Azure Kinect DK

Last updated: 2/20/2019

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1 Introduction

This document provides an overview of the software development kits (SDKs) and hardware specifications for Azure Kinect DK. The full SDK documentation will be available soon.

Azure Kinect DK is meant for developers and commercial businesses, not consumers. It is meant for use in an ambient temperature range of 10-25^{o} Celsius.

2 Software Development Kits

2.1 Sensor SDK

The Sensor SDK provides cross-platform low level access for Azure Kinect DK device configuration and hardware sensors streams, including:

- Depth camera access and mode control (a passive IR mode, plus wide and narrow field-of-view depth modes)
- RGB camera access and control (e.g. exposure and white balance)
- Motion sensor (gyroscope and accelerometer) access
- Synchronized Depth-RGB camera streaming with configurable delay between cameras
- External device synchronization control with configurable delay offset between devices
- Camera frame meta-data access for image resolution, timestamp, etc.
- Device calibration data access

Tools provided as sample code include:

- Viewer tool for checking device data streams and configuring different modes
- Sensor recording tool and playback reader API using Matroska container format
- Firmware update tool

The Sensor SDK has a Win32 C-API with preview support for Linux. The SDK will be open sourced and made available in GitHub.

Microphone specific functionality can be accessed using Speech SDK or directly through Windows Media Foundation.

2.2 Body Tracking SDK

The Body Tracking SDK includes a Windows library and runtime to track bodies in 3D using Azure Kinect DK hardware. This SDK includes the following features:

- Body segmentation
- An anatomically correct skeleton for each partial or full body in FOV
- A unique identity for each body
- The ability to track bodies over time

Tools provided as sample code include,

- A viewer tool to track bodies in 3D

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The Body Tracking SDK with Win32 C-API will be in open preview at Azure Kinect DK availability and in final release in the second half of 2019. Linux support will arrive after the Windows release.

2.3 Azure Cognitive Services

With Azure Kinect DK and Azure AI services you have all the power to build complete solutions. For example, you can utilize voice controls to interact with your product which scans objects for dimensions and labels.

For more information about Azure Cognitive Services:

- Speech Services enabled Azure connected speech services (e.g. speech-to-text and translation)
- Azure Vision Services provide several useful services to enhance your application capabilities (e.g. optical character recognition)

3 System Requirements

3.1 Supported operating systems and architectures

- Windows 10 April 2018 release (x64) or later
- Linux Ubuntu 18.04 (x64) with OpenGLv4.4 or later GPU driver

Sensor SDK is available for the Windows API (Win32) for native C/C++ Windows applications and is not currently available to UWP applications. Azure Kinect DK is not supported for Windows 10 in S mode.

3.2 Host PC hardware requirements

The PC host hardware requirement is very dependent on the application/algorithm/sensor frame rate/resolution processed on host PC.

The recommended minimum Sensor SDK configuration for Windows is:

- 7th Gen Intel® Core™ i3 Processor (Dual Core 2.4 GHz with HD620 GPU or faster)
- 4GB Memory
- Dedicated USB3 port

Lower end and older CPUs may also work depending on your use case/scenario. The Body Tracking minimum hardware requirement will be higher and published later.

3.3 Known compatibility issues

There are known compatibility issues with following USB Host controllers:

- ASMedia USB 3.1 eXtensible Host Controller (e.g. ASM1142)
- Texas Instruments USB 3.0 xHCI Host Controller

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4 Hardware Specification

Azure Kinect DK integrates Microsoft latest sensor technology into single USB connected accessory.

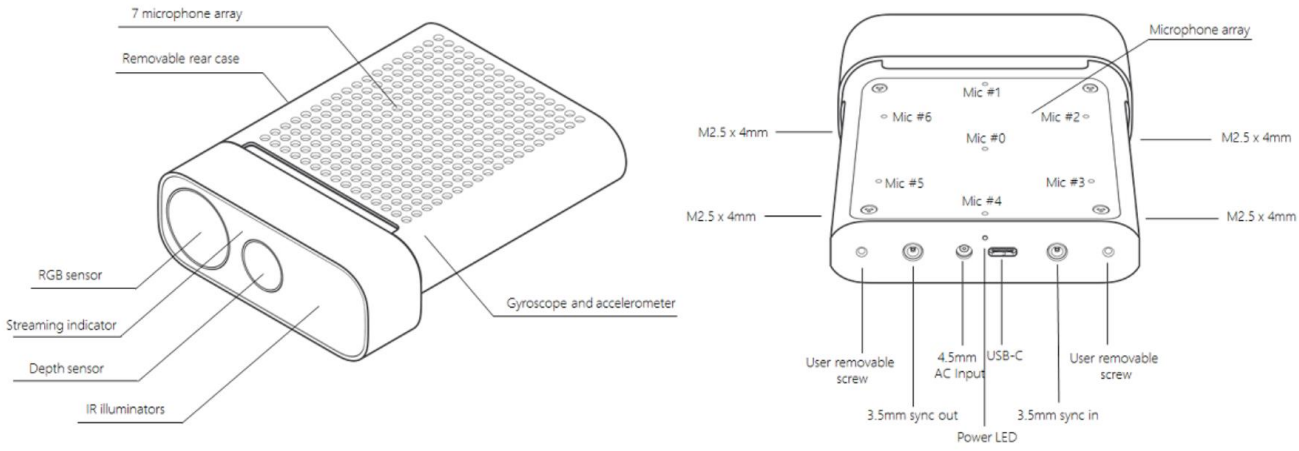

Figure 1. Azure Kinect DK

4.1 Product dimensions and weight

Dimensions: 103 x 39 x 126 mm

Weight: 440 g

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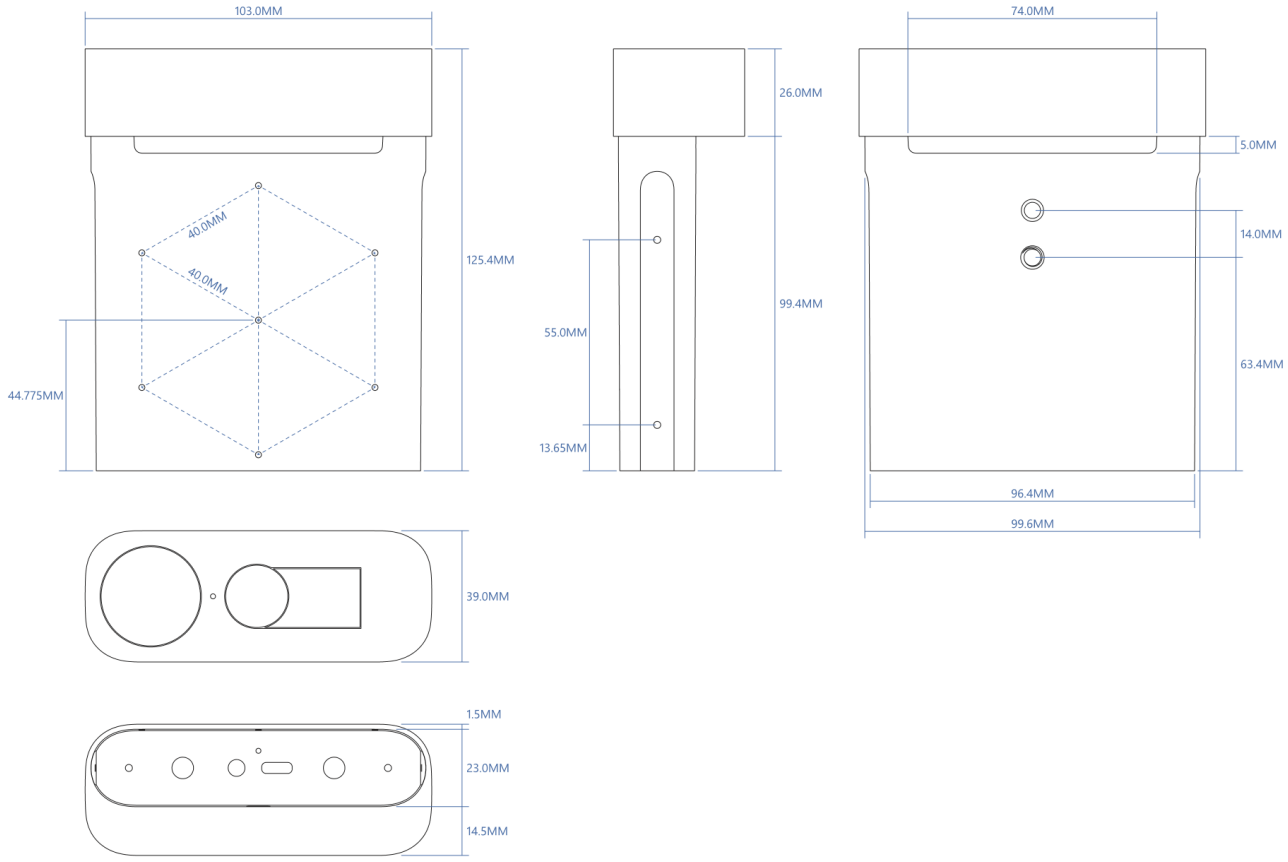

Figure 2. Product dimensions

4.2 Operating environment

Azure Kinect DK is intended for developers and commercial businesses operating under the following ambient conditions:

- Temperature: 10-25°C
- Humidity: 8-90% (non-condensing) RH

NOTE: Use outside of the ambient conditions could cause the device to fail and/or function incorrectly.

These ambient conditions are applicable for the environment immediately around the device under all operational conditions. When used with an external enclosure, active temperature control and/or other cooling solutions are recommended to ensure the device is maintained within these ranges. The device design features a cooling channel in between the front section and rear sleeve. In any implementation of the device, this cooling channel should not be obstructed.

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4.3 Depth camera supported operating modes

Azure Kinect DK integrates a Microsoft designed 1 Megapixel Time-of-Flight depth camera using the Yeats image sensor presented at ISSCC 2018. The depth camera supports the modes indicated below:

Table 1. Depth camera supported operating modes

MODE	RESOLUTION	FOI	FPS	OPERATING RANGE*	EXPOSURE TIME
NFOV unbinned	640x576	75°x65°	0, 5, 15, 30	0.5 - 3.86 m	12.8 ms
NFOV 2x2 binned (SW)	320x288	75°x65°	0, 5, 15, 30	0.5 - 5.46 m	12.8 ms
WFOV 2x2 binned	512x512	120°x120°	0, 5, 15, 30	0.25 - 2.88 m	12.8 ms
WFOV unbinned	1024x1024	120°x120°	0, 5, 15	0.25 - 2.21 m	20.3 ms
Passive IR	1024x1024	N/A	0, 5, 15, 30	N/A	1.6 ms

*15% to 95% reflectivity, 2.2 uW/cm^2/nm, σ <= 17 mm. Depth provided outside of indicated range depending on object reflectivity.

4.4 Color camera supported operating modes

Azure Kinect DK includes an OV12A10 12MP CMOS rolling shutter sensor. The native operating modes are listed below

Table 2. Color camera supported operating modes

RGB CAMERA RESOLUTION (HXV)	ASPECT RATIO	FORMAT OPTIONS	FRAME RATES (FPS)	NOMINAL FOV (HXV)
3840x2160	16:9	MJPEG	0, 5, 15, 30	90x59
2560x1440	16:9	MJPEG	0, 5, 15, 30	90x59
1920x1080	16:9	MJPEG	0, 5, 15, 30	90x59
1280x720	16:9	MJPEG/YUY2/NV12	0, 5, 15, 30	90x59
4096x3072	4:3	MJPEG	0, 5, 15	90x74.3
2048x1536	4:3	MJPEG	0, 5, 15, 30	90x74.3

The RGB camera is USB Video class compatible and can be used without the Sensor SDK.

4.5 Motion sensor

The embedded Inertial Measurement Unit (IMU) is an LSM6DSMUS and includes both an accelerometer and a gyroscope, simultaneously sampled at 1.6 kHz and reported to the host at a 208 Hz rate.

4.6 Microphone array

Azure Kinect DK embeds a high quality 7-Microphone circular array that identifies as a standard USB audio class 2.0 device. The performance specification is

- Sensitivity: -22 dBFS (94 dB SPL, 1 kHz)
- Signal to noise ratio > 65 dB
- Acoustic overload point: 116 dB

4.7 Indicators

The device has a camera streaming indicator on the front of the device that can be disabled programmatically using the Sensor SDK.

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The status LED behind the device indicates device state:

- Solid white – the device is powered and operating normally
- Blinking amber – the device does not have enough power to operate
- Blinking white – the device is powered but does not have a USB 3.0 data connection

4.8 Powering Device

The device can be powered using the in-box power supply and USB Type-C to A cable, or by using a Type-C to C cable for both power and data. A type-C to C cable is not included.

4.9 Power consumption

Azure Kinect DK consumes up to 5.9W; specific power consumption is use-case dependent.

4.10 Calibration

Azure Kinect DK is calibrated at the factory. The calibration parameters for visual and inertial sensors may be queried programmatically through the Sensor SDK.

4.11 External synchronization

The device includes 3.5mm synchronization jacks that can be used to link multiple units together to achieve coordinated Depth/RGB camera triggering. There are specific sync-in and sync-out jacks on the device, enabling easy daisy chaining. Compatible cable is not included in box and must be purchased separately, cable requirements:

- 3.5mm tip male-to-male cable ("3.5mm audio cable")
- Maximum cable length < 10m
- Both stereo and mono cable are supported

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5 Azure Kinect DK vs. Kinect for Windows v2

The Azure Kinect DK hardware and Software Development Kits have differences from Kinect for Windows v2. Any existing Kinect for Windows v2 applications will not work directly with Azure Kinect DK and require porting.

5.1 Hardware

A high-level summary of the differences between Azure Kinect DK and Kinect for Windows v2 is given in the table below

Table 3. Azure Kinect DK vs. Kinect for Windows v2 hardware

FEATURE		AZURE KINECT DK	KINECT FOR WINDOWS V2
Audio	Details	7-mic circular array	4-mic linear phased array
Motion sensor	Details	3-axis accelerometer + 3-axis gyro	3-axis accelerometer
RGB Camera	Details	3840 x 2160 px @30 fps	1920 x 1080 px @30 fps
Depth Camera	Method	Time-of-Flight	Time-of-Flight
	Resolution/FOV	640 x 576 px @30 fps	512 x 424 px @ 30 fps
		512 x 512 px @30 fps	
		1024x1024 px @15 fps	
Connectivity	Data	USB3.1 gen 1 with Type-C connector	USB 3.1 gen 1
	Power	External PSU or USB-C	External PSU
	Synchronization	RGB & Depth and IMU internal, external device-to-device	RGB & Depth internal only
Mechanical	Dimensions	103 x 39 x 126 mm	249 x 66 x 67 mm
	Mass	440 g	970 g
	Mounting	One ¼-20 UNC Four internal screw points	One ¼-20 UNC

5.2 Sensor access

A low-level device sensor access capability comparison is given in the table below.

Table 4. Sensor access comparison

FUNCTIONALITY	AZURE KINECT DK	KINECT FOR WINDOWS V2	NOTES
Depth	✔	✔	
IR	✔	✔	
Color	✔	✔	Color format support differences, Azure Kinect DK support camera controls like: Exposure, white balance, brightness, contrast, saturation, sharpness and gain control
Audio	(✔)	✔	Azure Kinect DK microphone access is through Speech SDK or Windows native API
IMU	✔	Partial (1-axis)	

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Depth-RGB internal sync	✔	✔	
Calibration data	✔	✔	OpenCV compatible camera calibration
External Sync	✔		
Sharing access with multiple clients		✔	Sensor SDK relies on WinUSB/libUSB to access device and does not have a service implemented to enable sharing device access with multiple processes.
Stream record / playback tool	✔	✔	Sensor SDK uses an open source Matroska container-based implementation

The Sensor SDK is under development and new features are expected to be made available over time; the SDK will be open sourced to enable contributions from outside Microsoft.

5.3 Feature mapping

The Azure Kinect SDK feature set is different from Kinect for Windows v2, as illustrated below

Table 5. Kinect v2 to Azure Kinect feature mapping

KINECT V2 FEATURE	KINECT V2 DATA TYPE	AZURE KINECT SDK/SERVICE
Sensor Data Access	DepthFrame	Sensor SDK
	InfraredFrame	Sensor SDK
	ColorFrame	Sensor SDK
	AudioBeamFrame	Not currently supported
Body Tracking	BodyFrame	Body Tracking SDK
	BodyIndexFrame	Body Tracking SDK
Coordinate Mapping	CoordinateMapper	Sensor SDK
Face Tracking	FaceFrame	Cognitive Services: Face
Speech Recognition	N/A	Cognitive Services: Speech

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