



# CV25AQ

## Automotive Computer Vision SoC

### Overview

Ambarella's AEC-Q100 qualified CV25AQ SoC combines image processing, 6MP30 video encoding, and CVflow<sup>®</sup> computer vision processing in a single, low-power design. The CV25AQ's CVflow architecture provides the deep neural network (DNN) required by the next generation of intelligent automotive cameras. Fabricated in advanced 10 nm process technology, it achieves an industry-leading combination of low-power and high-performance in both human vision and computer vision applications. It is an ideal platform for implementing multi-channel digital video recorders, single or dual channel eMirror with recording, driver / cabin monitoring cameras, and more.

The CV25AQ's CVflow architecture provides computer vision processing at 6MP resolution, enabling image recognition over long distances and with high accuracy. It includes efficient encoding in both AVC and HEVC video formats, delivering high-resolution video encoding with very low bit rates. The CV25AQ's next-generation image signal processor (ISP) provides outstanding imaging in low-light conditions while high dynamic range (HDR) processing extracts maximum image detail in high-contrast scenes, further enhancing the computer vision capabilities of the chip. It includes a suite of advanced security features to prevent hacking, such as secure boot, TrustZone<sup>®</sup> and I/O virtualization. A complete set of tools is provided to help customers easily port their own neural networks onto the CV25AQ SoC.



The CV25AQ chip targets automotive sensing camera designs

### Key Features

#### Computer Vision Engine **CVflow<sup>®</sup>**

- CNN- / DNN-based processing: detection, classification, tracking, and more
- Tools for high- and low-level algorithm development
- CNN toolkit for easy porting with Caffe, TensorFlow, and ONNX
- Open SDK

#### Advanced Image Processing

- Multi-exposure line-interleaved HDR
- Hardware dewarping engine support
- Electronic image stabilization (EIS)
- Support for multiple cameras
- Advanced LED flicker mitigation
- 3D motion compensated temporal filtering (MCTF)
- Superior low-light processing
- Support for RGGB, RCCB, RCCC, RGB-IR, and monochrome sensors

#### High-Efficiency Video Encoding

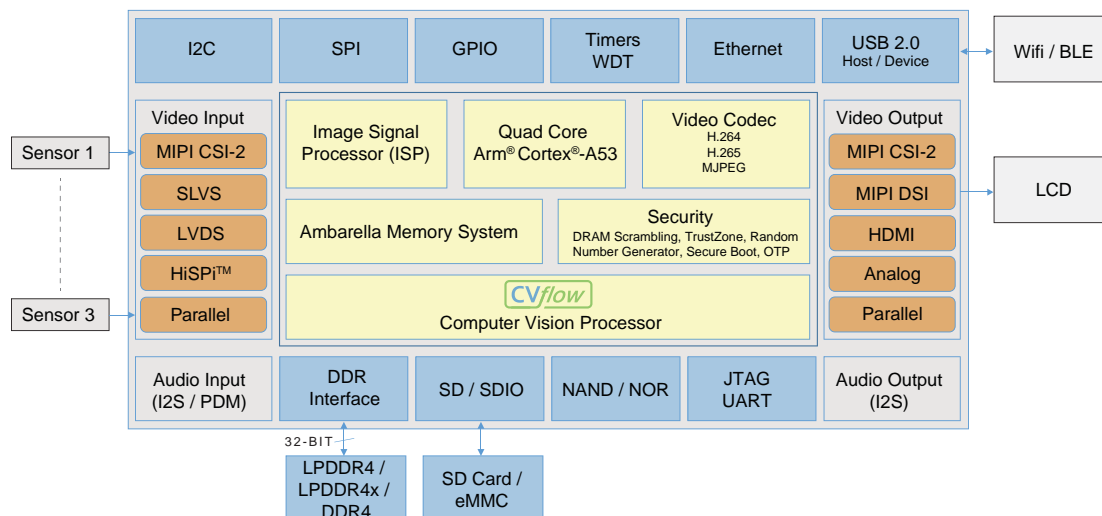
- H.265 and H.264 video compression
- Flexible multi-streaming capability
- 6MP30 video performance
- Multiple CBR and VBR bit rate control modes
- Smart H.264 and H.265 encoder algorithms

#### Target Applications

- Multi-channel drive recorder
- Single- / dual-channel eMirror
- Driver / cabin monitoring system (DMS / CMS)

### Block Diagram

The diagram below illustrates a design based on the Ambarella CV25AQ device.



## 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
- OTP, secure boot, TrustZone®, IO virtualization
- AES / 3DES / SHA-1 / MD5 crypto acceleration

### Video Input

- Single, dual, or triple sensor inputs with independent ISP configuration
- 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) out

### CMOS Sensor Processing / Image Processing

- 6MP30 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
- LED flicker compensation for LED sources
- High Dynamic range (HDR) engine
- Chromatic aberration correction
- 180° fisheye lens and geometric distortion correction
- 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

- H.265 (HEVC) MP L5.1, H.264 MP / HP L5.1, and MJPEG
- 6MP30 maximum encoding performance
- Flexible GOP configuration with I, P, and B frames
- Multiple CBR and VBR rate control modules

### Computer Vision Processor

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

### 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

### Memory Interfaces

- LPDDR4x / LPDDR4 / DDR4 up to 1.2 GHz clock rate, 32-bit data bus, up to 2-Gbyte capacity
- Three SD controllers
- Boot from SPI / parallel SLC NAND with BCH / SPI NOR / USB / eMMC
- Single- / dual- / quad-SPI NOR and SPI NAND

### Peripheral Interfaces

- 10 / 100 / 1000 Ethernet AVB with RMI / RGMII
- One USB 2.0 port configurable as device / host w/PHY
- Audio interface including I<sup>2</sup>S and DMIC
- Multiple SSI / SPI, IDC, and UART
- Multiple GPIO ports, PWM, IR, ADC
- Watchdog timer, multiple general purpose timers, and JTAG

### Physical

- 10 nm low-power CMOS
- FBGA package (361 balls, 13x13 mm, 0.65 mm pitch)
- Operating temperature -40°C to +105°C
- Automotive qualified (AEC-Q100 Grade-2)

## Computer Vision (CV) Applications

The CV25AQ vision processor enables different CV applications in different markets with its state-of-the-art technology.

### Perception Applications

- Driver and in-cabin monitoring system (DMS, CMS)
  - Driver drowsiness / distraction
  - Driver intent
  - Cabin monitoring
  - Driver authentication
  - Gesture control
- Object detection / classification (CNN-based)
  - Pedestrians, vehicles
  - Traffic signs, traffic lights
  - Headlight detection
- Free space detection
- Lane marking detection
- Parking lines detection

### Enabled Computer Vision Applications

- Lane departure warning / lane keeping assistance
- Forward collision warning
- Auto emergency braking (AEB)
- Intelligent headlight control / high beam assist
- Speed assist functions
- Auto parking assist (APA)
- Blind spot detection

**Contact** [www.ambarella.com/about/contact/inquiries.html](http://www.ambarella.com/about/contact/inquiries.html)

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