Foveon X3® F13 Direct Image Sensor
14.1 Megapixels in a 1.7x FLM Optical Format

Features

Foveon X3® Technology

- A stack of three pixels captures superior color fidelity by measuring full color at every point in the captured image or video.
- Images and video have improved sharpness and immunity to sampling artifacts (such as moiré) over mosaic CCD and CMOS image sensors.
- Foveon X3 technology directly converts light of all colors into useful signal information at every point in the captured image--no light absorbing filters are used to block out light.

Variable Pixel Size (VPS) Capability

- Neighboring pixels can be grouped together on-chip to obtain the effect of a larger pixel.
- Enables flexible still and video capture at a variety of resolutions.
- Enables higher ISO mode at lower resolutions.
- Reduces noise while increasing frame rate.

High Dynamic Range

- A >62 dB dynamic range assures a high quality image across a variety of lighting conditions.

Integrated Digital Control

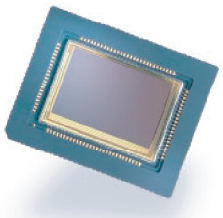
- Image sensor registers are set via a simple 3 wire serial register interface.

Ultra-low Power and Voltage Needs

- Voltage requirements are only 2.5V and -0.5V, allowing for easy integration into the host system.
- Use of advanced CMOS process technology results in ultra-low power consumption.
- Power consumption is less than 250mW during readout and less than 300µW in power-down mode.

Low Noise

- The Foveon X3 direct image sensor offers low-noise readout for high quality images.
- Proprietary readout circuits suppress fixed pattern noise artifacts commonly associated with CMOS image sensors.



The Foveon X3 F13 is a 1.7x FLM (focal length multiplier) high-resolution CMOS direct image sensor that incorporates breakthrough Foveon X3 technology. The latest in Foveon's large format CMOS imagers, the F13 achieves significantly longer exposure times, broader ISO selection, and improved dynamic range over its predecessors. Foveon X3 direct image sensors capture full-measured color images through a unique stacked pixel sensor design. By capturing full-measured color images, the need for indirect color interpolation and artifact-reducing blur filters is eliminated. As a result, the F13 delivers the highest effective resolution possible for the 1.7x FLM optical format without color artifacts. The Foveon F13 also features the powerful VPS (Variable Pixel Size) capability. VPS provides the on-chip capability of grouping neighboring pixels together to form larger pixels that are optimized for high frame rate, reduced noise, and dual mode still/video applications. The F13's high-performance makes it ideal for applications such as DSLR, medical, and scientific cameras.

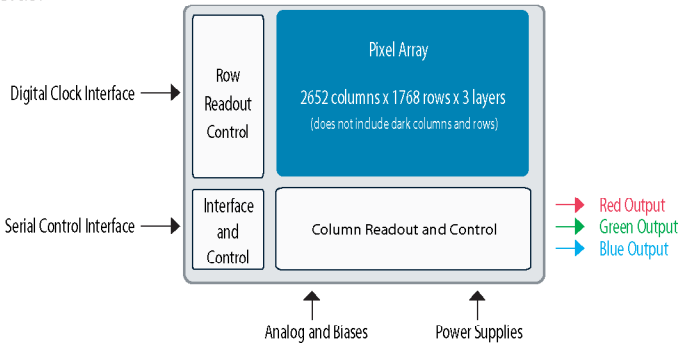


Image Sensor Brief Specifications

Parameter	F13 Image Sensor
Total Pixels	14.1 million active pixels, 14.4M total pixels 4.68R, 4.68G, 4.68B active (4.81R, 4.81G, 4.81B total) 2652 columns x 1768 rows x 3 layers
Active Array Size	20.67 mm x 13.79 mm
Pixel Pitch	7.8µm
Aspect Ratio	3:2
Frame Rate (1)	4 fps for •2652 columns x 1768 rows x 3 layers 24 fps for •1280 columns x 720 rows x 3 layers (VPS) 40 fps for •640 columns x 442 rows x 3 layers (VPS)

Notes:
(1) Defined as maximum number of frames per second in rolling shutter mode

Applications

- DSLR / Digital Still Cameras
- Scientific and Medical

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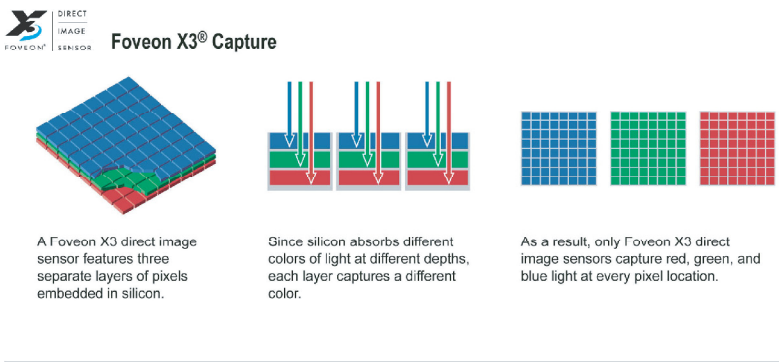
Foveon X3® Technology

The F13 direct image sensor, which is manufactured using Foveon's proprietary process, separates the incident photons into R, G, and B channels directly, without the use of an organic CFA (Color Filter Array). To capture the color that others miss, Foveon X3 image sensors use three layers of pixels embedded in silicon. The layers are positioned to take advantage of the fact that silicon absorbs different colors of light at different depths, so the top layer records blue, the middle green, and the bottom layer records red. This means that for every pixel location on a Foveon X3 image sensor, there are three pixels.

Foveon X3 Capture

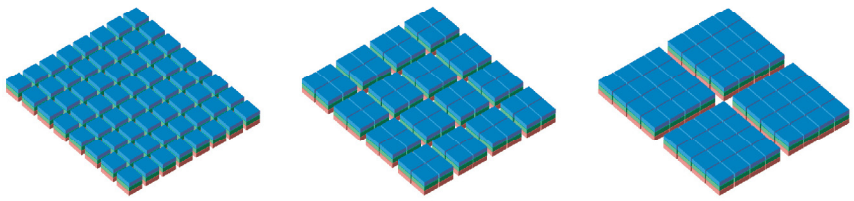


Variable Pixel Size (VPS)

Since Foveon X3 image sensors capture full color at every pixel location, adjacent pixels of each color type can be grouped together to create pixels that behave like a single, larger pixel. This capability is called Variable Pixel Size (VPS). With VPS, the signals from groups of pixels can be combined and output as one. Grouping pixels allows the sensor to capture fully-sampled images at reduced resolution without the strong aliasing artifacts that sub-sampled readout modes typically create in CFA (Color FIlter Array) image sensors. Grouping smaller pixels into larger pixels also increases the signal-to-noise ratio, allowing the camera to take full-color pictures at reduced resolutions in low-light conditions.

Using VPS to reduce the resolution also enables the image sensor to run at higher frame rates, increasing the rate at which images can be taken. The VPS feature also makes it possible to easily switcfsh from high-quality still photography to high quality digital video, enabling the development of cameras with true dual-mode functionality.

VPS Enables a Foveon X3 image sensor to be addressed in variable resolutions.



Capture Modes

The F13 can be operated in two different shutter modes: Stillshot and Rolling Shutter.

In stillshot exposure mode, all the pixels are reset simultaneously. Then the array is read out row-by-row to obtain the image. An external mechanical shutter is used to prevent light from reaching the pixels while image data is being read out.

In Rolling Shutter mode, rows of pixels are reset and read out on a row-by-row basis. The exposure time is determined by the number of rows between reset and readout. There are two sub-modes: Snapshot and Movie. In Snapshot mode, a single frame is captured. In Movie mode, multiple frames are captured to create a video sequence. Rolling Shutter mode can be used when an external shutter is not available.

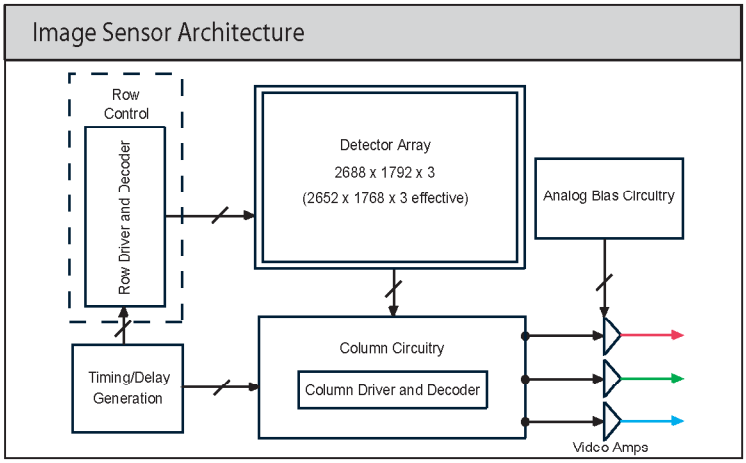
F13 Technical Specifications

Characteristic	F13
Total Pixels	14.4M (2688 x 1792 x 3)
Effective Pixels	14.1M (2652 x 1768 x 3)
Pixel Architecture	X3, three pixels per pixel location
Pixel Pitch	7.8µm x 7.8µm
Aspect Ratio	3:2
Optical Format	1.7x FLM
Image Area	20.67 mm x 13.79 mm
Image Area Diagonal	24.86 mm
Fill Factor	48%
Effective Fill Factor (with Micro Lenses)	92%
Dark Columns / Rows	18 / 12
Border (Transition) Pixel Columns / Rows	1 / 1 between dark and active per edge
Micro Lenses	Yes
Overflow Protection	Yes
Full Well Capacity (1)	>72,000 e^-
Electron Sensitivity/Conversion Factor (1)	9µv/e^-
RMS Noise Electrons (1)	<70e^-
Photo Sensitivity	0.8V/lux*sec
Dynamic range (1)	>62dB
Pixel Clock Rate	10 MHz min, 40 MHz typ
Readout Speed	40 MHz
Dark Frame Non-Uniformity	< ±0.2% with dark subtract, <±1% without dark subtract
Row Fixed Pattern Noise	< ±0.2% with dark subtract
Column Fixed Pattern Noise	< ±0.3% with dark subtract
Dark Leakage Current (1)	< 0.1nA/cm^2
Photo Response Non-Uniformity	< ±0.6% with dark subtract
Supply Voltage	2.5V and -0.5V
Power Consumption, Full Speed Readout	250mW during full frame readout
Operating Temperature	-10°C to 60°C

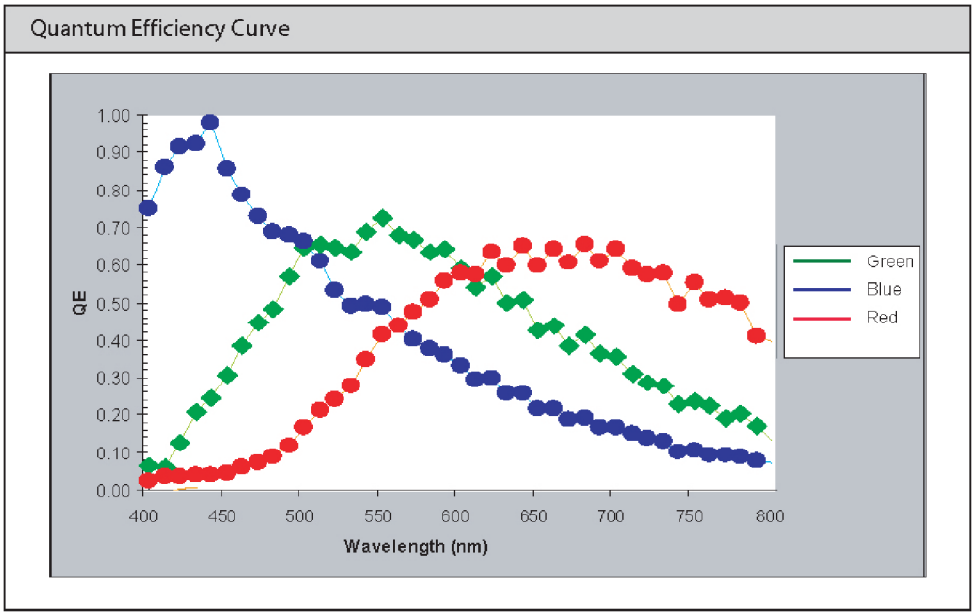
Notes:
(1) Green photodiode referred

All measured at 40 MHz clock, 25° C

Image Sensor Block Diagram



F13 Quantum Efficiency



Pinout Details

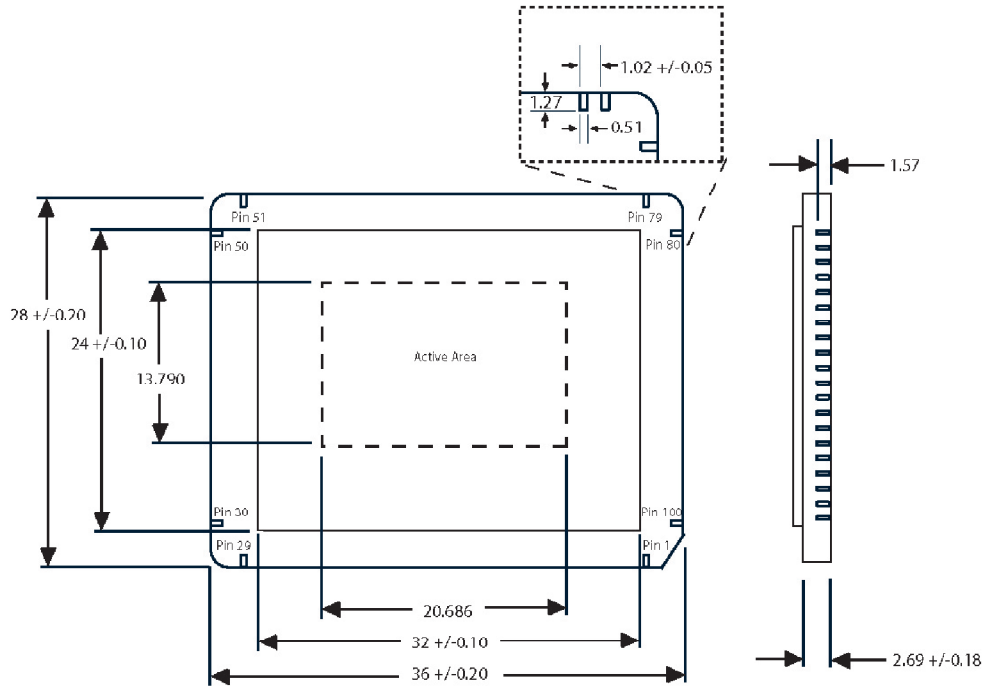
Package Pinout

Pin No.	Signal	Description
1	VCELL	Power
2	VCEL	Power
3	VPP	AntiFuse Programming Voltage
4	ColEn	Column Enable
5	DataLatchOut	Clock for External ADC or Data Latch
6	IOGND	Digital Ground
7	IOV_{DD}	Digital Power
8	Sdat/SDatin	Serial Data In/Out
9	MRB	Master Reset Bar
10	SClk	Serial Clock
11	LS	Load Start
12	SEN	Serial Enable
13	Reverse	Reverses Count Direction of Counters
14	CapSum	Combines col cap for linear vertical binning
15	ColShr<0>	ColShr<0:3> and ColShrB work together to generate the ColShr control signals that route the array column wire to a specific column capacitor
16	ColShr<1>	
17	ColShr<2>	
18	ColShr<3>	
19	ColShrB	
20	PwrDn	Global Imager Power Down
21	VidRstB	Reset the black video bus to VVRB
22	VidRstW	Reset the white video bus to VVRW
23	VidHold	Analog voltage to hold disabled bus segments
24	VCEL	Vertical Column Enable Low
25	VQNeg	QUIET Vertical Column Enable Low
26	VVRB	Black Video Bus Reset Level
27	VVRW	White Video Bus Reset Level
28	AGND	Analog Ground
29	VCAP	2.5V back side of column capacitors
30	VidClk	Video Clock Input
31	VidRN	Red Negative Differential Input
32	VidRP	Red Positive Differential Input
33	VidGN	Green Negative Differential Input
34	VidGP	Green Positive Differential Input
35	VidBN	Blue Negative Differential Input
36	VidBP	Blue Positive Differential Input
37	VidVneg	Negative Power Supply to the Video Amplifiers
38	VidVpos	Positive Power Supply to the Video Amplifiers
39	AGND	Analog Ground
40	VrefM	Common Mode Reference Voltage
41	Vrefp	Positive Reference Voltage
42	Vrefn	Negative Reference Voltage
43	Vref2.5	External clean 2.5V reference
44	IrefIN	Analog Current Reference In
45	VTubiso	Internal Isolation Input Voltage
46	VColBulks	0 ohm Register to AGND
47	IGND	Analog Ground (Imager Ring)
48	N/C	Do not connect
49	ESDN	ESD Negative
50	ESDP	ESD Positive
51	N/C	Do not connect
52	N/C	Do not connect
53	VSFD	Adjustable Vsfd Source
54	N/C	Do not connect
55	N/C	Do not connect
56	VCPD	Column Pull Down Voltage
57	VSFD	Adjustable Vsfd Source
58	VCPUR	Vpix for Red
59	VCPUB	Vpix for Blue
60	VCPUG	Vpix for Green
61	VSFD	Adjustable Vsfd Source
62	VCPD	Column Pull Down Voltage
63	N/C	Do not connect
64	N/C	Do not connect
65	VSFD	Adjustable Vsfd Source
66	N/C	Do not connect
67	VCPD	Column Pull Down Voltage
68	VSFD	Adjustable Vsfd Source
69	VCPUG	Vpix for Green
70	VCPUB	Vpix for Blue
71	VCPUR	Vpix for Red
72	VSFD	Adjustable Vsfd Source
73	N/C	Do not connect
74	VCPD	Column Pull Down Voltage
75	IGND	Analog Ground (Imager Ring)
76	VSFD	Adjustable Vsfd Source
77	VnefRst2	Negative Supply for Reset 2
78	VposRst2	Positive Supply for Reset 2
79	VREH	Positive Supply for Row Circuits
80	VREL	Negative Supply for Row Circuits
81	VposRes1	Positive Supply for Reset1
82	VnegRst1	Negative Supply for Reset1
83	Vmid	Pixel Overflow Protection Voltage
84	CPD	Column Pull Down
85	CPU	Column Pull Up
86	OVPen	Overflow Protection Enable
87	RowSelEn	Activate Row Selects for Selected Row
88	GRowSel	Select All Rows for Row Select Operations
89	DecodeEn	Enable Row Decoder Outputs
90	Reset2S	Activate Reset2 for Selected Rows
91	Reset1S	Activate Reset1 for Selected Rows
92	Reset1X	Activate Reset1 for Unselected Rows
93	GReset1	Select All Rows for Reset1 Operations
94	GReset2	Select All Rows for Reset2 Operations
95	VCLK	Vertical Clock
96	CntSel<0>	Counter Select, bit 0
97	CntSel<1>	Counter Select, bit 1
98	HClockEn	Horizontal Clock Enable
99	HCLK	Horizontal Pixel Clock
100	VCAP	2.5V Back Side of Column Capacitors

Package Details

The F13 is housed in a 100 pin CLCC package with an AR/AR coated glass window.

Package Dimensions



Product/Company Notes

The information contained in this data sheet is current as of the publication date shown below. Foveon Inc. reserves the right to modify, change, or discontinue any of its products without prior notice.

Part Number

Fx17-78-F13A	F13 14.1 Mpixel 1.7x FLM Optical Format CMOS Image Sensor

Ordering Information

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