Intel® RealSense™ 3D Camera ZR300

Product Datasheet

January 2017

Revision 1.0

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Revision History

Revision Number	Description	Revision Date
1.0	Initial public release	January 2017

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1 Overview

1.1 Disclaimer

This document is a preliminary guide to give customers an idea of design details the ZR300 peripheral. Requirements and hardware design are subject to change until 1.0. Post 1.0 updates will be to address bugs and issues. Please contact your Intel representative to be notified of changes to this document and future revision releases.

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2 Description and Features

Figure 2-1. ZR300 Camera Peripheral

ZR300 Description

The Intel® RealSense™ ZR300 Camera implements a stereovision depth imaging, 6 degree of freedom inertial measurement unit, and a fisheye optical sensor into a single module with a USB3.0 interface. The data is timestamped to a 50us reference clock for synchronization.

The small size of the ZR300 module provides system integrators flexibility to design into a wide range of products.

Applications(1)

- Object Recognition, Localization, and Tracking
- Person Recognition, Tracking, and Gestures
- SLAM real-time 6DoF tracking, mapping, and re-localization

Note: Additional software must be installed to enable these applications.

Features

- Onboard Imaging ASIC
- VGA, 480x360, and QVGA resolution
- Depth capture range 0.55m to 2.8m (1)
- Infrared (IR) Laser Projector System (Class 1)
- Inertial Measurement Unit
- Timestamp syncronization
- 1080p RGB color stream
- VGA fisheye monochrome stream
- Reference time synchronization mechanism

(1) 480x360 resolution

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3 Overview

3.1 ZR300 Description

The ZR300 camera is a device that can provide 6 degree of freedom motion, fisheye monochrome, color, depth, and infrared video streams over a combination of USB and CSI interfaces.

It uses stereovision techniques augmented by an infrared projection system to produce a depth stream in a compact, low power package.

Figure 3-1. Example Color Stream

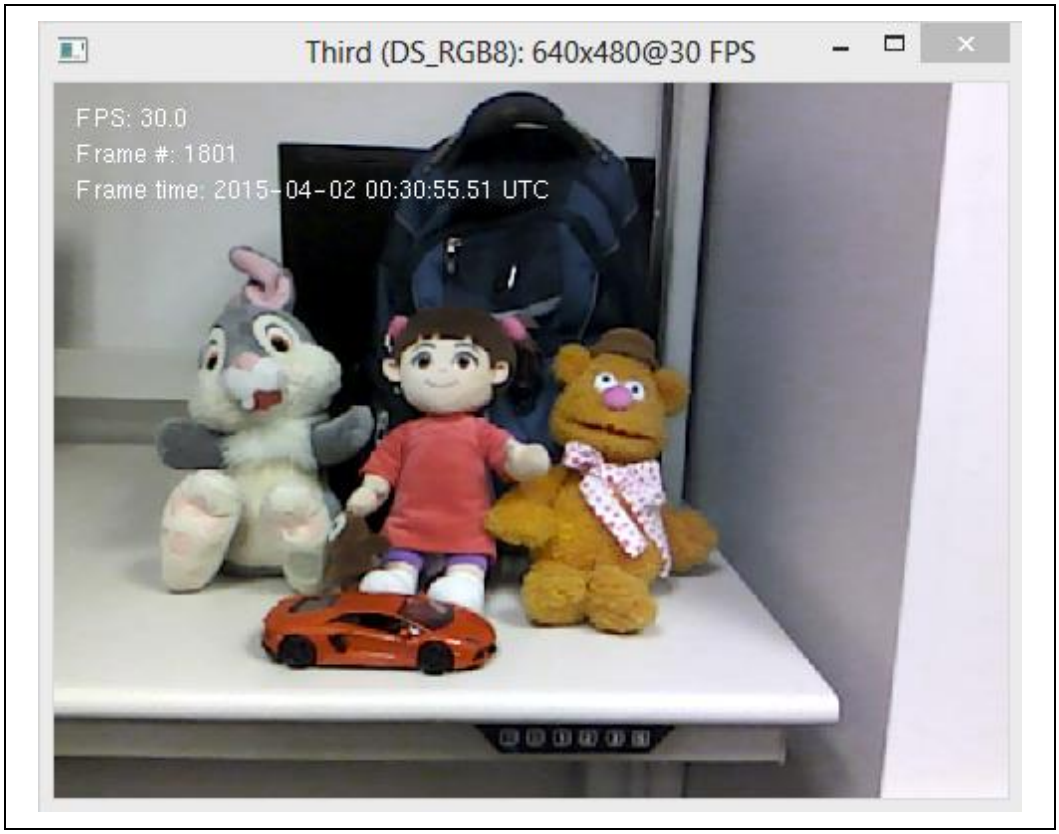


Figure 3-2. Example Depth Stream

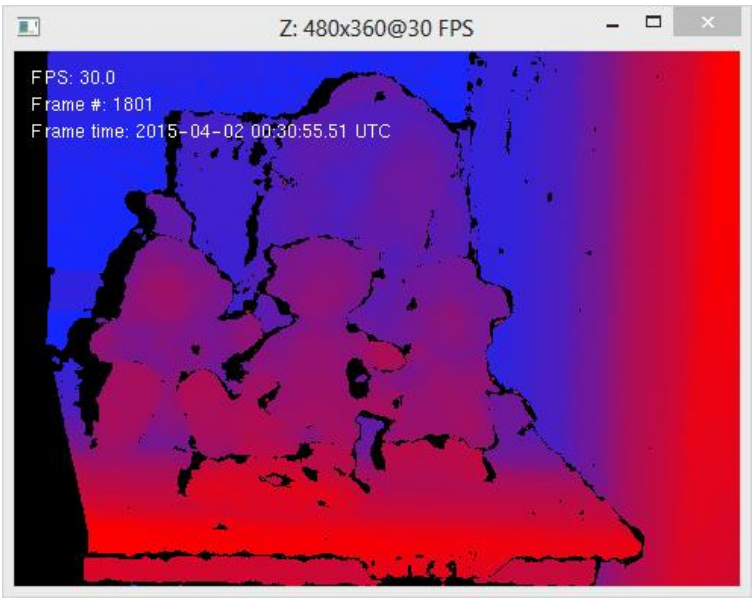
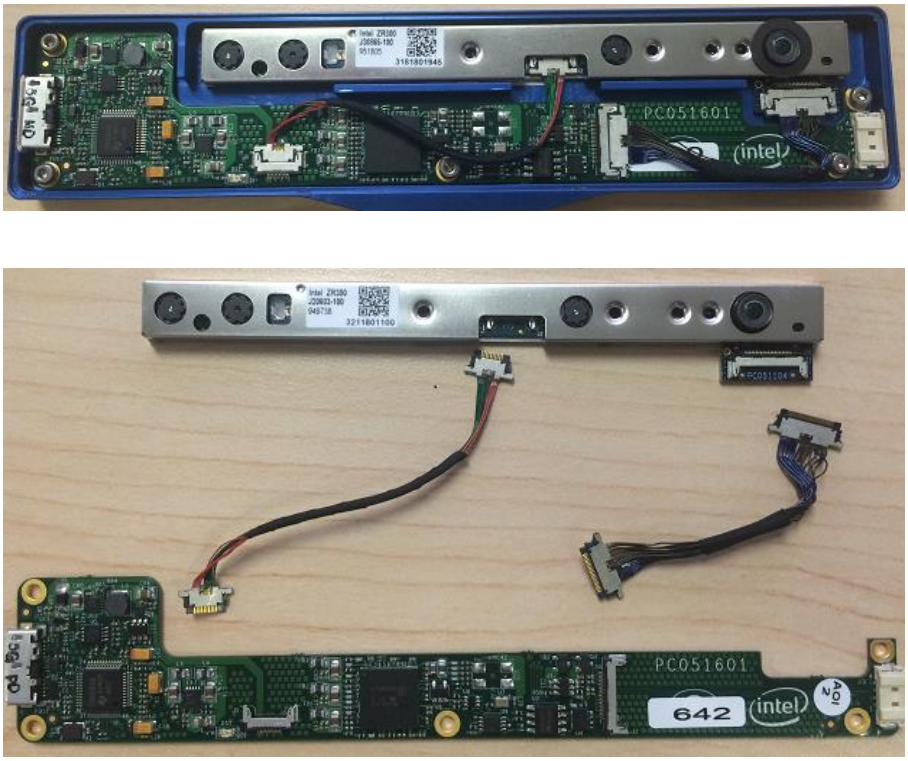


Figure 3-3. Example Fisheye Stream

3.2 ZR300 Camera Module

Figure 3-4. ZR300 Peripheral Components



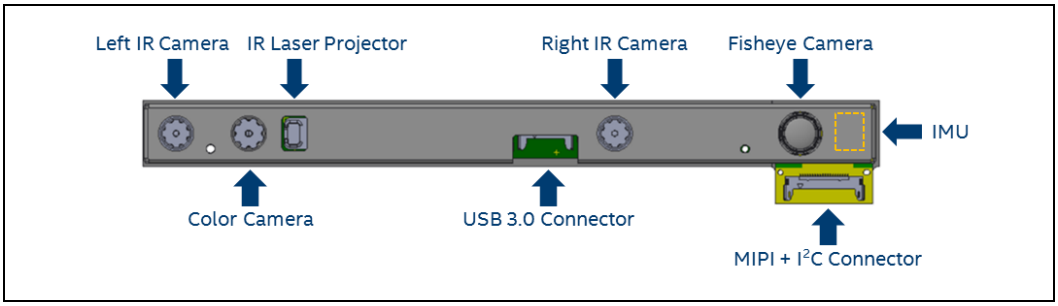
Note: ZR300 Peripheral internal assemblies which include the ZR300 module, cables, and USB3.0 interposer board

3.3 ZR300 Peripheral Components

Table 3-1: Component Descriptions

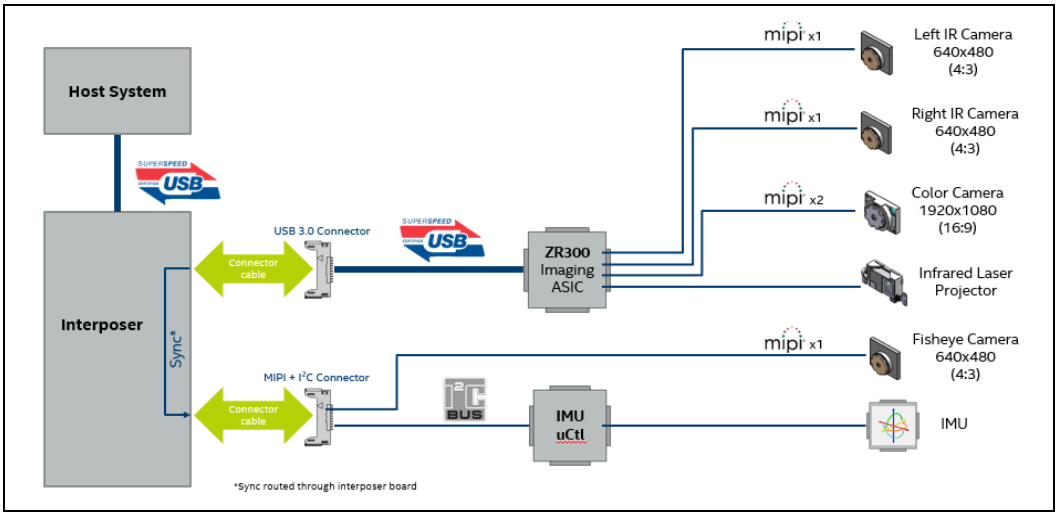
Component	Description
ZR300 Module	Camera module that provides depth, motion tracking, and timestamp capability
Cable #1	10 pin micro-coax cable
Cable #2	20 pin micro-coax cable
Interposer	Converts USB and MIPI signals from camera module into USB3.0 for connection to a host platform
Cover Material	Infrared pass through plastic material
Case	Milled aluminum case with magnet on back

Figure 3-5. Component Locations (Front View)



The camera module and components are illustrated in Figure 4-1. The module's major components are placed on two separate printed circuit boards.

Figure 3-6. Intel® RealSense™ ZR300 Module Block Diagram



3.4 Storage and Operating Conditions

Table 3-2: Storage and Operating Conditions

CONDITION	DESCRIPTION	MIN	MAX	UNIT
Storage (Still Air), Not Operating	Temperature (Sustained, Controlled)(1)	0	40	°C
	Temperature (Short Exposure)(2)	-40	70	°C
	Humidity, Non-Condensing	90% RH, 30°C		
Operating(3) (Still Air)	Temperature	0	50	°C

NOTES:
(1) Controlled conditions should be used for long term storage of product.
(2) Short exposure represents temporary max limits acceptable for transportation conditions.
(3) Component case temperature limits must be met for all operating temperatures.

3.5 Handling Conditions

The ZR300 has limited ESD protection built into the peripheral.

Table 3-3: Electrostatic Discharge Caution

	To provide a consistent ESD protection level, it is recommended that the JEDEC JESD625-A requirements standard be incorporated into the ESD environment controls.

3.6 Camera and Projector Field of View

Although the camera sensors are rectangular, the lens field of view is cone shaped. This is illustrated in Figure 3-7. Although most systems are designed with the chassis opening aligned to the cone shaped profile, the rectangles inside the cones show what is visible by the cameras and projector. In order to avoid obscuring the FOV or FOP, the rectangular area must project out of the chassis opening. This is illustrated in Figure 3-8.

Figure 3-7: Field of View and Projection Profiles

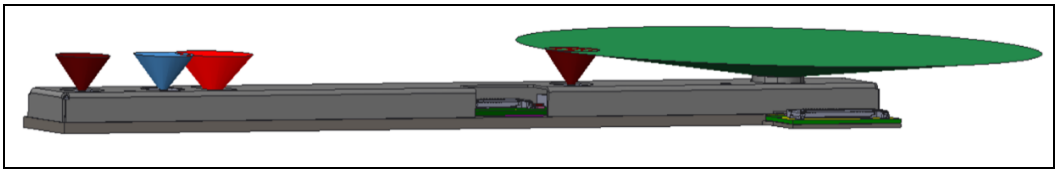
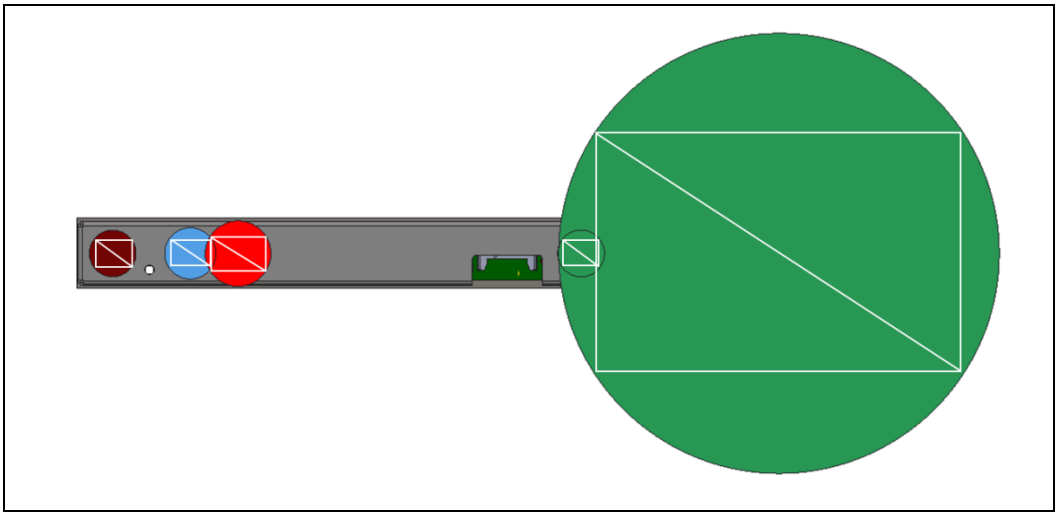


Figure 3-8: Effective FOV versus Geometric FOV



The FOP and FOV of each imaging component are listed below in Table 3-4.

Table 3-4: Imaging Component Effective Field of View and Projections

Component	Diagonal	Vertical	Horizontal
IR Laser Projector FOP	80° ± 5%	60° ± 5%	60° ± 5%
Infrared Camera FOV	70° ± 5%	46° ± 5%	59° ± 5%
Color Camera FOV	75° ± 4%	41.5° ± 2%	68° ± 2%
Fisheye Camera FOV	166.5° ± 4%	100° ± 3%	133° ± 3%

3.7 Cover Materials

It is not recommended to place cover materials over the peripheral as they will degrade performance. The cover material on the peripheral is designed to protect the infrared camera sensors and projector from dust and finger prints. Care must be taken not to touch the exposed RGB or Fisheye camera sensors. Doing so may cause poor image quality or a loss of calibration.

It is recommended that any cover materials placed in the FOV of the infrared cameras and projector have at least 98% transmission in the 830-890nm wavelength light range. Most covers will require an anti-reflective coating on both sides to achieve 98% transmission. Failure to meet this specification will cause a loss in the range of depth performance. Furthermore, it is recommended to use flat cover materials to avoid introducing distortion that would reduce depth performance.

Any cover material placed over the RGB and Fisheye camera sensors must not introduce distortion or loss of visible light transmission. It is recommended to use a flat cover material as curved materials will introduce distortion.

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3.8 USB Composite Device

The ZR300 peripheral connects to a host system via a USB3.0 cable. There is a USB3.0 micro B connector for connecting to a host system on the side of the peripheral. ZR300 ASIC is a USB 3.0 composite device which exposes all hardware endpoints to the operating system. The ASIC is a bulk device and transmits depth and color videos streams in data bursts rather than as constant video streams.

The ZR300 camera module is compliant with the USB 3.0 specification. The module does not support USB 2.0 connections and does not route the USB 2.0 pins. In the case of a USB 3.0 link training failure it is possible that the module will not be detected. Because the module is an integrated device, it is not expected for the module to encounter USB 3.0 link training failures.

Figure 3-9: USB Composite Device Hardware ID

HARDWARE ID	BITS	VALUE
Vendor ID	[15:0]	0x8086

Device ID	[15:0]	0x0AD0 and 0x0ACB
Revision ID	[15:12]	Firmware Major Version
	[11:5]	Firmware Minor Version
	[4:0]	Firmware Sub-Minor Version

3.9 USB Endpoints

The ZR300 peripheral exposes the following endpoints to the host system.

Table 3-5: USB Composite Device Endpoints

ENDPOINT
USB Composite Device
Intel® RealSense™ 3D Camera (ZR300) RGB
Intel® RealSense™ 3D Camera (ZR300) Depth
Intel® RealSense™ 3D Camera (ZR300) Left-Right
CX3-UVC

4 Functional Specification

4.1 Embedded 3D Imaging System

The ZR300 module uses stereo vision to calculate depth. The stereo vision implementation consists of left infrared camera, right infrared camera, and an infrared laser projector. The left and right camera data is sent to the ZR300 ASIC. The ASIC calculates depth values for each pixel in the image. The infrared projector is used to enhance the ability of the system to calculate depth in scenes with low amounts of texture. Traditionally, scenes with low texture such as walls presented a challenge for stereo vision systems to calculate depth. Please note the camera module output type is a depth measurement from the parallel plane of the module and not the absolute range from the module cameras as shown in Figure 4-2.

Figure 4-1: Active Stereo Technology Overview

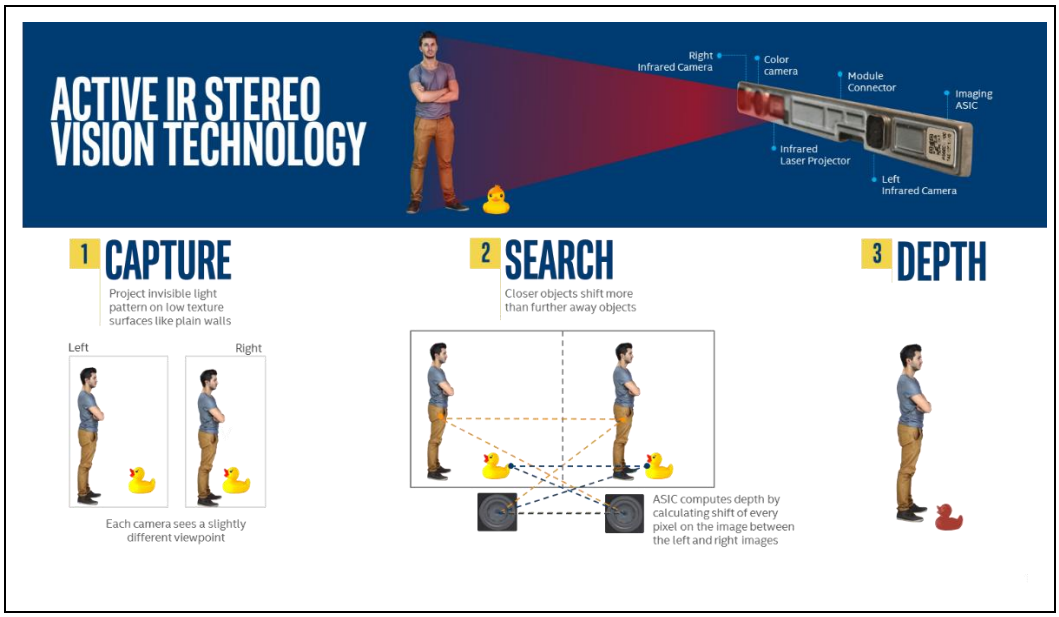
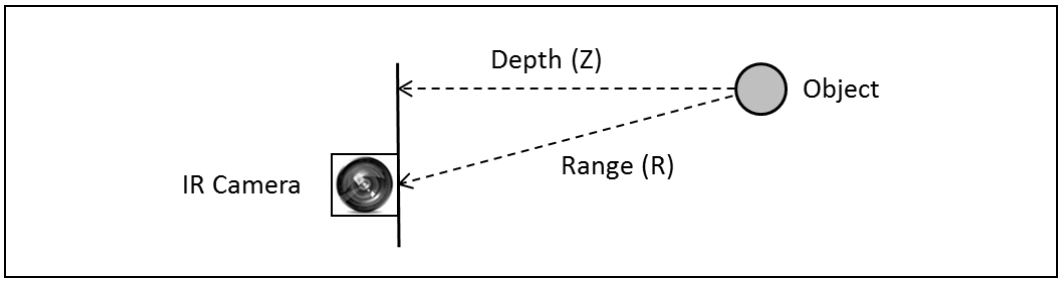


Figure 4-2: Depth (Z) versus Range (R)



4.2 Camera Video Stream Formats

Table 4-1: Supported Left/Right Infrared Camera Video Stream Formats and Modes

Format	Description	Resolution	Frame Rates
RY12LY12_4_3	12 bits right, 12 bits left, 4 pixels packed into 3 32 bit words	640x480, 492x372, 332x252	30, 60
LY_8_4_1	8 bits left, 4 pixels packed into 1 32 bit words	640x480, 492x372, 332x252	30, 60
LY12_2_1	12 bits left, 2 pixels packed into 1 32 bit words	640x480, 492x372, 332x252	30, 60
RY8LY8_2_1	8 bits right, 8 bits left, 2 pixels packed into 1 32 bit words	640x480, 492x372, 332x252	30, 60

Table 4-2: Supported Depth Video Stream Formats and Modes

Format	Description	Resolution	Frame Rates
Z16_2_1	16 bits, 2 pixels packed into 1 32 bit word	628x468, 480x360, 320x240	30, 60

Table 4-3: Supported Color Camera Video Stream Formats and Modes

Format	Description	Resolution	Frame Rates
YUY2		1920x1080	30
YUY2		640x480	15,30,60
YUY2		320x240	30,60

Table 4-4: Supported Fisheye Camera Video Stream Formats and Modes

Format	Description	Resolution	Frame Rates
Raw10	Monochrome image pattern	640x480	5, 30, 60

Note: The modes listed above are hardware supported modes and may not be visible to applications.

All frame rates are expressed as nominal. Effective frame rates can vary depending on the exposure settings of the camera. Camera settings that increase the exposure time can decrease the effective frame rate.

4.3 Infrared Projector Interference

In general, the ZR300 is not subject to infrared projector interference from multiple cameras in use simultaneously.

4.4 Peripheral Power Consumption

Table 4-5: Nominal Peripheral Power Consumption

DEPTH MODE	INFRARED MODE	COLOR MODE	Fisheye Mode	POWER	UNIT
OFF	OFF	OFF	OFF	1.1	W
VGA, 60FPS	VGA, 60FPS	HD, 30FPS	VGA, 60FPS	3.4	W

4.5 Module Power Consumption

Table 4-6: Nominal Module Power Consumption

DEPTH MODE	INFRARED MODE	COLOR MODE	Fisheye Mode	POWER	UNIT
OFF	OFF	OFF	OFF	0.5	W
VGA, 60FPS	VGA, 60FPS	HD, 30FPS	VGA, 60FPS	1.9	W

4.6 Thermal Requirements

To ensure proper functionality of the module and sensor components, the camera module must not exceed the thermal requirements. The peripheral is designed not to exceed specifications in typical operating conditions. However, because usages and environments vary it may be necessary to verify the following conditions are met. Failure to meet the conditions below will result in degraded performance and accelerated component failure.

Table 4-7: Component Case Temperature Limits

Component	Case Temperature Limit	ΔT Junction to Case	Junction Temperature (Est.)
1080P Color Camera Sensor	60°C	9°C	69°C
IR Camera Sensors	62°C	8°C	70°C
Laser Projector	69°C †	6°C	75°C
ASIC	95°C	-	-
Fisheye Camera	60°C	-	-
Motion Control Unit	85°C	-	-

Component	Case Temperature Limit	ΔT Junction to Case	Junction Temperature (Est.)
Inertial Measurement Unit	85°C	-	-
† Laser projector temperature should be monitored through the ZR300's embedded thermal sensor. Refer to the following section for more details.			

It is not possible to directly measure junction temperature of the module components. Because of this, Intel recommends taking measurements with thermal probes at the locations identified in Figure 4-3. The measurements can be correlated with the thermal model to estimate component junction temperatures.

Figure 4-3: Module Thermal Probe Points

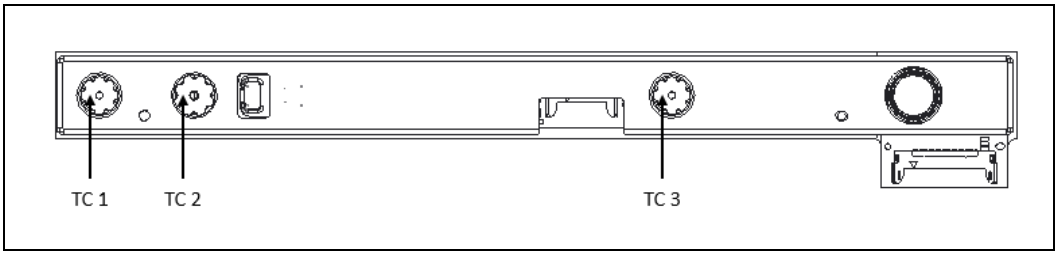


Table 4-8: Component Case Temperature vs. Junction Temperature

Point	Component	Junction Temp (Est.)
TC1	Right IR Camera Surface	Case Temp +8°C
TC2	RGB Camera Surface	Case Temp +9°C
TC3	Left IR Camera Surface	Case Temp +8°C

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5 Regulatory Compliance

5.1 Laser and Fire/Electrical Safety Compliance

This device complies with the Standard for Safety of Laser Products, EN/IEC 60825-1, Edition 2 (2007) and EN/IEC 60825-1, Edition 3 (2014) as a Class 1 laser product and additionally complies with US FDA performance standards for laser products under 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

This device also complies with the Standard for Information Technology Equipment, UL 60950-1, Edition 2, CAN/CSA C22.2 No. 60950-1, Edition 2 and IEC 60950-1, Edition 2; and is certified as a UL/cUL Recognized Component under UL File E139761.

5.2 Cautionary Statements

System integrators should refer to their respective regulatory and compliance owner to finalize regulatory requirements for a specific geography.

Caution - Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

There are no service/maintenance, modification, or disassembly procedures for the stereo module and infrared projector. The system integrator must either notify Intel or return modules before any failure analysis is performed.

- Do not attempt to open any portion of this laser product.
- There are no user serviceable parts with this laser product.
- Modification or service of the stereo module, specifically the infrared projector, may cause the emissions to exceed Class 1.

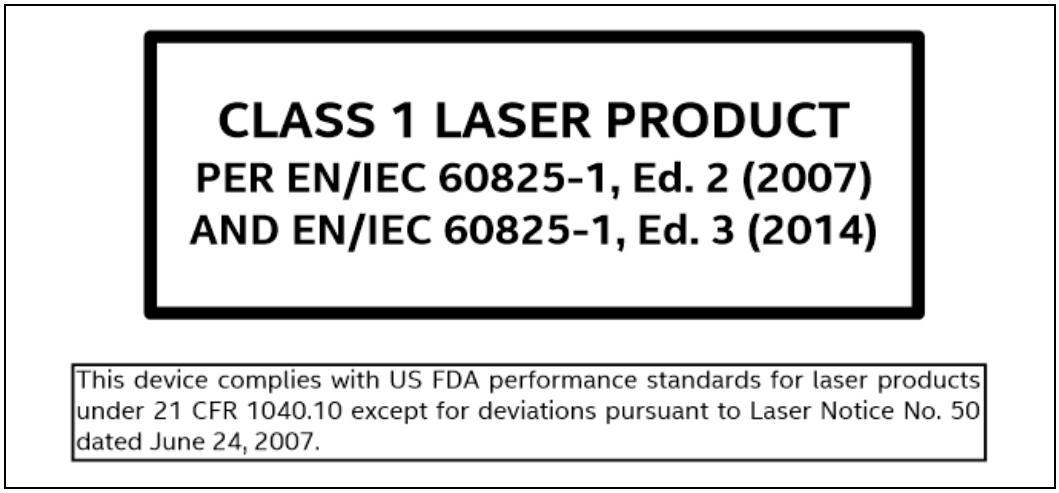
5.3 System Laser Compliance

The camera module certification is transferable to the system and no system re-certification is required. However, the following statements and labels must be included in the user manual of the system product.

5.3.1.1 Certification Statement

This product is classified as a Class 1 laser device under the IEC 60825-1, Edition 2 (2007) and IEC 60825-1, Edition 3 (2014) standards at the time of publication. This device also complies with US FDA performance standards under 21 CFR 1040.10 for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

5.3.1.2 Explanatory Label



5.4 FDA Accession Number

U.S. FDA accession number is **1420260-005** for ZR300.

This number should be entered into Box B.1 of the Food and Drug Administration (FDA) 2877 Declaration for Imported Electronic Products Subject to Radiation Control Standards.

5.5 Manufacturer Identification

Manufactured by Intel Corporation
2200 Mission College Blvd., Santa Clara, CA 95054
Model: Intel® RealSense™ Camera (ZR300)

5.6 Ecology Compliance

This device is EU RoHS 2 (Directive 2011/65/EU) compliant.

State of California Proposition 65 WARNING: This product contains chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

China RoHS Declaration:

产品中有毒有害物质的名称及含量

Hazardous Substances Table

部件名称 Component Name	有毒有害物质或元素 Hazardous Substance					
	铅 Pb	汞 Hg	镉 Cd	六价铬 Cr (VI)	多溴联苯 PBB	多溴二苯醚 PBDE
相机 Camera	X	○	○	○	○	○

○：表示该有毒有害物质在该部件所有均质材料中的含量均在GB/T 26572标准规定的限量要求以下。

○：Indicates that this hazardous substance contained in all homogeneous materials of such component is within the limits specified in GB/T 26572.

×：表示该有毒有害物质至少在该部件的某一均质材料中的含量超出GB/T 26572标准规定的限量要求。

×：Indicates that the content of such hazardous substance in at least a homogeneous material of such component exceeds the limits specified in GB/T 26572.

对销售之日的所售产品,本表显示我公司供应链的电子信息产品可能包含这些物质。注意:在所售产品中可能会也可能不会含有所有所列的部件。

This table shows where these substances may be found in the supply chain of our electronic information products, as of the date of sale of the enclosed product.

Note that some of the component types listed above may or may not be a part of the enclosed product.

除非另外特别的标注,此标志为针对所涉及产品的环保使用期限标志. 某些可更换的零部件可能会有一个不同的环保使用期限(例如,电池单元模块).

此环保使用期限只适用于产品在产品手册中所规定的条件下工作.

The Environment-Friendly Use Period (EFUP) for all enclosed products and their parts are per the symbol shown here, unless otherwise marked. Certain field-replaceable parts may have a different EFUP (for example, battery modules) number. The Environment-Friendly Use Period is valid only when the product is operated under the conditions defined in the product manual.

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6 Firmware

6.1 Firmware Updates

The ZR300 does not support user firmware updates.

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7 Software Controls

7.1 Infrared Camera Functions

The ZR300 module exposes the following image settings.

Table 7-1: Left and Right IR Sensor Configuration

Property	Min	Max	Default	Auto
Image Gain	1	63.9	-	Yes
Image Exposure	0.01	33.3	-	Yes

Note: The left and right IR sensors must share settings; it is not possible to configure each IR sensor individually.

7.2 Color Camera Functions

Table 7-2: RGB Sensor Configuration

Property	Min	Max	Default	Auto
Image Gain	1	128	64	Yes
Image Exposure	0.1	62.5	15.62	Yes
Brightness	0	255	55	No
Contrast	16	64	32	No
Saturation	0	255	128	No
Hue	-2200	2200	0	No
Gamma	100	280	220	No
White Balance	2000	8000	4600	Yes
Sharpness	0	7	0	No
Backlight Comp	0	4	1	No
PowerLine Freq (Hz)	50	60	60	Yes

7.3 Fisheye Camera Functions

Table 7-3: Fisheye Sensor Configuration

Property	Min	Max	Default	Auto
Power Mode	Standby	Active	-	-

Property	Min	Max	Default	Auto
Trigger (from Depth Camera)	Disable	Enable	Disable	-
Exposure	0.02ms	32ms	4ms	Yes
Gain	0	255	16	Yes

7.4 Inertial Measurement Sensor Functions

Table 7-4: Inertial Measurement Sensor Configuration

Property	Min	Max	Default	Auto
IMU Sync (Gyro & Acc)	Disable	Enable	Disable	-
Resolution	32MHz	8KHz	32MHz	-

7.5 Motion Control Unit Functions

Table 7-5: Motion Control Unit

Property	Min	Max	Default	Auto
Time Stamp Events	Disable	Enable	Disabled	-
G0 Trigger	Rising Edge	Falling Edge	Rising Edge	-
G1 Trigger	Rising Edge	Falling Edge	Rising Edge	-

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