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Synopsys

Powering Imaging Applications with MIPI CSI-2℠

2017 MIPI ALLIANCE DEVELOPERS CONFERENCE

HSINCHU CITY, TAIWAN
MIPI.ORG/DEVCON
Agenda

• Implementation of MIPI interfaces in mobile applications and beyond
• Advantages of implementing MIPI camera and sensor specifications
• Meeting reliability requirements of automotive applications
• Summary
MIPI Specifications in New Applications

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Industrial, Surveillance Applications

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Example: Multi-Image Sensor Surveillance
Advanced Driver Assistance Systems (ADAS)

- **Passive ADAS**
  - Back-up, side mirror, surround view camera
  - Distance alert system

- **Active ADAS**
  - Back-up camera with ID & braking
  - Collision avoidance
Surround View Automotive Applications

- Power Supply
- MPU
- Proprietary, LVDS or Ethernet Switch
- MIPI CSI-2 Image Sensors
  - Front Camera Module
  - Left Camera Module
  - Right Camera Module
  - Rear Camera Module
  - Other Camera Module

- Display
- CAN Interface
- DRAM
- Flash Memory

- LVDS or Ethernet Link

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- Front Camera
- Left Camera
- Right Camera
- Rear Camera

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Surround View Automotive Applications

Pedestrian/Obstacle Detection

Multi-Camera Module Image Processor

- MIPI CSI-2 Sensor 1
- MIPI CSI-2 Sensor 2
- MIPI CSI-2 Host
- ISP
- MIPI CSI-2 Device
- CPU

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MIPI CSI-2 Specification
MIPI CSI-2 Specification – Standardizing Image Sensor Interface in Mobile and Beyond

• MIPI’s first problem statement back in 2004!
  – No standard image sensor interface for Mobile
  – Interoperability challenges
  – Camera vendors had to pick and choose which devices/SoCs they developed for
  – Devices/SoCs had to pick and choose partners on the camera sensor side
  – Very difficult from a scalability point of view
## MIPI CSI-2 Specification

<table>
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<tr>
<th>CSI-2 Specification version</th>
<th>1.00 2005</th>
<th>1.01 2011</th>
<th>1.1 2013</th>
<th>1.2 2014</th>
<th>1.3 2014</th>
<th>2.0 2017</th>
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MIPI CSI-2 Over MIPI D-PHY

Packet Builder
- Data Format Definition
- Payload byte size
- Data CRC processing
- ECC protecting the header

Frame Buffer
- CSI-2 Receiver
  - Packet Decoder
  - Lane Merger
- CSI-2 Packet
- CSR-2 Packet
- D-PHY
- Clk+
- Clk-
- L0+
- L0-
- L1+
- L1-
- CSI-2 Host
- CCI Master
  - SCL
  - SDA

Packet Builder
- Lane Distribution
- CSI-2 Packet
- Frame Buffer
- CSI-2 Device
- CCI Slave
  - SCL
  - SDA

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MIPI CSI-2 v2.0 Feature Enhancements

• RAW-16 and RAW-20 color depth
• Latency Reduction & Transport Efficiency (LRTE)
• Differential Pulse Code Modulation (DPCM) 12-10-12 compression
• Scrambling to reduce Power Spectral Density (PSD) emissions
• Expanded number of virtual channels from 4 to 32

Image Quality/HDR - Latency - Reliability - Aggregation

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MIPI CSI-2 v2.0 Feature Enhancements

- CSI-2 1v3 color depths are sufficient for Mobile. Visually, there is almost no change between RAW14 and RAW16/20.
- RAW-16 and RAW-20 color depth bring advanced vision capabilities to Automotive and Industrial applications
  - Improves image capture when the environment changes suddenly and dramatically, for example in a big change in lighting condition.
MIPI CSI-2 v2.0 Feature Enhancements

- To accommodate the larger number of image sensors and their multiple data types
- To support multi-exposure and multi-range sensor fusion for ADAS
MIPI CSI-2 v2.0 Feature Enhancements

Added Latency Reduction and Transport Efficiency (LRTE)

- LRTE reduces frame transport latency & leakage power due to frequent “high speed - low power” transitions.
- This will enhance image sensor aggregation and multi exposure for real-time perception and decision making applications.
MIPI CSI-2 v2.0 Feature Enhancements

Added scrambling and compression scheme

- Galois Field Scrambling reduces power spectral density (PSD) emissions
  - Minimizes PSD emissions from aggressor components, which are particularly beneficial when placed near sensitive receivers

- New DPCM 12-10-12 compression to further boost image quality
  - Superior SNR using reduced bandwidth PHY
  - Removes more compression artifacts when comparing with previous CSI-2 1v3 compression mode
MIPI Specifications Beyond Mobile

- Tackling the evolving imaging and vision applications in the automotive platform
MIPI Specs for Multimedia, Storage, Sensor & Wireless Connectivity in Automotive Applications

**Infotainment**
- Navigation
- Audio/Video
- Entertainment

**Driver Information**
- Instrument clusters
- Voice recognition
- Hi-def displays
- Surround view

**Vehicle Networks & V2X**
- Real time video & data network
- Gateways
- Telematics
- V2V
- V2I
- Security

**Driver Assistance**
- Parking assist
- Lane departure warning & Lane keep aid
- Pedestrian detection & correction
- Automatic emergency braking
Safety-Critical ADAS Applications

Requiring ISO 26262 certification for target ASILs
Key Requirements of Automotive-Grade IP

- **Functional Safety**: Accelerate ISO 26262 functional safety assessments to help ensure designers reach target ASIL levels.

- **Reliability**: Reduce risk & development time for AEC-Q100 qualification of SoCs.

- **Quality**: Meet quality levels required for automotive applications.

*Synopsys*
DesignWare ASIL Ready ISO 26262 Certified CSI-2 IP

- Complete camera, display and sensor interface IP solutions from a single vendor
- MIPI CSI-2, MIPIJ D-PHY and MIPI I3C℠ protocols
  - Automotive grade1 and grade2 D-PHYs
- Enables new set of applications in automotive, AR/VR, IoT markets
  - Lowers integration risk for application processors, bridge ICs and multimedia co-processors
- Future proof IP supporting variety of speeds, proven in silicon
  - Reduces cost and power for multiple instantiations
  - Testability features enable low cost manufacturing

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Industry’s first MIPI I3C Demo
Synopsys® DesignWare® MIPI IP Portfolio
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THANK YOU

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