



1/3.2-Inch 13 Mp CMOS Digital Image Sensor Die

AR1337 Die Datasheet, Rev. 2

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Features

- 13 Mp CMOS sensor with advanced 1.1µm pixel BSI technology
- Phase Detection Auto Focus supported
- On Chip PDAF Optimized Defect Pixel Correction
- On Chip PDAF Calculations
- HSYNC output signal on GPIO for synchronizing PWM/OIS Driver Implementation
- Data interfaces: two- and four-lane serial mobile industry processor interface (MIPI)
- Bit-depth compression available for MIPI Interface: 10-8 and 10-6 to enable lower bandwidth receivers for full frame rate applications.
- 6.8 kbits one-time programmable memory (OTPM) for storing shading correction coefficients of three light sources and module information
- Programmable controls: gain, horizontal and vertical blanking, auto black level offset correction, frame size/rate, exposure, left-right and top-bottom image reversal, window size, and panning
- Two on-die phase-locked loop (PLL) oscillators for super low noise performance
- Bayer pattern horizontal down-size scaler
- Superior low-light performance
- Low dark current
- Simple two-wire fast-mode+ serial interface
- Auto black level calibration
- On-chip lens shading correction
- Support for external mechanical shutter
- Support for external LED or xenon flash
- Extended Flash duration that is up to start of frame readout

General Physical Specifications

- Die thickness: Supports 200 µm ±12 µm and 150 µm ±12 µm
(Consult factory for other thickness)
- Backside wafer surface of bare silicon
- Bond pad metallization composition: 6000Å Al over Cu
- Typical topside passivation: 1250Å Nitride over 2100Å Oxide

- Passivation openings (MIN): 88 µm x 77 µm

Die Database

- Die outline, see Figure 2 on page 9
- Singulated die size
 - 6300 ± 25µm x 5700 ± 25µm
- Bond Pad Identification Tables, see pages 5–10

Key Performance Parameters

- Optical format: 1/3.2-inch (4:3)
- Active imager size: 4.6mm x 3.4mm: 5.7mm diagonal
- Active pixels: 4208H x 3120V
- Pixel size: 1.1µm x 1.1µm back side illumination (BSI)
- Color filter array: RGB Bayer pattern
- CRA: 32 degrees
- Shutter type
 - Electronic rolling shutter (ERS)
- Maximum data rate/master clock
 - MIPI: 1.2 Gbps/lane (4 lanes)
- Frame rate
 - 13 Mp full resolution at 30 fps
- ADC resolution: 10-bit, on-die
- Responsivity: TBD e⁻/lux-seconds
- Dynamic range: TBD dB
- SNR MAX: TBD dB
- Supply voltage
 - Digital I/O: 1.8 V (1.7 V < V_{ripple} < 1.9 V)
 - Digital Core: 1.2 V (1.14V < V_{ripple} < 1.3V)
 - Analog: 2.7V (2.6V < V_{ripple} < 2.9)
 - Digital PHY: 1.14-1.3 V (1.2 V nominal)
- Power consumption:
 - Full resolution (MIPI): TBD mW at 60°C (Typ)
 - Hardware standby/shutdown: 50 µA max. at 60°C (by XSHUTDOWN pin). No state retention.
- Operating temperature: -30°C to +70°C (at junction)



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Ordering Information

Ordering Information

Table 1: Available Part Numbers

Part Number	Product Description	Orderable Product Attribute Description
AR1337C5SC32SMD20	13MP 1/3.2" CIS	Recon die 200µm thickness
AR1337C5SC32SMD20-E	13MP 1/3.2" CIS	Recon die 200µm thickness Samples

See the ON Semiconductor Device Nomenclature document (TND310/D) for a full description of the naming convention used for image sensors. For reference documentation, including information on evaluation kits, please visit our web site at www.onsemi.com.

General Description

The ON Semiconductor AR1337 is a 1/3.2-inch BSI (back side illuminated) PDAF supported CMOS active-pixel digital image sensor with a pixel array of 4208H x 3120V (4224H x 3136V including border pixels). The unique feature of AR1337 is high performance Phase Detect Auto Focus (PDAF) pixel technology which enables a fast auto focus camera system. It uses on-chip PDAF pixel defect correction to output a fully corrected image and on-chip calculations which provide AF correlation data (or raw PDAF data) via virtual channel or second MIPI data type.

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 AR1337 digital image sensor features ON Semiconductor'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 AR1337 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.

Die Testing Procedures

ON Semiconductor imager die products are tested with a standard probe (C1) test level. Wafer probe is performed at an elevated temperature to ensure product functionality in ON Semiconductor's standard package. Because the package environment is not within ON Semiconductor's control, the user must determine the necessary heat sink requirements to ensure that the die junction temperature remains within specified limits.

Image quality is verified through various imaging tests. The probe functional test flow provides test coverage for the on-die ADC, logic, serial interface bus, and pixel array. Test conditions, margins, limits, and test sequence are determined by individual product yields and reliability data.

ON Semiconductor retains a wafer map of each wafer as part of the probe records, along with a lot summary of wafer yields for each lot probed. ON Semiconductor reserves the right to change the probe program at any time to improve the reliability, packaged device yield, or performance of the product.



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Functional Specifications

Die users may experience differences in performance relative to ON Semiconductor's data sheets. This is due to differences in package capacitance, inductance, resistance, and trace length.

Functional Specifications

These specifications are provided for reference only. For target functional and parametric specifications, refer to the AR1337 Datasheet.

Bonding Instructions

The AR1337 imager die has 58 bond pads. Refer to Table 1 and Table 2 on pages 5–8 for a complete list of bond pads and coordinates.

The AR1337 imager die does not require the user to determine bond option features.

The die also has several pads defined as ATEST or TEST. These pads are used for engineering purposes and should not be used. Bonding these pads could result in a nonfunctional die. Use of switching regulator may severely degrade the performance and is thus not recommended.

Figure 1 on page 4 shows the AR1337 typical die connections. For low-noise operation, the AR1337 die requires separate supplies for analog and digital power. Power supply rails should be decoupled to ground using capacitors. The use of inductance filters is not recommended.

ON Semiconductor recommends having all supplies of a certain voltage tied together. The ground of the 2.7V supplies and the 1.8V supplies is considered analog ground (AGND) and must be tied together closely. The ground of the 1.2V supply is considered digital ground (DGND) and all DGND must be tied together. Doing so will minimize risk of damage to the sensor in an ESD event. The integrity of the VAA_PIX 2.7V supply and its associated analog ground AGND is essential to the pixel performance.

The 1.8V supply is used for both I/O purpose (VDD_IO) and analog purpose (VDDIO_ANA). For better performance, it is recommended that star-connections are used to separate the traces for VDD_IO and VDDIO_ANA.

The 1.2V supply/ground is used for both digital purpose (DVDD/DGND) and for analog purpose (DVDD_ANA/DGND_ANA). For better performance, it is recommended that star-connections are used to separate the traces for DVDD/DGND and DVDD_ANA/DGND_ANA).

To ensure the performance of the PLL, it is recommended that star-connections are used to separate the trace for VDD_PLL.

To ensure the performance of the MIPI, good power connection is recommended for DVDD_PHY. DVDD_PHY is internally connected to DVDD inside the chip. DVDD_PHY and DVDD can thus be tied together at module or board level.

Storage Requirements

ON Semiconductor die products are packaged in a cleanroom environment for shipping. Upon receipt, the customer should transfer the die to a similar environment for storage. ON Semiconductor recommends the die be maintained in a filtered nitrogen atmosphere until removed for assembly. The moisture content of the storage facility



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Storage Requirements

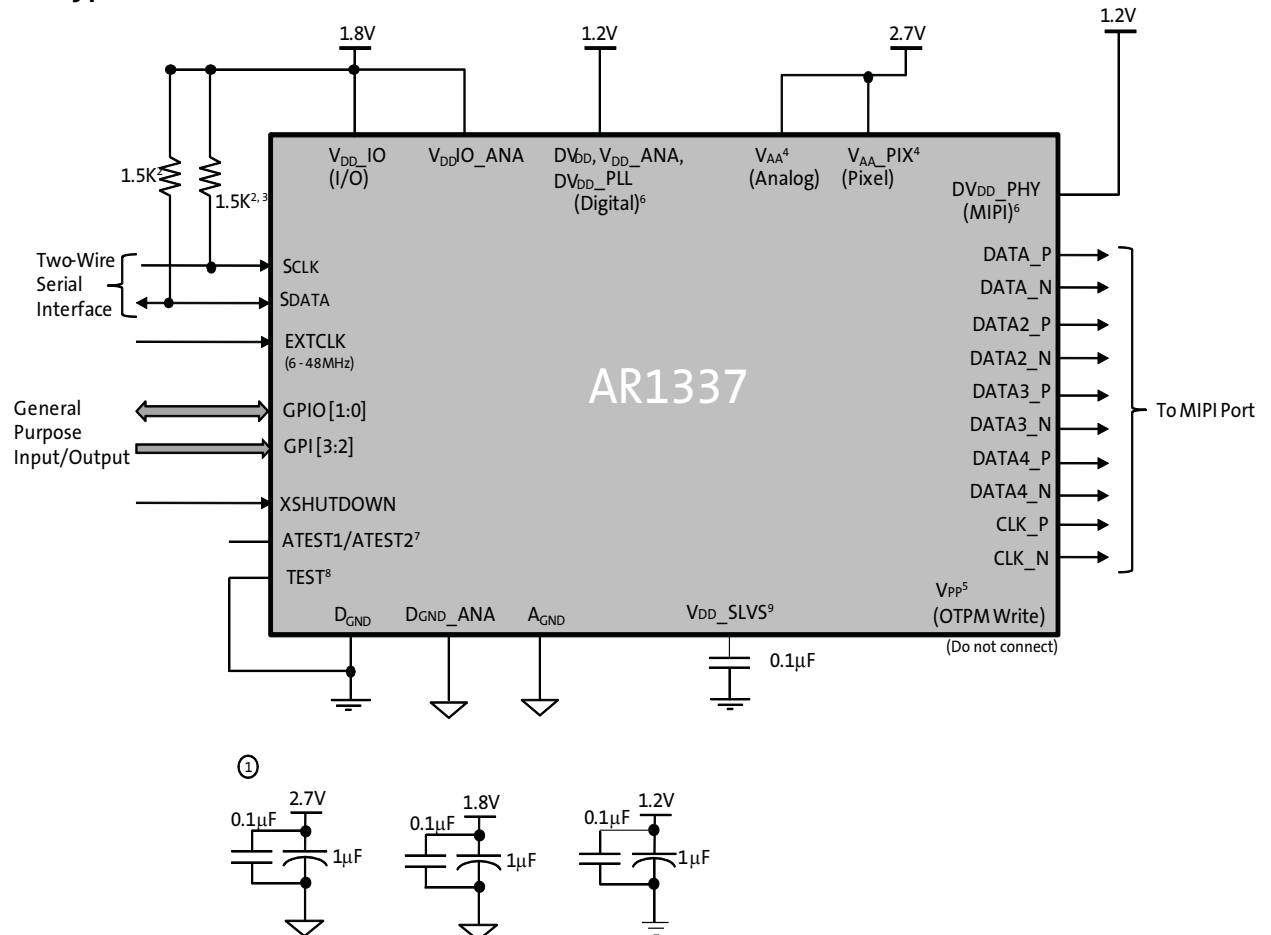
should be maintained at 30 percent relative humidity ± 10 percent. ESD damage precautions are necessary during handling. The die must be in an ESD-protected environment at all times for inspection and assembly.



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Typical Connections

Typical Connections

Figure 1: Typical Connections



For connectivity above:

- Notes:
1. All power supplies should be adequately decoupled; recommended cap values are:
 - 2.7V: 1.0 μ F and 0.1 μ F
 - 1.2V: 1.0 μ F and 0.1 μ F
 - 1.8V: 1.0 μ F and 0.1 μ F
 2. Resistor value 1.5k Ω is recommended, but may be greater for slower two-wire speed.
 3. This pull-up resistor is not required if the controller drives a valid logic level on SCLK at all times.
 4. VAA and VAA_PIX must be tied together.
 5. Internal charge pump is used for OTPM programming.
 6. Digital and MIPI supply can be tied together.
 7. ATEST1/ATEST2 must be left floating.
 8. TEST pin must be tied to D_GND.
 9. VDD_SLVS must be connected to D_GND with a bypass cap (0.1 μ F).



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Bond Pad Identification Tables

Bond Pad Identification Tables

Table 2: Bond Pad Location and Identification from Center of Pad1

Pad Number	Pad Name	"X"1 μm	"Y"1 μm
1	DVDD	0.0	0.0
2	DGND	0.0	-203.8
3	TEST	0.0	-357.0
4	DVDD	0.0	-580.2
5	DGND	0.0	-742.0
6	GPI3	0.0	-885.8
7	GPI2	0.0	-1025.8
8	DVDD	0.0	-1249.0
9	SDATA	0.0	-1365.2
10	SCLK	0.0	-1479.8
11	DGND	0.0	-1992.4
12	DVDD	0.0	-2277.8
13	VPP	0.0	-2470.6
14	VDD_IO	0.0	-2597.0
15	GPIO1	0.0	-2796.2
16	GPIO0	0.0	-2908.2
17	XSHUTDOWN	0.0	-3044.8
18	AGND	0.0	-3319.4
19	VAA_PIX	0.0	-3495.6
20	ATEST1	0.0	-3756.0
21	VAA	0.0	-3892.4
22	AGND	0.0	-4068.6
23	VAA	0.0	-4194.8
24	AGND	0.0	-4371.0
25	VDDIO_ANA	0.0	-4548.4
26	DVDD_ANA	0.0	-4754.0
27	DGND_ANA	0.0	-4957.0
28	DGND_ANA	-5956.0	-5059.2
29	DVDD_ANA	-5956.0	-4856.2
30	VDD_IO	-5956.0	-4650.6
31	AGND	-5956.0	-4473.2
32	VAA	-5956.0	-4297.0
33	AGND	-5956.0	-4185.8
34	ATEST2	-5956.0	-4010.2
35	VAA_PIX	-5956.0	-3800.6
36	AGND	-5956.0	-3624.4
37	DVDD_PHY2	-5956.0	-3314.0
38	DATA4_N	-5956.0	-3174.0
39	DATA4_P	-5956.0	-3014.0
40	DATA3_N	-5956.0	-2854.0
41	DATA3_P	-5956.0	-2694.0
42	DGND	-5956.0	-2534.0
43	VDD_SLVS	-5956.0	-2374.0
44	CLK_N	-5956.0	-2214.0



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor

Bond Pad Identification Tables

Table 2: Bond Pad Location and Identification from Center of Pad1 (continued)

Pad Number	Pad Name	"X" ¹ μm	"Y" ¹ μm
45	CLK_P	-5956.0	-2054.0
46	DATA2_N	-5956.0	-1894.0
47	DATA2_P	-5956.0	-1734.0
48	DATA1_N	-5956.0	-1574.0
49	DATA1_P	-5956.0	-1414.0
50	DVDD_PHY1	-5956.0	-1274.0
51	DVDD	-5956.0	-1026.2
52	DGND	-5956.0	-799.2
53	VDD_IO	-5956.0	-683.2
54	EXTCLK	-5956.0	-571.8
55	DVDD	-5956.0	-457.2
56	DGND	-5956.0	-230.2
57	DVDD_PLL1	-5956.0	44.6
58	DVDD_PLL2	-5956.0	269.0

Note: 1. Reference to center of each bond pad from center of bond pad 1.



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Bond Pad Identification Tables

Table 3: Bond Pad Location and Identification from Center of Die (0,0)

Pad Number	Pad Name	"X" μm	"Y" μm
1	DVDD	2978.0	2397.6
2	DGND	2978.0	2193.8
3	TEST	2978.0	2040.6
4	DVDD	2978.0	1817.4
5	DGND	2978.0	1655.6
6	GPI3	2978.0	1511.8
7	GPI2	2978.0	1371.8
8	DVDD	2978.0	1148.6
9	SDATA	2978.0	1032.4
10	SCLK	2978.0	917.8
11	DGND	2978.0	405.2
12	DVDD	2978.0	119.8
13	VPP	2978.0	-73.0
14	VDD_IO	2978.0	-199.4
15	GPI01	2978.0	-398.6
16	GPI00	2978.0	-510.6
17	XSHUTDOWN	2978.0	-647.2
18	AGND	2978.0	-921.8
19	VAA_PIX	2978.0	-1098.0
20	ATEST1	2978.0	-1358.4
21	VAA	2978.0	-1494.8
22	AGND	2978.0	-1671.0
23	VAA	2978.0	-1797.2
24	AGND	2978.0	-1973.4
25	VDDIO_ANA	2978.0	-2150.8
26	DVDD_ANA	2978.0	-2356.4
27	DGND_ANA	2978.0	-2559.4
28	DGND_ANA	-2978.0	-2661.6
29	DVDD_ANA	-2978.0	-2458.6
30	VDD_IO	-2978.0	-2253.0
31	AGND	-2978.0	-2075.6
32	VAA	-2978.0	-1899.4
33	AGND	-2978.0	-1788.2
34	ATEST2	-2978.0	-1612.6
35	VAA_PIX	-2978.0	-1403.0
36	AGND	-2978.0	-1226.8
37	DVDD_PHY2	-2978.0	-916.4
38	DATA4_N	-2978.0	-776.4
39	DATA4_P	-2978.0	-616.4
40	DATA3_N	-2978.0	-456.4
41	DATA3_P	-2978.0	-296.4
42	DGND	-2978.0	-136.4
43	VDD_SLVS	-2978.0	23.6
44	CLK_N	-2978.0	183.6
45	CLK_P	-2978.0	343.6



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Bond Pad Identification Tables

Table 3: Bond Pad Location and Identification from Center of Die (0,0)

Pad Number	Pad Name	"X" μm	"Y" μm
46	DATA2_N	-2978.0	503.6
47	DATA2_P	-2978.0	663.6
48	DATA1_N	-2978.0	823.6
49	DATA1_P	-2978.0	983.6
50	DVDD_PHY1	-2978.0	1123.6
51	DVDD	-2978.0	1371.4
52	DGND	-2978.0	1598.4
53	VDD_IO	-2978.0	1714.4
54	EXTCLK	-2978.0	1825.8
55	DVDD	-2978.0	1940.4
56	DGND	-2978.0	2167.4
57	DVDD_PLL1	-2978.0	2442.2
58	DVDD_PLL2	-2978.0	2666.6

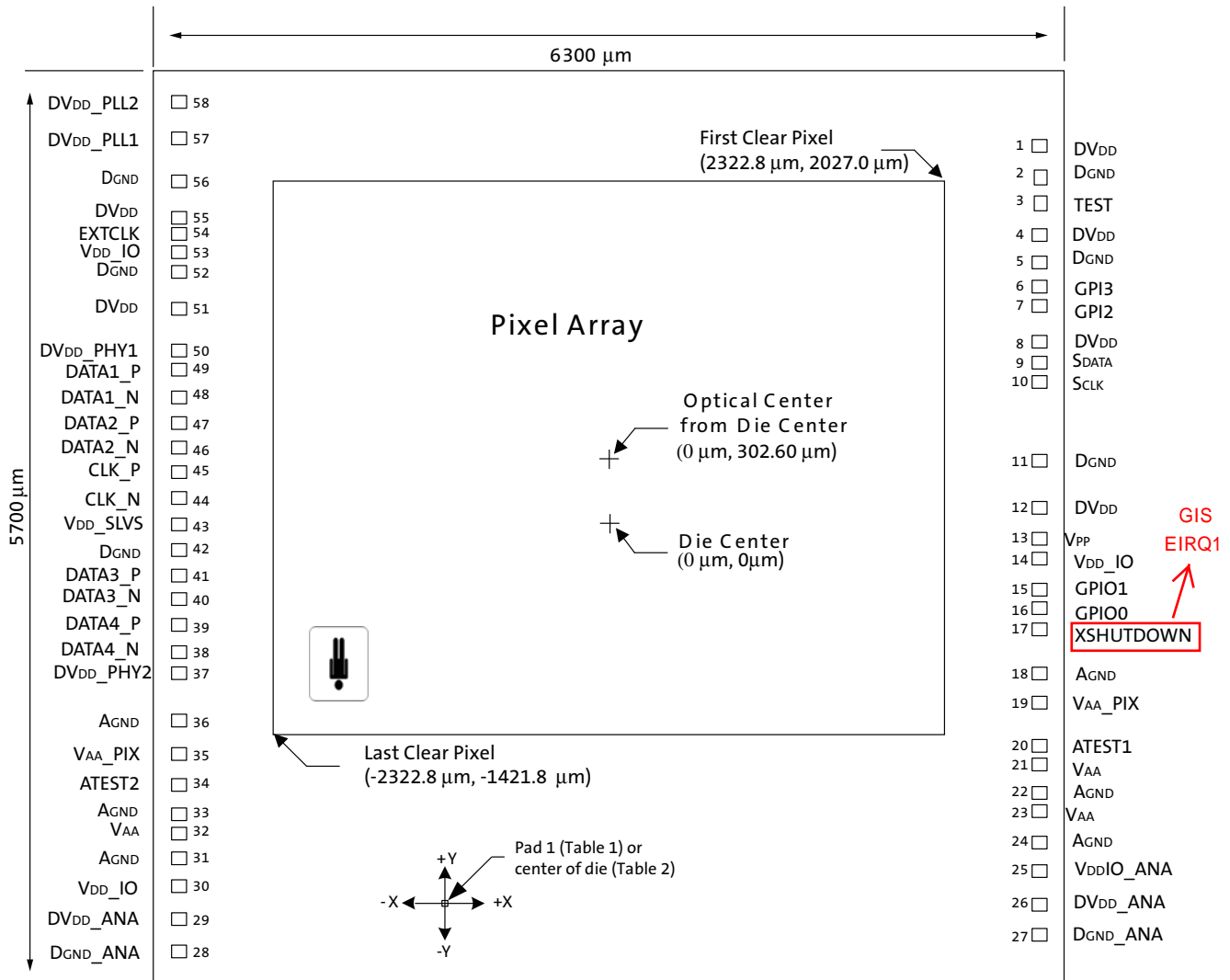
Note: 1. Reference to center of each bond pad from center of die(0,0).



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Die Features

Die Features

Figure 2: Conceptual Die Mechanical Layout





Physical Specifications

Table 4: Physical Dimensions

Feature	Dimensions
Wafer diameter	300 mm
Die thickness	200 μm \pm 12 μm , 150 mm \pm 12 μm
Singulated die size (after wafer saw)	6300 \pm 25 μm 5700 \pm 25 μm
Bond pad size (MIN)	96 μm x 85 μm
Passivation openings (MIN)	88 μm x 77 μm
Minimum bond pad pitch	111 μm
Optical array Optical center from die center: Optical center from center of pad1:	0 μm , 302.60 μm -2978 μm , -2095.0 μm
First clear pixel From die center: From center of pad1: From First Clear Pixel:	2322.8 μm , 2027.0 μm -655.2 μm , -370.6 μm (0,0)
First readout pixel (as 13 Mp) From die center: From center of pad1: From First Clear Pixel:	2314 μm , 2018.2 μm -664 μm , -379.4 μm (-8,-8)
First PDAF row From die center: From center of pad1: From First Clear Pixel:	2102.8 μm , 1780.6 μm -875.2 μm , -617 μm (-200,-224)

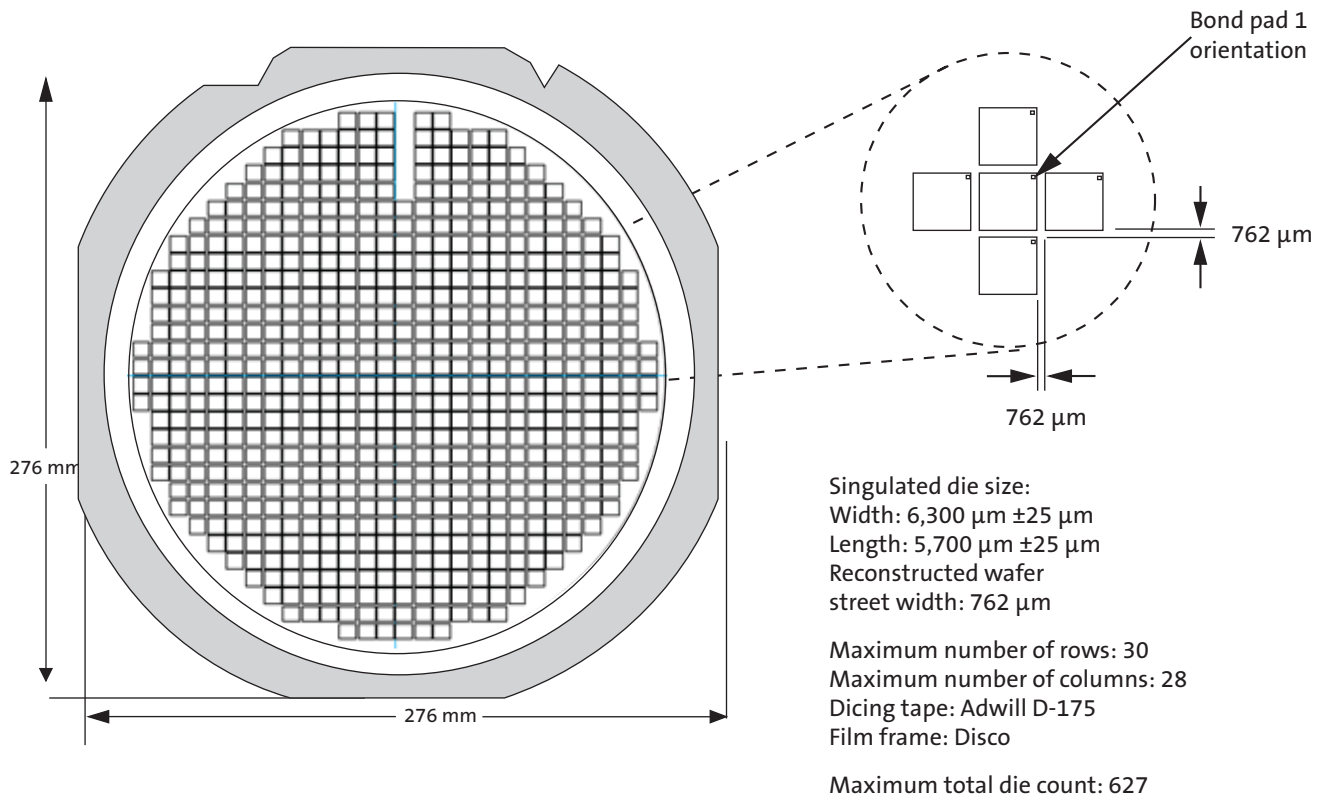
Figure 3: Die Orientation in Reconstructed Wafer, 150 μm

TBD



AR1337: 1/3.2-Inch 13 Mp CMOS Digital Image Sensor Physical Specifications

Figure 4: Die Orientation in Reconstructed Wafer, 200 μm





Revision History

Rev. 2	7/1/15
<ul style="list-style-type: none"> Corrected Figure 4: "Die Orientation in Reconstructed Wafer, 200 μm," on page 12 	
Rev. 1	6/29/15
<ul style="list-style-type: none"> Initial release 	

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