THEIA-CAM Kits

THSCU101

13M pixel PDAF UVC Camera

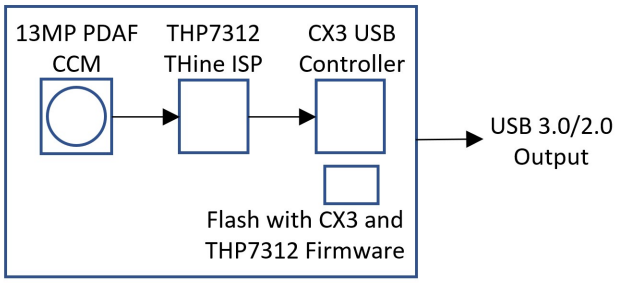
General Description

THSCU101 is the first kit of THine's THEIA-CAM family of camera Reference Design Kits.

THSCU101 is a 13M pixel PDAF camera board with USB interface, incorporating THine's THP7312 ISP, Sony's IMX258 sensor, and Cypress' CX3 USB controller. The PDAF sensor module is fully calibrated to perform fast and accurate auto focus. The ISP firmware is fully developed to support fine image quality.

THSCU101 can be embedded into final products as is, used as a reference design, or used as the foundation to be customized. All functions and choices for resolution defined herein are configurable via UVC Control. THSCU101 design files as well as tools to customize the camera system and/or THP7312 can be requested to THine Solutions, Inc.

Block Diagram



Features

- ✓ Up to 13Mega-pixel resolution
- ✓ PDAF (Phase Detection Auto Focus)
- ✓ UVC (USB Video Class) control
- ✓ Supports Windows and Mac
- ✓ Fully fine-tuned image quality
- ✓ 1.4" x 1.4" Single PCB

Applications

- Bodycams
- Barcode Reading Devices
- Education and Web Conference Cameras
- Robotics, Drone and AI Cameras
- Smart Glasses and AR/VR systems
- Surveillance Cameras
- Webcams

Use Case

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1. System Requirement

Item	Specification
Hardware	Windows PC • x64 architecture • USB3.0 HOST Type A or USB2.0 HOST Type A Mac (*) • USB3.0 HOST Type A or USB2.0 HOST Type A, or • USB3.0 HOST Type C and Type-A to C adaptor
Software	Windows 10 • Windows camera application version 2020.504.40.0 macOS Big Sur • PhotoBooth 11.0

(*) THSCU101 works on Mac with the firmware binary THSCU101_CX3_1_36_ISPFW_03_49.img (CX3 Firmware: 1.36, THP7312 Firmware: 3.49, Updated on Sep 10, 2021) or newer one.

2. Contents of Kit

2.1 Contents in the Box

Item	Description
UVC Camera	PCB with 13M pixel Camera module, THP7312, CX3
Camera Case	Clear coated transparent case
Cable	1m USB 3.0 micro B to Type A cable

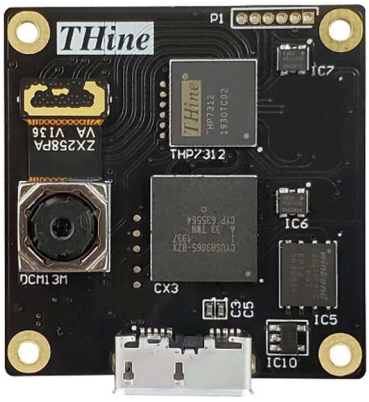

Figure 1 UVC Camera


Figure 2 Camera Case


Figure 3 USB3.0 micro B to Type A Cable

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2.2 Contents Online (Available at https://www.thinesolutions.com/13mp-pdaf-uvc-camera See Documents Section)

Item	Description
Datasheet	This document
Quick Start Guide	Brief document guiding how to set up initially
Camera Extension Controller	Windows Application to control Camera Extension
Camera Extension Controller User Manual	User Manual for Camera Extension Controller
THSCU101 Latest Firmware Binary (*)	Firmware Binary to control THP7312 and CX3
THSCU101 Firmware Update User Manual	User Manual to update the Firmware

(*) The firmware in your THSCU101 may not be the latest and it is highly recommended to be updated before any use. Visit https://www.thinesolutions.com/13mp-pdaf-uvc-camera (Documents Section) to download the latest version of firmware for the ISP (THine's THP7312) and USB Controller (Cypress' CX3).

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3. Specifications

3.1 Operating Condition

Item	Description
Power supply	USB bus power
Power consumption	2265[mW] @13Mp 20fps 1480[mW] @1080p 30fps
Operating temperature range	0 to 60 ℃

3.2 Mechanical Specification

Item	Value
Board Width	35 mm
Board Height	36 mm
Board thickness	1.2 mm
Width with case	39 mm
Height with case	40 mm
Thickness with case	35.2 mm
Weight (Camera)	6 g
Weight (including camera case)	26 g

3.3 Optical Specifications

Item	Description
Image sensor pixel size	1.12um x 1.12um
Optical size	1/3.06”
Type of Shutter	Rolling shutter
Focus Type	PDAF, Contrast AF and Manual Focus available
Field of View (Diagonal)	78.4°
F. NO	2.0 +/- 5%
Effective Focal Length (EFL)	3.57 mm
TV Distortion	< 1.5%
Optical Distortion	< 2.0%

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3.4 Mechanical Drawings

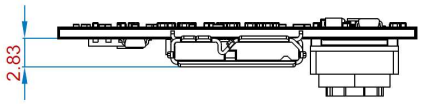
Notes:
(1) 4 x Φ2.20
[2] 6 x Φ0.60

Table

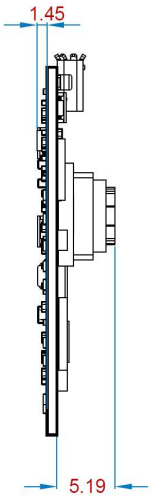
Material	FR-4
Thickness	1.2mm

Note: All dimensions are in mm

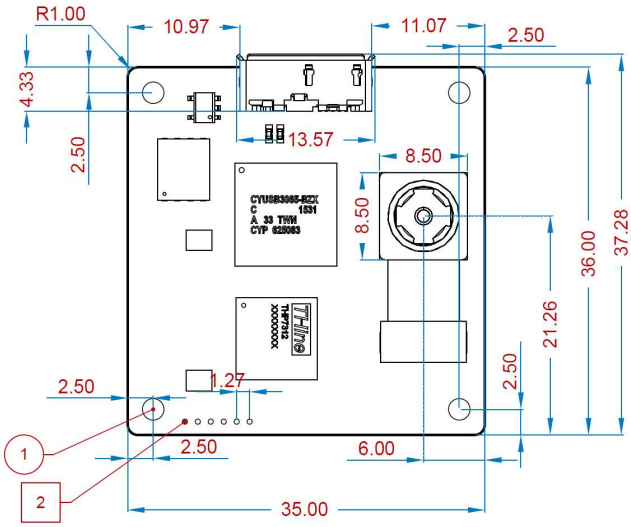
View from Back side (Scale 2)



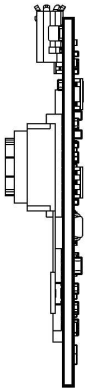
View from Left side (Scale 2)



View from Top side (Scale 2)



View from Right side (Scale 2)



Note:
These drawings are for reference and may not represent the latest kit precisely. The actual specification with tolerance is subject to change without any prior notice.

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3.5 Camera Functions

Output

Item	Description
Protocol	USB 3.0 and 2.0
Connector	USB Micro-B Receptacle
Cable	USB Micro-B Plug to Type A Plug

Available Image Sizes and Frame Rates

Item	Description
Image size and frame rate USB 3.0	1920x1080(binning) 29.6fps @YUV422 1920x1080(binning) 59.6fps @JPEG 2016x1512(binning) 29.6fps @YUV422 3840x2160(crop) 29.5fps @JPEG 4160x3120(full) 19.8fps @JPEG
Image size and frame rate USB 2.0	1920x1080(binning) 29.6fps @JPEG

Auto Focus Mode

Mode	Description
One shot contrast AF	THSCU101 executes contrast-based AF once.
Continuous contrast AF	THSCU101 executes contrast-based AF every time it detects scene change automatically.
One shot contrast and PDAF hybrid AF	THSCU101 executes hybrid AF of PDAF and contrast-based AF once.
Continuous contrast and PDAF hybrid AF	THSCU101 executes hybrid AF of PDAF and contrast-based AF every time it detects scene change automatically.

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UVC Functions

Category	Function	Description in Windows application	Default of THSCU101
General	Output Size, Frame Rate, and Image Format	Combination selectable from Table "Available Image Sizes and Frame Rates"	N/A (Contingent on USB Host)
Camera Control	Focus	Focus mode selection Auto Focus (Default) Manual Focus	Auto Focus
	Manual Focus Distance	19 steps available when "Manual Focus" is selected 3000 : 3000mm or far (Infinity) (Default) 965 : 965mm 576 : 576mm 411 : 411mm 320 : 320mm 262 : 262mm 222 : 222mm 193 : 193mm 171 : 171mm 153 : 153mm 139 : 139mm 127 : 127mm 117 : 117mm 109 : 109mm 101 : 101mm 95 : 95mm 90 : 90mm 85 : 85mm 80 : 80mm (nearest) Note 1: Distance will be set to the closest one of these 19 steps. Note 2: Conditions: Camera facing in horizontal direction under room temperature.	3000: 3000mm or far (Infinity)
	Exposure	Exposure mode selection Auto Exposure (Default) Manual Exposure	Auto Exposure

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Category	Function	Description in Windows application	Default of THSCU101
	Manual Exposure Value	Available when “Manual Exposure” selected: 12 steps Manual Exposure value (exposure time[ms] x image sensor gain) * 1 : 2000 (66.7ms x 30.0) 0 : 1000 (66.7ms x 15.0) -1 : 500 (62.5ms x 8.0) -2 : 250 (33.3ms x 7.5) -3 : 125 (33.3ms x 3.7) -4 : 62.5 (31.3ms x 2.0) -5 : 31.2 (15.6ms x 2.0) -6 : 15.6 (15.6ms x 1.0) (Default) -7 : 7.8 (7.8ms x 1.0) -8 : 3.9 (3.9ms x 1.0) -9 : 2 (2.0ms x 1.0) -10 : 1 (1.0ms x 1.0) * Example of exposure time and image sensor gain when “Auto Adjust Frame Rate” is selected as “Auto-Exposure Priority”.	-6: 15.6 (15.6ms x 1.0)
	Roll	Image direction 0 (Default) +180	0
	Auto-Exposure Priority	Exposure or frame rate priority Auto Adjust Frame Rate Fix Frame Rate (Default)	Fix Frame Rate

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Category	Function	Description in Windows application	Default of THSCU101
Image Processing	Brightness	Brightness gain: 21 steps 10 : x1.6250 9 : x1.5625 8 : x1.5000 7 : x1.4375 6 : x1.3750 5 : x1.3125 4 : x1.2500 3 : x1.1875 2 : x1.1250 1 : x1.0625 0 : x1.0000 (Default) -1 : x0.9375 -2 : x0.8750 -3 : x0.8125 -4 : x0.7500 -5 : x0.6875 -6 : x0.6250 -7 : x0.5625 -8 : x0.5000 -9 : x0.4375 -10 : x0.3750	0 : x1.0000
	Contrast	Contrast : 21 steps 0 : Lowest … 10 (Default) … 20 : Highest	10
	Hue	Hue : 15 steps in Cb/Cr space -35 : -35 degree -30 : -30 degree -25 : -25 degree -20 : -20 degree -15 : -15 degree -10 : -10 degree -5 : -5 degree 0 : 0 degree (Default) 5 : 5 degree 10 : 10 degree 15 : 15 degree 20 : 20 degree 25 : 25 degree 30 : 30 degree 35 : 35 degree	0 : 0 degree

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Category	Function	Description in Windows application	Default of THSCU101
	Saturation	Saturation gain : 32 steps 0 : No color 1 : x0.1 2 : x0.2 3 : x0.3 4 : x0.4 5 : x0.5 6 : x0.6 7 : x0.7 8 : x0.8 9 : x0.9 10 : x1.0 (Default) 11 : x1.1 12 : x1.2 13 : x1.3 14 : x1.4 15 : x1.5 16 : x1.6 17 : x1.7 18 : x1.8 19 : x1.9 20 : x2.0 21 : x2.1 22 : x2.2 23 : x2.3 24 : x2.4 25 : x2.5 26 : x2.6 27 : x2.7 28 : x2.8 29 : x2.9 30 : x3.0 31 : x3.1	10 : x1.0
	Sharpness	Sharpness : 32 steps 0 : Weakest … 8 (Default) … 31 : Strongest	8

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Category	Function	Description in Windows application	Default of THSCU101
	Gamma	Gamma : 21 steps 100 : gamma 1.0 110 : gamma 1.1 120 : gamma 1.2 130 : gamma 1.3 140 : gamma 1.4 150 : gamma 1.5 160 : gamma 1.6 170 : gamma 1.7 180 : gamma 1.8 190 : gamma 1.9 200 : gamma 2.0 210 : gamma 2.1 220 : gamma 2.2 (Default) 230 : gamma 2.3 240 : gamma 2.4 250 : gamma 2.5 260 : gamma 2.6 270 : gamma 2.7 280 : gamma 2.8 290 : gamma 2.9 300 : gamma 3.0	220 : gamma 2.2
	White Balance	White balance mode selection Auto (Default) Temperature	Auto
	White Balance Temperature	White balance temperature : 61 steps 2000 : 2000K 2100 : 2100K … 6500 : 6500K (Default) … 7900 : 7900K 8000 : 8000K	6500 : 6500K
	Backlight compensation	Backlight compensation 0 : Off (Default) 1 : On	0 : Off
	Power Line Frequency (Anti Flicker)	Flicker frequency 50Hz (Default) 60Hz	50Hz

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Extension functions

Category	Function	Description
Extension	Exposure Compensation	Exposure compensation : 13 steps 0 : -6/3EV 1 : -5/3EV 2 : -4/3EV 3 : -3/3EV 4 : -2/3EV 5 : -1/3EV 6 : 0EV (Default) 7 : +1/3EV 8 : +2/3EV 9 : +3/3EV 10 : +4/3EV 11 : +5/3EV 12 : +6/3EV
	Flicker Cancel Priority	Put priority to 0 : AE (Default) 1 : Flicker cancel
	Maximum Frame Rate	Set maximum frame rate as 0 : default frame rate (Default) 1-2 : N/A 3 : 3 fps … 60 : 60 fps
	Auto Focus Mode	Auto focus mode 0 : One shot contrast AF 3 : Continuous contrast AF 8 : One shot contrast and PDAF hybrid AF F : Continuous contrast and PDAF hybrid (Default) Other : N/A
	Noise Reduction Mode	Nose reduction mode 1 : Auto (Default) 2 : Fixed
	Noise Reduction Strength	Noise reduction strength in Fixed mode 0 : Weakest (Default) … 10 : Strongest
	Document Scanner Mode	Document scanner mode 1 : Normal (Default) 2 : Document
	Color Mode	Color mode 1 : Color (Default) 2 : Mono 3 : Negative 4 : Black and White

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Category	Function	Description
	Black and White Threshold	Set Black and White Y value threshold in Black and White mode as 0 : Auto (Default) 1 : 1 … 255 : 255
	JPEG Q-Factor control	JPEG Q-Factor control 0 : Manual 1 : Auto (Default)
	JPEG Q-Factor	Set JPEG Quality factor in manual control as 13 : 13 … 95 : 95 (Default) … 100 : 100

Note:

(1) Extension Functions are configurable through Camera Extension Controller. The Camera Extension Controller (Windows Application) and Camera Extension Controller User Manual are available at: https://www.thinesolutions.com/13mp-pdaf-uvc-camera (See Documents Section)

(2) UVC function are available to select with Windows PC. Each UVC/Extension function's configurability in Mac OS is contingent on the version of Mac OS. In case certain function is not configurable in Mac OS, the function works in its default setting. (e.g., PDAF Hybrid for Auto Focus Mode)

(3) Default are THSCU101 default settings or values of UVC video capture filter/property.

4. Quick Start Guide

Quick Start Guide of THSCU101 is available at:
https://www.thinesolutions.com/13mp-pdaf-uvc-camera (See Documents Section)

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5. Software Tool

Camera Extension Controller and its User Manual are available at:
https://www.thinesolutions.com/13mp-pdaf-uvc-camera (See Documents Section)

Note: Camera Extension Controller works on Windows.

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Appendix

Camera function and image quality customization

You can customize camera functions and image quality by customizing firmware of CX3 and THP7312.

Item	Description
CX3 firmware customization	Special SDK for this kit can be used to customize CX3 firmware. Contact THine Solutions, Inc. to get dedicated SDK of CX3 for THSCU101. You can implement your own USB/UVC camera functions based on the SDK for THSCU101.
THP7312 firmware customization	Camera Development Kit (CDK) by THine can be used to customize THP7312 firmware. Contact THine Solutions, Inc. for CDK License Agreement. You can implement your own camera function and image quality with CDK.

Note:

It is recommended to evaluate the performance and the image quality with the latest version of firmware for the ISP (THine's THP7312) and USB Controller (Cypress' CX3). The firmware can be requested for through THine Solutions, Inc. Please contact inquiries@thinesolutions.com or inquire through https://www.thinesolutions.com/13mp-pdaf-uvc-camera

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Important Notice

1. The product specifications described in this document are subject to change without prior notice.

2. The circuit diagrams described in this document are examples of the application. THine Solution, Inc. ("THine") assumes no responsibility for any losses incurred by you or third parties from the use of these circuit diagrams.

3. Testing and other quality control techniques are used to this product to the extent THine deems necessary to support warranty for performance of this product. Except where mandated by applicable law or deemed necessary by THine based on the user's request, testing of all functions and performance of the product is not necessarily performed.

4. This product is presumed to be used for general electric device, not for applications which require extremely high reliability/safety.

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