

Smart Digital Camera  
With stackable card design  
& Embedded DSP Capability

**Camelot**



## INTRODUCTION

Camelot is a family of digital cameras for machine vision applications with fast USB2 connection and embedded Digital Signal Processor capable of performing advanced image processing algorithms on the camera on the fly and capable of storing a buffer of images on the camera without the need to send all images to the PC. The cameras are intended for medical and industrial applications requiring superior image quality high performance and yet attractive pricing.

### Camelot series features

- Compact design
- Board level option
- C-Mount, CS-Mount, M12 lens support
- Internal / External LED support
- Various resolutions
- Configurable ROI
- External trigger support
- 6 Programmable PWM Timers
- 9 Programmable GPIOs
- USB 2.0 or Ethernet connection
- Electronic shutter
- Controllable Gain
- On board 64MByte DDR
- On board 16MByte Flash
- DirectShow Interface
- Software Development Kit
- Multiple camera support
- Stand alone mode
- Hi Sensitivity

## MAIN BOARD

The Camelot USB camera requires at least a main DSP board and an image sensor board.

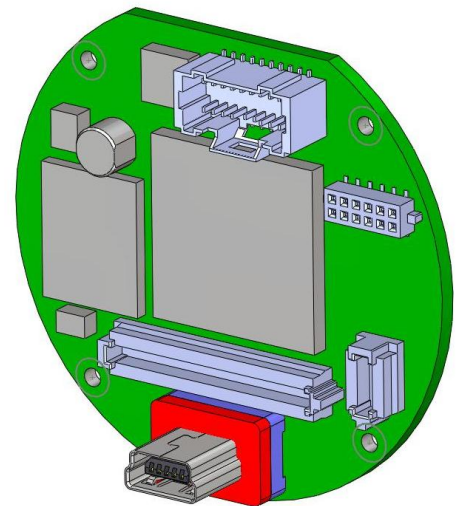
The image sensor board is dependent on the type of sensor board required. The Camelot series is based on the Analog devices BF548 Blackfin DSP processor. The BF548 Core Module is the most powerful Blackfin based single core processor module available, providing exceptional high performance (DDR RAM) and a large number of interfaces. This processor was chosen in order to perform advanced image processing algorithms in very limited space and power applications. It is therefore possible to run the camera on USB power without any need of adding an additional power supply.

### Main board components

#### Analog Devices BF548 processor unit

##### *Processor Specifications*

- Up to 1066MMAC (533MHz)
- RISC-like register and instruction model
- Programmable on-chip voltage regulator
- DDR SDRAM Support
- Two 16-bit MACs, two 40-bit ALUs, four 8-bit video ALUs
- 4 DMA pairs
- High-speed USB On-the-Go (OTG) with integrated PHY
- On board RAM 64MByte DDR-167MHz-8 Meg x 16 x 4 Banks



##### Flash memory

- 16MByte serial flash
- 32 sectors
- Page program (1024/1056 bytes)
- Sector erase (256Kbyte)

## Communications interface

- USB2 high speed (480Mbps)

## Power source

- USB or 5VDC via 20 pin Molex connector

## Connectors

- JTAG–Female 12 pin (2x6) 1.27mm pitch
- Expansion connector–100 pin-0.4mm pitch 4mm board stacking-Samtec SS4
- Expansion connector–20 pin-0.4mm pitch 4mm board stacking-Samtec SS4
- Images sensor board connector-40 pin-0.5mm pitch 4mm board stacking-Hirose DF12
- USB–Cable connection (modified according to customer requirements)
- GPIO-20 pin Molex Pico-clasp 1mm Pitch board to wire connector ,Molex PN : 5011902017 , mating connector : 501189-2010 .
- Mini – USB Connector .
- DC Jack ( for 5V Input only ) .

## Interfaces available

- USB2
- 9 x GPIO , 3.3V logic levels
- 2 x SPI ( via expansion connector )
- PPI ( via expansion connector )
- JTAG ( via expansion connector )
- 6 x PWM ( via expansion connector )
- 2 x UART ( via expansion connector )
- I2C ( via expansion connector )
- Image sensor board ( via expansion connector )

## USB GPIO connector

The GPIO connector on the Main board uses a 20 pin Molex Pico-clasp 1mm Pitch board to wire connector ,Molex PN : 5011902017 , mating connector : 501189-2010 .

And crimp pins. PN: 501193-2000

Each GPIO can be configured as strobe or trigger.

Pin	Pin name	Pin description	Remarks	Pin	Pin name	Pin description	Remarks
1	PB0	GPIO- Open-drain	10K Pull-Up	2	Power		5V
3	PC7	GPIO		4	Power		5V
5	PC8	GPIO		6	PB9	TMR1 (PWM)	
7	PG6	SPI1_SEL2#		8	PB10	TMR2 (PWM)	
9	PG8	SPI1_SCK		10	PG11	SPI1_SS#	
11	PG9	SPI1_MISO		12	PC9	GPIO	
13	PG10	SPI1_MOSI		14	PC10	GPIO	
15	PB4	UART2-TX	10K Pull-Up	16	PC11	GPIO	
17	GND			18	PH3	TMR9 (PWM)	10K Pull-Up
19	GND			20	PB5	UART2-RX	10K Pull-Up

## Interface connector 20 pin

The interface connector 20 pin on the Main board is a 20 pin Board to board connector from Samtec , PN : SS4-10-3.00-L-D-P-TR .

Pin	Signal	Pin	Signal
1	SD_D0	2	SP_TF0
3	SD_D1	4	SP_DT0SEC
5	SD_D2	6	SP_DT0PRI
7	SD_D3	8	SP_DTSClk0
9	SD_CLK	10	SP_RFS0
11	SD_CMD	12	SP_DR0SEC
13	DSP_GPIO10	14	SP_DR0PRI
15	TMR9	16	SP_RSCLK0
17	TMR10	18	TMR8
19	DGND	20	VCC_IN

## Interface connector 100 pin

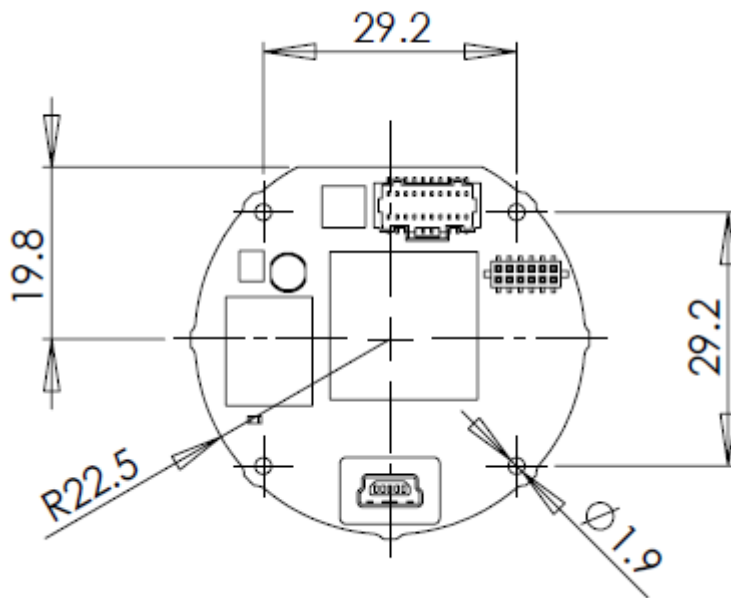
The Interface connector 100 pin on the Main board is a 100 pin Board to board connector from Samtec, PN: SS4-50-3.00-L-D-P-TR.

Pin	Signal	Pin	Signal	Pin	Signal	Pin	Signal
1	A1	2	VCC_IN	51	SCL1	52	PPIO_D9
3	A2	4	VCC_IN	53	SDA1	54	PPIO_D10
5	A3	6	PPIO_CLK	55	PB2	56	PPIO_D11
7	A4	8	PPIO_FS1	57	PB3	58	PPIO_D12
9	A5	10	PPIO_FS2	59	PB4	60	PPIO_D13
11	A6	12	SPI1_SCK	61	PB5	62	PPIO_D14
13	A7	14	SPI1_MISO	63	PB6	64	PPIO_D15
15	A8	16	SPI1_MOSI	65	PB7	66	PPIO_D6
17	A9	18	SPI1_SS#	67	PB9	68	PPIO_D17
19	A10	20	SPI1_SEL1#	69	PB10	70	D0
21	A11	22	SPI1_SEL2#	71	PB11	72	D1
23	A12	24	SPI1_SEL3#	73	PB12	74	D2
25	A13	26	UART0_TX	75	PB13	76	D3
27	A14	28	UART0_RX	77	PB14	78	D4
29	A15	30	UART1RTS#	79	AMS1#	80	D5
31	A16	32	UART1CTS#	81	AMS2#	82	D6
33	A17	34	PPIO_D0	83	AMS3#	84	D7
35	A18	36	PPIO_D1	85	AOE#	86	D8
37	A19	38	PPIO_D2	87	ARE#	88	D9
39	A20	40	PPIO_D3	89	AWE#	90	D10
41	A21	42	PPIO_D4	91	ABE0#	92	D11
43	A22	44	PPIO_D5	93	ABE1#	94	D12
45	A23	46	PPIO_D6	95	TMR7	96	D13
47	A24	48	PPIO_D7	97	DGND	98	D14
49	A25	50	PPIO_D8	99	DGND	100	D15

## Physical Characteristics

- Circular design with a diameter of 45mm

### Main board physical dimensions



## SENSOR BOARDS

This section describes all the sensor boards.

**Table 1: Sensor Board Component**

Component	Description
<b>Lens</b>	<ul style="list-style-type: none"> <li>C-mount or CS-Mount</li> <li>M12 micro lens adaptor</li> </ul>
<b>LEDs</b>	<ul style="list-style-type: none"> <li>Four LED controlled LED Drivers</li> <li>Four on-board LEDs (optional)</li> <li>External connector for LED camera illuminator</li> </ul>

**Table 2: Sensor Technical Information**

Sensor	WVGA	1.3 Mp	3 Mp	5 Mp	10 Mp
<b>Max Resolution</b>	752*480	1280*1024	2048*1536	2592*1944	3664*2748
<b>Sensor Frame Rate</b>	60FPS <sup>(1)</sup>	30FPS <sup>(1)</sup>	12FPS <sup>(1)</sup>	14FPS <sup>(1)</sup>	7.5FPS <sup>(1)</sup>
<b>USB Frame rate</b>	60FPS <sup>(1)(2)</sup>	30FPS <sup>(1)(2)</sup>	12FPS <sup>(1)(2)</sup>	8FPS <sup>(1)(2)</sup>	4 FPS <sup>(1)(2)</sup>
<b>Optical Format</b>	1/3"	1/2" (5:4)	1/2" (4:3)	1/2.5" (4:3)	1/2.3" (4:3)
<b>Shutter</b>	Global	Rolling	Rolling	Rolling	Rolling

(1) Higher frame rates for region of interest or sub resolutions.

(2) Frame rate at maximum resolution, dependent on the PC. Frame rate for processing might be higher.

### External illuminator connector

The sensor boards can include four LEDs each with a separately controlled programmable current source up to 30mA (current sink).

There is an optional connector for external illumination instead of the on board LED's.

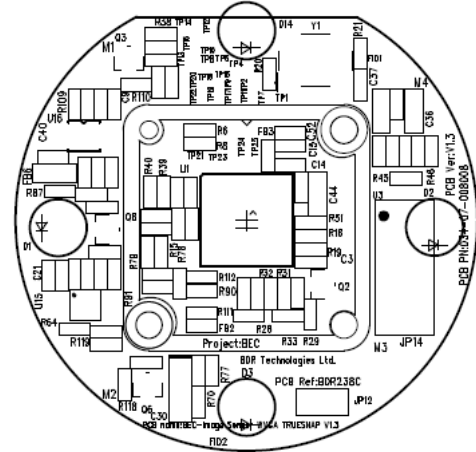
In order to use the external illuminator connector, use Samtec wire to board connector.

Mating wire to board connector PN: SFSD-05-28-H-10.00-DR-NDX

Pin	Signal Description	Pin	Signal Description
<b>1</b>	VCC_LIGHT	<b>2</b>	LED1
<b>3</b>	VCC_LIGHT	<b>4</b>	LED2
<b>5</b>	NC	<b>6</b>	LED3
<b>7</b>	LGND	<b>8</b>	LED4
<b>9</b>	LGND	<b>10</b>	NC

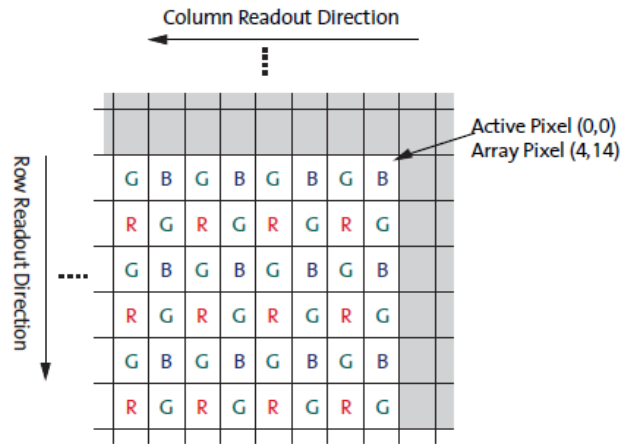
## WVGA sensor board

The WVGA sensor board is based on the Aptina sensor MT9V024 True-Snap with global shutter capability.

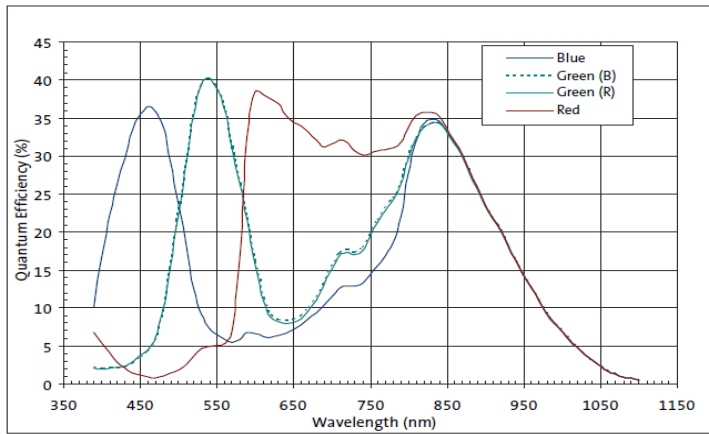


Item	Description or Value
<b>Sensor</b>	Aptina MT9V024
<b>Resolution</b>	WVGA
<b>Optical Format</b>	1/3-inch
<b>Active Image Size</b>	4.51mm (H) x 2.88mm (V) 5.35mm diagonal
<b>Active Pixels</b>	752H x 490V
<b>Pixel Size</b>	6.0 x 6.0µm
<b>Color Filter Array</b>	Monochrome or color RGB Bayer pattern
<b>Shutter Type</b>	TrueSNAP™ Global shutter
<b>Maximum Data Rate</b>	27 MHz
<b>Frame Rate</b>	60 fps
<b>Full Resolution</b>	752 x 480
<b>ADC Resolution</b>	10-bit-on-chip. Board can work in either 10 bit or 8 bit.
<b>Responsivity</b>	4.8V/lux-sec (550nm)
<b>Dynamic Range</b>	>55dB Linear >100dB in HDR mode
<b>Power Consumption</b>	160mW
<b>LEDs</b>	Four 5mm LEDs on board.
<b>LED Drivers</b>	Four separated controlled LED Drivers-programmable current source up to 30mA.
<b>External Illumination</b>	Connector for external illumination using the four LED drivers.

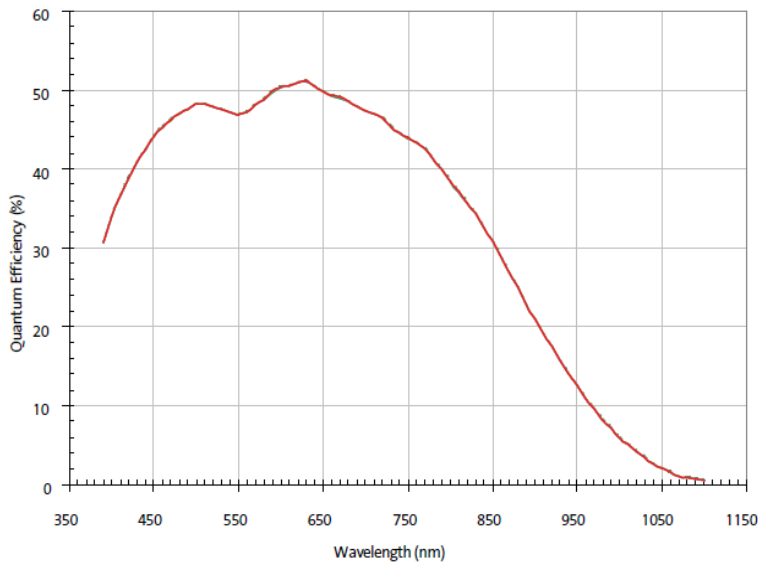
### Pixel Color Pattern Detail (Top Right Corner)



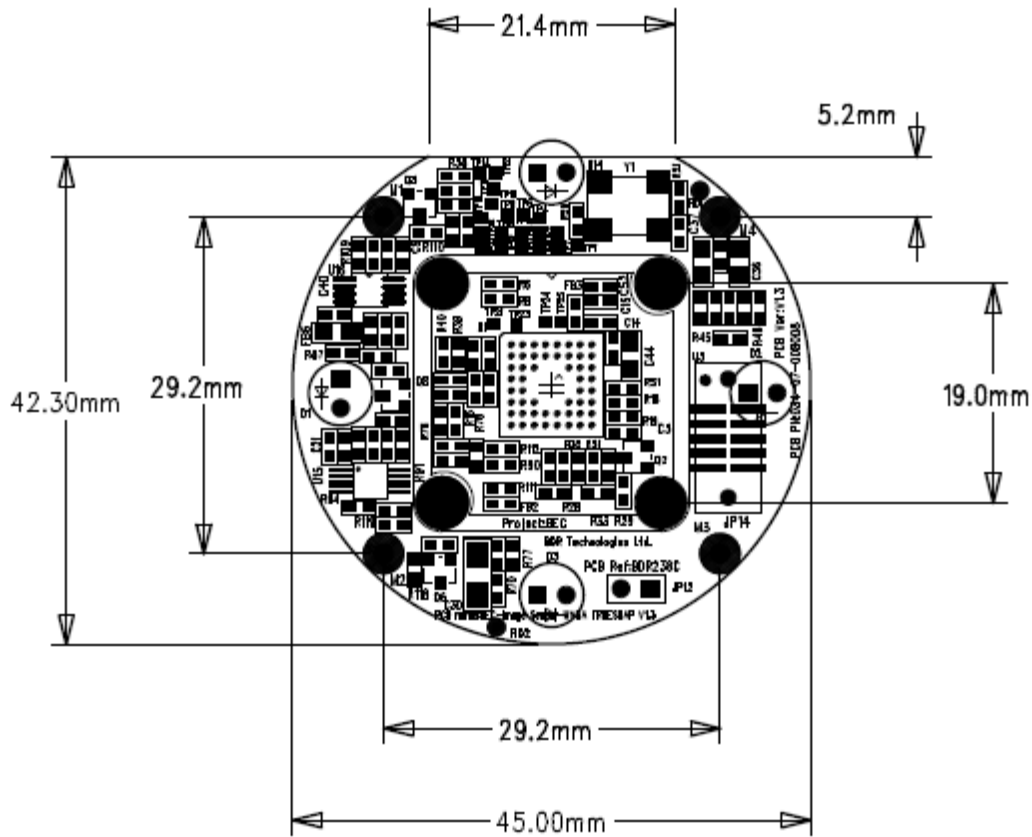
### Typical Quantum Efficiency—Color



### Typical Quantum Efficiency—Monochrome



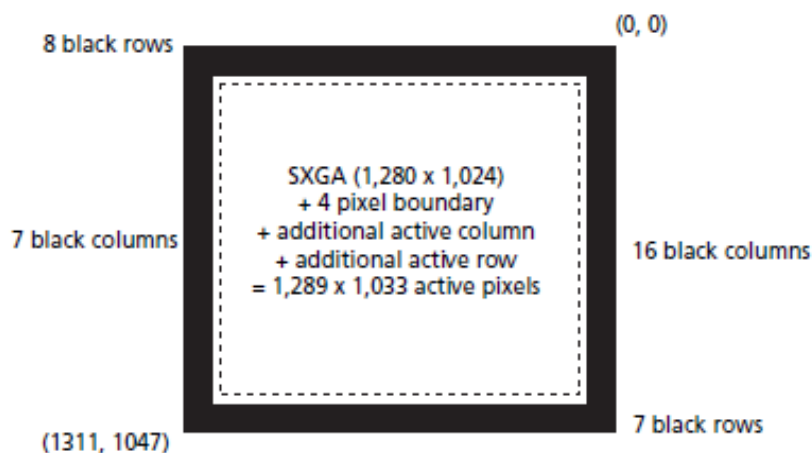
Board dimensions



## 1.3Mpixel B&W sensor board

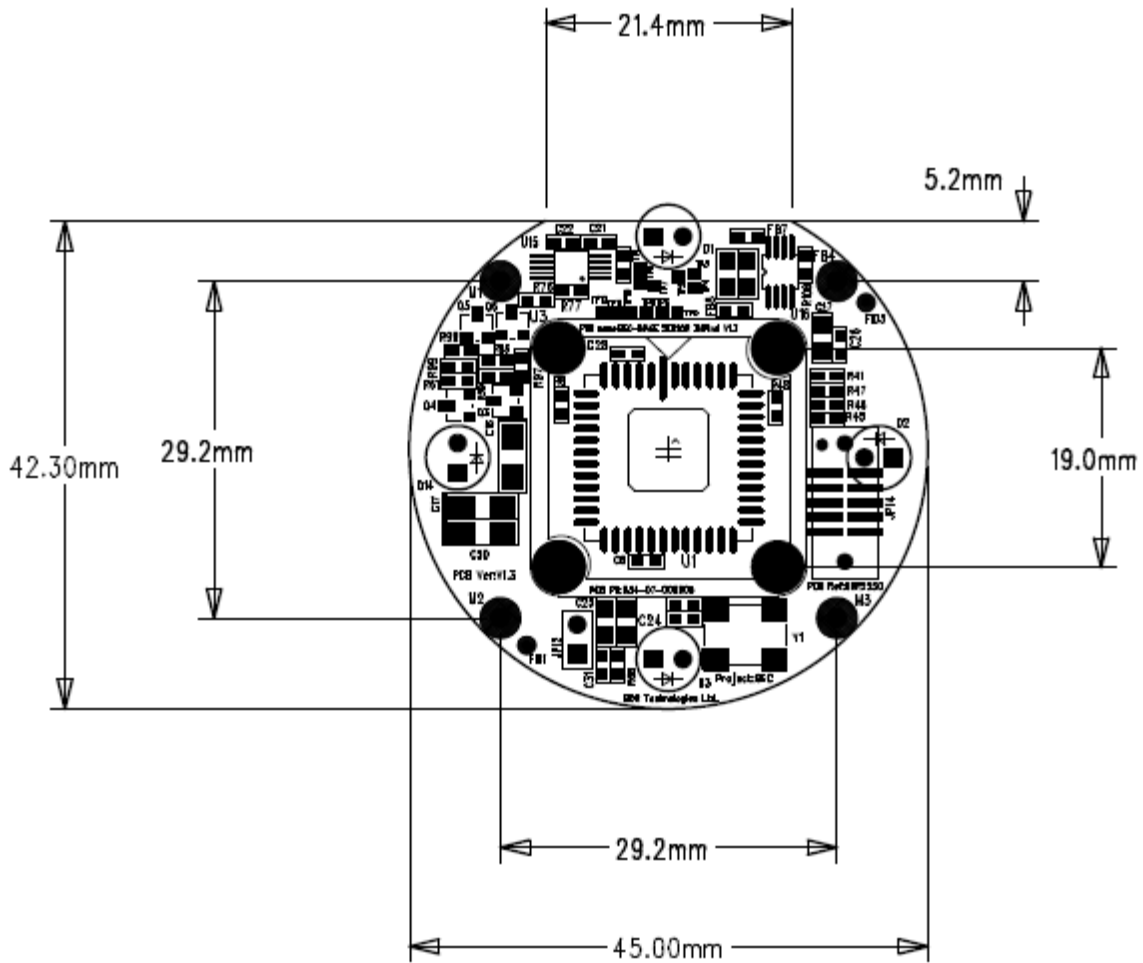
The 1.3Mpixel sensor board is based on the Aptina sensor MI-1300 B/W and is able to capture both continuous video and single frames.

Item	Description or Value
<b>Sensor</b>	Aptina MT9M001C12
<b>Resolution</b>	1.3Mpixel
<b>Optical Format</b>	1/2-inch (4:3)
<b>Active Image Size</b>	6.66mm(H) x 5.32mm(V)
<b>Active Pixels</b>	1,280H x 1,024V
<b>Pixel Size</b>	5.2 x 5.2 $\mu$ m
<b>Color Filter Array</b>	RGB Bayer pattern
<b>Shutter Type</b>	Electronic rolling shutter (ERS)
<b>Maximum Data Rate</b>	48 Mp/s at 48 MHz
<b>Frame Rate</b>	30 fps
<b>ADC Resolution</b>	10-bit-on-chip. Board can work in either 10 bit or 8 bit.
<b>Responsivity</b>	2.1V/lux-sec (550nm)
<b>Pixel Dynamic Range</b>	68.2db
<b>SNR Max</b>	45db
<b>Power Consumption</b>	363mW
<b>LEDs</b>	Four 5mm LEDs on board.
<b>LED Drivers</b>	Four separately controlled LED Drivers-programmable current source up to 30mA (current sink).
<b>External Illumination</b>	Connector for external illumination using the four LED drivers.





Board dimensions

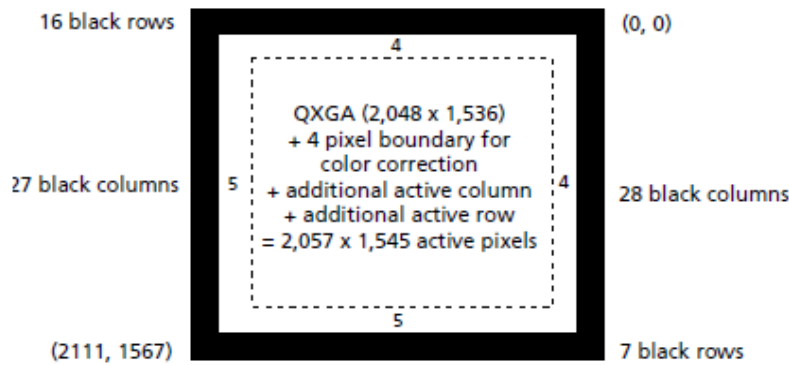


## 3Mpixel sensor board

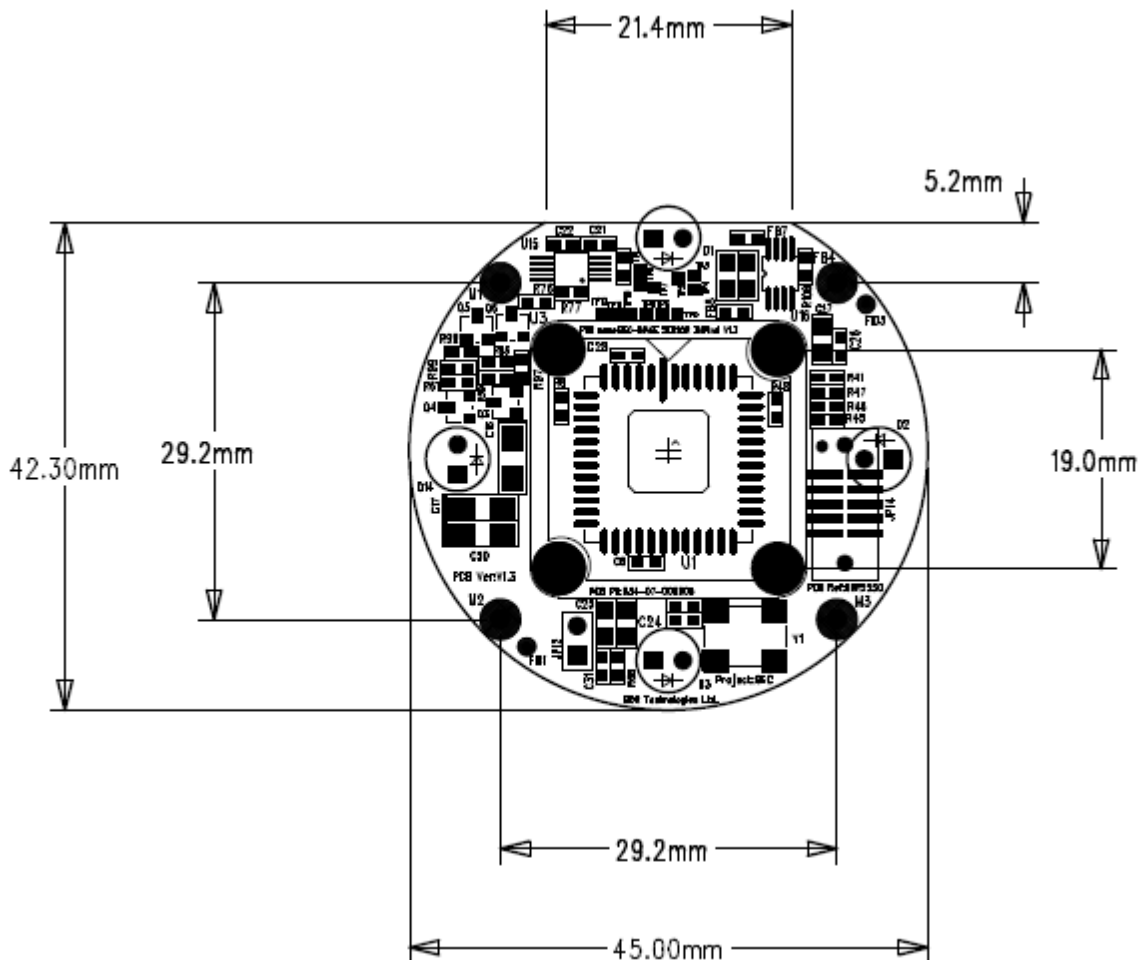
The 3Mpixel sensor board is based on the Aptina sensor MI3000 and is able to capture both continuous video and single frames.

Item	Description or Value
<b>Sensor</b>	Aptina MT9T001
<b>Resolution</b>	3Mpixel
<b>Optical Format</b>	1/2-inch (4:3)
<b>Active Image Size</b>	6.554mm(H) x 4.915mm(V) 8.192 (Diagonal)
<b>Active Pixels</b>	2,048H x 1,536V
<b>Pixel Size</b>	3.2 x 3.2 $\mu$ m
<b>Color Filter Array</b>	RGB Bayer pattern
<b>Shutter Type</b>	Electronic rolling shutter (ERS) Global reset release (GRR)
<b>Maximum Data Rate</b>	48 Mp/s at 48 MHz
<b>Frame Rate</b>	12 fps
<b>ADC Resolution</b>	10-bit-on-chip. Board can work in either 10 bit or 8 bit.
<b>Responsivity</b>	>1.0V/lux-sec (550nm)
<b>Pixel Dynamic Range</b>	61db
<b>SNR Max</b>	43db
<b>Power Consumption</b>	240mW
<b>LEDs</b>	Four 5mm LEDs on board.
<b>LED Drivers</b>	Four separately controlled LED Drivers-programmable current source up to 30mA (current sink).
<b>External Illumination</b>	Connector for external illumination using the four LED drivers.

### Pixel array description



### Board dimensions



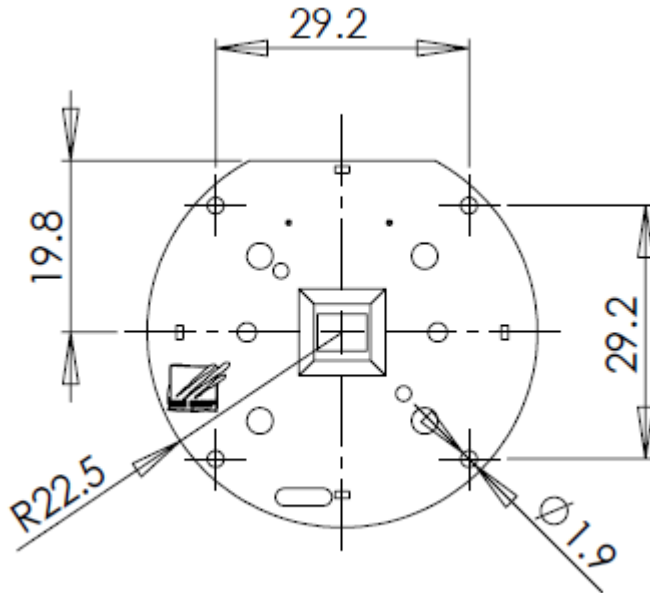
## 5Mpixel sensor board

The 5Mpixel sensor board is based on the Aptina sensor MT9P031, which incorporates sophisticated camera functions on-chip.

Item	Description or Value
<b>Sensor</b>	Aptina MT9P031
<b>Resolution</b>	5Mpixel
<b>Optical Format</b>	1/2.5-inch (4:3)
<b>Active Image Size</b>	5.7mm (H) x 4.28mm (V) 7.13mm diagonal
<b>Active Pixels</b>	2,592H x 1,944V
<b>Pixel Size</b>	2.2 x 2.2 $\mu$ m
<b>Color Filter Array</b>	RGB Bayer pattern
<b>Shutter Type</b>	Electronic rolling shutter (ERS) Snapshot only Global reset release (GRR)
<b>Maximum Data Rate</b>	96 Mp/s at 96MHz
<b>Frame Rate</b>	14 fps
<b>ADC Resolution</b>	12-bit-on-chip. Board can work in either 12 bit or 8 bit.
<b>Responsivity</b>	1.4V/lux-sec (550nm)
<b>Pixel Dynamic Range</b>	70.1db
<b>SNR Max</b>	38.1db
<b>Power Consumption</b>	381mW
<b>LEDs</b>	Four 5mm LEDs on board.
<b>LED Drivers</b>	Four separately controlled LED Drivers-programmable current source up to 30mA (current sink).
<b>External Illumination</b>	Optional connector for external illumination using the four LED drivers.



### Board dimensions

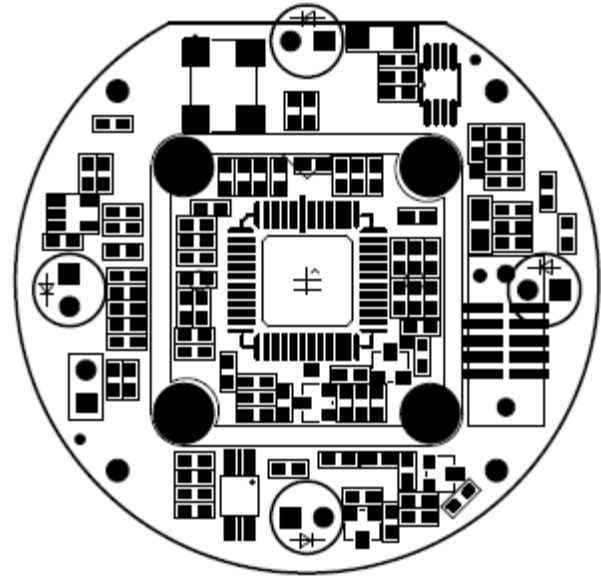


## 10Mpixel sensor board

The 10Mpixel sensor board is based on the Aptina sensor MT9J003, which incorporates sophisticated camera functions on-chip, with snapshot mode.

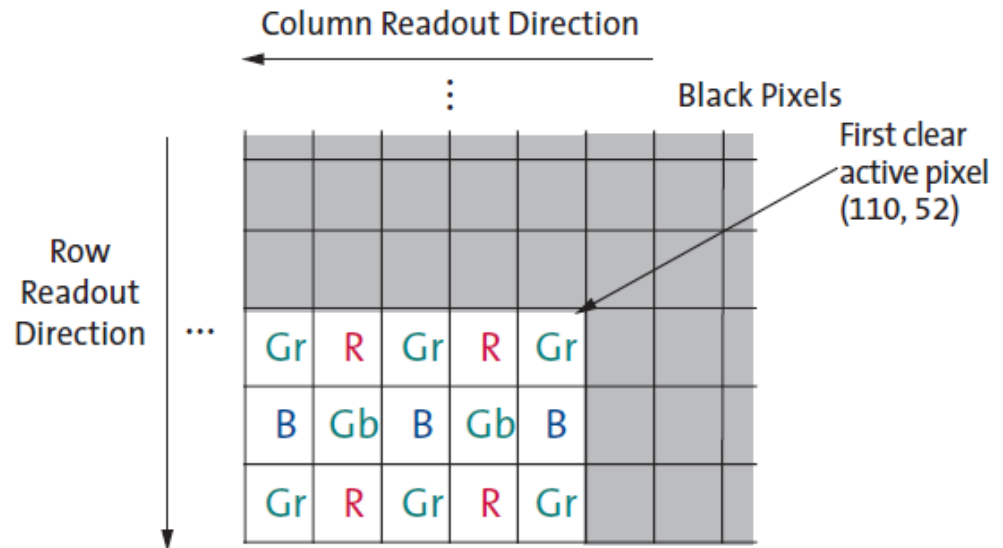
The sensor board can include four LEDs each with a separately controlled programmable current source up to 30mA (current sink).

There is an optional connector for external illumination instead of the on board LED's.

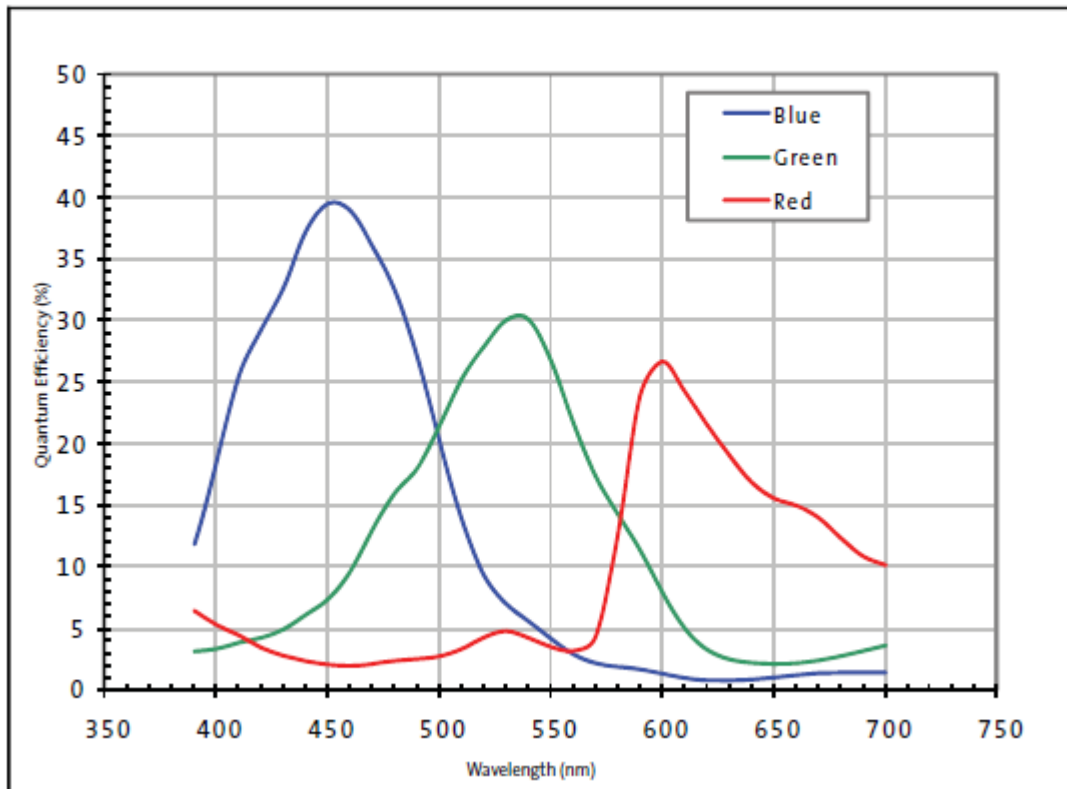


Item	Description or Value
<b>Sensor</b>	Aptina MT9J003
<b>Resolution</b>	10Mpixel
<b>Optical Format</b>	1/2.3-inch (4:3)
<b>Active Image Size</b>	6.119mm (H) x 4.589mm (V) 7.649mm diagonal
<b>Active Pixels</b>	3,664H x 2,748V
<b>Pixel Size</b>	1.67 x 1.67 $\mu$ m
<b>Color Filter Array</b>	RGB Bayer pattern
<b>Shutter Type</b>	Electronic rolling shutter (ERS) with Global reset release (GRR)
<b>Maximum Data Rate</b>	80 Mp/s at 80MHz
<b>Frame Rate</b>	7.5 fps
<b>ADC Resolution</b>	12-bit-on-chip. Board can work in either 12 bit or 10 bit or 8 bit.
<b>Responsivity</b>	0.31V/lux-sec (550nm)
<b>Pixel Dynamic Range</b>	65.2db
<b>SNR Max</b>	34 db
<b>Power Consumption</b>	388mW
<b>LEDs</b>	Four 5mm LEDs on board.
<b>LED Drivers</b>	Four separately controlled LED Drivers-programmable current source up to 30mA (current sink).
<b>External Illumination</b>	Optional connector for external illumination using the four LED drivers.

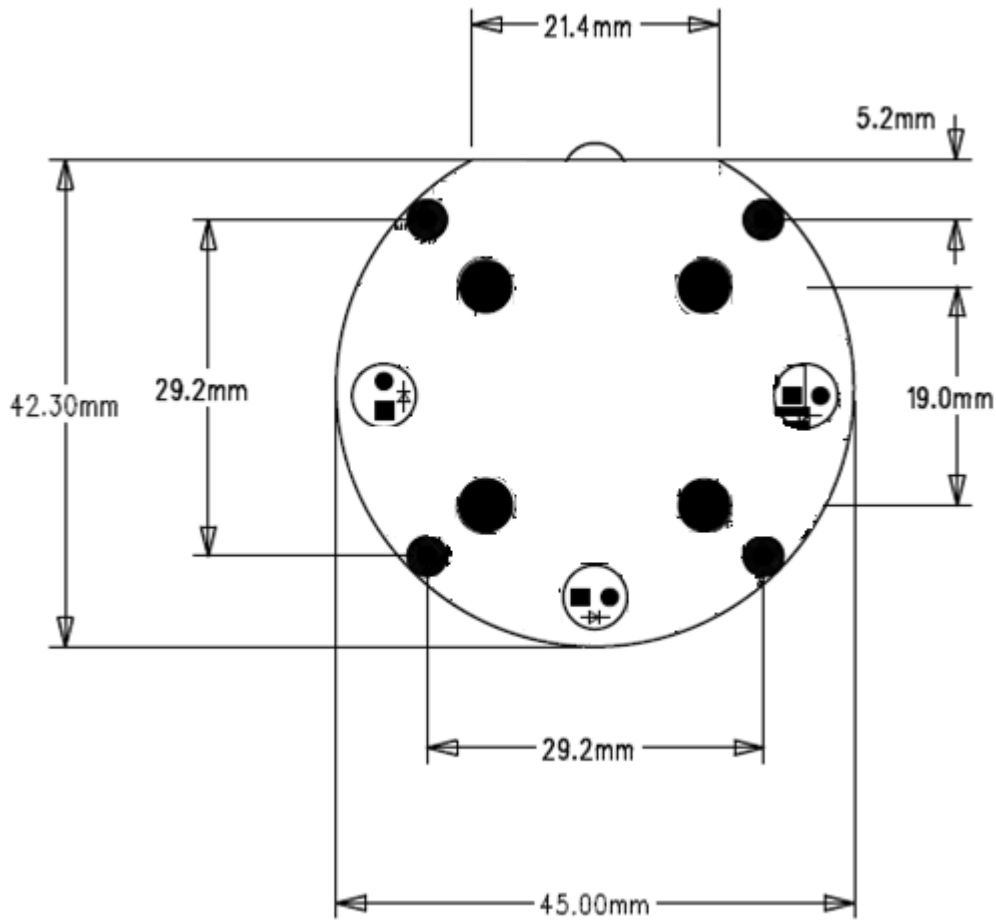
## Pixel Color Pattern Detail (Top Right Corner)



### Quantum Efficiency

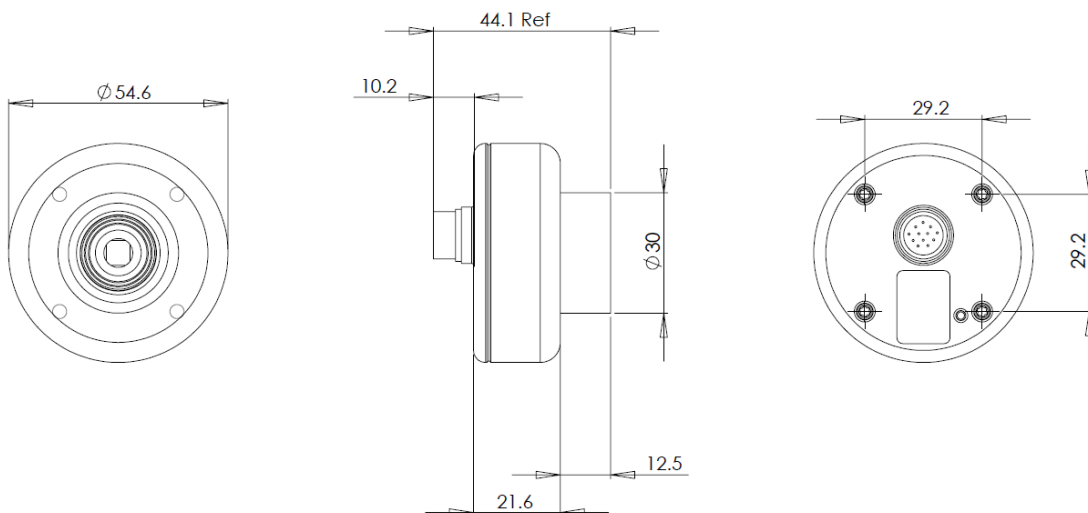


### Board dimensions

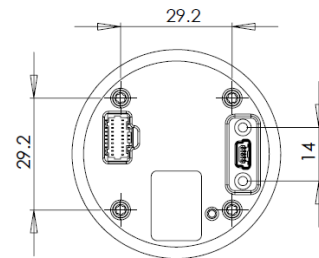
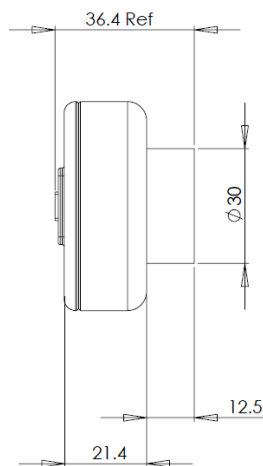
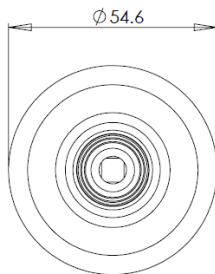


## CAMERA HOUSING

### Camera housing physical dimensions and locations Option1



## Option2



# HOW TO CONTACT US

## Website

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## Support

[support@imagine2d.com](mailto:support@imagine2d.com)

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[sales@imagine2d.com](mailto:sales@imagine2d.com)

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