

OPT8320-CDK-EVM

User's Guide



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OPT8320-CDK-EVM

This user's guide describes the characteristics, operation, and use of the OPT8320-CDK-EVM evaluation module. It discusses how to set up and configure the software and hardware, and reviews various aspects of the program operation. Throughout this document, the terms evaluation board, evaluation module, and EVM are synonymous with the OPT8320-CDK-EVM. This document also includes an electrical schematic, printed-circuit board (PCB) layout drawings, and a parts list for the EVM.

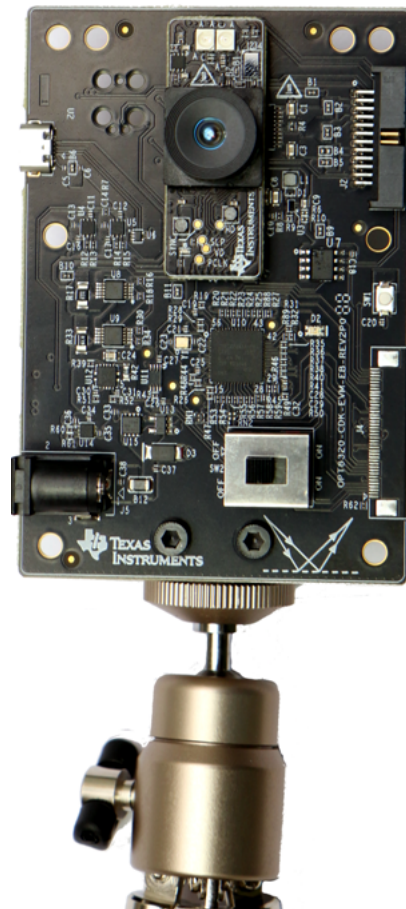


Figure 1. EVM Image

1 Introduction

The OPT8320-CDK-EVM showcases TI's high-performance single chip integrated 3D Time-of-Flight (ToF) sensor OPT8320. The EVM is designed to be reconfigurable and modular in order to enable evaluation at a wide range of operating points and is not optimized for any specific application, by default. The accompanying software is designed to enable evaluation of the TI 3D ToF technology at various levels of detail.

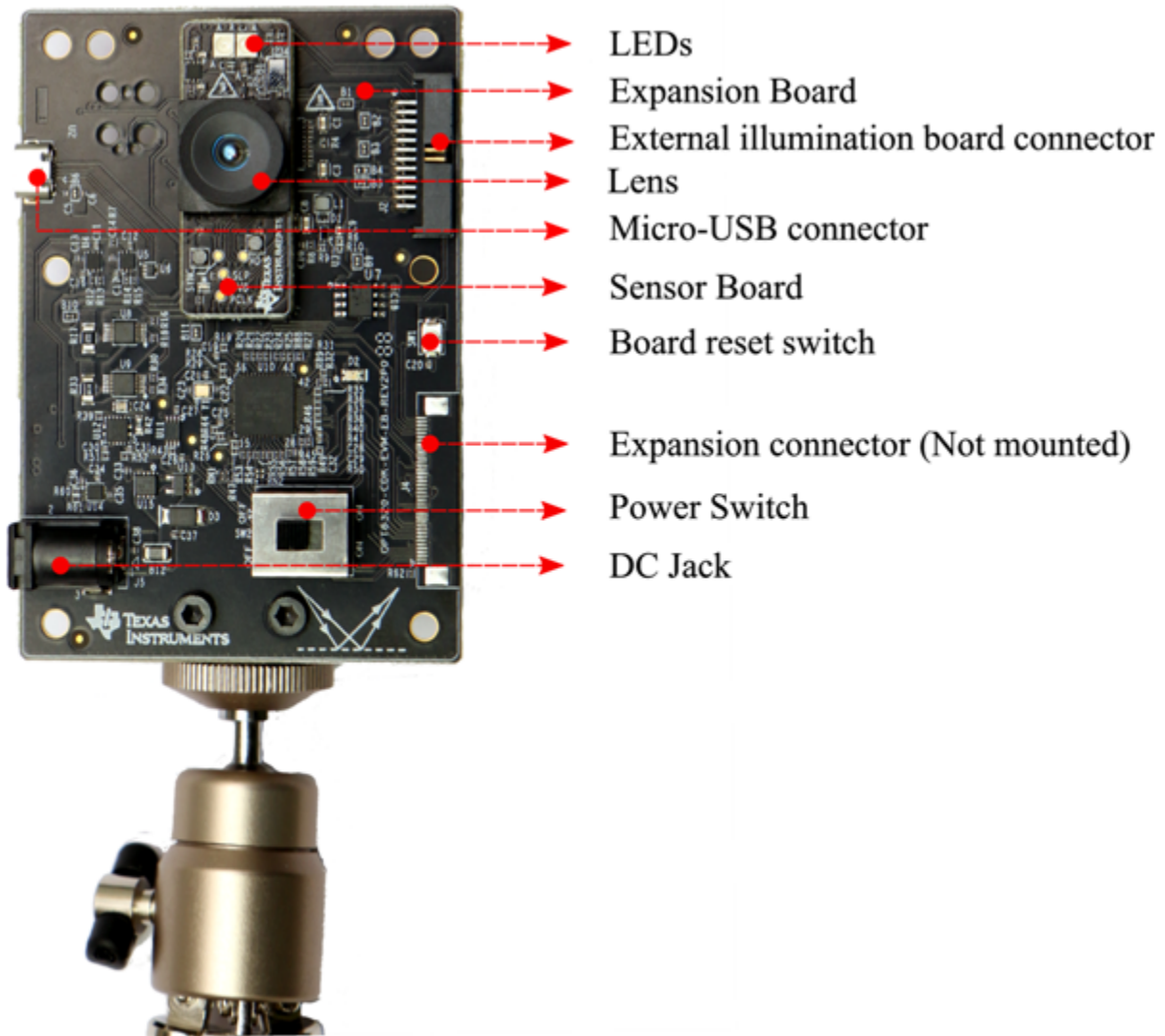


Figure 2. Components of the EVM

2 Safety

This is a class A product as defined by standard EN 61326-1:2013. This product is not intended to be used in domestic establishments and also in establishments that are directly connected to a low-voltage power-supply network that supplies buildings used for domestic purposes. In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

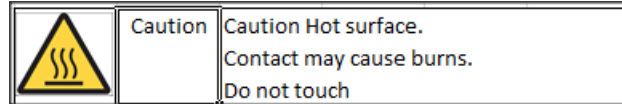
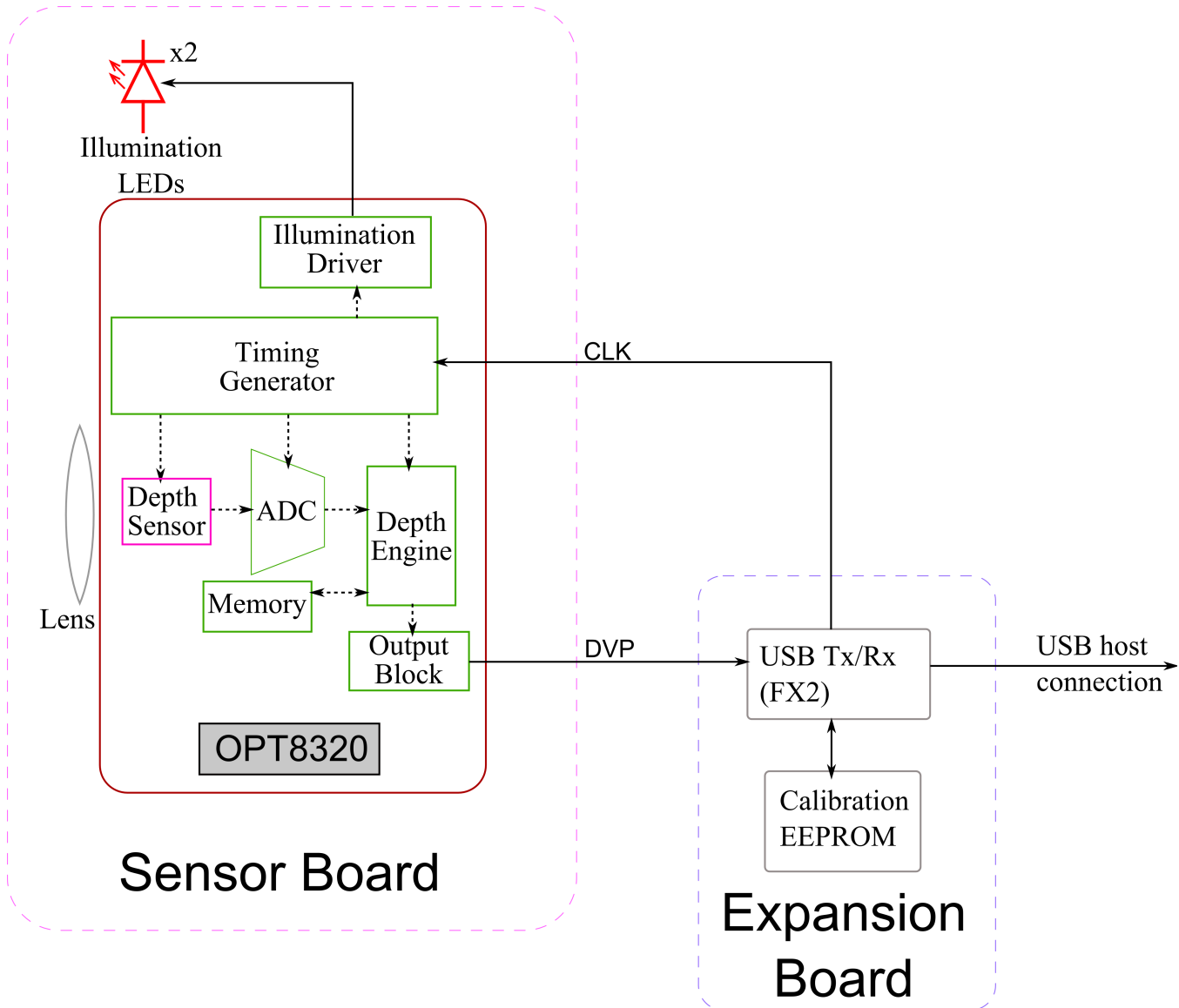


Figure 3. Hot To Touch

3 Hardware

3.1 Block Diagram

The OPT8320 sensor provides the modulation for the internal pixel array as well as for any external illuminators. The received light is focused using a lens on to the OPT8320 sensor. The depth correlation data obtained by the OPT8320 sensor is digitized and then processed in digital domain to obtain the distance output for each pixel. A Cypress FX2 chip is used as a USB transceiver to enable PC-based acquisition of data and to control the configuration of the CDK dynamically through register writes.



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Figure 4. EVM Block Diagram

3.2 Design Specifications

The hardware consists of an assembly of customizable boards. The hardware comes assembled by default and it is not recommended to disassemble the hardware. The individual boards are listed below with their main constituents:

- Sensor board
 - Sensor, lens holder, lens, connectors
 - LEDs, snubber circuitry
 - Power Management IC
- Expansion board
 - Sensor board connectors, USB connector, power supply connector, expansion connector, illumination board connector
 - USB transceiver

The overall specifications of the CDK hardware are listed in [Table 1](#).

Table 1. EVM Specifications

| Item | Specification |
|---------------------------------------|--|
| Time of Flight Sensor | OPT8320 |
| Sensor resolution | 80 x 60 (QQQVGA) |
| Field of view | 73.0 (H) x 58.1 (V) |
| Frame-rate | 12–240 fps |
| Illumination source median wavelength | 850 nm |
| Operating range | Up to 1 m |
| Connectivity | USB 2.0, micro connector |
| Cable | 1.8 m, Micro USB B-type and standard Male A type |
| Operating Conditions | 0°C to 40°C (Ambient) |
| Size | 88.8 mm (L) x 60 mm (W) x 19.3 mm (H) |

3.3 Expansion Board

The expansion board consists of all interconnects and the corresponding connectors. The illumination board can be mechanically held to the expansion board using spacers. However, the illumination board compatibility is only a provision. The EVM does not come with an external illumination board. The electrical connections between expansion board and sensor board are achieved using board to board connectors. The expansion board also provides an expansion connector for connecting the boards to this EVM.

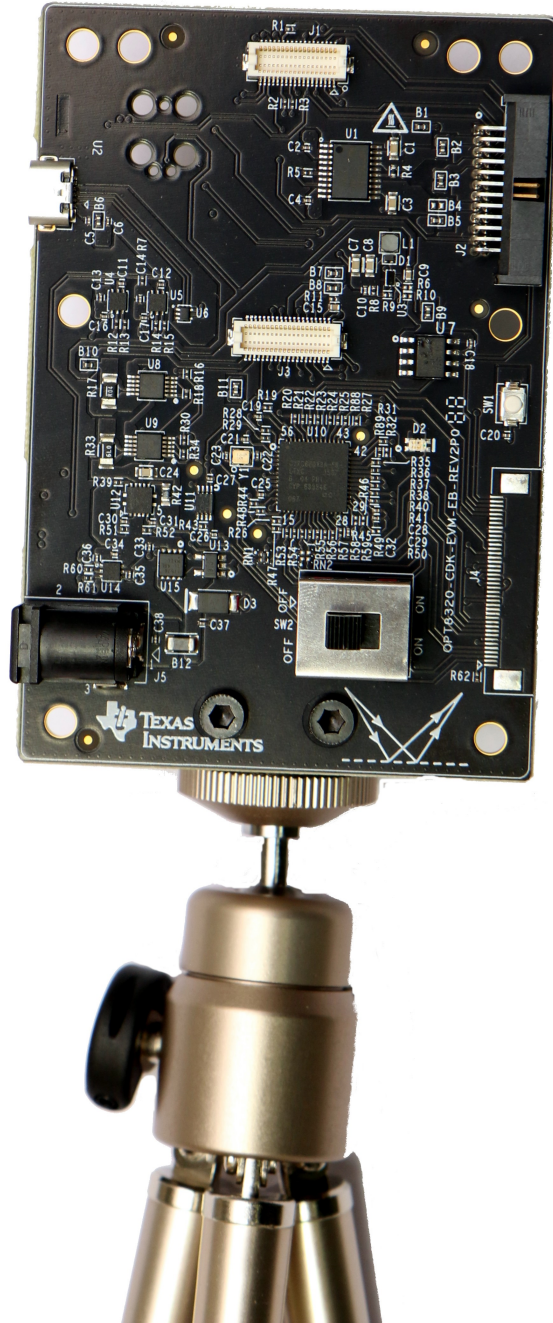


Figure 5. Expansion Board

The specifications for the expansion board are listed in [Table 2](#).

Table 2. Expansion Board Specifications

| Item | Specification |
|---------------------------|---------------------------------------|
| Size | 88.8 mm (L) x 60 mm (W) x 18.9 mm (H) |
| DC jack current limit (A) | 2.5 |

3.3.1 Indicator LEDs

The expansion board has a bi-color LED for indicating various operating states of the board. The various states of the board are listed in [Table 3](#).

Table 3. LED Indicator States

| State | Sensor Board LED | Expansion Board LED |
|-----------------------|------------------|---------------------|
| All OK, Streaming OFF | Blue | Blue |
| All OK, Streaming On | Blue | Magenta |
| No power to SB | Off | X |
| No FX2 firmware | Blue | Off |

In usual operating conditions, the expansion board LED should be Magenta and the sensor board LED should be blue.

3.3.2 Power Switch

The power switch controls the power to both the sensor board and the illumination board when connected. The switch controls are shown in [Figure 6](#).

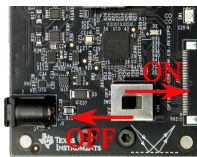


Figure 6. Power Switch

3.3.3 Reset Switch

The reset switch resets the entire board without the need to power-cycle the board. As part of the reset process, the reset triggers a USB connect and disconnect on the USB and output data streaming stops. This may cause the evaluation software on the PC to malfunction if the software is in the connected state. Disconnect and connect operations on the software should restore the CDK operation with reset parameters. [Figure 7](#) shows the location of the reset switch.

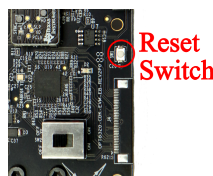


Figure 7. Reset Switch

3.3.4 Lens Assembly

The lens and the lens mount are both custom parts. It is not compatible with standard M12 lens mounts as they are not compact enough. Some M12 X 0.5 lenses should be compatible with this lens mount.

3.3.5 Tripod Mount

A tripod mount comes assembled with the hardware. The tripod mount can be unscrewed from the assembly, if necessary. [Figure 8](#) shows the tripod mount location and the screws that hold the tripod mount to the rest of the assembly.

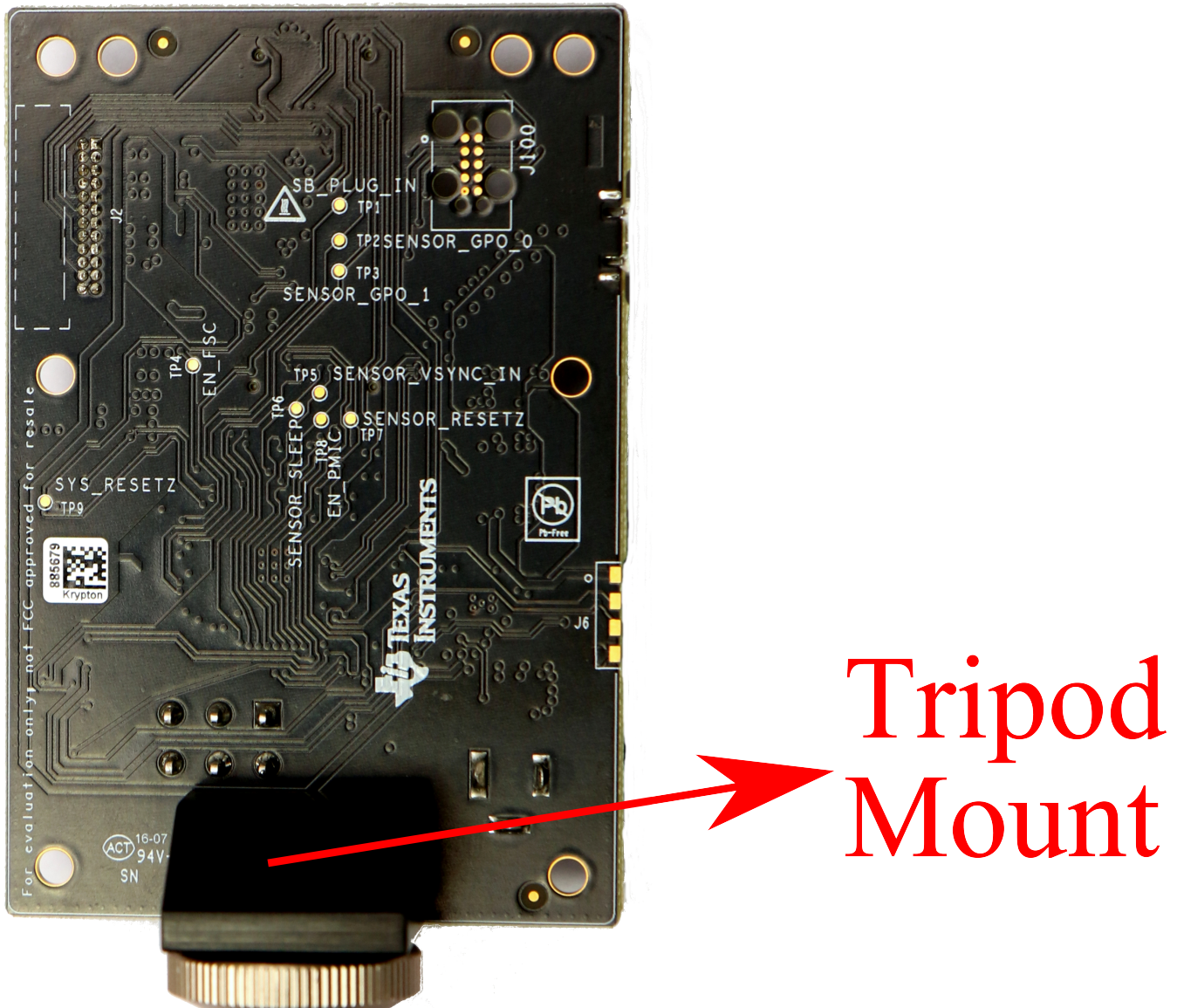


Figure 8. Tripod Mount

3.4 Sensor Board

The sensor board consists of all the basic hardware to obtain depth information in a 3D ToF camera. This board directly gives depth data in digital form to the USB transceiver. The sensor board contains the sensor, lens assembly, LEDs for illumination and a power management IC. The sensor is capable of driving the LEDs by itself without use of external LED driving circuitry. The operating point of the sensor board is controlled using I²C interface-based register writes from the USB transceiver in the expansion board. The Voxel Viewer software can be used to configure the sensor board's operating points. The sensor board does not drive the modulation signals for the external illumination board by default. It can be configured to drive the external illumination board modulation signals through Voxel Viewer software.

The sensor board can be directly interfaced with an external embedded systems hardware. The board takes a 5-V supply, an optional IO voltage supply and an optional –5-V supply. For signals, the sensor board interfaces with 8 bit data signals, control signals, I²C signals and external illumination modulation control signals.

Table 4 lists the specifications of the illumination boards.

Table 4. Sensor Board Specifications

| Item | Specification ⁽¹⁾ |
|---|--|
| Size | 15 mm (W) x 40 mm (L) x 13.6 mm (H) |
| Illumination type | 2 x Near IR LED |
| Average output optical power ⁽²⁾ | 70 mW |
| Peak optical output power | 180 mW |
| Modulation frequency | 10-MHz to 30-MHz |
| Pulse train width | 18 μs–28 ms |
| Median wavelength | 850 nm |
| Output beam divergence | 60° at 50% power relative to the center, cosine fall off |
| LED beam shape | Circular |

⁽¹⁾ All values are typical.

⁽²⁾ The illumination power can be changed between 0 to 100% of the total power.

3.5 Power Supply

The EVM can function on USB power alone when an external Illumination board is not plugged in. However, an external power supply is required when external illumination boards are used. The expansion board can automatically switch between USB and external power supply as per availability. The image of the recommended power supply is shown in Figure 9.



Figure 9. Power Supply

The power supply specifications are shown in [Table 5](#).

Table 5. Power Supply Specifications

| Item | Specification ⁽¹⁾ |
|----------------|----------------------------------|
| Part Number | EMSA050300-P5RP-SZ |
| Output Voltage | 5 V |
| Output Current | Up to 3 A |
| Input Voltage | 90 ≈ 264 VAC |
| Frequency | 47 to 63 Hz |
| Efficiency | Level V |
| Blade options | US, UK, Europe, Australia, China |

⁽¹⁾ All values are typical.

NOTE: TI recommends using an external power supply that complies with applicable regional safety standards; such as, UL, CSA, VDE, CCC, PSE, and so forth.

4 Calibration

The EVM is factory-calibrated. The calibration on the EVM is for demonstration purposes only and is not meant to be treated as the most accurate calibration possible. Since the EVM can be configured dynamically using the software, the EVM goes out of calibration whenever a critical parameter is changed. Three default profiles are provided in the hardware to serve as templates. [Table 6](#) lists the default calibration profiles.

Table 6. Calibration Profiles

| Parameter | Short Range |
|----------------------------|------------------------------------|
| Parent Profile | Short Range |
| Frame rate (fps) | 120 |
| Sub-Frames | 1 |
| Quads | 4 |
| Integration Duty Cycle (%) | 70 |
| De-aliasing | Disabled |
| Illumination Power (%) | 100 |
| Unambiguous Range (m) | 6.25 |
| Base Frequency (MHz) | 24 |
| Usable Range | 1.0 m |
| Calibrations performed | Common phase offset ⁽¹⁾ |

⁽¹⁾ Profiles that have a parent derive all the calibrations from the parent. Calibrations in a child override the calibrations derived from the parent.

Calibration is sensitive to system parameter changes. Any change in a parameter value could put the EVM in a non-calibrated state. The most common parameter changes that mandate re-calibration are listed in [Table 7](#).

Table 7. Calibration Sensitivity Table

| Parameter Changed | Re-Calibration Required? | | |
|---|----------------------------|----------------------------|---|
| | Common phase offset | Pixel-to-Pixel Differences | Non-Linearity Calibration, Pixel Cross-Talk Calibration |
| Unambiguous range (any change in modulation frequency) | Yes | Yes | Yes |
| Frame rate, number of quads, number of sub-frames (any change in quad timing) | Yes, but to a small extent | No | No |
| Integration duty cycle | Yes, but to a small extent | No | No |
| Illumination power | Yes | No | No |

5 Software

The EVM is supported by the open source 3D Camera software development kit – [Voxel-SDK](#). To make the evaluation easier, Voxel Viewer, a closed source viewer built on top of Voxel SDK is provided by TI. The viewer supports the following functionality:

- View the following streamed data real-time:
 - Phase
 - Amplitude
 - Ambient
 - Distance
 - Depth
 - Point cloud
- Configure the camera settings
- Basic statistics:
 - Temporal and spatial averaging
 - Temporal and spatial standard deviation
 - Histogram
- Filters (Spatial and temporal):
 - Filter addition/deletion/insertion
 - Configuration of filter coefficients
- Calibrate the camera

The details of the viewer are covered in the [Voxel Viewer User's Guide \(SBOU157\)](#).

6 Known Issues

List of known issues for the hardware revision Rev2P0:

- Hardware issues:
 - USB current draw limiter is set to 0.9-A peak. This exceeds the limits specified in the USB 2.0 specification.
- Calibration issues:
 - Frequency calibration is not performed on the boards. This may lead to gain errors in distance measurement.
 - Non-linearity calibration is not performed on the boards. This may lead to varying phase slopes versus distance.
 - Temperature calibration is performed on a sample set of boards and programmed into every board. Thermal coefficients may vary on a board-to-board basis.

7 Related Documentation From Texas Instruments

Related documentation regarding the EVM is available here: <http://www.ti.com/tool/OPT8320-cdk-evm>.
The documentation related to the ToF chipset used in the EVM is available in the following:

- Sensor - <http://www.ti.com/product/OPT8320>

Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| Changes from Original (April 2016) to A Revision | Page |
|--|-------------|
| • Added class A product statement pertaining to EN 61326-1:2013 in the <i>Safety</i> section. | 6 |

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1. *Delivery:* TI delivers TI evaluation boards, kits, or modules, including any accompanying demonstration software, components, and/or documentation which may be provided together or separately (collectively, an "EVM" or "EVMs") to the User ("User") in accordance with the terms set forth herein. User's acceptance of the EVM is expressly subject to the following terms.
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3. *Regulatory Notices:*
 - 3.1 *United States*
 - 3.1.1 *Notice applicable to EVMs not FCC-Approved:*

FCC NOTICE: This kit is designed to allow product developers to evaluate electronic components, circuitry, or software associated with the kit to determine whether to incorporate such items in a finished product and software developers to write software applications for use with the end product. This kit is not a finished product and when assembled may not be resold or otherwise marketed unless all required FCC equipment authorizations are first obtained. Operation is subject to the condition that this product not cause harmful interference to licensed radio stations and that this product accept harmful interference. Unless the assembled kit is designed to operate under part 15, part 18 or part 95 of this chapter, the operator of the kit must operate under the authority of an FCC license holder or must secure an experimental authorization under part 5 of this chapter.
 - 3.1.2 *For EVMs annotated as FCC – FEDERAL COMMUNICATIONS COMMISSION Part 15 Compliant:*

CAUTION

This device complies with part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

FCC Interference Statement for Class A EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

FCC Interference Statement for Class B EVM devices

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

3.2 Canada

3.2.1 For EVMs issued with an Industry Canada Certificate of Conformance to RSS-210

Concerning EVMs Including Radio Transmitters:

This device complies with Industry Canada license-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Concernant les EVMs avec appareils radio:

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

Concerning EVMs Including Detachable Antennas:

Under Industry Canada regulations, this radio transmitter may only operate using an antenna of a type and maximum (or lesser) gain approved for the transmitter by Industry Canada. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that necessary for successful communication. This radio transmitter has been approved by Industry Canada to operate with the antenna types listed in the user guide with the maximum permissible gain and required antenna impedance for each antenna type indicated. Antenna types not included in this list, having a gain greater than the maximum gain indicated for that type, are strictly prohibited for use with this device.

Concernant les EVMs avec antennes détachables

Conformément à la réglementation d'Industrie Canada, le présent émetteur radio peut fonctionner avec une antenne d'un type et d'un gain maximal (ou inférieur) approuvé pour l'émetteur par Industrie Canada. Dans le but de réduire les risques de brouillage radioélectrique à l'intention des autres utilisateurs, il faut choisir le type d'antenne et son gain de sorte que la puissance isotrope rayonnée équivalente (p.i.r.e.) ne dépasse pas l'intensité nécessaire à l'établissement d'une communication satisfaisante. Le présent émetteur radio a été approuvé par Industrie Canada pour fonctionner avec les types d'antenne énumérés dans le manuel d'usage et ayant un gain admissible maximal et l'impédance requise pour chaque type d'antenne. Les types d'antenne non inclus dans cette liste, ou dont le gain est supérieur au gain maximal indiqué, sont strictement interdits pour l'exploitation de l'émetteur

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http://www.tij.co.jp/lstds/ti_ja/general/eStore/notice_01.page

3.3.2 *Notice for Users of EVMs Considered "Radio Frequency Products" in Japan:* EVMs entering Japan may not be certified by TI as conforming to Technical Regulations of Radio Law of Japan.

If User uses EVMs in Japan, not certified to Technical Regulations of Radio Law of Japan, User is required to follow the instructions set forth by Radio Law of Japan, which includes, but is not limited to, the instructions below with respect to EVMs (which for the avoidance of doubt are stated strictly for convenience and should be verified by User):

1. Use EVMs in a shielded room or any other test facility as defined in the notification #173 issued by Ministry of Internal Affairs and Communications on March 28, 2006, based on Sub-section 1.1 of Article 6 of the Ministry's Rule for Enforcement of Radio Law of Japan,
2. Use EVMs only after User obtains the license of Test Radio Station as provided in Radio Law of Japan with respect to EVMs, or
3. Use of EVMs only after User obtains the Technical Regulations Conformity Certification as provided in Radio Law of Japan with respect to EVMs. Also, do not transfer EVMs, unless User gives the same notice above to the transferee. Please note that if User does not follow the instructions above, User will be subject to penalties of Radio Law of Japan.

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3.4 *European Union*

3.4.1 *For EVMs subject to EU Directive 2014/30/EU (Electromagnetic Compatibility Directive):*

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4 *EVM Use Restrictions and Warnings:*

4.1 EVMS ARE NOT FOR USE IN FUNCTIONAL SAFETY AND/OR SAFETY CRITICAL EVALUATIONS, INCLUDING BUT NOT LIMITED TO EVALUATIONS OF LIFE SUPPORT APPLICATIONS.

4.2 User must read and apply the user guide and other available documentation provided by TI regarding the EVM prior to handling or using the EVM, including without limitation any warning or restriction notices. The notices contain important safety information related to, for example, temperatures and voltages.

4.3 *Safety-Related Warnings and Restrictions:*

4.3.1 User shall operate the EVM within TI's recommended specifications and environmental considerations stated in the user guide, other available documentation provided by TI, and any other applicable requirements and employ reasonable and customary safeguards. Exceeding the specified performance ratings and specifications (including but not limited to input and output voltage, current, power, and environmental ranges) for the EVM may cause personal injury or death, or property damage. If there are questions concerning performance ratings and specifications, User should contact a TI field representative prior to connecting interface electronics including input power and intended loads. Any loads applied outside of the specified output range may also result in unintended and/or inaccurate operation and/or possible permanent damage to the EVM and/or interface electronics. Please consult the EVM user guide prior to connecting any load to the EVM output. If there is uncertainty as to the load specification, please contact a TI field representative. During normal operation, even with the inputs and outputs kept within the specified allowable ranges, some circuit components may have elevated case temperatures. These components include but are not limited to linear regulators, switching transistors, pass transistors, current sense resistors, and heat sinks, which can be identified using the information in the associated documentation. When working with the EVM, please be aware that the EVM may become very warm.

4.3.2 EVMs are intended solely for use by technically qualified, professional electronics experts who are familiar with the dangers and application risks associated with handling electrical mechanical components, systems, and subsystems. User assumes all responsibility and liability for proper and safe handling and use of the EVM by User or its employees, affiliates, contractors or designees. User assumes all responsibility and liability to ensure that any interfaces (electronic and/or mechanical) between the EVM and any human body are designed with suitable isolation and means to safely limit accessible leakage currents to minimize the risk of electrical shock hazard. User assumes all responsibility and liability for any improper or unsafe handling or use of the EVM by User or its employees, affiliates, contractors or designees.

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