



# CV22 - Computer Vision SoC for Consumer Cameras

## Overview

Ambarella's CV22 SoC combines image processing, 4Kp60+ video encoding, and CVflow™ computer vision processing in a single, low-power design. The CV22's CVflow architecture provides the DNN (Deep Neural Network) processing required for the next generation of intelligent sports, VR / 360°, drone, and wearable 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.

The CV22's CVflow architecture provides computer vision processing at full 4K at 60 frames per second, to enable image recognition over long distances 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 to minimize storage costs. The CV22's next-generation ISP (Image Signal Processor) provides outstanding imaging in low-light conditions while HDR (High Dynamic Range) 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 implement advanced on-device physical security, including secure boot, TrustZone™, and I/O virtualization. A complete set of tools is provided to help customers to easily port their own neural networks onto the CV22 SoC. Please see the list of possible applications in the CV22 Applications section on the second page of the product brief.



The CV22 chip targets sports, VR/360°, drone, and wearable camera designs

## Key Features

### Flexible Low-Power Platform

- 10 nm low-power CMOS process
- 64-bit ARM® Quad Core Cortex®-A53 CPU up to 1.0 GHz
- ThreadX and Linux OS support
- CVflow vector processor with CNN / DNN algorithms
- Industry leading image sensors support

### Computer Vision Engine

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

### Advanced Image / Video Processing

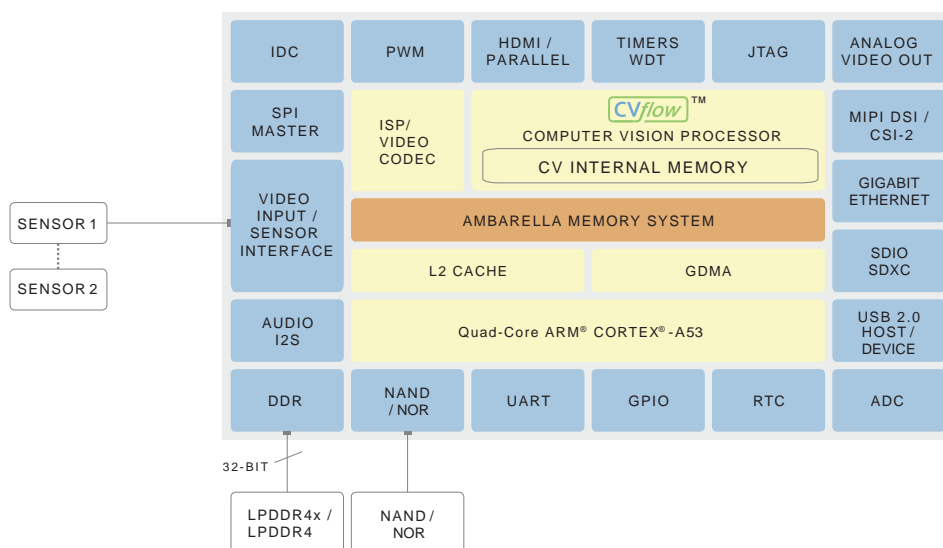
- More than 800 MPixels input rate
- Multi-exposure HDR
- Hardware de-warping engine support
- 3D Electronic Image Stabilization (EIS) and rolling shutter correction
- Dual independent sensor inputs
- Multi-sensor and video processing support for VR / 360° cameras, stereo cameras, and optical flow for drones
- 2D / 3D noise filtering for improved SNR in lowlight conditions

### High-Efficiency Video Encoding

- H.265 and H.264 video compression up to 4Kp60+
- Flexible multi-streaming capability
- Multiple CBR and VBR bit rate control modes
- Smart H.264 and H.265 encoder algorithms

## Block Diagram

The diagram below illustrates a design based on the Ambarella CV22 device.



## General Specifications

### Processor Cores

- Quad-core ARM® Cortex®-A53 up to 1.0 GHz
- 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
- Ambarella Image and Video DSPs

### Sensor and Video I/O

- Single or dual sensor input with Independent ISP configuration
- Single 8-lane sub-LVDS / SLVS / HiSPi™ or dual 4-lane SLVS
- Single 8-lane MIPI or dual 4-lane MIPI CSI-2
- 16-bit parallel LVCMOS
- BT.601 / 656 video in and 16-bit BT.601 out
- HDMI® 2.0 output including PHY with CEC support
- PAL / NTSC composite SD video out
- 4-lane MIPI DSI/CSI-2 and FPD (VESA/JEIDA) out

### Front End Sensor Processing

- 800 MHz maximum pixel rate
- Multi-exposure HDR

### Video / Image Processing

- 3D motion compensated noise reduction (MCTF)
- 3-Axis Electronic Image Stabilization (EIS) and rolling shutter correction
- Adjustable AE / AWB / AF
- High quality polyphase scalers
- Digital PTZ and Virtual Cameras
- OSD engine, overlays, privacy mask
- Crop, mirror, flip, 90° / 270° rotation
- On-chip stitching for VR / 360° applications
- Defect pixel correction
- Geometric lens distortion correction
- Chromatic aberration compensation
- Gamma compensation and color enhancement
- Backlight compensation
- Lens shading correction
- WDR with local tone mapping

### Intelligent Video Analytics

- **CVflow** vision processor for CNN / DNN edge analytics
- People counting, tracking
- Face detection, tracking, recognition
- Human / Pet / Vehicle classification
- Object classification, recognition, and more
- License plate recognition

### Video Encoding

- H.265 (HEVC) MP L5.1, H.264 BP/MP/HP L5.1 and MJPEG
- 4Kp60+ maximum encoding performance
- Simultaneous stream encodes
- Flexible GOP configuration with I, P, and B frames
- Temporal Scalable Video Codec with 4 layers (SVCT)
- Dual encoding for VR / 360° cameras
- Multiple CBR and VBR rate control modules

### Memory Interfaces

- LPDDR4 / LPDDR4x up to 1.8 GHz, 32-bit data bus
- Two SD controller with SDXC SD™ card
- NAND flash, SLC with ECC
- Boot from SPI-NAND/NOR, SPI-EEPROM, NAND flash, USB, or eMMC

### Peripheral Interfaces

- 10 / 100 / 1000 Ethernet with RMII / RGMII
- USB Ports configurable for host/device
- Multiple I2S, SSI / SPI, I2C, and UART
- Many GPIO ports, PWM, Steppers, IR, ADC
- Watchdog Timer, multiple general purpose timers, JTAG
- Digital MIC support over PDM

### Physical

- 10 nm low-power CMOS
- Operating temperature -20°C to + 85°C
- FBGA package with 441 balls, 16x16 mm, 0.65 mm pitch

## CV22 Applications

The CV22 vision processor enables different applications in different markets with its state-of-the-art technology.

### Drone

- Person detection and tracking
- Object detection / classification (CNN-based)

### Sports / VR / 360° / Wearable Cameras

- Face detection and recognition
- Object detection / classification (CNN-based)
- Automatic content tagging / generation for time-lapse video

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

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