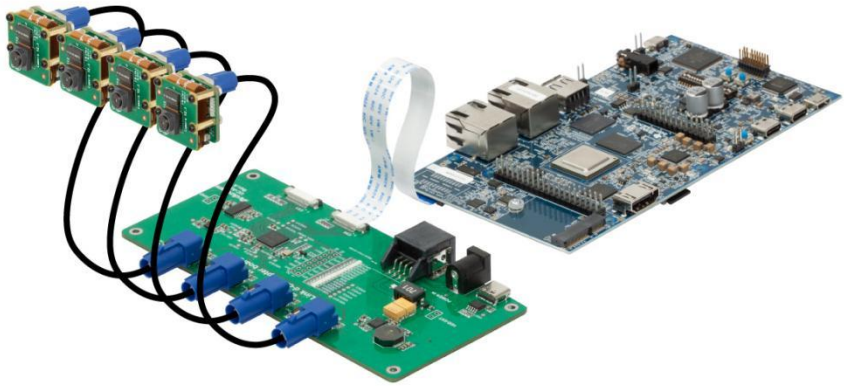
Arducam V^{3}Link Camera Solution

V^{3}Link-based cost-effective camera solutions Datasheet

November, 2023



by ARDUCAM TECHNOLOGY CO., LTD

ArduCam

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ArduCam

1. Introduction

1.1 What is Arducam V³Link Camera Solution

Arducam consistently collaborates with Texas Instruments' engineering team to provide you with the most adaptable, on-demand camera systems for various industrial applications. Arducam has created a versatile and cost-effective camera solution based on **TI V³Link SerDes**. Breaking free from camera bundles, we opted for a radically different camera solution which is flexible and adaptable.

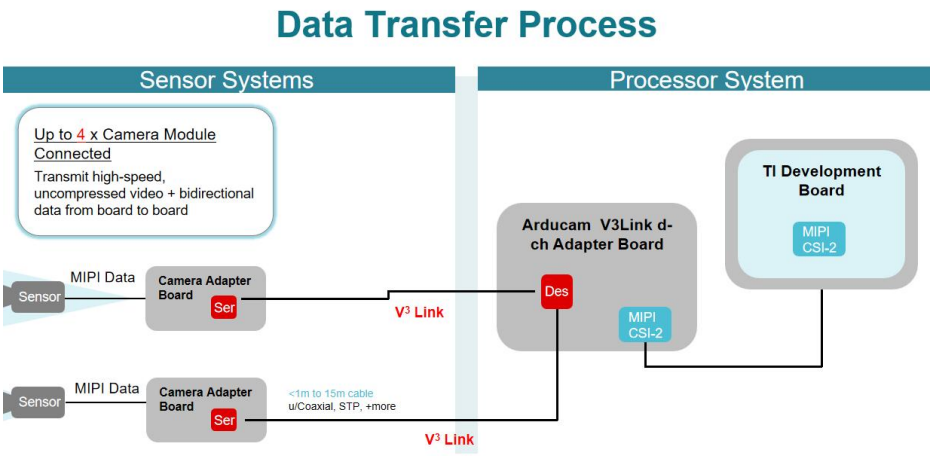
1.2 About TI V³Link

TI V³Link is a multi-protocol physical layer technology, an industrial variant of FPD-Link III that aggregates data from different industry standard protocols and transmits it over coaxial or twisted pair cables. It acts as a bridge between protocol-based data interfaces to transmit high-bandwidth data over short distances, and can also act as a data converter in case the source interface does not match the synchronization interface.

1.3 TI V³Link SerDes

TI V³Link SerDes presently features a high-speed bidirectional data transfer serializer and a versatile deserializer designed for seamlessly handling high-speed data streams. Through the combined use of V³Link serializers and V³Link deserializer, high-speed transmission of multi-channel data from multiple sensors

can be achieved. Data is received and aggregated into MIPI CSI-2 standard compliant outputs for interconnection with downstream processors.



<1m to 15m* cable: The maximum extension distance depends on the cable you are using.

Figure 1.1 Data Transfer of Arducam V^{3}Link Camera Solution

2. Highlight Features

Highlight Features of Arducam V^{3}Link Camera Solution for TI Development Kits:

- **One for All**: Compatible with more than 100+ off-the-shelf camera module series, covering various resolutions, lens types, sensors and shutter types, etc. You can use it with any Arducam MIPI CSI-2 camera.
- **Flexible and ultra-long range**: Provides up to 15 meters of high-frequency stable cable connection on up to 4 camera channels. Enables smaller footprint and flexible deployment.
- **Wide applicability & low development cost**: Freely create a synchronous 4-channel vision system, suitable for various applications such as automotive,

surveillance, medical, industrial imaging, etc., effectively reducing your costs.
- **Channel switching, independent control**: Supports arbitrary switching of four channels. The camera adapter kit accommodates connectivity for up to four cameras, each capable of high-frequency signal transmission and independent control.
- **Highly flexible customization**: Customizable in Every Way for Any Platform. Supports diversified customization of various sensors, lenses, carrier boards, housings, embedded development platforms, operating systems, project types, etc.

3. Board Configuration

3.1 Abstract

Arducam V^{3}Link camera solution consists of two parts of hardware, including Arducam V^{3}Link d-ch adapter board used to connected to the TI development board and integrated with a TI TDES960 deserializer chip, and Arducam V^{3}Link camera adapter board used to connected to the camera module and integrated with TI TSER953 serializer chip.

3.2 Basic Schematic (d-ch Adapter Board)

Note

The demo board was designed for easy accessibility to device pins with tap points for monitoring or applying signals, additional pads for termination, and multiple connector options.

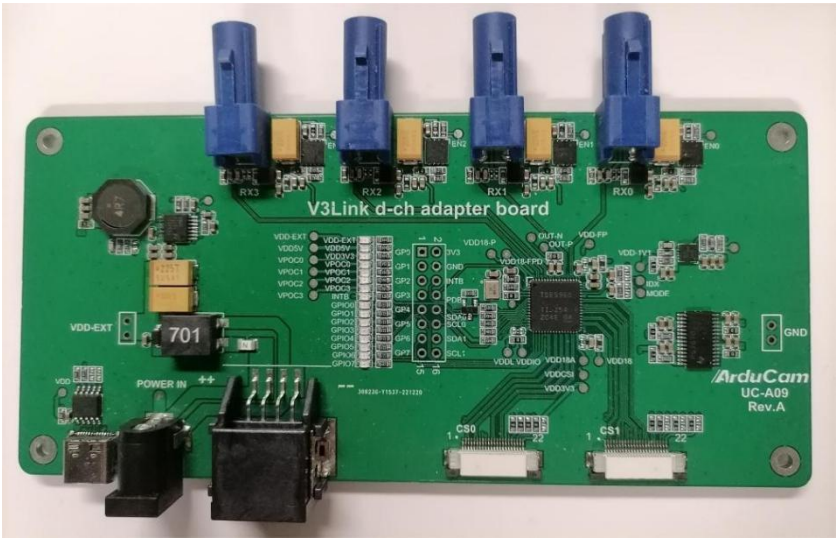
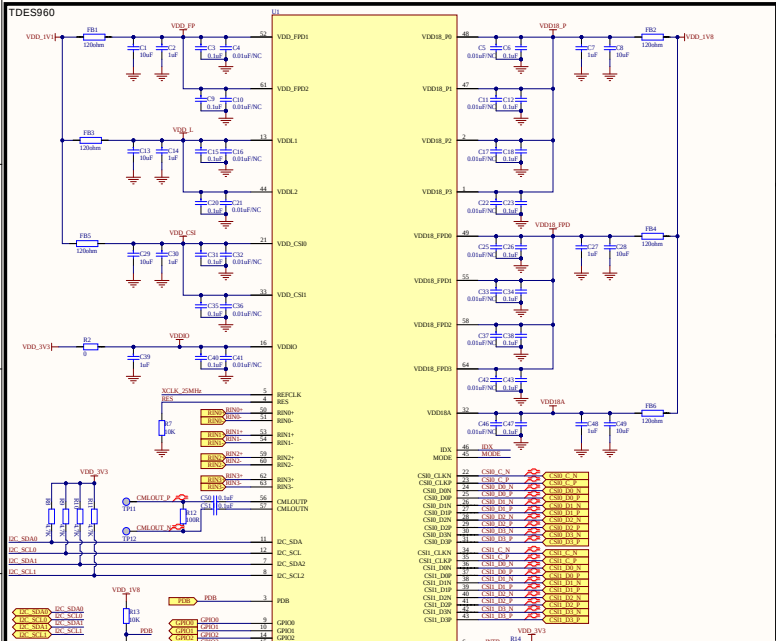
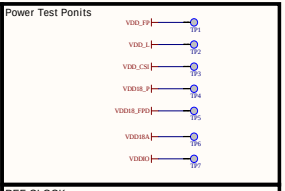


Figure 3.1 Arducam V[3]Link d-ch Adapter Board

TDES960



Power Test Ponits



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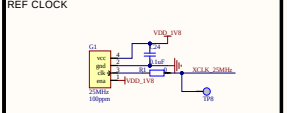

MODE& IDx Selection

Table 7-17. Serial Control Bus Addresses for IDX

NO.	V_{IDX} VOLTAGE RANGE			V_{IDX} TARGET VOLTAGE	SUGGESTED STRAP RESISTORS (1% TOL)		PRIMARY ASSIGNED I2C ADDRESS
	V_{MIN}	V_{TYP}	V_{MAX}	VDD18 = 1.80 V	R_{HIGH} (kΩ)	R_{LOW} (kΩ)	7-BIT	8-BIT
0	0	0	0.131 × V_{VDD18}	0	OPEN	10.0	0x50	0xA0
1	0.170 × V_{VDD18}	0.210 × V_{VDD18}	0.247 × V_{VDD18}	0.374	69.7	23.2	0x52	0xA4
2	0.290 × V_{VDD18}	0.330 × V_{VDD18}	0.362 × V_{VDD18}	0.592	75.0	30.1	0x54	0xA8
3	0.412 × V_{VDD18}	0.440 × V_{VDD18}	0.474 × V_{VDD18}	0.702	71.5	56.2	0x56	0xAC
4	0.520 × V_{VDD18}	0.559 × V_{VDD18}	0.592 × V_{VDD18}	0.905	76.7	97.6	0x58	0xB0
5	0.642 × V_{VDD18}	0.673 × V_{VDD18}	0.704 × V_{VDD18}	1.202	39.2	76.7	0x5A	0xB4
6	0.761 × V_{VDD18}	0.792 × V_{VDD18}	0.823 × V_{VDD18}	1.420	20.5	97.6	0x5C	0xB8
7	0.876 × V_{VDD18}	V_{VDD18}	V_{VDD18}	1.8	10.0	OPEN	0x60	0xA4

Table 7-1. Strap Configuration Mode Select

NO.	V_{MODE} VOLTAGE RANGE			V_{MODE} TARGET VOLTAGE	SUGGESTED STRAP RESISTORS (1% TOL)		I2C MODE
	V_{MIN}	V_{TYP}	V_{MAX}	VDD18 = 1.80 V	R_{HIGH} (kΩ)	R_{LOW} (kΩ)	
0	0	0	0.131 × V_{VDD18}	0	OPEN	10.0	CSI-2 Mode
1	0.170 × V_{VDD18}	0.210 × V_{VDD18}	0.247 × V_{VDD18}	0.374	69.7	23.2	RWFD [2:1]*
2	0.290 × V_{VDD18}	0.330 × V_{VDD18}	0.362 × V_{VDD18}	0.592	75.0	30.1	RWFD [1:0]*
3	0.412 × V_{VDD18}	0.440 × V_{VDD18}	0.474 × V_{VDD18}	0.702	71.5	56.2	RWFD
4	0.520 × V_{VDD18}	0.559 × V_{VDD18}	0.592 × V_{VDD18}	0.905	76.7	97.6	CSI-2 Mode
5	0.642 × V_{VDD18}	0.673 × V_{VDD18}	0.704 × V_{VDD18}	1.202	39.2	76.7	RWFD [2:1]*
6	0.761 × V_{VDD18}	0.792 × V_{VDD18}	0.823 × V_{VDD18}	1.420	20.5	97.6	RWFD [1:0]*
7	0.876 × V_{VDD18}	V_{VDD18}	V_{VDD18}	1.8	10.0	OPEN	RWFD

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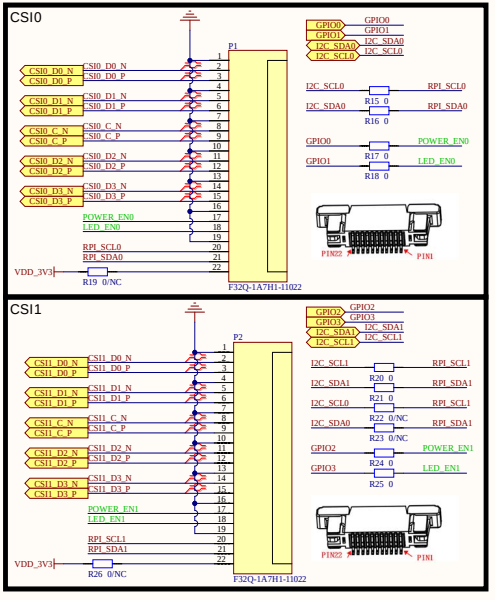
MIPI CSI-2 Output



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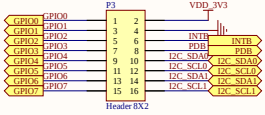
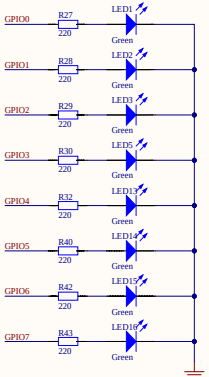
LED Indicators and GPIO Header

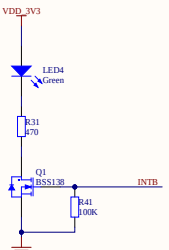
GPIO Header



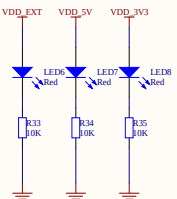
GPIO LEDs



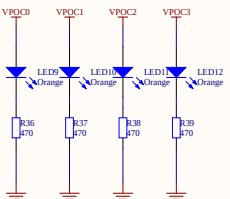
INTB LED



Input Power LEDs



Power Over Coax LEDs



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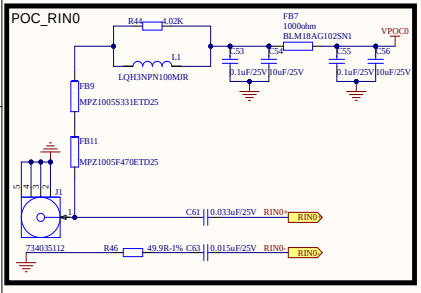
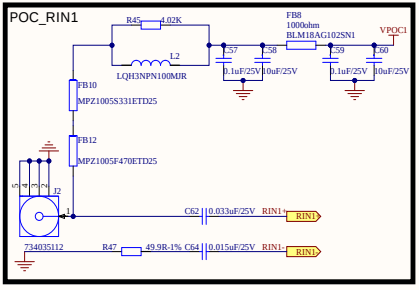
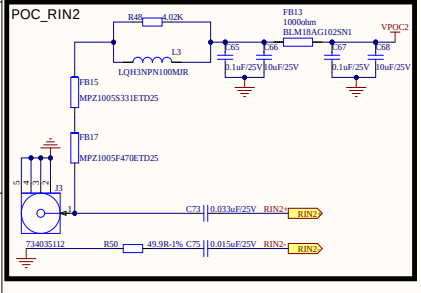
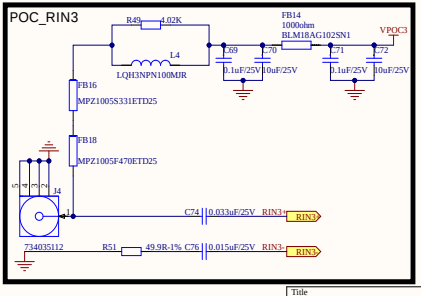
Power Over Coax









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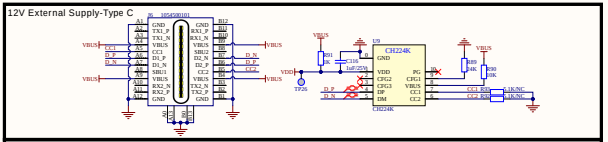
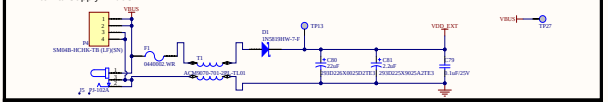
Power

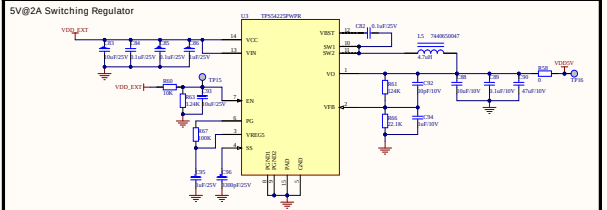
12V External Supply-Type C



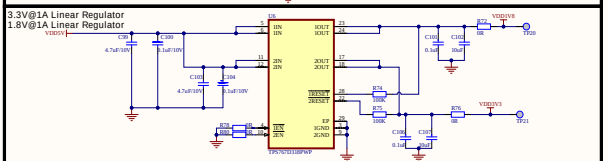
12V External Supply-D2/JST



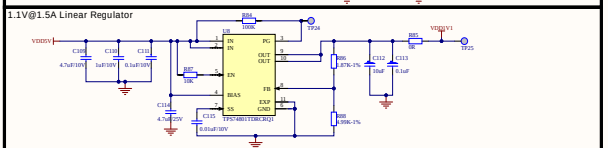
5V@2A Switching Regulator



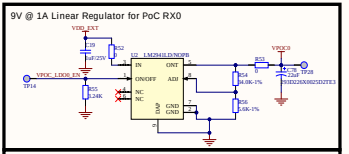
3.3V@1A Linear Regulator
1.8V@1A Linear Regulator



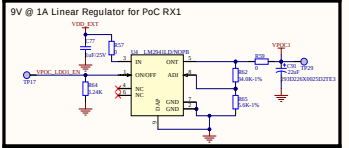
1.1V@1.5A Linear Regulator



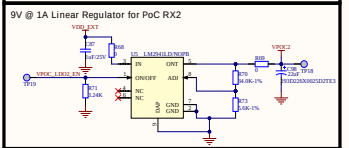
9V @ 1A Linear Regulator for PoC RX0



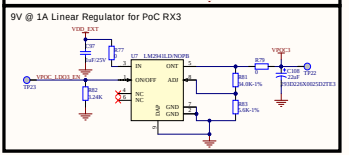
9V @ 1A Linear Regulator for PoC RX1



9V @ 1A Linear Regulator for PoC RX2



9V @ 1A Linear Regulator for PoC RX3



CSI-2 TX = 2 x (4 data lanes + 1 CLK lane) CSI-2 TX line rate = 1.664 Gbps 4 + V*Link RX inputs V*Link line rate = 4.16 Gbps CSI-2 mode, Replicate mode Default registers	VDD11	174	380	mA
	VDD18	312	370	
	VDDIO	2	3	
CSI-2 TX = 2 x (4 data lanes + 1 CLK lane) CSI-2 TX line rate = 832 Mbps 4 + V*Link RX inputs V*Link line rate = 4.16 Gbps CSI-2 mode, Replicate mode Default registers	VDD11	127	305	
	VDD18	369	415	
	VDDIO	2	3	

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3.3 Major Interfaces (d-ch Adapter Board)

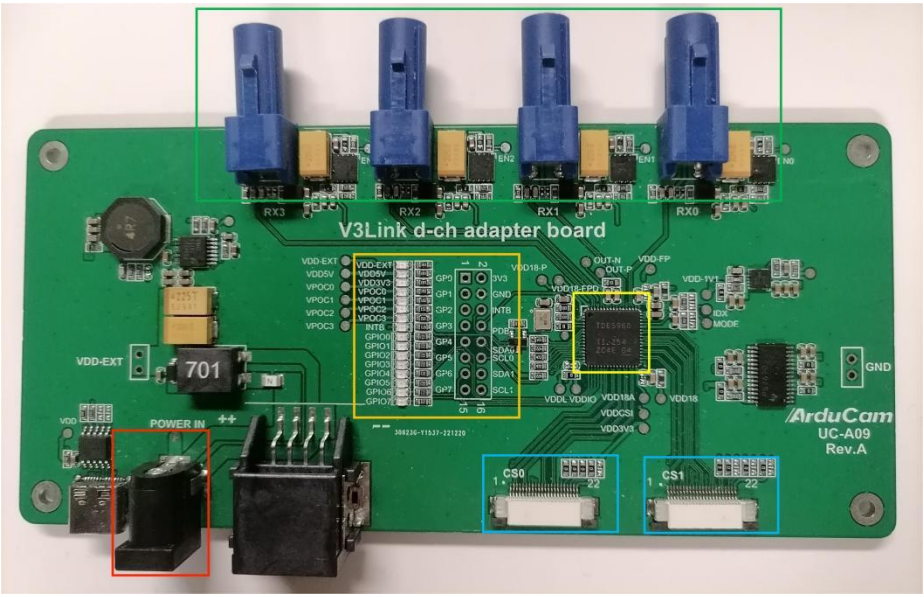


Figure 3.2 Interface of Arducam V[3]Link d-ch Adapter Board

Content:

1. FPD Link interface: Each FPD Link receiver interface can be connected to the slave device through an access coaxial cable. (Allows up to four devices to be connected simultaneously)

2. Allows connecting up to two MIPI CSI-2 output ports to TI development boards (such as SK-AM62A-LP). Every MIPI CSI-2 port is able to control four slave devices connected with FPD Link.

3. The TI TDES960 deserializer chip is integrated on the Arducam V^{3}Link d-ch adapter board and is used to receive data sent from the camera and TI TSER953 serializer chip.

4. When multiple slave devices are connected through FPD Link, each device is controlled independently without affecting each other.

3.4 Basic Schematic (Camera Adapter Board)

- **Simulation 3D Drawing (front)**

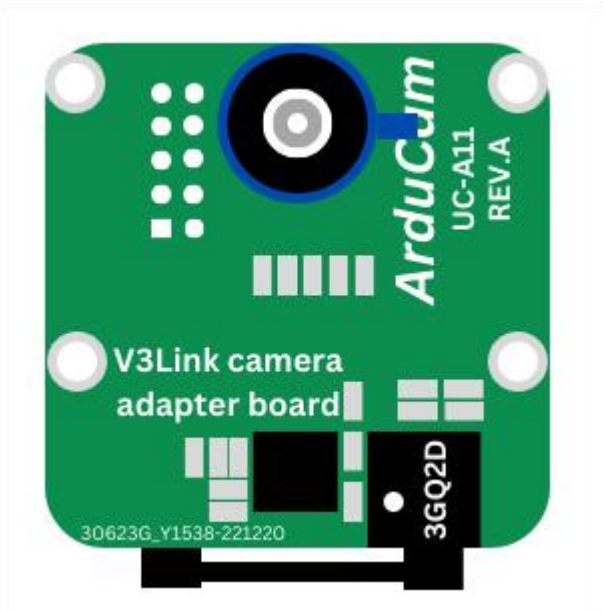


Figure 3.3 Arducam V^{3}Link Camera Adapter Board (Front)

- **Simulation 3D Drawing (back)**

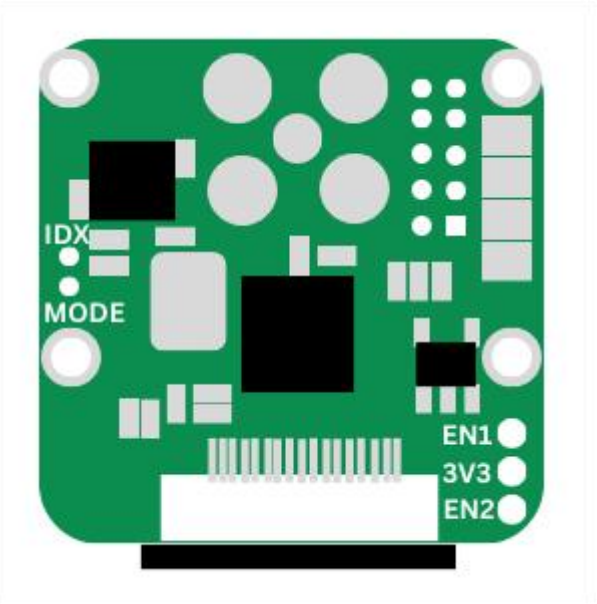
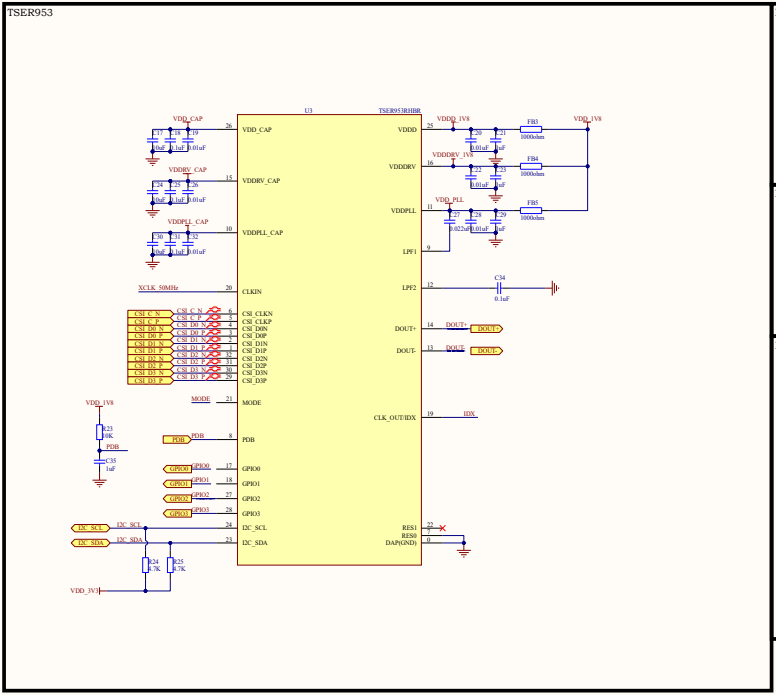
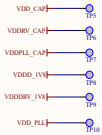


Figure 3.4 Arducam V^{3}Link Camera Adapter Board (Back)

TSER953



Power Test Ponits



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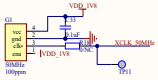

MODE& IDx Selection

Table 7-8. IDX Configuration Setting

IDX	$V_{TRANSIT}$ VOLTAGE RANGE			TRANSIT VOLTAGE	SUGGESTED STRAP RESISTORS (1% TOL)		FC & SET ADDRESS	FC1-SET ADDRESS	V_{DDD} SEE SO VOLTAGE
	RATIO MIN	RATIO TYP	RATIO MAX	V_{TYP} = 1.5 V	R_{MAX} (kΩ)	R_{LOW} (kΩ)			
1	0	0	0.101 x V_{DDD}	0	Open	49.2	0x30	0x18	1.8 V
2	0.119 x V_{DDD}	0.214 x V_{DDD}	0.256 x V_{DDD}	0.305	180	47.5	0x32	0x19	1.8 V
3	0.337 x V_{DDD}	0.564 x V_{DDD}	0.591 x V_{DDD}	1.015	82.5	102	0x30	0x18	3.3 V
4	0.672 x V_{DDD}	0.679 x V_{DDD}	0.706 x V_{DDD}	1.223	88.1	137	0x32	0x19	3.3 V

Table 7-8. Strap Configuration Mode Select

MODE SELECT		$V_{TRANSIT}$ VOLTAGE RANGE			$V_{TRANSIT}$ STRAP VOLTAGE	SUGGESTED STRAP RESISTORS (1% TOL)		DESCRIPTION
MODE	NAME	RATIO MIN	RATIO TYP	RATIO MAX	V_{TYP} = 1.5 V	R_{MAX} (kΩ)	R_{LOW} (kΩ)	
0	Synchronous	0	0	0.101 x V_{DDD}	0	OPEN	10	CSI-2 Synchronous mode - VTrans Clock reference derived from the deserializer
1	Non-Synchronous External Clock	0.208 x V_{DDD}	0.325 x V_{DDD}	0.387 x V_{DDD}	0.588	75	35.7	CSI-2 Non-synchronous mode - VTrans Clock reference derived from external clock reference input on CLKIN pin
2	Non-Synchronous Internal Clock	0.472 x V_{DDD}	0.643 x V_{DDD}	0.674 x V_{DDD}	0.750	71.5	58.2	CSI-2 Non-synchronous - VTrans Clock reference derived from internal ADN clock
3[1]	DVP Mode	0.692 x V_{DDD}	0.873 x V_{DDD}	0.794 x V_{DDD}	1.202	38.3	78.7	DVP with External clock

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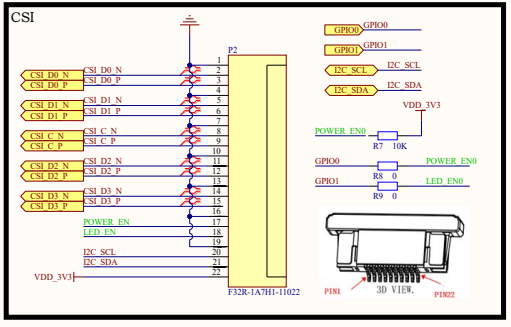
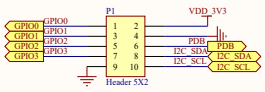
MIPI CSI-2 Input



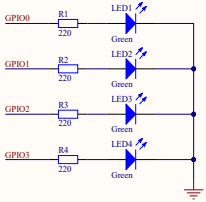
Title			
Size A4	Number		Revision
Date:	11-25-2022	Sheet2 of 5	
File:	C:\Users\..\MIPI CSI-2 Input.SchDoc	Drawn By:	

LED Indicators and GPIO Header

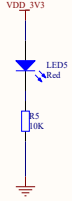
GPIO Header



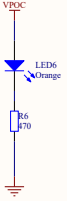
GPIO LEDs



Input Power LEDs



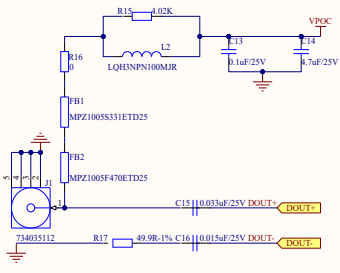
Power Over Coax LEDs



Title		
Size: A4	Number	Revision
Date: 11-25-2022	Sheet 3 of 5	
File: C:\Users\...\LED Indicators and GPIO Header.SchDoc		

Power Over Coax

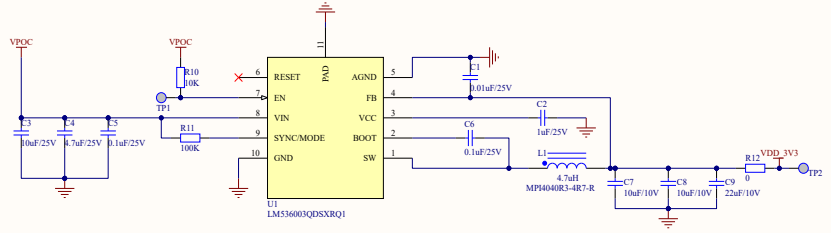
POC_DOUT



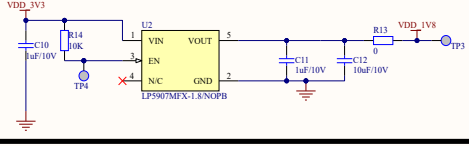
Title			
Size	Number		Revision
A4			
Date:	11-25-2022	Sheet4 of	5
File:	C:\Users\...\Power Over Coax.SchDoc	Drawn By:	

Power

3.3V@650mA Switching Regulator



1.8V@250mA Switching Regulator



PARAMETER		TEST CONDITIONS	PIN OR FREQUENCY	MIN	TYP	MAX	UNIT
POWER CONSUMPTION							
I_{DD_TOTAL}	Supply current	416-MHz CSI Input Clock, 4 Lane Mode, Checkerboard Pattern	VDDPLL, VDDD, VDDDRV		180	225	mA
I_{DDPLL}			VDDPLL		55	80	
I_{DDD}			VDDD		45	70	
I_{DDDRV}			VDDDRV		60	75	

Title		
Size: A4	Number	Revision
Date: 11-25-2022		Sheet5 of 5
File: C:\Users\...\Power.SchDoc		Drawn By:

3.5 Major Components (Camera Adapter board)

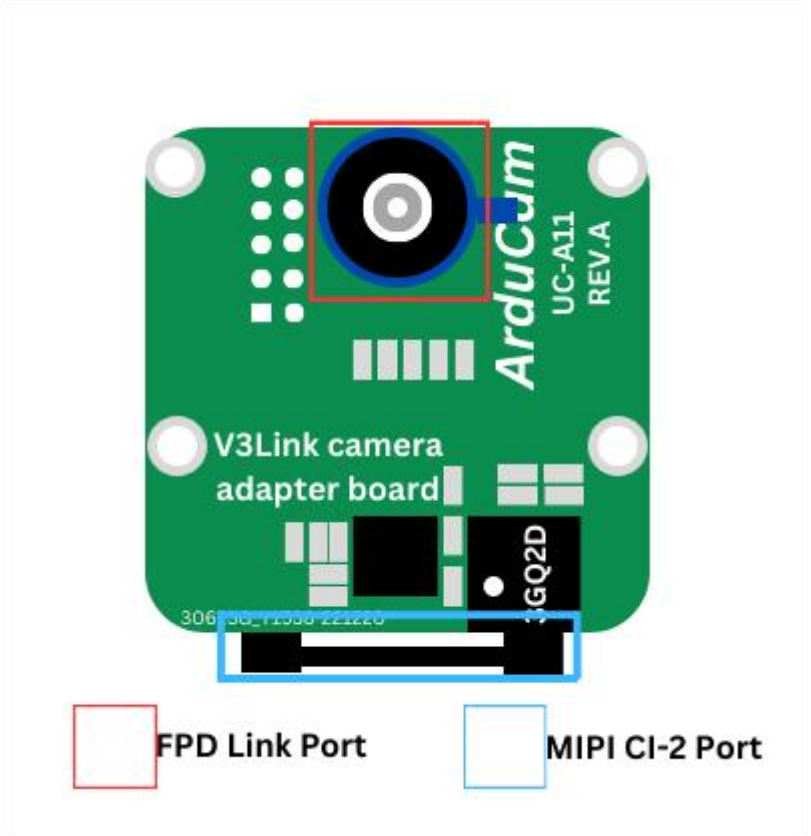


Figure 3.5 Interface (Front)

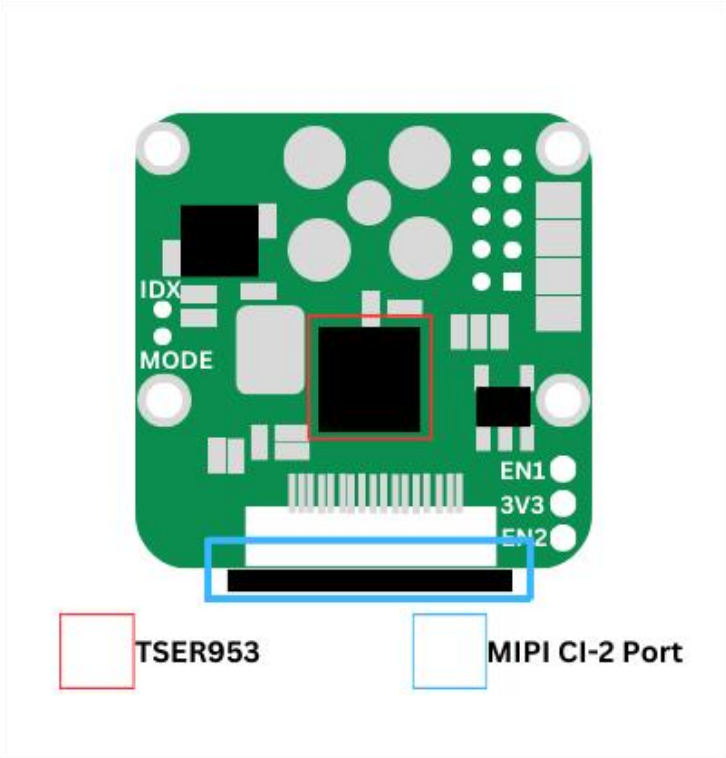


Figure 3.6 Interface (Back)

Content:

1. Each Arducam V^3Link camera adapter board owns a FPD Link interface, which is used to connect to the FPD Link receiver input port on the Arducam V^3Link d-ch adapter board.
2. All camera adapter boards are integrated with a TI TSER953 serializer chip to process the data of a single camera independently and perform data transmission and communication with the receiving port deserializer.
3. Each camera adapter board contains a 15 pin to 22-pin MIPI CSI-2 interface for direct connection to a single camera for camera data transmission.

ArduCam

4. Pin Definition & Connector

4.1 TX Serializer

Input MIPI Connector: F32R-1A7H1-11022

Output FAKRA Connector: 73403-5072

Serializer Pin Definition:

Table 4.1 Serializer Pin Definition

Pin No.	PIN NAME	TYPE	DESCRIPTION	Level
1	DGND	Ground	Power ground	GND
2	MDN0	Input	Pixel Data Lane0 Negative	1.2V
3	MDP0	Input	Pixel Data Lane0 Positive	1.2V
4	DGND	Ground	Power ground	GND
5	MDN1	Input	Pixel Data Lane1 Negative	1.2V
6	MDP1	Input	Pixel Data Lane1Positive	1.2V
7	DGND	Ground	Power ground	GND
8	MCN	Input	Pixel Clock Output Form Sensor Negative	1.2V
9	MCP	Input	Pixel Clock Output Form Sensor Positive	1.2V
10	DGND	Ground	Power ground	GND
11	MDN2	Input	Pixel Data Lane2 Negative	1.2V
12	MDP2	Input	Pixel Data Lane2 Positive	1.2V
13	DGND	Ground	Power ground	GND

14	MDN3	Input	Pixel Data Lane3 Negative	1.2V
15	MDP3	Input	Pixel Data Lane3 Positive	1.2V
16	DGND	Ground	Power ground	GND
17	POWER-EN	Output	Power Enable	3.3V
18	LED-EN	Output	Led Enable/XCLK	3.3V
19	DGND	Ground	Power ground	GND
20	SCL	Output	SCCB serial interface clock output	3.3V
21	SDA	I/O	SCCB serial interface data I/O	3.3V
22	VCC	Power	3.3V Power supply	POWER

4.2 RX Deserializer

Input FAKRA Connector: 73403-5112

Output MIPI Connector: F32R-1A7H1-11022

Deserializer Pin Definition:

Table 4.2 Deserializer Pin Definition

Pin No.	PIN NAME	TYPE	DESCRIPTION	Level
1	DGND	Ground	Power ground	GND
2	MDN0	Input	Pixel Data Lane0 Negative	1.2V
3	MDP0	Input	Pixel Data Lane0 Positive	1.2V
4	DGND	Ground	Power ground	GND
5	MDN1	Input	Pixel Data Lane1 Negative	1.2V

6	MDP1	Input	Pixel Data Lane1Positive	1.2V
7	DGND	Ground	Power ground	GND
8	MCN	Input	Pixel Clock Output Form Sensor Negative	1.2V
9	MCP	Input	Pixel Clock Output Form Sensor Positive	1.2V
10	DGND	Ground	Power ground	GND
11	MDN2	Input	Pixel Data Lane2 Negative	1.2V
12	MDP2	Input	Pixel Data Lane2 Positive	1.2V
13	DGND	Ground	Power ground	GND
14	MDN3	Input	Pixel Data Lane3 Negative	1.2V
15	MDP3	Input	Pixel Data Lane3 Positive	1.2V
16	DGND	Ground	Power ground	GND
17	POWER-EN	Output	Power Enable	3.3V
18	LED-EN	Output	Led Enable/XCLK	3.3V
19	DGND	Ground	Power ground	GND
20	SCL	Output	SCCB serial interface clock output	3.3V
21	SDA	I/O	SCCB serial interface data I/O	3.3V
22	VCC	Power	3.3V Power supply	POWER

5. Dimension

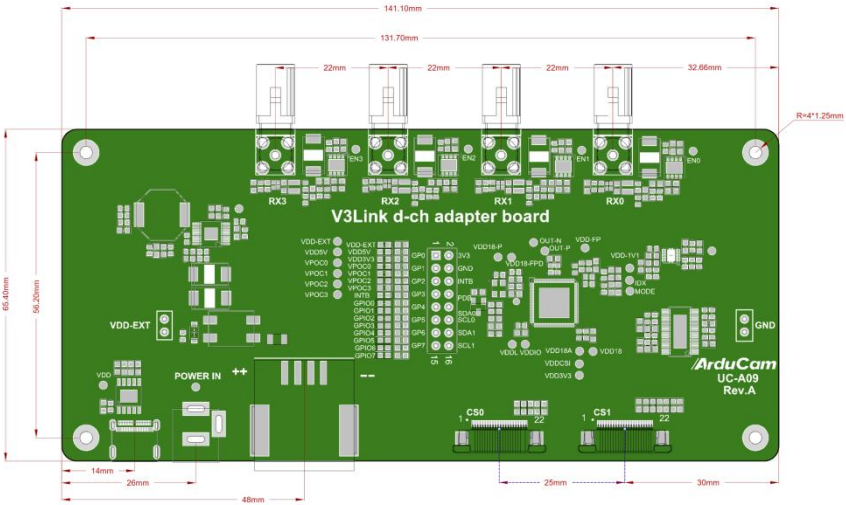


Figure 5.1 Dimension of Arducam V3Link d-ch Adapter Board

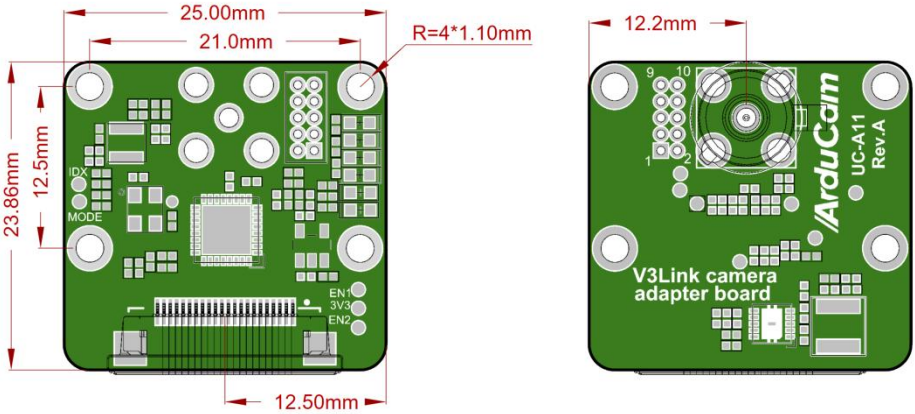


Figure 5.2 Dimension of Arducam V3Link Camera Adapter Board

6. Specifications

Specification	
Arducam V3Link d-ch adapter board	
Number of Supported Sensors	Up to 4 sensors
Data Transfer Protocol	MIPI CSI-2 v1.3
MIPI Port Type	2 x MIPI CSI-2 Output Ports
I^2C Rate	Dual I^2C Ports, up to 1 Mbps
Transmission Cable	FPD Link(Power over-Coax (PoC))
Arducam V3Link camera adapter board	
Power Supply	Single 1.8V
Connector	MIPI CSI-2
MIPI Lane	2-Lane
Transmission Cable	Power-over-Coax (PoC) compatible transceiver
Power Consumption	Low (0.28 W typical) power consumption
Operating Temperature	–20℃ to +85℃

7. Supported Camera Module

Currently, TI official kernel driver only supports the V^{3}Link camera extension solution for Arducam IMX219 camera series. The subsequent adaptation and development processes for other cameras will continue to be updated.

Table 6.1 Arducam IMX219 Camera Common Specs

Camera Specifications	
Sensor	SONY IMX219
Optical Format	1/4''
Resolution	8MP
Active Pixels	3280 (H) × 2464 (V)
Pixel Size	1.12μm×1.12μm
Interface	MIPI CSI-2
CSI-2 Date Output	2-lane mode
Color Array Filter	Quad Bayer RGB
Output Format	RAW Bayer 10bit
Shutter Type	Rolling Shutter

If you need Arducam IMX219 Camera Module, you can click the following link:
Arducam 4xIMX219 V3Link FPD-Link kit for TI Development Boards

8. Quick Start Guide

Please refer to the following doc for more details:

Arducam V3Link camera solution on TI Platforms - Quick Start Guide