Adapt to every light condition

ON SEMICONDUCTOR IMAGE SENSORS
FOR LOW LIGHT IMAGING

Content

Low Light Imaging

**ON SEMICONDUCTOR IMAGE SENSORS –
SEE THE FORMERLY UNSEEN**

While capturing a still image or a video clip on a bright, sunny day can be straightforward, the situation becomes much more complicated when lighting is uncontrolled. A street at night, an underground garage, a dark corner with little illumination – these are the type of situations where a standard image sensor may not be sufficient.

Fortunately, several different technologies are available which can enhance an image sensor's ability to successfully capture an image under these types of challenging lighting. Specialized color filter arrays increase the amount of visible light available for capture, or enable capture of near-infrared light. Pixel designs can be modified to maximize the amount of light that can be captured by the image sensor, and advanced electron multiplication technology can enable detection under sub-lux illumination.

ON Semiconductor has implemented these technologies – and more – in a portfolio of image sensors designed for use in challenging lighting conditions. See how these advanced devices, available from Avnet Silica, can help solve your low-light imaging needs.

Technologies
for low light image sensing

RGB-INFRARED (RGB-IR)

RGB-Infrared (RGB-IR) is a different filter type where one green spot in the standard Bayer Color Filter Array (CFA) is substituted with a spot which admits the Near-Infrared (NIR) wavelength to reach the sensor.
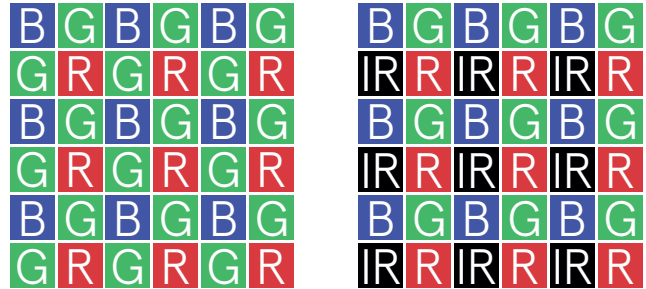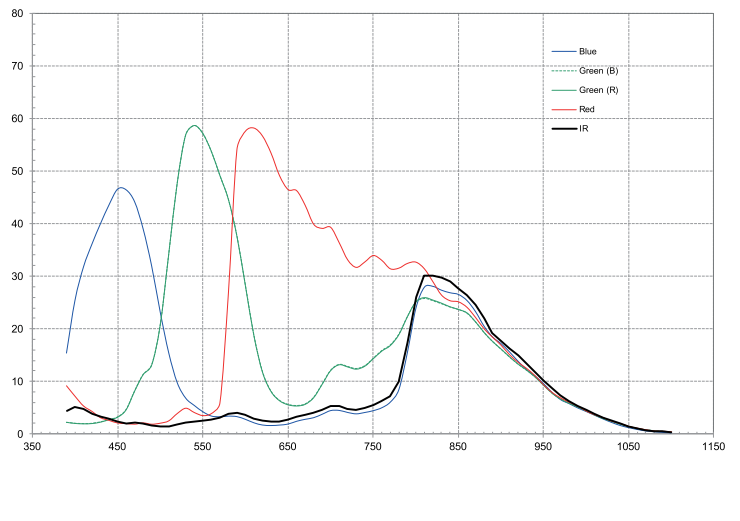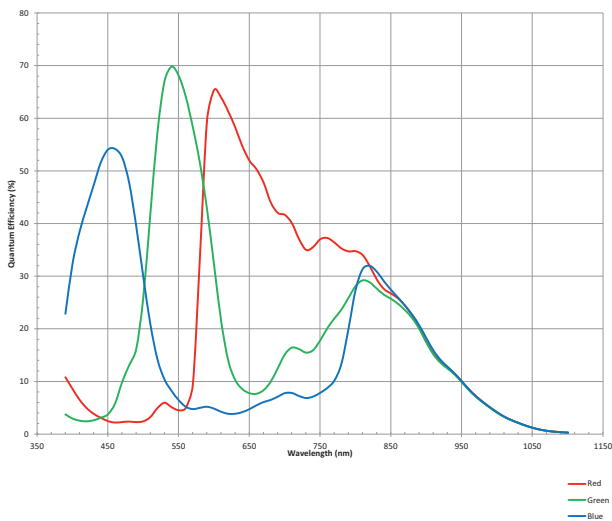

Standard Bayer RGB CFA   RGB-IR

This RGB-IR filter lets the sensor to be used as a standard color and as a NIR sensor. This is very useful in applications where the camera needs to be used in very different light conditions (i.e. day and night): during the night, the scene can be illuminated with a Infrared light source which is only visible by the camera and not by the human eye.

The drawback of this technology is a loss of the quantum efficiency for the RGB wavelengths.

Here two quantum efficiency plots are taken from a sensor which shows the difference between a conventional Bayer CFA and an RGB-IR filter. The RGB-IR technology allows development of camera systems that operate in both visible spectrum and NIR spectrum without need for mechanical, selectable NIR filter. The technology trades the mechanical components for image processing and reduction in resolution.

CLARITY+

Clarity+ (C+) is an alternative filter where, in the standard Bayer Color Filter Array (CFA), the green spots are substituted with clear spots, allowing the entire visible spectrum to pass through.
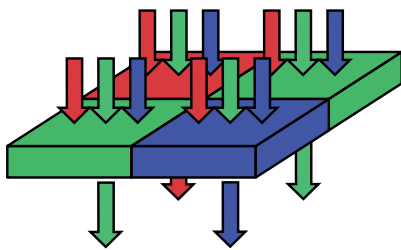
Standard Bayer RGB CFA
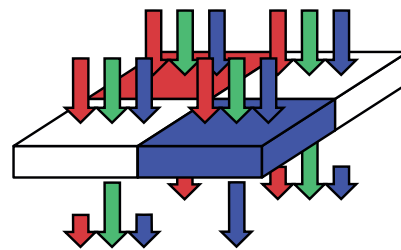
Clarity+

The advantage of this technology is an improvement of the SNR (Signal to Noise Ratio) thanks to the fact that the sensor takes almost 2 times the light compared to the standard configuration. This helps improving the quality of the image, especially in low light conditions where the Clarity+ taps all its potential.

Standard Bayer RGB CFA

Clarity+

HIGH-DYNAMIC RANGE (HDR)

High-Dynamic Range (HDR) is a technology more efficient for photo capturing than for video. To take an HDR photo, the sensor takes different shots of the same scene at different exposure times a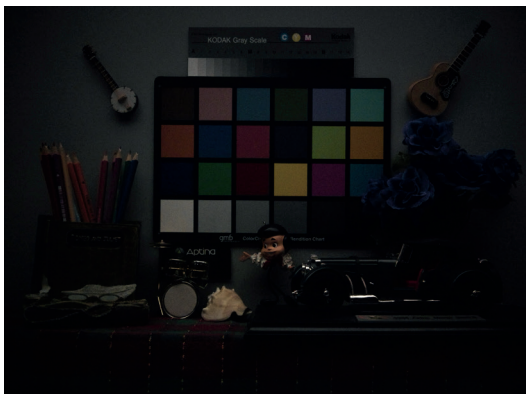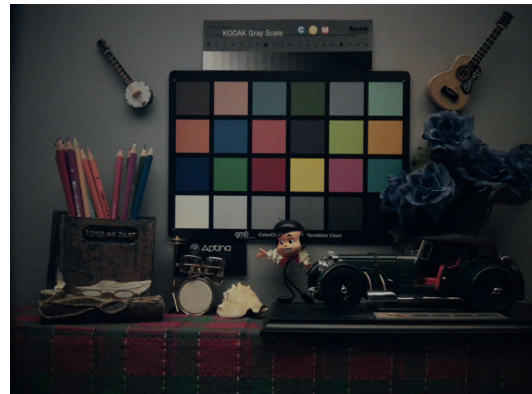nd then mixes the shots by selecting the best. Basically, an HDR picture is a mix of pictures that takes out the best exposure time of the specific areas of the pictures according to their illumination. A longer exposure time is used for low illuminated areas while a shorter one is intended for high illuminated areas. For this reason, HDR photos should normally be taken for static scenes and not for moving objects. If the object is moving between the shots,

the HDR photo will show motion artefacts. In the case of videos, this problem is more evident.

There are different techniques how to increase the Dynamic Range of an image sensor. ON Semiconductor applies the multi-exposure technique which, like for HDR photo, takes more shots of the same frame at different exposure times and then interpolates the shots creating a single HDR frame. In order to perform a good quality HDR video, the sensor needs to do some motion compensation processing of the video itself in order to avoid motion artefacts.

HDR mode
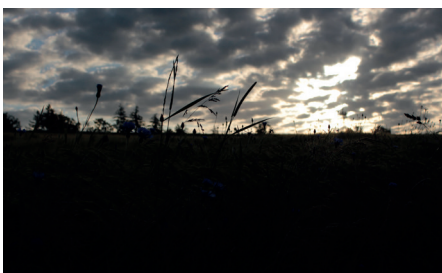
Underexposed image
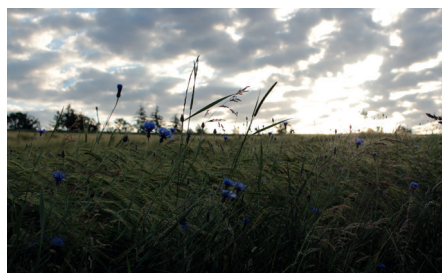
Normal exposed image

linear mode

BACK SIDE ILLUMINATION (BSI)

Back-Side Illumination, as the definition suggests, is referring to the part of the sensor which is actually exposed to the light. In standard CMOS sensor design, the photosensitive part is the substrate of the silicon. Above it is the rest of the pixel circuit including the wires, which are carrying the signals. The wires and the junctions in the top layer of the silicon are positioned in a way to let the light pass through and reach the photosensitive substrate but, despite this, some photons are bounced back by the wires, thus the sensor will not take all the available light.

To implement the BSI technology, the silicon is mounted upside down in the package in order for the substrate to be directly exposed to the light. This process is not so simple because the bottom part of the chip needs to be treated by applying a very thin photosensitive material.

A BSI sensor gets a lot more light than a standard sensor which makes it perfect for all those applications where the sensor is placed in dark environment.

Incident light

Microlens & Planarization

Color Filter

Passivation

Metal

Oxide Layers

Photo diode

e⁻ e⁻ e⁻

e⁻ e⁻ e⁻

Silicon

Front Side Illumination

Incident light

Microlens & Planarization

Color Filter

Anti reflective coating

Deep Photo Diode

e⁻ e⁻ e⁻ e⁻ e⁻ e⁻

Silicon

Metal

Oxide Layers
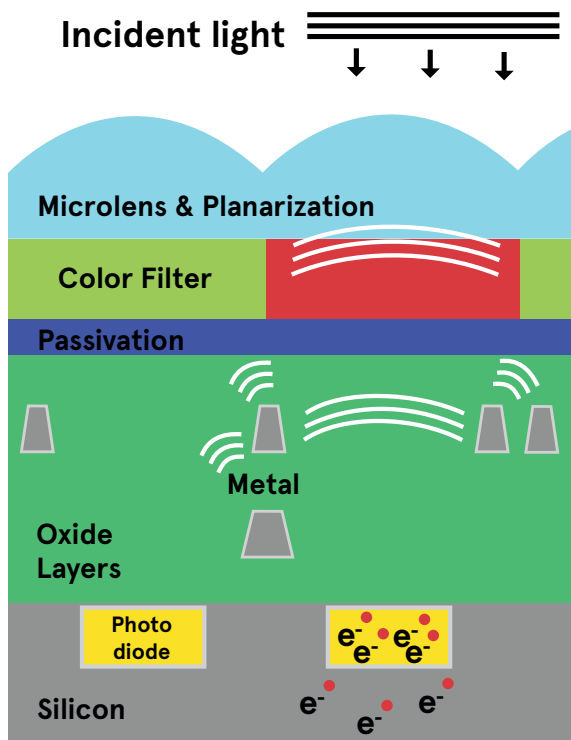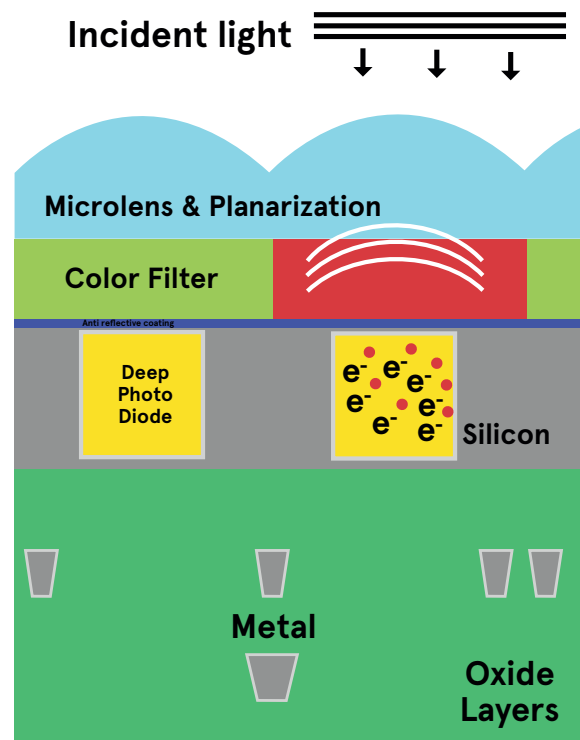
Back Side Illumination

Target markets for low light imaging

SECURITY & SURVEILLANCE

In security and surveillance applications, there is very often the need to monitor environments which could be either very bright or very dark. In such applications a sensor should have good performance in dark light conditions as well as a high dynamic range.

MEDICAL & SCIENTIFIC

Medical imaging applications often require wide dynamic range and high light sensitivity to enable capture of the subtlest details without the loss of valuable information. Scientific imaging also presents demanding imaging requirements, whether for research or analysis, with the finest details of an image needing to be faithfully preserved.

AUTOMOTIVE

Advanced Driver Assistance Systems (ADAS) require sensors with higher functionality to meet the evolving standards for car safety. Automotive camera systems are performing more complex algorithms at higher vehicle speeds and in new, challenging lighting conditions. Detecting and recognizing road signs, people, moving objects, hazards in low light scenarios is critical for ADAS systems.

Product Matrix

Product	Resolution (Mp)	Pixel size (µm)	Optical Format	Framerate	Dynamic Range max. (dB)	SNR	Output Interface
AR0132AT	1,2	3,75	1/3"	45 fps	115 dB	44 dB	HiSPi™, Parallel
AR0136AT	1,2	3,75	1/3"	60 fps	120 dB	43,9 dB	HiSPi™, Parallel
AR0140AT	1	3,0	1/4"	60 fps	96 dB	41 dB	HiSPi™, Parallel
AR0230AT	2	3,0	1/2.7"	30 fps	96 dB	41 dB	HiSPi™, Parallel
AR0238	2	3,0	1/2.7"	60 fps	96 dB	41 dB	HiSPi™, Parallel
AR0263	2,1	1,4	1/6"	60 fps	66,5 dB	37,5 dB	MIPI
AR0331	3,1	2,2	1/3"	60 fps	100 dB	39 dB	HiSPi™, Multi
AR0521	5,1	2,2	1/2.5"	60 fps	96 dB	40 dB	HiSPi™, MIPI
AR1335	13	1,1	1/3.2"	120 fps	69 dB	37 dB	MIPI
AR1820HS	18,1	1,25	1/2.3"	24 fps	65,8 dB	36,3 dB	HiSPi™, MIPI
KAE-02150	2,1	5,5	2/3"	30 fps	86 dB	43 dB	Analog
KAE-02152 (NIR)	2,1	5,5	2/3"	30 fps	86 dB	43 dB	Analog
KAE-04471	4,4	7,4	4/3"	15 fps	92 dB	46 dB	Analog
KAE-08151	8,2	5,5	4/3"	8 fps	86 dB	43 dB	Analog

| Operating Temperature	Package type	Implemented Technologies				
		RGB-IR	IT-EMCCD	HDR on chip	HDR off chip	BSI
-40 to +105 °C	IBGA-63			•		
-40 to +105 °C	IBGA-63			•		•
-40 to +105 °C	IBGA-63			•		
-40 to +105 °C	IBGA-80			•		
-30 to +70 °C	PLCC-48	•			•	
-30 to +70 °C	ODCSP-35				•	•
-30 to +85 °C	IBGA-63, ILCC-48			•		
-30 to +85 °C	mPLCC,iBGA-63				•	•
-30 to +70 °C	CSP-63				•	•
-30 to +70 °C	IBGA-60					•
-40 to +70°C	CPGA-135, CPGA-143		•			
-40 to +70°C	CPGA-135, CPGA-143		•			
-30 to +70°C	CPGA-155		•			
-40 to +70°C	CPGA-155		•			

Evaluation
Kit "AR" Devices
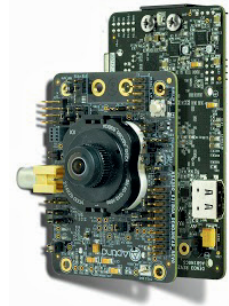
Evaluation kits are available for all the ON Semiconductor sensors in these formats:
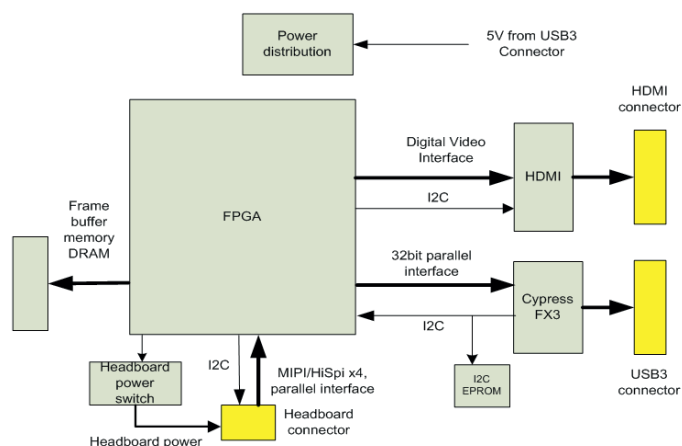
GEVK– complete kit including:

- Main board
- Sensor header board
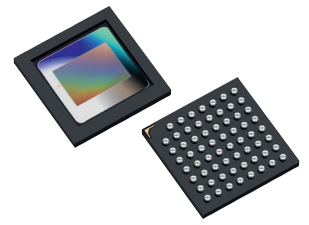- Tripod
- Cable
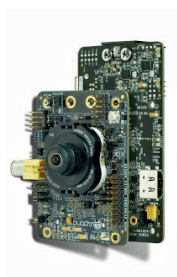
GEVK block diagram

Complete Kit

GEVB – Sensor header board only

DevWare software

AR0132AT
1/3-Inch CMOS
Digital Image Sensor

Features

- Superior low-light performance
- HD video (720p60)
- Linear or high dynamic range capture
- Video/Single Frame modes
- On-chip AE and statistics engine
- Parallel and serial output
- Auto black level calibration
- Context switching
- Temperature Sensor

Applications

- Automotive imaging
- Video surveillance
- 720p60 video applications
- High dynamic range imaging

ON Semiconductor's AR0132AT is a 1/3-inch CMOS digital image sensor with an active-pixel array of 1280H x 960V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as auto exposure control, windowing, and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0132AT produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including surveillance and HD video.

Parameter		Typical Value
Optical format		1/3-inch (6 mm)
Active pixels		1280 x 960 = 1.2 Mp
Pixel size		3.75 µm
Color filter array		RGB Bayer, or monochrome
Shutter type		Electronic rolling shutter
Input clock range		6 – 50 MHz
Output clock maximum		74.25 MHz
Output	Serial	HiSPi 12-, 14-, or 20-bit
	Parallel	12-bit
Frame rate	Full resolution	45 fps
	720p	60 fps
Responsivity		5.48 V/lux-sec
SNR_{MAX}		43.9 dB
Maximum dynamic range		>115 dB
Supply voltage	I/O	1.8 or 2.8 V*
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.4V or 1.8V
Power consumption (typical)		270 mW (1280 x 720 60 fps Parallel output Linear Mode) 460 mW (1280x720 60 fps Parallel output HDR Mode)
Operating temperature		−40°C to + 105° C (ambient) −40°C to + 120° C (junction)
Package options		9x9 mm iBGA
		Bare die

Note: *1.8V VDD_IO is recommended for better row noise performance

AR0136AT
1/3-Inch CMOS
Digital Image Sensor
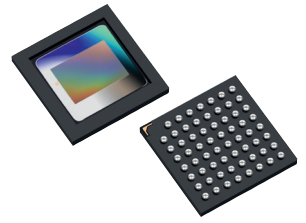
Features

- Superior low-light performance
- Backside Illuminated (BSI) pixel architecture
- HD video (720p60)
- Linear or high dynamic range capture
- Video/Single Frame modes
- On-chip AE and statistics engine
- Parallel and serial output
- Auto black level calibration
- Context switching
- Temperature Sensor

Applications

- Automotive imaging
- Video surveillance
- 720p60 video applications
- High dynamic range (HDR) imaging

The ON Semiconductor AR0136AT is a 1/3-inch CMOS digital image sensor with an active-pixel array of 1280H x 960V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as auto exposure control, windowing, and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0136AT produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including automotive imaging.
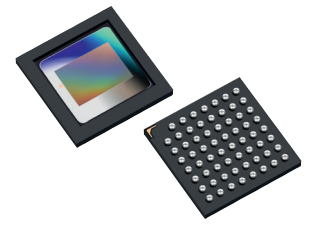
Parameter		Typical Value
Output clock maximum		74.25 MHz
Output	Serial	HiSPi 12-, 14-, or 20-bit
	Parallel	12-bit
Frame rate	Full resolution	45 fps
	720p	60 fps
Responsivity		6.3 V/lux-sec
SNR_{MAX}		43.9 dB
Maximum dynamic range		>120 dB
Supply voltage	I/O	1.8 or 2.8 V
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.4V or 1.8V
Power consumption (typical)		270 mW (1280 x 720 60 fps Parallel output Linear Mode) 460 mW (1280x720 60 fps Parallel output HDR Mode)
Operating temperature		−40°C to + 110° C (ambient) −40°C to + 125° C (junction)
Package options		9x9 mm iBGA
		Bare die

AR0140AT
1/4-Inch Digital
Image Sensor

Features

- Superior low-light performance
- Latest 3.0 m pixel with ON Semiconductor DR-Pix™ technology
- Linear or high dynamic range capture
- 1.0 Mp and 720P (16:9) images
- Interleaved T1/T2 output
- Support for external mechanical shutter
- Support for external LED or xenon flash
- On-chip phase-locked loop (PLL) oscillator
- Integrated position-based color and lens shading correction
- Slave mode for precise frame-rate control
- Stereo/3D camera support
- Statistics engine
- Data interfaces: four-lane serial high-speed pixel interface (HiSPi) differential signaling (SLVS and HiVCM), or parallel
- Auto black level calibration
- High-speed context switching
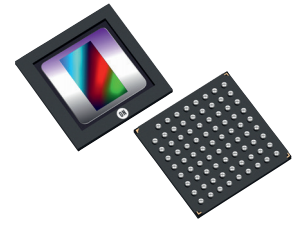- Temperature sensor

Applications

- Video surveillance
- Stereo vision
- Automotive scene viewing
- 720p60 video applications
- High dynamic range imaging

The ON Semiconductor AR0140AT is a 1/4-inch CMOS digital image sensor with an active-pixel array of 1280Hx800V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as inpixel binning, windowing and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0140AT produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including surveillance and HD video.

Parameter		Typical Value
Optical format		1/4-inch
Active pixels		1280(H) x 800(V) (entire array)
Pixel size		3.0 μm x 3.0 μm
Color filter array		RGB Bayer
Shutter type		Electronic rolling shutter and GRR
Input clock range		6 – 50 MHz
Output clock maximum		148.5 Mp/s (4-lane HiSPi) 74.25 Mp/s (Parallel)
Output	Serial	HiSPi 12-, 14-, or 16-bit
	Parallel	10-, 12-bit
	720p	60 fps
Responsivity		4.0 V/lux-sec
SNR$_{MAX}$		41 dB
Maximum dynamic range		Up to 96 dB
Supply voltage	I/O	1.8 or 2.8 V
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.3 V - 0.6 V, 1.7V - 1.9 V
Power consumption (typical)		326mW (Linear Mode 1280x720 60 fps) 372mW (HDR Mode 1280x720 60 fps)
Operating temperature		−40°C to 105°C
Package options		9x9mm 63-pin iBGA

AR0230AT
1/2.7-Inch 2.1 Mp/Full
HD Digital Image Sensor

Features

- Superior low-light performance
- Latest 3.0 m pixel with ON Semiconductor DR-Pix™ technology
- Linear or high dynamic range capture
- 1.0 Mp and 720P (16:9) images
- Interleaved T1/T2 output
- Support for external mechanical shutter
- Support for external LED or xenon flash
- On-chip phase-locked loop (PLL) oscillator
- Integrated position-based color and lens shading correction
- Slave mode for precise frame-rate control
- Stereo/3D camera support
- Statistics engine
- Data interfaces: four-lane serial high-speed pixel interface (HiSPi) differential signaling (SLVS and HiVCM), or parallel
- Auto black level calibration
- High-speed context switching
- Temperature sensor

Applications

- Video surveillance
- Stereo vision
- Automotive scene viewing
- 720p60 video applications
- High dynamic range imaging

The ON Semiconductor AR0140AT is a 1/4-inch CMOS digital image sensor with an active-pixel array of 1280Hx800V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as inpixel binning, windowing and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0140AT produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including surveillance and HD video.

Parameter		Typical Value
Optical format		1/2.7-inch (6.6 mm)
Active pixels		1928(H) x 1088(V) (16:9 mode)
Pixel size		3.0 μm x 3.0 μm
Color filter array		RGB Bayer
Shutter type		Electronic rolling shutter and GRR
Input clock range		6 – 48 MHz
Output clock maximum		148.5 Mp/s (4-lane HiSPi) 74.25 Mp/s (Parallel)
Output	Serial	HiSPi 12-, 14-, or 20-bit
	Parallel	10-, 12-bit
	720p	30 fps
Responsivity		4.0 V/lux-sec
SNR$_{MAX}$		41 dB
Maximum dynamic range		Up to 96 dB
Supply voltage	I/O	1.8 or 2.8 V
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.3 V - 0.6 V (SLVS), 1.7 V - 1.9 V (HiVcm)
Power consumption (typical)		<515 mW (HDR 1080p30, HiSPi Power Saving Mode, 8x gain, 25°C)
Operating temperature		−40°C to +105°C ambient
Package options		10x10 mm 80-pin iBGA

AR0238
1/2.7-Inch 2.1 Mp/Full
HD Digital Image Sensor
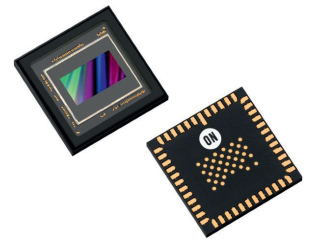
Features

- Superior low-light performance
- Latest 3.0 m pixel with ON Semiconductor DR-Pix™ technology with Dual Conversion Gain
- Full HD support at up to 1080P 60 fps for superior video performance
- Linear or high dynamic range capture
- Supports line interleaved T1/T2 readout to enable
- HDR processing in ISP chip
- Support for external mechanical shutter
- On-chip phase-locked loop (PLL) oscillator
- Integrated position-based color and lens shading correction
- Slave mode for precise frame-rate control
- Stereo/3D camera support
- Statistics engine
- Data interfaces: four-lane serial high-speed pixel interface (HiSPi) differential signaling (SLVS and HiVCM), or parallel
- Auto black level calibration
- High-speed configurable context switching
- Temperature sensor

Applications

- Video recording and streaming
- 1080p60 (monitoring) video applications
- High dynamic range imaging

ON Semiconductor's AR0238 is a 1/2.7-inch CMOS digital image sensor with an active-pixel array of 1928Hx1088V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as in-pixel binning, windowing and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0238 produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including surveillance and HD video.

Parameter		Typical Value
Optical format		1/2.7-inch (6.6 mm)
Active pixels		1928(H) x 1088(V) (16:9 mode)
Pixel size		3.0 µm x 3.0 µm
Color filter array		RGB Bayer
Shutter type		Electronic rolling shutter and GRR
Input clock range		6 – 48 MHz
Output clock maximum		148.5 Mp/s (4-lane HiSPi) 74.25 Mp/s (Parallel)
Output	Serial	HiSPi 10-, 12-, 14-, 16-, or 20-bit
	Parallel	10-, 12-bit
Frame rate	1080p	60 fps Linear HiSPi 30 fps Linear Parallel 30 fps Line Interleaved HiSPi 15 fps Line Interleaved Parallel
Responsivity		4.0 V/lux-sec
SNR_{MAX}		41 dB
Maximum dynamic range		Up to 96 dB
Supply voltage	I/O	1.8 or 2.8 V
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.3 V - 0.6 V (SLVS), 1.7 V - 1.9 V (HiVcm)
Power consumption (typical)		< 300mW Line interleaved 1080p30 <190mW 1080p30 Linear Mode
Operating temperature		−30°C to +85°C ambient
Package options		10x10 mm 80-pin iBGA 11.43x11.43 mm 48-pin mPLCC

AR0263
1/6-inch 2 Mp CMOS
Digital Image Sensor
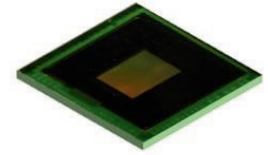
Features

- 2 Mp CMOS Sensor with Advanced 1.4 m Pixel BSI Technology
- Data Interfaces: One- and Two-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
- 3D Synchronization Controls to Enable Stereo Video Capture
- Interlaced Multi-exposure Readout Enabling High Dynamic Range (HDR) Still and Video Applications
- 8.8 kbits One-time Programmable Memory (OTPM) for Storing Shading Correction Coefficients 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
- On-chip Dual Phase-locked Loop (PLL) Oscillator Structure for Improved EMI Characteristics
- Superior Low-light Performance
- Low Dark Current
- Simple Two-wire Serial Interface
- On-chip Lens Shading Correction
- Support for External Mechanical Shutter
- Support for External LED and Xenon

Applications

- Chip-on-Tip Endoscopes
- Full HD Endoscopes
- Disposable Endoscopes

The AR0263MD from ON Semiconductor is a 1/6-inch BSI (back side illuminated) CMOS active-pixel digital image sensor with a pixel array of 1920 (H) × 1080 (V) (1936 (H) × 1096 (V) 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 AR0263MD 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 AR0263MD sensor can generate full resolution image at up to 60 frames per second (fps). An on-chip analog-to-digital converter (ADC) generates a 10-bit value for each pixel.

Parameter	Typical Value
Optical format	1/6-inch (16:9)
Active pixels	1936 (H) × 1096 (V)
Pixel size	1.4 μ m Back Side Illuminated (BSI)
Chief Ray Angle (CRA)	0°
Die Size	4.08 × 3.88 mm (15.83 mm2)
Input clock frequency	10-48 MHz
Interface	**Maximum PHY MIPI Data Output Rate per Lane:** • 1 Gbps for MIPI 1st data lane (lane 0) when operating on one MIPI lane • 758 Mbps for both MIPI 1st data lane (lane 0) and 2nd data lane (lane 1) when operating on two MIPI lanes
Subsampling Modes	X – Bin: 2×, Skip: 2×, 4×
	Y – Bin: 2×, Skip: 2×, 4×
ADC Resolution	10 bits, On-die
Analog Gain	1×, 2×, 4×, 8×
Compression	DPCM: 10-8-10, 10-6-10
3D Support	Frame Rate and Exposure Synchronization; Color Stats and Color Gains
Supply Voltage	2.6-2.9 V (2.8 V Nominal) 1.7-1.9 V (1.8 V Nominal) 1.14-1.3 V (1.2 V Nominal) 1.14-1.3 V (1.2 V Nominal)
Power Consumption	175 mW at 2 Mp 60 fps (+70°C) Typical
Responsivity	0.75 V/lux-sec
SNR$_{MAX}$	37.5 dB
Dynamic Range	66.5 dB
Operating Temperature	−30°C to +70°C
Functional Temperature	−30°C to +85°C

AR0331
1/3-Inch 3.1 Mp/Full HD
Digital Image Sensor
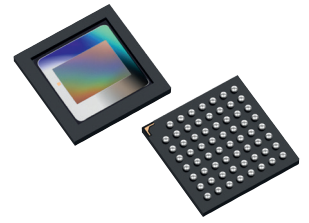
Features

- Superior low-light performance
- Latest 2.2 μm pixel with ON Semiconductor A-Pix™ technology
- Full HD support at 1080P 60 fps for superior video performance
- Linear or high dynamic range capture
- 3.1M (4:3)and 1080P full HD (16:9) images
- Optional adaptive local tone mapping (ALTM)
- Interleaved T1/T2 output
- Support for external mechanical shutter
- Support for external LED or Xenon flash
- Slow-motion video (VGA 120 fps)
- On-chip phase-locked loop (PLL) oscillator
- Integrated position-based color and lens shading correction
- Slave mode for precise frame-rate control
- Stereo/3D camera support
- Statistics engine
- Data interfaces: four-lane serial high-speed pixel interface (HiSPi™) differential signaling (SLVS and HiVCM), or parallel
- Auto black level calibration
- High-speed context switching
- Temperature sensor

Applications

- Video surveillance
- Stereo vision
- Smart vision
- Automation
- Machine vision
- 1080p60 video applications
- High dynamic range imaging

The ON Semiconductor AR0331 is a 1/3-inch CMOS digital image sensor with an active-pixel array of 2048Hx1536V. It captures images in either linear or high dynamic range modes, with a rolling-shutter readout. It includes sophisticated camera functions such as in-pixel binning, windowing and both video and single frame modes. It is designed for both low light and high dynamic range scene performance. It is programmable through a simple two-wire serial interface. The AR0331 produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a wide range of applications, including surveillance and HD video.

Parameter		Typical Value
Optical format		1/3-inch (5.8 mm) Note: Sensor optical format will also work with lenses designed for 1/3.2" format
Active pixels		2048(H) x 1536(V) (4:3, mode)
Pixel size		2.2 μm x 2.2 μm
Color filter array		RGB Bayer
Shutter type		Electronic rolling shutter and GRR
Input clock range		6 – 48 MHz
Output clock maximum		148.5 Mp/s (4-lane HiSPi) 74.25 Mp/s (Parallel)
Output	Serial	HiSPi 10-, 12-, 14-, or 16-bit
	Parallel	10-, 12-bit
Frame rate	Full resolution	30 fps
	1080p	60 fps
Responsivity		1.9 V/lux-sec
SNR_{MAX}		39 dB
Maximum dynamic range		Up to 100 dB
Supply voltage	I/O	1.8 or 2.8 V
	Digital	1.8 V
	Analog	2.8 V
	HiSPi	0.3V - 0.6V, 1.7 V - 1.9 V
Power consumption (typical)		<780 mW
Operating temperature (ambient)		−30°C to + 85° C
Package options		10 x 10 mm 48 pin iLCC 9.5 x 9.5 mm 63-pin iBGA

AR0521/D
1/2.5-inch 5.1 Mp
Digital Image Sensor
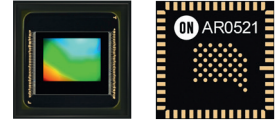
Features

- 5 Mp at 60 fps for Excellent Video Performance
- Small Optical Format (1/2.5-inch)
- 1440p Mode for 16:9 Video
- Superior Low-light Performance
- 2.2 m Back Side Illuminated Pixel Technology
- Supports Line Interleaved T1/T2 Readout to Enable HDR Processing in ISP Chip
- Support for External Mechanical Shutter
- On-chip Phase-locked Loop (PLL) Oscillator
- Integrated Color and Lens Shading Correction
- Slave Mode for Precise Frame-rate Control
- Data Interfaces:
  - HiSPi (SLVS) – 4 Lanes
  - MIPI CSI-2 – 4 Lanes
- Auto Black Level Calibration
- High-speed Configurable Context Switching
- Temperature Sensor
- Fast Mode Plus Compatible 2 Wire Interface

Applications

- Video Surveillance
- High Dynamic Range Imaging

The AR0521 is a 1/2.5-inch CMOS digital image sensor with an active-pixel array of 2592 (H) x 1944 (V). It captures images in either linear or high dynamic range modes with a rolling-shutter readout, and includes sophisticated camera functions such as binning, windowing and both video and single frame modes. It is designed for both low light and high dynamic range performance, with line interleaved T1/T2 read out to support off chip HDR in an ISP chip. The AR0521 produces extraordinarily clear, sharp digital pictures, and its ability to capture both continuous video and single frames makes it the perfect choice for a security applications.

Parameter	Typical Value
Optical format	1/2.5-inch (7.13 mm)
Active pixels	2592 (H) x 1944 (V) 4:3 aspect ratio
Pixel size	2.2 µm x 2.2 µm (BSI)
Color filter array	RGB Bayer, Clarity + , Monochrome
Shutter type	Electronic Rolling Shutter and Global Reset Release
Input clock range	10 – 48 MHz
Output clock maximum	HiSPi –SLVS (Max data rate 1.0 Gbps/lane) MIPI CSI-2 (Max data rate 1.2 Gbps/lane)
Output	8, 10 or 12 bit
Key Operating Modes	5Mp 60 fps @ 10 bit linear 30 fps @ 10 bit line interleaved mode 5Mp 37 fps @ 12 bit linear 15 fps @ 12 bit line interleaved mode 1440p 60 fps @ 10 bit linear 30 fps @ 10 bit line interleaved mode 1440p 50 fps @ 12 bit linear 25 fps @ 12 bit line interleaved mode
Responsivity	18.8 ke–/lux
SNR$_{MAX}$	40 dB
Maximum dynamic range	73 dB Linear, more than 96 dB (Interleaved) T1/T2 programmable
Full Well Capacity	12 ke–
Read Noise	2.8 e– rms @ 8x Analog gain
Supply Voltage	Analog Pixel: 2.7 V I/O: 1.8 V Digital, PLL, MIPIPhy: 1.2 V
Power consumption (typical)	<400 mW Full resolution @ 60 fps, 10 bit; MIPI (4 lanes) interface
Operating temperature	−40°C to +85°C ambient
CRA	9°
Package options	iBGA (9 x 9 mm); mPLCC (12 x 12 mm)

AR1335 CSP
1/3.2-Inch 13 Mp CMOS
Digital Image Sensor
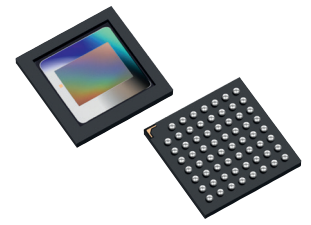
Features

- 13 Mp CMOS sensor with advanced 1.1 m pixel BSI technology
- Data interfaces: two-, three-, 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
- 3D synchronization controls to enable stereo video capture
- 6.8 kbits one-time programmable memory (OTPM) for storing
- shading correction coefficients 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
- On-chip temperature sensor
- Bayer pattern horizontal down-size scaler
- Simple two-wire fast-mode+ serial interface
- Low dark current
- Interlaced multi-exposure readout enabling High Dynamic Range (HDR) still and video applications
- On-chip lens shading correction
- Support for external mechanical shutter
- Support for external LED or Xenon Flash
- Extended Flash duration up to start of frame readout

Applications

- Cellular Phones
- Digital Still Cameras
- PC Cameras
- PDAs

Parameter		Typical Value
Optical format		1/3.2 -inch 13 Mp (4:3)
Active pixels		4208H x 3120V)
Pixel size		1.1 µm Back Side Illuminated (BSI)
Chief ray angle (CRA)		11°
Die size		6.3 mm x 5.7 mm
Input clock frequency		6 – 48 MHz
Interface		4-lane MIPI (2- and 3-lane supported); Max data rate: 1.2 Gbps/lane
Subsampling modes (column and row)		skip2 bin2 skip3 bin3 skip4 bin4 skip2bin2
ADC resolution		10 bits, on-die
Analog gain		1x – 7.75x
Digital gain		Up to 7.98x
Scaler		Adjustable scaling up to 8x
Temperature sensor		10-bit, controlled by two-wire serial I/F
3D support		Frame rate and exposure synchronization
Supply voltage	VAA, VAA_PIX	2.6 - 2.9 V (2.7 V nominal)
	VDD_IO, VDDIO_ ANA	1.7 - 1.9 V (1.8 V nominal)
	VDD, VDD_ANA, VDD_PLL, VDD_PHY	1.14 – 1.3 V (1.2 V nominal)
Power consumption		270 mW at 60°C (TYP) at 13 Mp 30 fps
Responsivity		4700 e-/lux-sec
SNR_{MAX}		37 dB
Dynamic Range		69 dB
Operating Temperature Range (at junction) – TJ		−30°C to +70°C

AR1820HS
1/2.3-Inch 18Mp CMOS
Digital Image Sensor
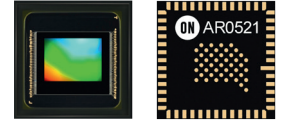
Features

- 1.25 μm pixel with ON Semiconductor A-PixHS™, which brings BSI technology together with advanced sensor architecture pixel technology
- Simple 2-wire and 3-wire serial interface
- Auto black level calibration
- Full frame 18 Mp, 12-bits at 24 fps for HiSPi 8 Lanes, and 10-bits 15 fps for MIPI 4 Lanes.
- Support Full HD with 27.5% EIS, full of view, output 2448 x 1378 with X-binning/Y(in-pixel)-summing at 60 fps.
- Support 8 Mp 16:9 HD cropping 77% FOV, 55 fps for HiSPi 8 Lanes, and 10-bits 30 fps for MIPI 4 Lanes.
- Support for external mechanical shutter
- Support 1080p120 fps cropping 78% FOV
- Support for external LED or Xenon flash
- 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
- Data interfaces: (HiSPi): programmable to 4 or 8 lanes HiSPi, high-speed serial pixel interface differential signaling support SLVS or sub-LVDS
- (MIPI): Programmable to 2-, 3-, or 4-lane serial mobile industry processor interface.
- On-chip phase-locked loop (PLL) oscillator
- Integrated position and color-based shading correction
- Slave mode for precise frame-rate control and for synchronizing multiple sensors
- On-chip temperature sensor, controlled by two-wire serial interface
- Supports Bit-Depth Compression for lower bandwidth receivers: A-Law Compression for HiSPi
- 12-10-12, 12-8-12, 10-8-10 and DPCM for MIPI: 10-8-10, 10-6-10

Applications

- Digital still cameras
- Digital video cameras
- Smart phones
- PC cameras
- Tablets

Parameter		Typical Value
Optical format		1/2.3-inch (4:3)
Pixel size		1.25 μm x 1.25 μm A-PixHS™ BSI
Entire array format		4912H x 3684V
Primary modes		4:3 - 18 Mp full resolution at 24 fps (HiSPi-8L), 15 fps (MIPI-4L)
		16:9 - 14 Mp at 30 fps (HiSPi-8L), 20 fps (MIPI-4L)
		16:9 - 8 Mp at 55 fps (HiSPi-8L), 30 fps (MIPI-4L)
		16:9 - Full HD + 27.5%EIS at 60 fps
		16:9 - Full HD at 120 fps
Chief ray angle		0°, 11.4°, and 31°
Color filter array		RGB Bayer pattern
Shutter type		Electronic rolling shutter (ERS) with global reset release (GRR)
Input clock frequency		6 - 54 MHz
Interface and maximum data rate		MIPI (4/3/2Lanes) or HiSPi (8/4-lanes) with 800 Mbps/lane
ADC resolution		12-bit, on-chip
Pixel data format		12/10-bit per pixel (RAW12 or RAW10)
Analog gain		1x – 8x
Responsivity		0.62 V/lux-sec (545nm)
Dynamic range		65.8 dB
SNR$_{MAX}$		36.3 dB
Supply voltage	Analog (VAA)	2.7 - 3.1 V (2.8 V nominal)
	Digital (VDD)	1.14 - 1.3 V (1.2 V nominal)
	Pixel (VAA_PIX)	2.7 - 3.1 V (2.8 V nominal)
	Digital (VDD_1V8)	1.7 - 1.9 V (1.8 V nominal)
	I/O (VDD_IO)	1.7 - 1.9 V (1.8 V nominal) or 2.7 - 3.1 V (2.8 V nominal)
	Serial interface (VDD_TX)	0.3 - 0.6 V (0.4 V nominal for HiSPi) 1.14 - 1.3 V (1.2 V nominal for MIPI)

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