CAMERA MODULE SPECIFICATION

CUSTOMER NAME:
CUSTOMER PRODUCT NAME:
BYD PRODUCT NAME:

Customer Service Unit
Division Ⅵ
BYD COMPANY LIMITED

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NOTICE

This document is a general product description and maybe changed basing on customer's requirement.

Revision History

Version	Date [D/M/Y]	Notes	Writer
1.0	2014.04.30		

APPROVALS		
PREPARED BY	CHECKED BY	APPROVED BY
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Table of Contents

Abbreviations

CMOS····· Complementary Metal-Oxide-Semiconductor Transistor
SVGA ····· Super Video Graphics Array (800x600)
SXGA ····· Super Extended Graphics Array (1280x1024)
SXVGA····· Super Extended Video Graphics Array (1280x960)
UXGA····· Ultra Extended Graphics Array (1600x1200)
VGA····· Video Graphics Array (640x480)
SCCB····· Serial Camera Control Bus
fps····· Frames per second
FPN····· Fixed Pattern Noise
AEC····· Auto Exposure Control
AGC····· Automatic Gain Control
AWB····· Auto White Balance
ABF····· Automatic Band Filter
ABLC····· Automatic Black-Level Calibration
TTL ·····Total Track Length
EFL····· Effective Focus Length
F/NO·····F Number
FOV····· Field Of View
CRA····· Chief Ray Angle
I^2C ····· Inter IC bus IF Interface
ISP····· Image Signal Processor
LSB····· Least Significant Bit
APE····· Application Processor Engine
bps····· bit per second
CCP····· Compact Camera Port
CCI ····· Camera Control Interface
DPCM····· Differential Pulse Code Modulation
CDS····· Correlated Double Sampling
I/O····· Input/Output

General description

The Aptina AR0833 is a 1/3.2-inch BSI(back side illuminated) CMOS active-pixel digital image sensor with a pixel array of 3264H x 2448V (3280H x 2464V including border pixels). It incorporates sophisticated on-chip camera functions such as mirroring, column and row skip modes, and snapshot mode. It is programmable through a simple two-wire serial interface and has very low power consumption. The AR0833 digital image sensor features Aptina's breakthrough low-noise CMOS imaging technology that achieves near-CCD image quality (based on signal-to-noise ratio and low-light sensitivity) while maintaining the inherent size, cost, and integration advantages of CMOS. The AR0833 sensor can generate full resolution image at up to 30 frames per second (fps). An on-chip analog-to-digital converter (ADC) generates a 10-bit value for each pixel.

Specification

Lens Specification

Table 1. Lens Specification

Composition	5Elements (5Plastic)
TTL	4.63mm
CRA	32.4 º
FNO	2.2
FOV	Diagonal: 69.5º
TV-Distortion	<1%
Relative Illuminance	40.4%
Barrel Material	PC(BLACK)

Sensor Specification

Sensor Key Specification

- **8Mp (4:3) still images at 30 fps**
- **1.4µm BSI pixel providing best-in-class low-light image quality.**
- **Optional on-chip high-quality bayer scaler resizes 6Mp 30 fps HD video to 1080p30 (2Mp 30 fps).**
- **Serial MIPI interface supports either 4-lane, 3-lane, or 2-lane configurations and speeds up to 1Gbps/lane.**
- **On-chip temperature sensor**
- **Support for external mechanical shutter•Support for external LED or Xenon flash**
- **Programmable controls: gain, horizontal and vertical blanking, auto black level offset correction, framesize/rate, exposure, left–right and top–bottom image reversal, window size, and panning**
- **On-die phase-locked loop (PLL) oscillator**
- **Integrated position and color-based shading correction**
- **8Kb one-time programmable memory (OTPM) for storing shading correction coefficients of three light sources and module information**
- **Internal VCM driver •Slave mode for precise frame-rate control and for synchronizing two sensor**
- **Interlaced High Dynamic Range (iHDR)**

Module Specification

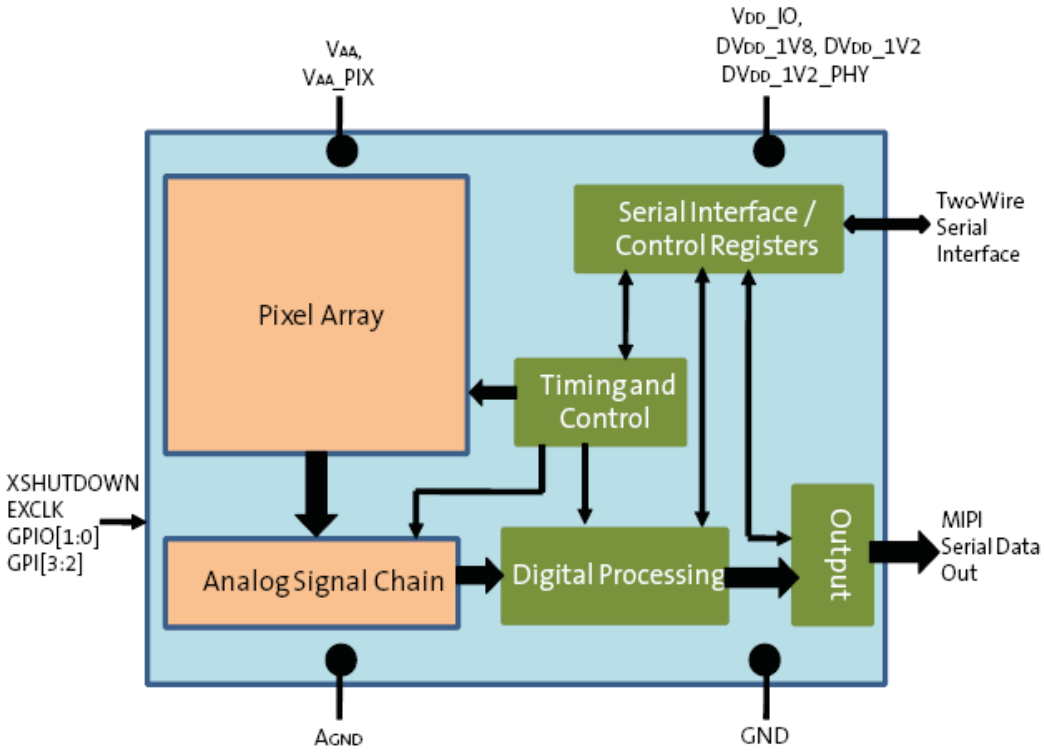
Module General Specification

No	Item		Specification
1	Optical Format		1/3.2”
2	Pixel array number		3280 (H) × 2464 (V)
3	Supply	Analog	2.5 - 3.1 V (2.8V nominal)
		Digital	1.14 - 1.3 V (1.2V nominal)
		Pixel	2.5 - 3.1 V (2.8V nominal)
		OTPM	1.7 - 1.9 V (1.8V nominal)
		MIPI	1.14 - 1.3 V (1.2V nominal)
		IO	1.7 - 1.9 V (1.8V nominal) 2.5 - 3.1 V (2.8V nominal)
4	Data interface		4-lane MIPI (2-lane and 3-lane modes supported); Max data rate: 1Gbps/lane
5	Output data depth		10 bits
6	Interface		BTB
7	Package (size)		8.5*8.5*5.28mm

Module Pin Description

PIN No.	NAME	Type	Description
1	AFVCC	Power	Actuator Power
2	AFGND	Ground	Actuator GND
3	AVDD	Power	Power supply for sensor analog circuit block
4	DGND	Ground	Ground of digital circuit block
5	RESET	Input	Clears all registers and resets them to their default values.
6	DGND	Ground	Ground of digital circuit block
7	MD2P	Output	Differential MIPI Serial 2nd Data Lane(positive)
8	MD2N	Output	Differential MIPI Serial 2nd Data Lane(Negative)
9	DGND	Ground	Ground of digital circuit block
10	MD0P	Output	Differential MIPI Serial 0 Data Lane(positive)
11	MD0N	Output	Differential MIPI Serial 0 Data Lane(Negative)
12	DGND	Ground	Ground of digital circuit block
13	MD3P	Output	Differential MIPI Serial 3rd Data Lane(positive)
14	MD3N	Output	Differential MIPI Serial 3rd Data Lane(Negative)
15	DGND	Ground	Ground of digital circuit block
16	DGND	Ground	Ground of digital circuit block
17	MD1N	Output	Differential MIPI Serial 1st Data Lane(Negative)
18	MD1P	Output	Differential MIPI Serial 1st Data Lane(positive)
19	DGND	Ground	Ground of digital circuit block
20	MCN	Output	Differential MIPI Serial Clock/Strobe (Negative)
21	MCP	Output	Differential MIPI Serial Clock/Strobe (Positive)
22	DGND	Ground	Ground of digital circuit block
23	MCLK	Input	Master Input Clock
24	WP	Input	E2prom Write Protect
25	SCL	Input	I^2C Input Clock
26	SDA	I/O	I2C slave data
27	CORE_EN	Input	NC
28	DOVDD18	Power	Power supply for sensor digital circuit block Module data output
29	AGND	Ground	Ground of analog circuit block
30	VDD12	Power	Power supply for sensor digital circuit block

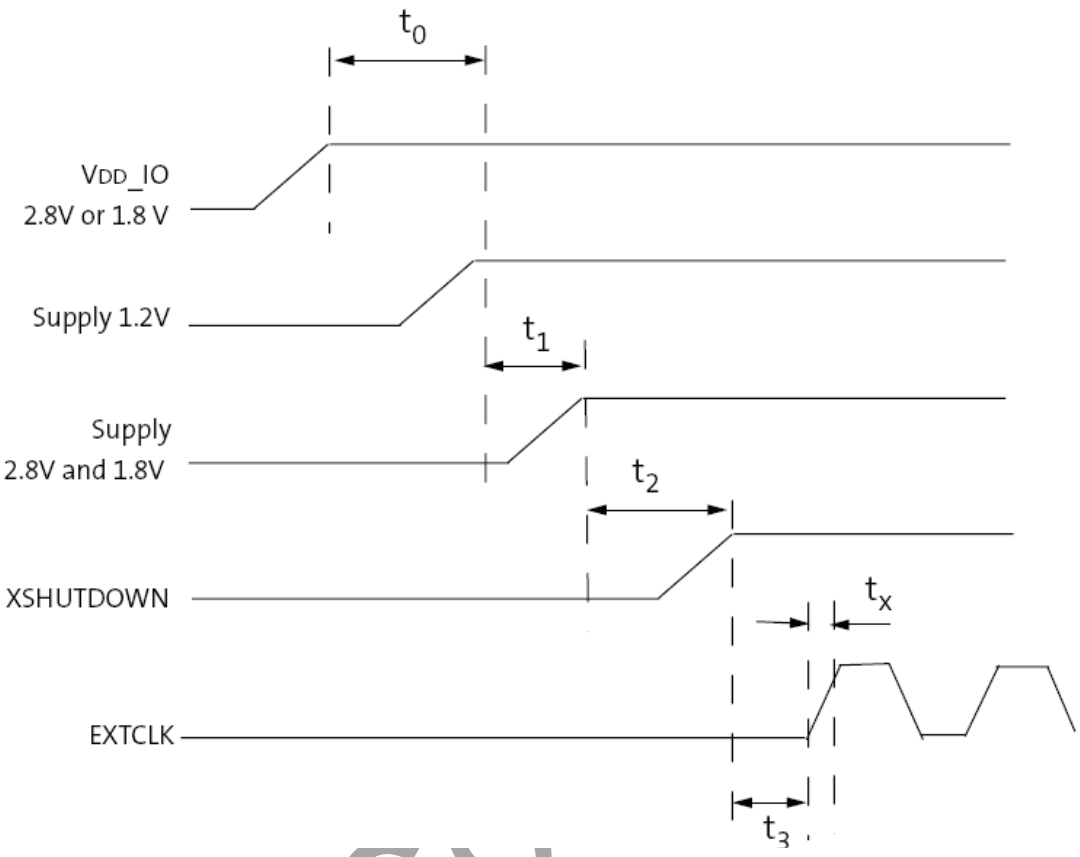
Top Level Block Diagram



The core of the sensor is an 8Mp active-pixel array. The timing and control circuitry sequences through the rows of the array, resetting and then reading each row in turn. In the time interval between resetting a row and reading that row, the pixels in the row inte-grate incident light. The exposure is controlled by varying the time interval between reset and readout. Once a row has been read, the data from the columns is sequenced through an analog signal chain (providing gain), and then through an ADC. The output from the ADC is a 10-bit value for each pixel in the array. The ADC output passes through a digital processing signal chain (which provides further data path corrections and applies digital gain).The pixel array contains optically active and light-shielded ("dark") pixels. The dark pixels are used to provide data for on-chip offset-correction algorithms ("black level" control).The sensor contains a set of control and status registers that can be used to control many aspects of the sensor behavior including the frame size, exposure, and gain setting. These registers can be accessed through a two-wire serial interface. The output from the sensor is a Bayer pattern; alternate rows are a sequence of either green and red pixels or blue and green pixels. The offset and gain stages of the analog signal chain provide per-color control of the pixel data. The control registers, timing and control, and digital processing functions shown in Figure1 on page7 contain the following logical parts

• A digital shading correction block to compensate for color/brightness shading intro-duced by the lens or chief ray angle (CRA) curve mismatch.
• Additional functionality is provided. This includes a horizontal and vertical image scaler, a limiter, a data compressor, and a serializer.
• A flash output signal is provided to allow an external xenon or LED light source to synchronize with the sensor exposure time.
• Additional I/O signals support the provision of an external mechanical shutter.

Figure2: Recommended Power-up Sequence



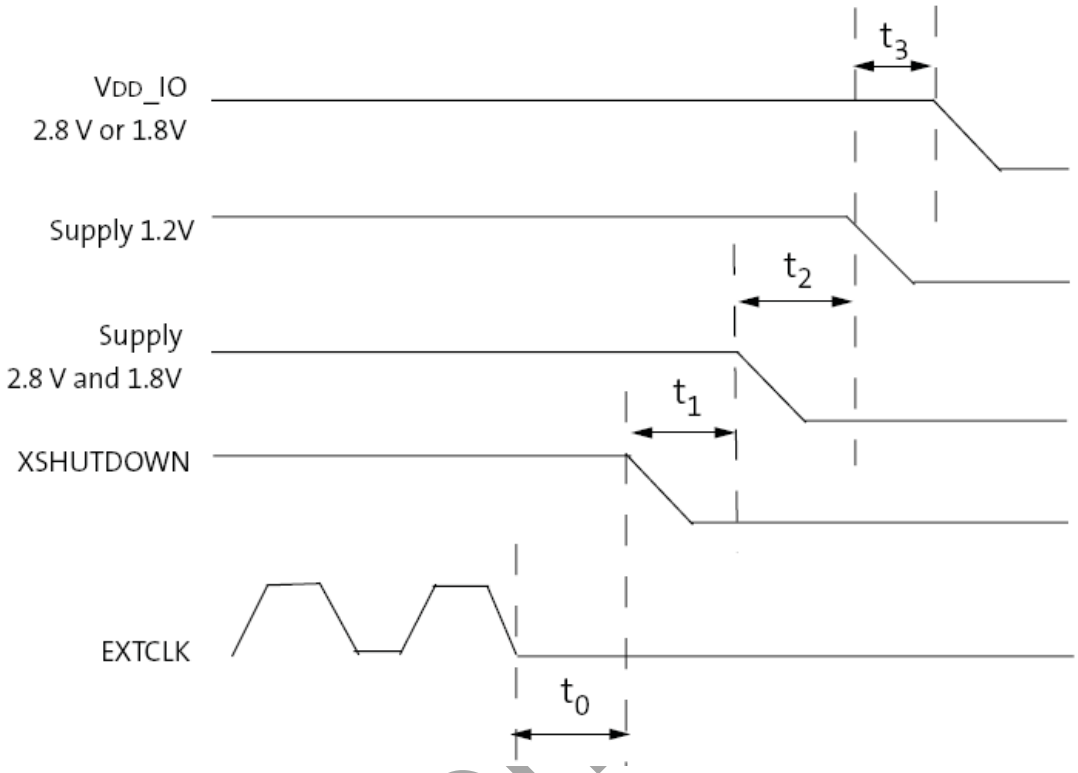
Power-up Sequence

Definition	Symbol	Minimum	Typical	Maximum	Unit
VDD_IO to supply 1.2V	t_0	0.2	–	500	ms
Supply 1.2V to supply 2.8V/1.8V	t_1	0	200	500	ms
Supply 2.8V/1.8V to XSHUTDOWN	t_2	0.2	–	500	ms
XSHUTDOWN to EXTCLK	t_3	100	–	–	μs
External clock rise/fall time	t_x	–	30	–	ns

Operation Specifications in 2-wire Serial Communication

The recommended power-down sequence for the AR0833 is shown in below figure.
The three power supply domains (1.2V, 1.8V, and 2.8V) must have the separation specified below.
1. Disable streaming if output is active by setting standby R0x301a[2] = 0.
2. After disabling the internal clock EXTCLK, disable XSHUTDOWN.
3. After XSHUTDOWN is LOW disable the 2.8V/1.8V supply.
4. After the 2.8V/1.8V supply is LOW disable the 1.2V supply.
5. After the 1.2V supply is LOW disable the VDD_IO supply.

Recommended Power-down Sequence



Power-down Sequence

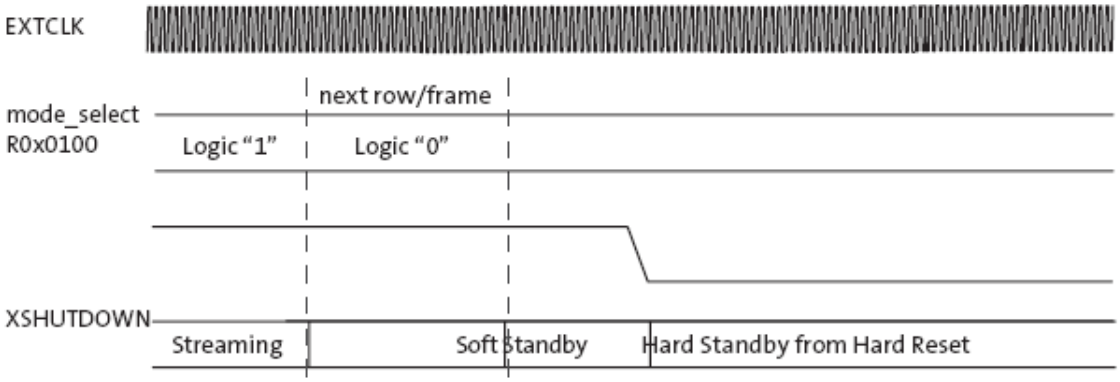
Definition	Symbol	Minimum	Typical	Maximum	Unit
EXTCLK to XSHUTDOWN	t_0	100	–	–	µs
XSHUTDOWN to supply 2.8V/1.8V	t_1	200	–	–	µs
Supply 2.8V/1.8V to supply 1.2V	t_2	0	200	–	µs
Supply 1.2V to VDDD_IO	t_3	200	–	–	µs

Hard Standby and Hard Reset

The hard standby state is reached by the assertion of the XSHUTDOWN pad (hard reset). Register values are not retained by this action, and will be returned to their default values once hard reset is completed. The minimum power consumption is achieved by the hard standby state. The details of the sequence are described below and shown in Figure6.

1. Disable streaming if output is active by setting mode_select 0x301A[2] = 0.
2. The soft standby state is reached after the current row or frame, depending on configuration, has ended.
3. Assert XSHUTDOWN (active LOW) to reset the sensor.
4. The sensor remains in hard standby state if XSHUTDOWN remains in the logic “0” state.

Input specifications are shown below when square-wave inputs directly into the external pin INCK.



Testing

Optical testing

Optical testing

No	Test Item	Illumination Type	Distance	Intensity Range
1	Field of View	DNP Light Box(5100K)	N/A	>200Lux
2	TV-Distortion	DNP Light Box(5100K)	30cm	>200Lux
3	Resolution	Daylight Fluorescent (6500K)	Take the picture for full chart	250±50Lux
4	Shading	DNP Light Box(5100K)	Take the picture for full chart	>300Lux
5	Sensitivity	Daylight Fluorescent (6500K)	Take the picture for full chart	250±50Lux
6	MTF	Daylight Fluorescent (6500K)	Take the picture for full chart	>200Lux
7	Gray Scale	Daylight Fluorescent (6500K)	Take the picture for full chart	>200Lux
8	Focal Range	Daylight Fluorescent (6500K)	N/A	>200Lux
9	Dark Noise	Daylight Fluorescent (6500K)	N/A	<1mLux
10	Color Rendition	Daylight Fluorescent (6500K)	Take the picture for full chart	>200Lux
11	Inside Picture	Daylight Fluorescent (6500K)	40CM	>200Lux

Environment testing

Environment testing

No	Test Item	Test Conditions	Judge standard
1	Temperature Change shock test	High Temp.：80 ± 3°C Low Temp.：－30 ± 3°C Temp. changeover time：30min Test duration：24 cycles	No image distort and good color rendition.
2	High Temp & Damp test	Temp.：60°C ± 2°C Damp：90% ± 3%RH Test duration：48h	No image distort and good color rendition. Not to be dewy
3	Low Temperature Storage	Temp.：－30°C ± 3°C Test duration：48h	No image distort and good color rendition.
4	High Temperature Storage	Temp.：80± 2°C Test duration：48h	No image distort and good color rendition.
5	ESD(Electrostatic Discharge)	Voltage：10kv time：3	No image distort and good color rendition.
6	Vibration (Package State)	Frequency range：10－50 Hz amplitude：0.75mm Duration 1 h for each position. Test all 3 axes (X, Y, Z)	No image distort，good color rendition ，no white、black、colorful dot.
7	Drop test Free fall (Package State)	Surface (floor)：Concrete or steel Number of drops：10 Positions：Random Height：120cm	No image distort，good color rendition ，no white、black、colorful dot.

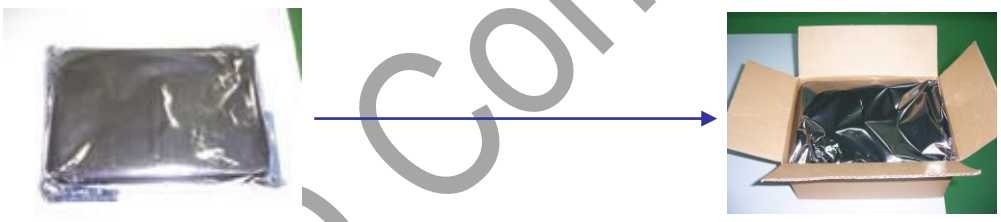
Appendix 1: Packaging

The package must prevent damage to the components during transport and must be suitable for electrostatic-sensitive devices. The single camera modules shall be delivered in a reusable tray of antistatic plastic material. Several cameras shall be packed in one tray. The tray has separate holders for each camera-module.

TRAY SPECIFICAITON:
Material: black antistatic PS
Resistance:<1010 Ω
Dimension:260 (W) x 180 (D) x 11 (H) mm (Top tray and bottom tray assembly)
Capacity : 50 units (50pcs camera module)

Example:
BOTTOM TRAY **CAMERA** **TOP**

ESD SHIELDING BAG SPECIFICATION:
Resistance: 107~1010 Ω
Dimension:430 (W) x 380 (D) x 0.075 (T) mm
Capacity : 10 units (500pcs camera module)



CARTON SPECIFICAITON:
Dimension:276 (W) x 198 (D) x 113 (H) mm
Dimension:270 (W) x 192 (D) x 2.5 (T) mm

PAPER SHEET SPECIFICAITON:
Capacity : 1 units (500pcs camera module)

PACKAGING:

Appendix 2: Engineering Drawing