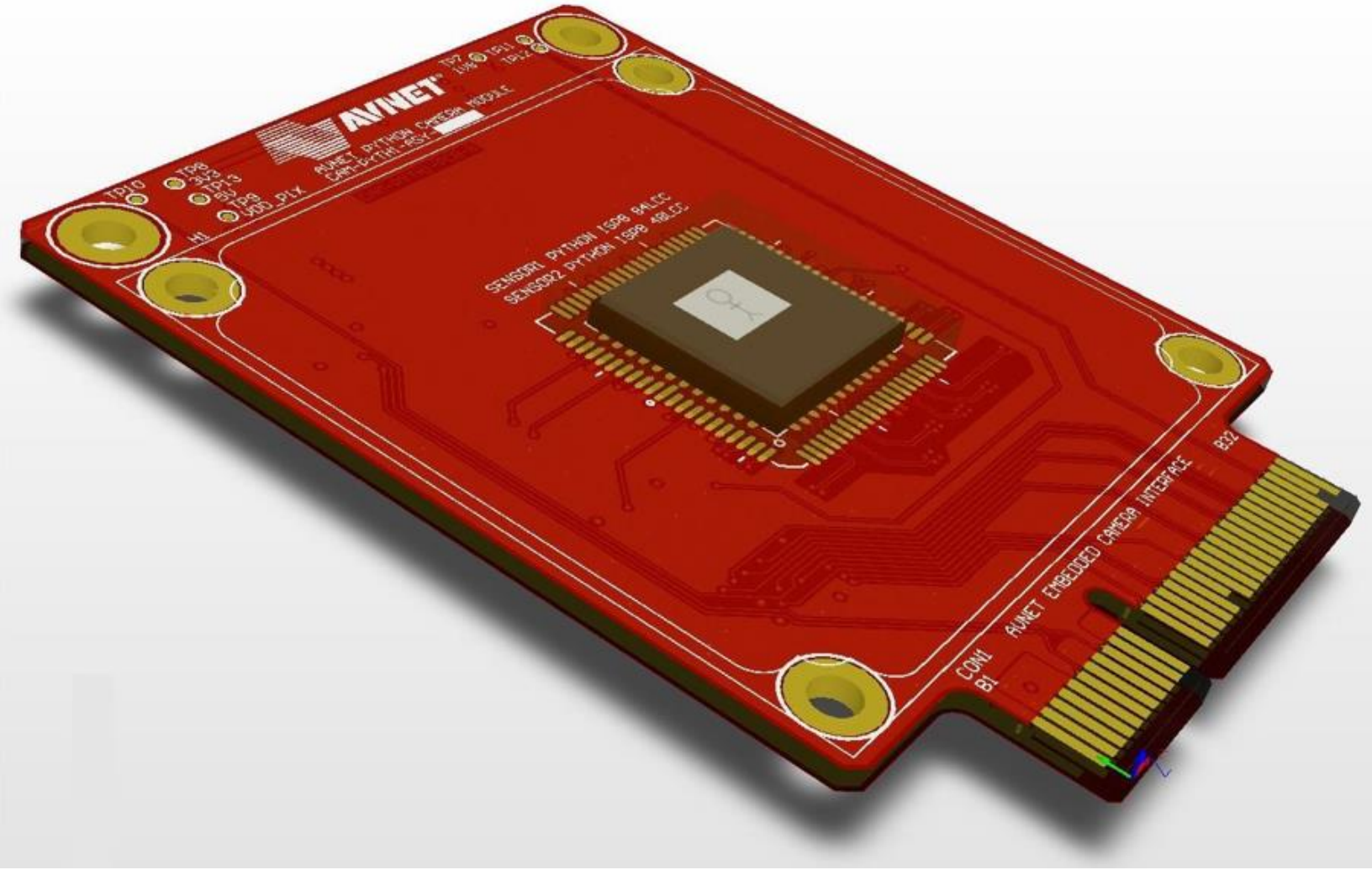

ON Semiconductor
PYTHON 1300-C CAMERA MODULE
Hardware User Guide

Version 1.0

LIT# 5267-UG-CAM-PYTHON-1300C-V1

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Prior Version History

Version	Date	Comment
1.0	1/20/2015	Initial Release

Contents

1 Introduction

The ON Semiconductor PYTHON-1300-C CAMERA MODULE features an ON Semiconductor PYTHON-1300 color image sensor. The PYTHON-1300 is a 1/2 inch Super-eXtended Graphics Array (SXGA) CMOS image sensor with a pixel array of 1280 by 1024 pixels. Designed to address the needs of general purpose industrial image sensing applications, the new global shutter image sensor combines flexibility in configuration and resolution with high speed and high sensitivity for the industrial imaging market. The ON Semiconductor PYTHON-1300-C CAMERA MODULE is compatible with the MicroZed™ Embedded Vision Carrier Card and the Smart Vision Development Kit.

The features provided by the ON Semiconductor PYTHON-1300-C CAMERA MODULE consist of:

- Support for MicroZed™ Embedded Vision Carrier Card
  - PCIe x4 Proprietary Camera Interface
- PYTHON-1300 Color Image Sensor
  - SXGA Resolution – 1280 (H) x 1024 (V) Format
  - 210 Frames Per Second (fps) at Full Resolution
  - 4.8um x 4.8um Pixel Size
  - ½ inch Optical Format
  - Pipelined and Triggered Global Shutter
  - Random Programmable Region of Interest (ROI) Readout
  - On-Chip Fixed Pattern Noise (FPN) Correction
  - Automatic Exposure Control (AEC)
  - High Dynamic Range (HDR)
- Level Translation
  - Supports 2.5V and 3.3V IO Voltages (VIODD) to CAMERA MODULE
- Power
  - Primary Supply
    - +5V from the Carrier Card
  - On-Board Regulators featuring ST Microelectronics
    - +3.3V VDD @ 1A
    - +3.3V VDDPIX @ 500mA
    - +1.8V VDD @ 1A
- Reference Designs at MICROZED.ORG
  - Go to www.microzed.org
  - Click **Support** → Reference Designs/Tutorials
  - Scroll down to **MicroZed Embedded Vision Kits**
  - Click on **Related Parts**
  - Click on the **ON PYTHON-1300-C CAMERA MODULE's View** button.

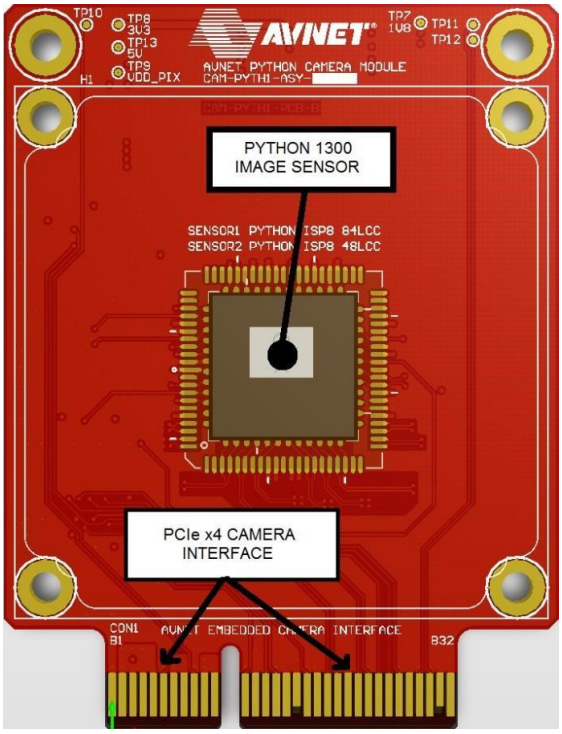

Figure 1 – PYTHON-1300-C CAMERA MODULE Topology – Sensor Side

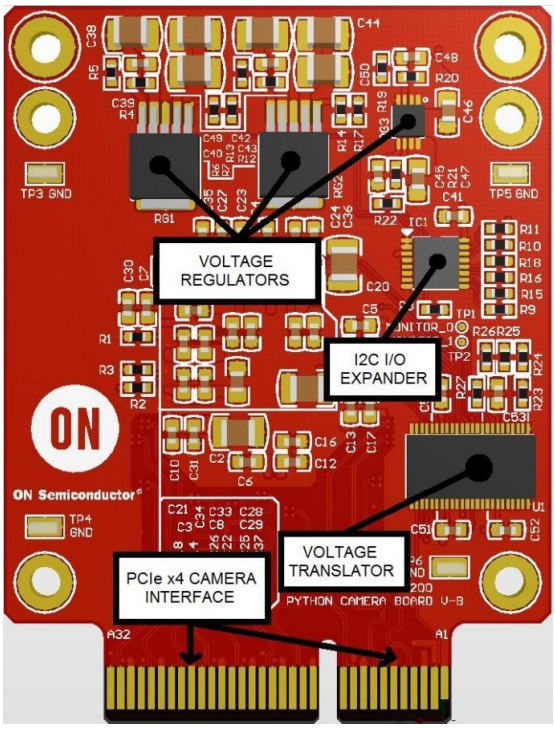

Figure 2 –PYTHON-1300-C CAMERA MODULE Topology – Component Side

2 Functional Description

The ON Semiconductor PYTHON-1300-C CAMERA MODULE is an optional add-on expansion board for the MicroZed™ Embedded Vision Carrier Card that will help engineers to quickly develop solutions targeting custom video-specific applications.

2.1 PYTHON-1300-C Block Diagram

The following figure shows a high level block diagram of the PYTHON-1300-C CAMERA MODULE. The important interface is the Avnet designed camera interface which allows the module to mate to the MicroZed™ Embedded Vision Carrier Card.

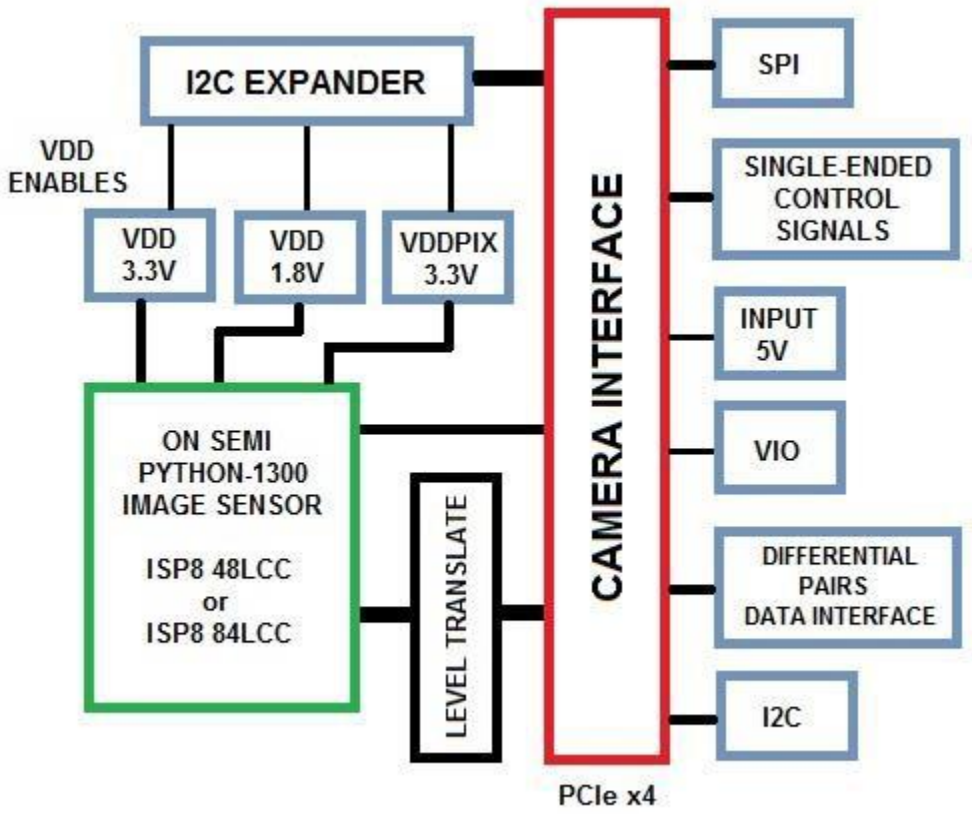

Figure 3 – Block Diagram of PYTHON-1300-C CAMERA MODULE

2.2 Camera Interface

The PYTHON-1300-C CAMERA MODULE supports the Avnet camera interface, which defines pins for the following functions:

- Configuration & Control (single-ended signals)
  - I2C
  - SPI
  - Reset/Reference Clock
  - Trigger
  - Monitor
  - User IO
- Video (differential signals)
  - CLK
  - SYNC
  - DATA[7:0]
- Power
  - 5V, used by Camera Modules to create on-board voltages
  - VIODD used for single-ended I/O

2.2.1 Camera Module Form Factor

The Camera Modules connection to the MicroZed™ Embedded Vision Carrier Card is a standard PCI Express connector. The x4 connector is chosen in order to support all the signals required by the Camera Interface (10 differential pairs, 16 single-ended signals).

The Camera Module form factor is depicted in the following figure.

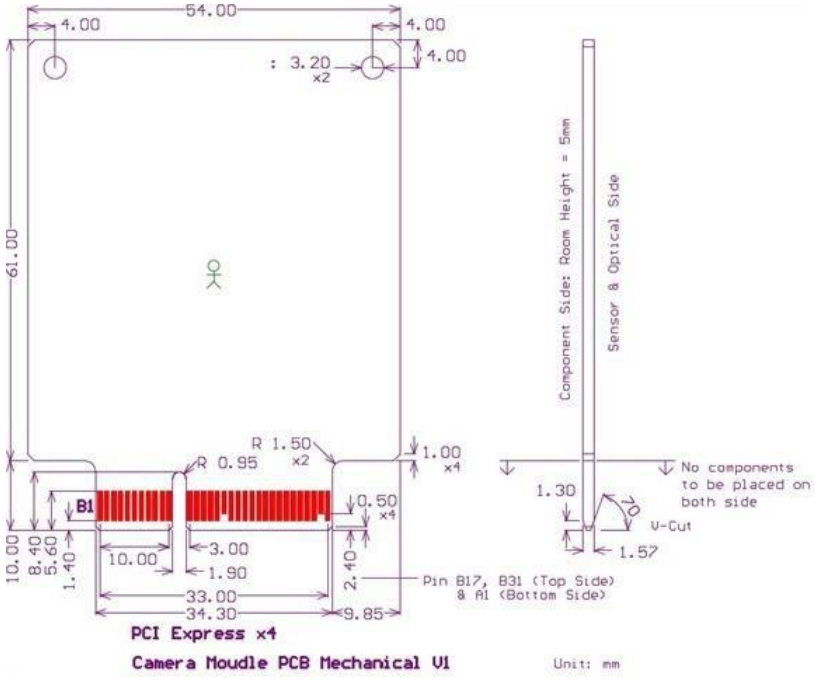

Figure 4 – Camera Module Form Factor

2.2.2 Mapping the Camera Interface

The following table describes the proprietary camera interface pin assignment on the PCIe x4 Lane Camera Interface.

84 LCC Sensor Pin	48 LCC Sensor Pin	Mapping for Camera Interface Side B	Mapping for Camera Interface Side A	48 LCC Sensor Pin	84 LCC Sensor Pin
PCI Express x1					
-	-	GND	GND	-	-
-	-	+5V	CAM_CLK_PLL	25	44
-	-	+5V	GND	-	-
-	-	+5V	CLOCK_OUT_P	8	15
-	-	+5V	CLOCK_OUT_N	7	14
*I2C EXPAND	*I2C EXPAND	SCL	GND	-	-
-	-	+5V	GND	-	-
-	-	VIODD	DOUT0_P	N/A	11
-	-	VIODD	DOUT0_N	N/A	10
*I2C EXPAND	*I2C EXPAND	SDA	GND	-	-
-	-	VIODD	DOUT1_P	N/A	9
-	-	VIODD	DOUT1_N	N/A	8
Key Notch					
5	4	CAM_SPI_SCLK	GND	-	-
-	-	GND	DOUT2_P	10	17
83	47	CAM_SPI_SSEL#	DOUT2_N	9	16
4	3	CAM_SPI_MISO	GND	-	-
-	-	GND	DOUT3_P	12	19
-	-	GND	DOUT3_N	11	18
3	2	CAM_SPI_MOSI	GND	-	-
PCI Express x4					
-	-	GND	DOUT4_P	14	26
82	46	CAM_RESET#	DOUT4_N	13	25
** TP	** TP	PWDN	GND	-	-
-	-	GND	DOUT5_P	16	28
70	41	CAM_TRIGGER0	DOUT5_N	15	27
78	44	CAM_MONITOR0	GND	-	-
71	42	CAM_TRIGGER1	DOUT6_P	N/A	36
77	43	CAM_TRIGGER2	DOUT6_N	N/A	35
81	45	CAM_MONITOR1	GND	-	-
-	-	GND	DOUT7_P	N/A	34
** TP	**TP	USER_IO1	DOUT7_N	N/A	33
** TP	**TP	USER_IO2	GND	-	-
-	-	GND	SYNC_P	18	30
-	-	GND	SYNC_N	17	29

Table 1 – Camera Interface Pin Assignments

2.2.3 Camera Interface Implementation

2.2.3.1 Singled-ended Signals

All of the single-ended signals on the camera interface are at the VIODD voltage.

The single ended signals on the Camera Interface connector are directly connected to the PYTHON 1300 Color Image Sensor. The PYTHON 1300 Color Image Sensor requires these signals to be at a different voltage level, so they are voltage level translated on the Camera Module. This is illustrated in the following figure by buffers placed on the Camera Module.

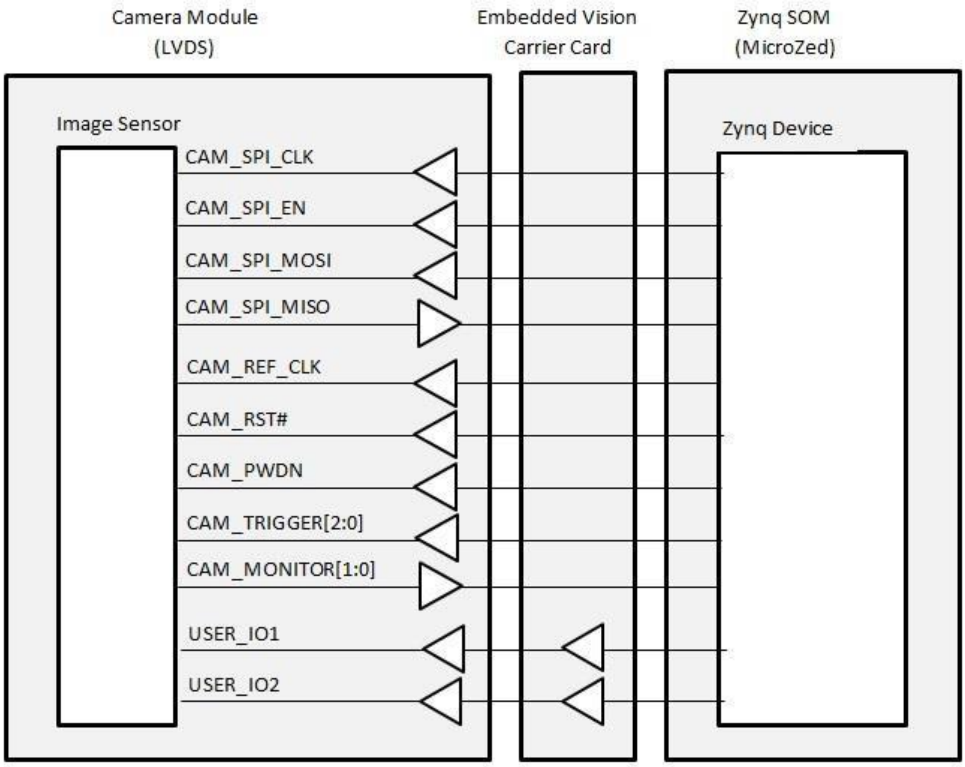

Figure 5 – Single-Ended Voltage Level Translation

Note: On the PYTHON 1300-C CAMERA MODULE, the USER IO1, USER_IO2, and CAM_PWDN signals are tied to Test Points on the board and functionally do not connect to the PYTHON 1300 Color Image Sensor.

2.2.3.2 I2C Interface – Regulator Enables

The PYTHON 1300-C CAMERA MODULE uses an I2C Expander to generate three ENABLE signals for the three on-board Power Regulators. The I2C Expander is configured at I2C address 0x24/0x3C depending on which I2C Expander is populated.

The I2C I/O Expander is accomplished with the use of an **ON Semiconductor PCA9654**. The I2C I/O Expander takes an I2C interface from the Carrier Card and decodes that interface to provide 8 USER GPIO on its pins. In our case, only 3 of the 8 USER GPIO are used to create the VOLTAGE REGULATOR ENABLE signals.

The figure below shows a high level diagram of the I2C I/O Expander circuit on the PYTHON 1300-C CAMERA MODULE.

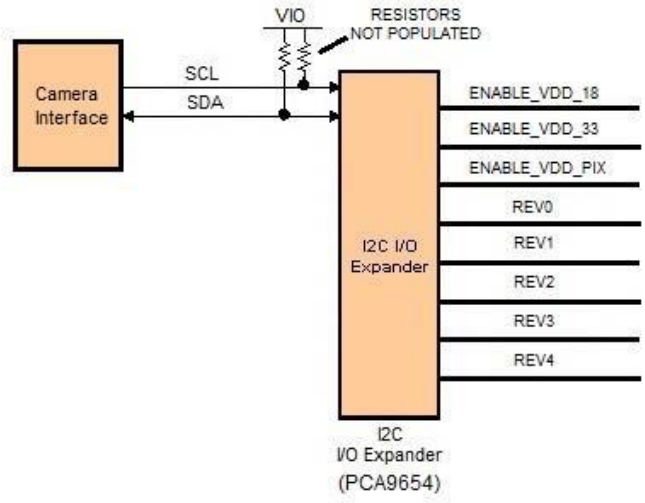

Figure 6: I2C I/O Expander Block Diagram

The table below shows what signals the I2C I/O Expander circuit on the PYTHON 1300-C CAMERA MODULE can control.

Control Signal	Function	Default Value	Direction	Expander Port
ENABLE_VDD_18	1.8V Power Regulator Enable	Pulled-Low	Output	P0
ENABLE_VDD_33	3.3V Power Regulator Enable	Pulled-Low	Output	P1
ENABLE_VDD_PIX	3.3V Power Regulator Enable	Pulled-Low	Output	P2
REV0	Revision GPIO	Pulled-Low	Input	P3
REV1	Revision GPIO	Pulled-Low	Input	P4
REV2	Revision GPIO	Pulled-Low	Input	P5
REV3	Revision GPIO	Pulled-Low	Input	P6
REV4	Revision GPIO	Pulled-Low	Input	P7

Table 2 – I2C IO Expander Signal Summary

The PYTHON 1300-C CAMERA MODULE implements I2C pull-ups, but they are optional and not placed on the board

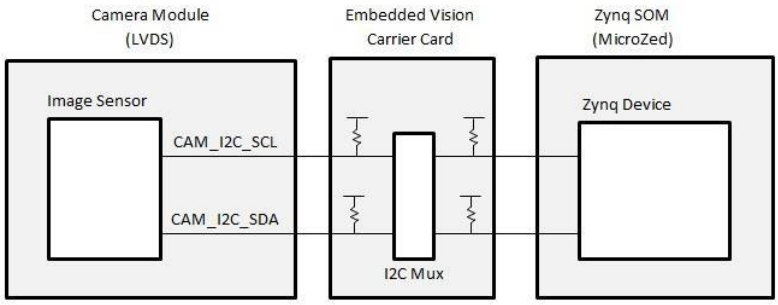

Figure 7 – Camera Module I2C Interface

2.2.3.3 *LED Illumination Control*

The PYTHON 1300 Color Image Sensor supports external triggering. Implementing the CAM_TRIGGER[2:0] signals can be used to trigger LED illumination. This would allow a designer to implement a “camera flash” type illumination.

2.2.3.4 *Differential Signals*

The PYTHON 1300 Color Image Sensors utilizes LVDS signaling. The PYTHON 1300-C CAMERA MODULE does not contain any special circuitry for this I/O standard.

2.2.3.5 *LVDS Implementation*

LVDS has a common mode voltage of 1.25V, and a swing of 350mV.

The following circuit illustrates how the differential pairs of the LVDS interface on the PYTHON 1300 Color Image Sensor is directly connected to the Zynq device on the MicroZed™.

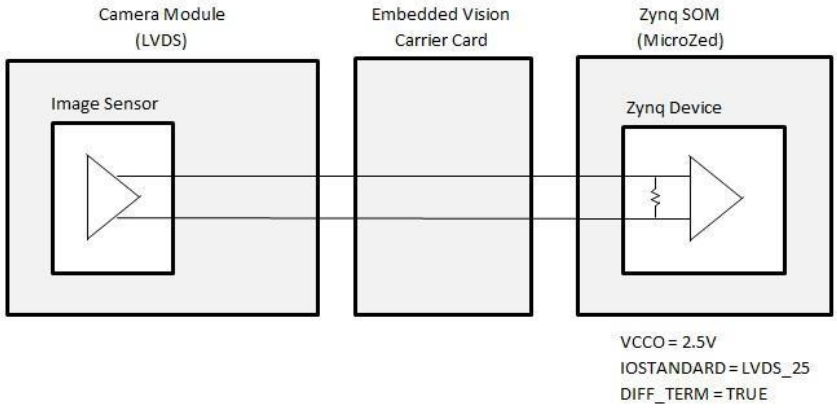

Figure 8 – Camera Module LVDS Interface

2.3 Power Supplies

2.3.1 Voltage Rails and Sources

The PYTHON 1300-C CAMERA MODULE is powered through the physical connection to the Carrier Card. The primary board power is +5V and is supplied via the PCIe x4 Edge Connector. Another source of power is the VIODD pins on the PCIe x4 Edge Connector. The VIODD pins are intended to power the IO interface to the Color Image Sensor.

There are three regulators that reside on the PYTHON 1300-C CAMERA MODULE that provide VDD 1.8V, VDD 3.3V, and VDD PIXEL power rails. These regulators are used to power the required rails for the PYTHON 1300 Color Image Sensor. The regulators are provided by **ON Semiconductor**. A 500mA high performance low drop voltage regulator, **NCP3335,** is used to generate VDDPIX at 3.3V. The other two regulators are **NCP5661** devices. These are 1A ultra-fast DC low dropout linear regulators and are used to generate VDD 3.3V and VDD 1.8V.

The following diagram shows a high level depiction of the power scheme for PYTHON 1300-C CAMERA MODULE.

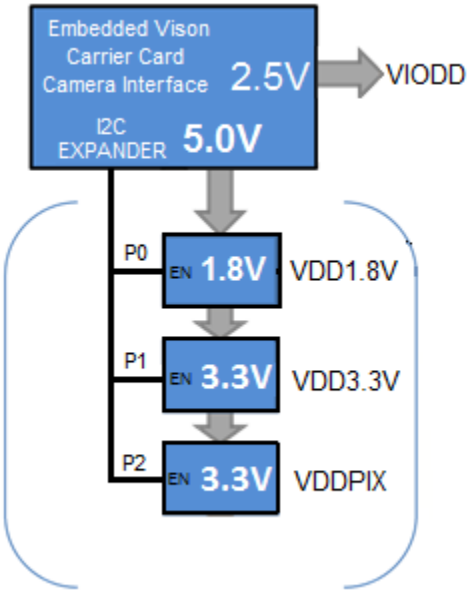

Figure 8: PYTHON 1300-C CAMERA MODULE Power Scheme

The table below shows the maximum output current for each of the **ON Semiconductor** regulators on the PYTHON 1300-C CAMERA MODULE.

ON Semiconductor Part Number	Input Voltage Range (V)	Input Voltage (V)	Output Voltage (V)	Max Current (mA)
NCP5661	2.0V to 9.0V	5V	1.8V	1000mA
NCP5661	2.0V to 9.0V	5V	3.3V	1000mA
NCP3335A	2.6 to 12V	5V	3.3V	500mA

Table 3 – Voltage Rails w/ Max Output Current

3 Mechanical

The PYTHON 1300-C CAMERA MODULE measures 54.00 mm x 61.00 mm. Other pertinent dimensions are presented in the following figure.

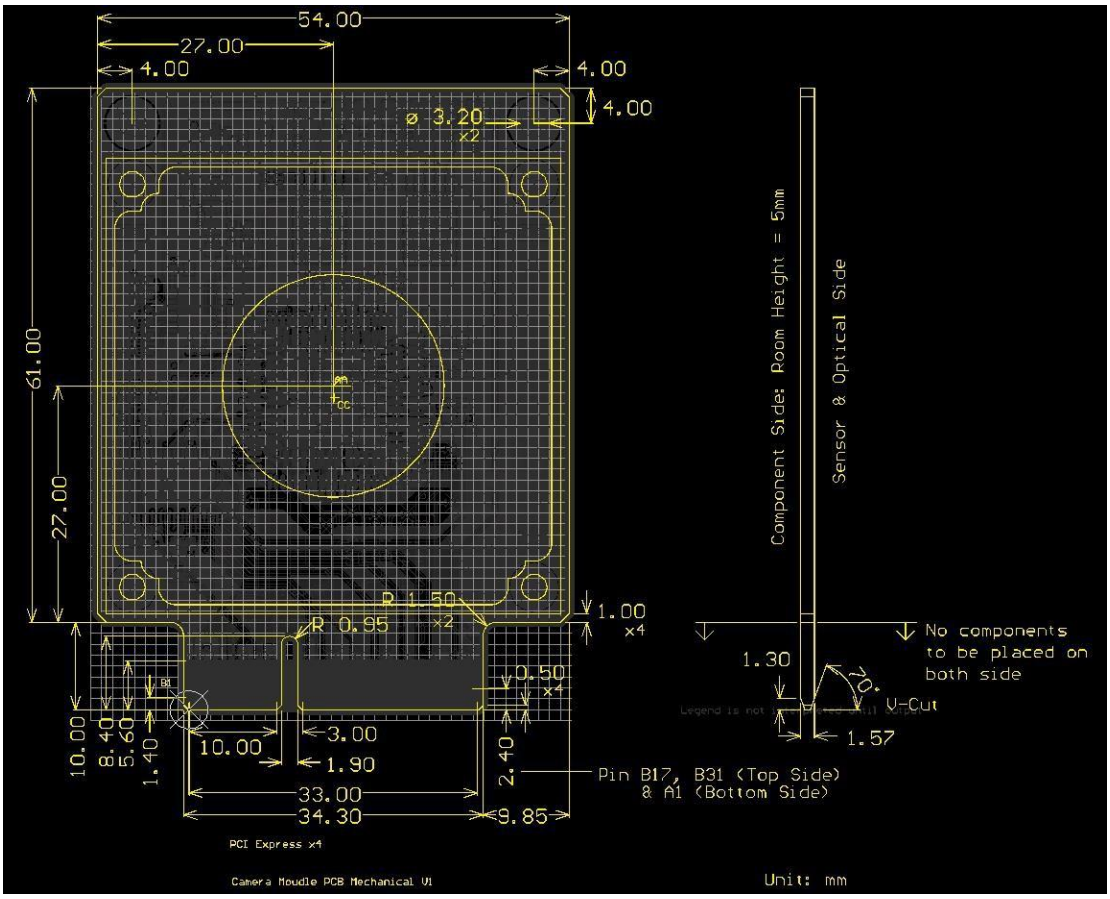

Figure 9 – PYTHON 1300-C CAMERA MODULE Top View Mechanical Dimensions

The PYTHON 1300-C CAMERA MODULE is allowed a maximum vertical dimension of 5.00mm on the component side of the module. A listing of the actual vertical dimensions is presented in the following figure.

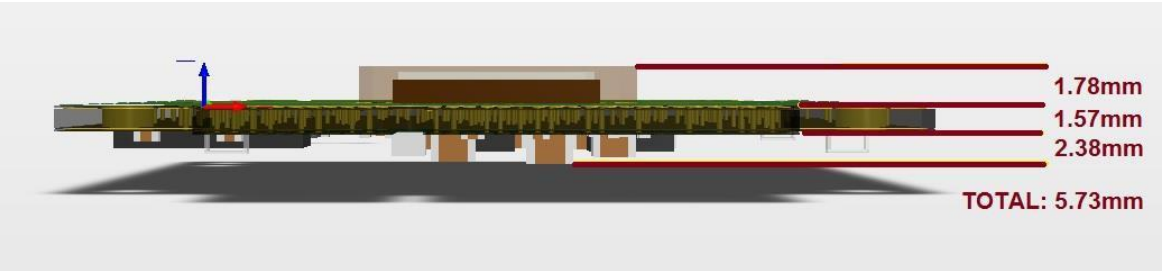

Figure 10 – PYTHON 1300-C CAMERA MODULE Side View Vertical Dimension