CYPRESS SEMICONDUCTOR CORPORATION
Internal Correspondence

TITLE: Cypress EZ-USB® CX3™—Programmable MIPI® CSI-2 USB 3.0 Camera Controller

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Frequently Asked Questions

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PRODUCT FEATURES

Q1. What is CX3?
A: CX3 is a MIPI CSI-2 to USB 3.0 bridge controller.

Q2. What does the acronym MIPI CSI-2 stand for?

Q3. What are the key features of EZ-USB CX3?
A: The key features of EZ-USB CX3 are outlined below:
- USB 3.0 peripheral controller with full backward compatibility to USB 2.0
- Supports any image sensor with up to four MIPI CSI-2 data lanes
- Each lane supports up to 1-Gbps data rate (max. overall bandwidth up to 2.4 Gbps)
- Fully accessible 32-bit ARM926EJ-S CPU core with 200 MHz operation
- 512K embedded SRAM
- I²C master controller – support 100 kHz, 400 kHz and 1 MHz
- I²S master (transmitter only)
- UART support up to 4 Mbps
- SPI master – support up to 33 MHz
- 12 GPIOs

Q4. What packages are available for CX3?
A: Currently, CX3 is available in a 121-pin BGA (10 x 10 x 1.7-mm, 0.8-mm pitch) package. Cypress plans to create an 8.2 x 5 x 0.75-mm, 0.4-mm pitch, 0.26-mm-ball-diameter WLCSP package. Please contact usb3@cypress.com to request timelines and pricing for the WLCSP package.

Q5. Is this product available in the commercial temperature grade?
A: Currently CX3 is available only in the industrial temperature grade. Contact usb3@cypress.com to request timelines and pricing for the commercial grade package.
SYSTEM IMPLEMENTATION / BOM

Q6. What are the major external components required to make a CX3-based camera?
A: A CX3-based camera requires three major external components:
- Image sensor
- 19.2-MHz clock oscillator
- 1.2-V, 1.8-V/2.5-V or 3.3-V I/O power supply

The firmware can be downloaded from the USB Host to the internal RAM in CX3, so no external memory is required for storing the firmware.

Q7. Can CX3 perform Image Signal Processing (ISP) functions?
A: No. CX3 is a MIPI CSI-2 to USB 3.0 bridge. It will not perform image format conversion or image signal processing. To accomplish these functions, external ISP chips can be used between the image sensor and CX3, or ISP can be implemented in the PC Host software and graphics processing unit (GPU). Cypress is working with ISP vendors and can provide schematics review and firmware development support for using external ISPs (for example, Fujitsu, Aptina and Thine ISPs). Contact usb3@cypress.com for more information.

Q8. What debugging features does CX3 provide?
A: CX3 has JTAG and UART ports, which can be used for debugging the firmware.

Q9. Is it possible to connect two MIPI CSI-2 image sensors with one CX3?
A: No. It is not possible to connect two image sensors to one CX3. An external ISP with two image sensor input channels and one MIPI CSI-2 output interface is required to connect two sensors to one CX3. Contact Cypress at usb3@cypress.com for help in selecting an ISP that can support two image sensors.

Q10. Does CX3 have a method to control the LED using PWM? Will it need an additional microcontroller for this?
A: CX3 has GPIOs that can provide PWM output. The CX3 built-in microcontroller can be used to control the LED using PWM output.

Q11. What is the maximum current the CX3 will draw from the USB VBUS pin for bus-powered application?
A: For 1080p at 30 fps, 24-bit format video streaming configuration, the maximum current CX3 draws from the 5-V source in normal mode is approximately 112.6 mA.

If CX3 is using only the USB 2.0 port, then the current drawn is approximately 98.6 mA. When the device is in standby mode, it draws approximately 68 µA; in suspend mode, it draws approximately 3.2 mA.
Note: These values are based on the criteria summarized in the following table. The table assumes current from VBUS is using switching regulators with approximately 85 percent efficiency for 5-V to 1.2-V, 1.8-V or 3.3-V conversions.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Voltage (V)</th>
<th>Current (mA)</th>
<th>Power (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core</td>
<td>1.25</td>
<td>159.2</td>
<td>0.199</td>
</tr>
<tr>
<td>VBUS</td>
<td>6</td>
<td>22.6</td>
<td>0.136</td>
</tr>
<tr>
<td>U3Tx</td>
<td>1.25</td>
<td>17.1</td>
<td>0.021</td>
</tr>
<tr>
<td>U3Rx</td>
<td>1.25</td>
<td>30.2</td>
<td>0.038</td>
</tr>
<tr>
<td>I/O Supply</td>
<td>3.6</td>
<td>23.5</td>
<td>0.085</td>
</tr>
<tr>
<td>Total Power</td>
<td></td>
<td></td>
<td>0.478</td>
</tr>
<tr>
<td>Current from VBUS</td>
<td>5</td>
<td>112.6</td>
<td></td>
</tr>
</tbody>
</table>

**SOLUTION CAPABILITY**

Q12. What color formats are supported by CX3?
A: CX3 can support all of the image data formats supported by the MIPI CSI-2 specification. For example, RAW, YUV, RGB and JPEG data formats are supported.

Q13. Does CX3 support image sensors with parallel or serial low-voltage differential signaling (LVDS), sub-LVDS, or HiSPI interfaces?
A: No. CX3 is optimized to support MIPI CSI-2 image sensors only. Cypress FX3™, with its programmable GPIF II interface, should be used for interfacing image sensors with parallel interfaces. In addition, image sensors with serial LVDS, sub-LVDS, or HiSPI interfaces can be interfaced to FX3 using external serial LVDS-to-Parallel converters or FPGAs.

**APPLICATIONS**

Q14. What are the target applications for CX3?
A: The following are target applications for CX3:
- HD (720p), FHD (1080p), UHD (4K x 2K) webcams
- USB 3.0 industrial cameras with low-cost MIPI CSI-2 image sensors
- USB 3.0 surveillance cameras with MIPI CSI-2 image sensors
- USB 3.0 3D light field cameras with MIPI CSI-2 image sensors
- USB 3.0 video conference cameras
SOFTWARE / TOOLS / DRIVERS

Q15. What firmware examples does Cypress provide for CX3?
A: Cypress provides firmware examples for MIPI CSI-2 image sensors OV5640 and AS0260B. They are part of the EZ-USB FX3 Software Development Kit (SDK).

Q16: What USB drivers are supported by CX3?
A: CX3 firmware examples provided with the FX3 SDK support the standard USB Video Class (UVC) driver that comes with the OS. If the application requires a custom driver, please contact Cypress technical support by creating a support case. Cypress has firmware examples using the Cypress CYUSB3.sys driver. Tech support can help the customer customize this firmware example according to specific requirements.

COMPETITION/POSITIONING

Q17. What products can compete with CX3?
A: The following products can compete with CX3
- Realtek RTS5825—USB3.0 PC camera controller with a two-channel MIPI CSI-2 interface and USB 3.0 with built-in ISP and MJPEG Encoder
- Genesys logic GL865A—PC camera controller with a single-channel MIPI CSI-2 interface and USB 2.0
- Any FPGA-based MIPI CSI-2 to USB 3.0 bridge
- Mobile application processors with a MIPI CSI-2 interface and USB 3.0 interface

Realtek and Genesys logic solutions are targeted for the PC webcam market only and have one or two MIPI CSI-2 channels. CX3 has four MIPI CSI-2 channels and supports up to 1080p at 30-fps video. CX3 is completely programmable to suit any kind of imaging application.

The FPGA-based, two-chip MIPI CSI-2 to USB 3.0 bridge is more expensive than the CX3-based single-chip solution.
SUPPORT

Q18. How can I place sample orders for CX3?
A: CX3 can be ordered through the Oracle CRM system. Cypress employees will be able to request samples by going to my.cypress.com > my applications > my samples and requesting the engineering sample of CX3 MPN: CYUSB3065-BZXI.

Q19. Does Cypress provide reference schematics to help customers develop their own camera?
A: Yes, Cypress CX3 has a Reference Design Kit developed by one of its design partners, e-con Systems. The reference schematics of the RDK and image sensor base board can be downloaded from the following link: http://www.e-consystems.com/CX3-RDK-Documents.asp#Denebola_SCH.

Q20. Does Cypress provide hardware design guidelines for customers who are building PCBs with CX3?
A: Yes, Cypress provides hardware design guidelines for CX3 as part of the AN90369 - How to Interface a MIPI CSI-2 Image Sensor With EZ-USB® CX3 application note.

Q21. Where can knowledge base articles about CX3 be found?
A: There are three major knowledge base articles covering frequently asked questions on hardware, firmware and software:
CX3 Hardware: Frequently Asked Questions – KBA91295
CX3 Firmware: Frequently Asked Questions – KBA91297
CX3 Application Software / USB Driver: Frequently Asked Questions – KBA91298

Q22. What resources are available to design a camera using CX3, and how can Cypress support the customer during the design phase?
A: Follow the steps below to design a CX3-based camera:
1. Order a CX3 Reference design kit from a Cypress design partner.
2. Download the kit documentation, firmware and UVC Video player from the kit > documentation tab.
4. Download the FX3 Software development kit (SDK), which includes the CX3 APIs and example firmware for the OmniVision OV5640 and Aptina AS0260 image sensor interface to CX3.
5. Download the CX3 Technical Reference Manual to get more details about the various registers of CX3.
6. Download AN90369 - How to Interface a MIPI CSI-2 Image Sensor With EZ-USB® CX3 for information on how customers can design their own boards and develop firmware.

7. The customer can modify the schematics and firmware based on individual requirements and create a tech support case for schematics and firmware review.

8. Cypress Tech Support can review the schematics and firmware to help customers complete their designs.

Q23. Can CX3 support any application other than a MIPI CSI-2 image sensor-based camera?
A: CX3 can be programmed to work as a MIPI CSI-2 transmitter and can be used as an image sensor simulator. If the customer is looking for a USB-to-MIPI CSI-2 TX bridge, send an email to usb3@cypress.com to get more details.