



# CV2FS

## Automotive Computer Vision SoC

### Overview

Ambarella's ASIL B compliant CV2FS combines high performance and power-efficient computer vision acceleration, superior image processing (ISP), and H.264 video compression in a single SoC. Ambarella's highly efficient CVflow<sup>®</sup> computer vision engine delivers deep neural network (DNN) processing and a dedicated stereo vision accelerator to enable efficient implementation of mono and stereo algorithms for the next generation of intelligent automotive cameras.

The ISP provides outstanding imaging in low-light conditions while its high dynamic range (HDR) processing extracts maximum image detail in high-contrast scenes, enhancing the computer vision capabilities of the chip and delivering crisp video for driver viewing. CV2FS delivers high-resolution video recording and streaming at very low bit rates with efficient encoding in H.264 video formats. A suite of advanced cyber-security features such as secure boot, TrustZone<sup>®</sup>, and I/O virtualization enable secure operation of the system.

Fabricated in advanced 10 nm process technology, the CV2FS achieves an industry-leading combination of high-performance and low-power for computer vision applications. It is an ideal platform for implementing single- and multi-camera advanced driver assistance systems (ADAS), driver monitoring systems (DMS) and in-cabin solutions, single- and multi-channel eMirrors with blind spot detection (BSD), and intelligent parking assistance systems.



The CV2FS chip targets automotive sensing camera designs

### Key Features

#### Computer Vision Engine

- Stereo processing to enable generic obstacle detection, terrain modeling, and more
- CNN- / DNN-based processing to enable detection, classification, tracking, and more
- Dense optical flow engine
- Tools for high- and low-level algorithm development
- CNN toolkit for easy porting with Caffe, PyTorch, TensorFlow, and ONNX

#### Advanced Image Processing

- Multi-exposure line-interleaved HDR
- Real time multi-scale / multi-FOV generation
- Hardware dewarping engine support
- Support for multiple cameras
- LED flicker mitigation
- Superior low-light processing
- Support for RGGB, RCCB, RCCC, RGB-IR, and monochrome sensors

#### High-Efficiency Video Encoding

- 4MP30 H.264 video encoding performance
- Flexible multi-streaming capability
- Multiple CBR and VBR bit rate control modes
- Smart H.264 encoder algorithms

#### Functional Safety

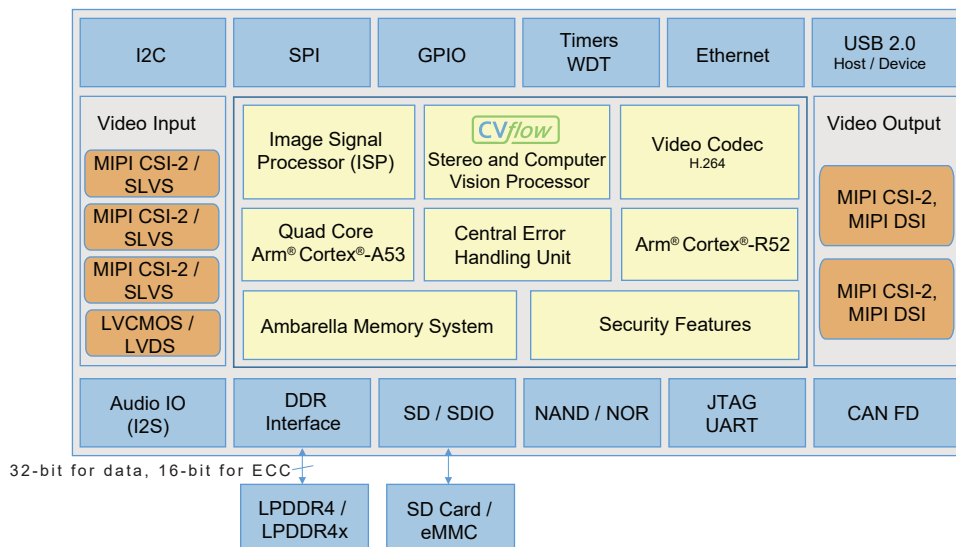
- Error correcting code (ECC) protection of on-chip memory on DRAM
- Central error handling unit (CEHU)
- Processing island targeted to meet ASIL B requirements; safety island targeted to meet ASIL D requirements

#### Target Applications

- Single- / multi-camera ADAS
- DMS and in-cabin solutions
- Single- / multi-channel eMirrors with BSD
- Parking assistance systems

### Block Diagram

The diagram below illustrates the CV2FS block diagram.



## General Specifications

### Processor Cores

- Quad-core Arm® Cortex®-A53 up to 1 GHz
  - 32 KB / 32 KB L1 cache, 1 MB L2 cache
- Arm Cortex-R52 504 MHz with DCLS (dual-core lock step)
  - 32 KB / 32 KB I/D L1 cache, 1 MB of embedded SRAMs
- NEON™ SIMD and FPU acceleration
- AES / 3DES / SHA-1 / MD5 crypto acceleration using Arm V8 extensions

### Computer Vision Processor

- **CVflow** processor optimized for high performance CNN / DNN execution
- Disparity mapping
- Dense optical flow engine

### Video Input

- Multi-sensor input with independent ISP configuration
- Three MIPI CSI-2 (one port with virtual channels) / three SLVS
- LVCMOS / LVDS

### Video Output

- Two MIPI CSI-2 / MIPI DSI
- OSD engine and overlays

### CMOS Sensor Processing / Image Processing

- Processing up to 480 MPixel/s
- 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
- Dynamic range (WDR and HDR) engine
- Chromatic aberration correction
- Geometric distortion correction
- Gamma compensation and color enhancement
- Vignetting compensation
- 3-axis electronic image stabilization (EIS)
- Crop, mirror, flip, 90° / 270° rotation

### Video Encoding

- H.264 MP / HP L5.0
- 4MP30 maximum encoding performance
- Flexible GOP configuration with I and P frames
- Multiple CBR and VBR rate control modules

### Security Features

- OTP, secure boot, TrustZone®, IO virtualization

### Tools for Development

- CNN toolkit to ease the porting of CNN trained popular frameworks such as Caffe, TensorFlow, or ONNX
- Compiler, debugger, and profiler for both Arm and Microcode development

### Memory Interfaces

- LPDDR4x / LPDDR4 up to 1.8 GHz clock rate, 32-bit data bus for data and 16-bit data bus for ECC, up to 4 GB capacity
- Two SD controllers
- Boot from SPI / SPI NAND with BCH / SPI NOR / USB / eMMC
- Single- / dual- / quad- / octal-SPI NOR and single- / dual- / quad-SPI NAND

### Peripheral Interfaces

- Six CAN FD controllers
- Two ethernet ports with 10- / 100- / 1000-Mbps data transfer rates
- One USB 2.0 port configurable as device / host w/PHY
- Multiple SSI / SPI, IDC, and UART
- Multiple GPIO ports, PWM, steppers, ADC
- Watchdog timer, general purpose timers, and JTAG
- Audio interface (I<sup>2</sup>S)

### Physical

- 10 nm low power CMOS
- FBGA package (14x14 mm, 0.65 mm pitch)
- Operating temperature -40°C to +125°C (T<sub>j</sub>)
- Automotive qualified (AEC-Q100 Grade-2, ASIL B)

## CV2FS Camera Development Platform

The CV2FS 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 (EVK)

- CV2FS main board with connectors for sensor / lens board and peripherals
- Sensor board: Sony, ON Semi, Omnivision, and others
- Datasheet, BOM, schematics, and layout
- SDK and reference application with C source code

### Software Development Kit (SDK)

- ISO 26262 compliant SDK, OS, and middleware
- Royalty-free libraries for ISP, dewarp, and video recording
- Image tuning and manufacturing calibration tools
- Safety documentation for applications required to meet ISO 26262 requirements
- Detailed documentation with programmer's guide and application notes
- CNN / DNN training, profiling, and porting tools

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

Copyright Ambarella, Inc. All rights reserved. Ambarella, and the Ambarella logo are trademarks of Ambarella, Inc. All other brands, product names and company names are trademarks of their respective owners. The information in this document is believed to be reliable, but may project preliminary functionality not yet available. Ambarella, Inc. makes no guarantee or warranty concerning the accuracy and availability of said information and shall not be responsible for any loss or damage whatever nature resulting from the use of, or reliance upon it. Ambarella, Inc. does not guarantee that the use of any information contained herein will not infringe upon patent, trademark, copyright, or other rights of third parties. Ambarella, Inc. reserves the right to make changes in the product and/or its specifications presented in this publication at any time without notice.