in both AVC and HEVC video formats, delivering high-resolution video streaming with very low bit rates. The CV2AQ's next-generation image signal processor (ISP) provides outstanding imaging in low-light conditions, while its high dynamic range (HDR) processing extracts maximum image detail in high-contrast scenes, further enhancing the computer vision capabilities of the chip.

CV2AQ includes a suite of advanced cyber-security features such as secure boot with TrustZone® and secure memory, true random number generator (TRNG), one-time programmable memory (OTP), DRAM scrambling and virtualization, and a programmable secure level for each peripheral interface. To help customers easily port their own neural networks onto the CV2AQ SoC, Ambarella's software development kit (SDK) offers a complete set of tools.



CV2AQ Block Diagram

# General Specifications

## Processor Cores

- Quad-core Arm® Cortex®-A53 up to 756 MHz
- 32 KB / 32 KB I/D and 1 MB L2 cache
- NEON™ SIMD and FPU acceleration
- AES / SHA1 / SHA2-256 crypto acceleration

## Video Input

- Hexa sensor input with independent ISP configuration
- Sub-LVDS / MIPI CSI-2® / SLVS / HiSPi™
- 16-bit parallel LVCMOS (BT.601 / 656)

## Video Output

- 16-bit parallel LVCMOS (BT.601)
- HDMI® 2.0 including PHY with CEC support
- PAL / NTSC composite SD video
- MIPI DSI® / CSI-2 and FPD (VESA / JEIDA)

## CMOS Sensor / Image Processing

- 12MP30 maximum input resolution
- Lens shading, fixed-pattern noise correction
- Multi-exposure HDR (line-interleaved sensors)
- 3D motion-compensated temporal filtering (MCTF)
- RGGB / RCCB / RCCC / RGB-IR / monochrome sensor support
- Adjustable AE / AWB
- Advanced dynamic range (WDR and HDR) engine
- Chromatic aberration correction
- 180° fisheye lens and geometric distortion correction

- On-screen display (OSD) engine and overlays
- Gamma compensation and color enhancement
- Vignetting compensation
- 3-axis electronic image stabilization (EIS)
- Crop, mirror, flip, 90° / 270° rotation

## Video Encoding / Decoding

- H.265 MP L5.1, H.264 MP / HP L5.1, and MJPEG
- 12MP30 maximum encoding / decoding performance
- Up to eight simultaneous stream encodes
- Flexible group of pictures (GOP) configuration with I, P, and B frames
- Multiple CBR and VBR control modules

## Computer Vision Processor

- CVflow processor with parallel architecture to boost performance of the low-level portion of perception algorithms
- Stereo matching
- Feature matching

## Tools for Development

- CNN toolkit to ease the porting of CNN trained with Caffe, TensorFlow, or ONNX
- Compiler, debugger, and profiler for both Arm and microcode development

## Security Features

- Secure boot with TrustZone® and secure memory, TRNG, OTP, DRAM scrambling and virtualization

## Memory Interfaces

- LPDDR4x / LPDDR4 up to 1.4 GHz clock rate, 64-bit data bus, up to 4 GB capacity
- Two SD controllers
- Boot from SPI / parallel SLC NAND with BCH / SPI NOR / USB / eMMC
- Single- / dual- / quad-SPI NOR and SPI NAND

## Peripheral Interfaces

- One USB 2.0 port configurable as device / host with PHY
- Audio interface including I²S
- Multiple SSI / SPI, IDC, and UART
- Multiple GPIO ports, PWM, steppers, IR, and ADC
- Watchdog timer, multiple general purpose timers, and JTAG

## Physical

- 10 nm low-power complimentary metal-oxide semiconductor (CMOS)
- HFC BGA package (716 balls, 19x19 mm, 0.65 mm pitch)
- Operating temperature -40°C to + 105°C
- Automotive qualified (AEC-Q100 Grade-2)

## CV2AQ Camera Development Platform

The CV2AQ camera development platform contains the necessary tools, software, hardware, and documentation to develop a camera utilizing the powerful CVflow processor while supporting development of customized features.

### Evaluation Kit

- CV2AQ main board with connectors for sensor / lens board and peripherals
- Sensor board: Sony, onsemi, Omnivision, and others
- Datasheet, BOM, schematics, and layout
- SDK and reference application with C source code available with additional licensing

### Software Development Kit

- Royalty-free libraries for ISP, dewarp, and video recording
- Image tuning and manufacturing calibration tools
- Detailed documentation, including a programmer's guide and more
- CNN / DNN training, profiling, and porting tools

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