Product Bulletin

CCDs and Cameras

Key Benefits

- High speed
- High sensitivity from deep UV to near IR
- High resolution
- High dynamic range
- High blue response
- Low dark current
- Fast clear capability
- Multi-mode readout capability
  - Progressive scan
  - Interlaced scan
  - Partial scan/skip capability
  - Multi-line readout
  - Image-area line summing
  - Smear subtraction
- Solid-state reliability with no image burn-in, residual imaging, image distortion, image lag, or microphonics

Texas Instruments (TI) has been involved in the development and manufacture of image sensors since the invention of the charge-coupled device (CCD) concept in 1970. Early work began in the design of CCDs for astronomy and led to the development of advanced virtual-phase technology (AVP). Advanced virtual-phase technology offers large improvements in quantum efficiency, blue response, and reduced dark current in comparison with conventional multi-phase CCDs. Furthermore, advanced virtual phase technology simplifies the design of support circuitry by reducing the number of required clock drivers. Subsequent TI breakthroughs in sensor technology include the clocked antiblooming gate, the advanced plastic package, and the latest innovation, the Single Photon Detection (SPD) CCD.

TI's patented advanced virtual-phase CCDs are high speed and have very high sensitivity in the spectral range from deep ultraviolet (DUV) to near infrared (NIR). TI's high quality CCDs and cameras are well suited for industrial, security/surveillance, military, spectroscopy, traffic, astronomy and medical applications.

Cameras

Camera	CCD Imager	Imager Size	Active Pixels (HxV)	Pixel Size (µm)	Scan Type	Output
MC-680	TC237	1/3 inch	658 x 486	7.4 x 7.4	2:1 Interlace	LVDS (10 bit)
MC-780	TC241	2/3 inch	754 x 484	11.5 x 13.5	2:1 Interlace*	NTSC
MC-781	TC341	2/3 inch	754 x 484	11.5 x 13.5	2:1 Interlace	NTSC & LVDS (10 bit)
MC-1001	TC281	2/3 inch	1000 x 1000	8.0 x 8.0	Progressive Scan	LVDS (10 bit)
MC-2000	TC229	1 inch	2000 x 1000	8.0 x 8.0	Progressive Scan	Composite Analog

* Progressive Scan optional

TC253

The TC253 is a frame-transfer CCD image sensor designed for use in black and white NTSC TV, computer, and special-purpose applications requiring high sensitivity, ultra-low noise, and small size.

The TC253 is the first device of the SPD family of ultra-low noise, high sensitivity image sensors that multiply charge directly in charge domain before conversion to voltage. The charge carrier multiplication (CCM) is achieved by using a low-noise, single-carrier impact ionization process that occurs during repeated carrier transfers through high field regions. Applying multiplication pulses to specially designed gates activates the CCM. The amount of multiplication is adjustable depending on the amplitude of the multiplication pulses. The device function resembles image intensifiers implemented in solid state.

The image-sensing area of the TC253 is configured into 500 lines with 680 pixels in each line. Twenty-two pixels are provided in each line for dark reference. The blooming protection is based on an advanced lateral overflow drain concept that does not reduce NIR response. The sensor can be operated in the interlaced or progressive scan modes and can capture a full 340,000 pixels in one image field. The frame transfer from the image sensing area to the memory area is accomplished at a very high rate that minimizes image smear. The electronic exposure control is achieved by clearing unwanted charge from the image area using a short positive pulse applied to the antiblooming drain. This marks the beginning of the integration time, which can be arbitrarily shortened from its nominal length.

After charge is integrated and stored, it is multiplied and converted to voltage by using a low noise charge detection node followed by a single stage source follower buffer amplifier. When accompanied by an off-chip high performance CDS circuit, with the noise floor of less than 3 $nV\sqrt{Hz}$, it is possible to achieve approximately 90 dB (15 bits) of intra-scene dynamic range (DR).

TC253 Single Photon Detection (SPD) CCD

NEW!

- Applications: Security/Surveillance, Bio Analysis, Machine Vision
- Ultra-low noise high sensitivity—electronically variable
- High-resolution, 1/3-in. format, solid-state CCD frame transfer image sensor for black and white NTSC, CCTV, and computer applications
- 340,000 pixels per field
- Frame memory
- 658 (H) x 496 (V) active pixels in image sensing area compatible with electronic centering
- Multi-mode readout capability
  - Progressive scan
  - Interlace scan
  - Line summing and skip capability
- Fast single-pulse clear capability
- Continuous electronic exposure control from 1/60 s to 1/50,000 s
- 7.4-µm square pixels
- Advanced lateral overflow drain
- High dynamic range
- Low dark current
- High photoresponse
- Uniformity from DUV to NIR
- Solid-state reliability with no image burn-in, residual imaging, image distortion, image lag, or microphonics

The TC253 is built using TI's advanced Split-Gate Virtual-Phase CCD (SGVPCCD) technology, which provides devices with a wide spectral response, ranging from DUV to NIR, high quantum efficiency (QE), low dark current, and high response uniformity. The TC253 sensors are characterized for operation from –10°C to 45°C.

TC237B

The TC237B is a frame-transfer CCD image sensor designed for use in single-chip black and white NTSC TV, computer, and special-purpose applications requiring low cost and small size.

The image-sensing area of the TC237B is configured into 500 lines with 680 elements in each line. Twenty-two elements are provided in each line for dark reference. The blooming-protection feature of the sensor is based on an advanced lateral-overflow-drain (ALOD) concept. The sensor can be operated in a true-interlace mode as a 658 (H) x 496 (V) sensor with a very low dark current. One important feature of the TC237B high-resolution sensor is the ability to capture a full 340,000 pixels per field. The image sensor also provides high-speed image-transfer capability. This capability allows for a continuous electronic exposure control without the loss of sensitivity and resolution inherent in other technologies. The charge is converted to signal voltage at 13 µV per electron, by a high-performance structure with a reset and a voltage-reference generator. The signal is further buffered by a low-noise, two-stage, source-follower amplifier to provide high output-drive capability.

The TC237B is built using TI's advanced virtual-phase (AVP) technology, which provides devices with high blue response, low dark signal, good uniformity, and single-phase clocking. It is characterized for operation from –10°C to 45°C.

TC281

The TC281 is a frame-transfer CCD image sensor that provides a very high-resolution image acquisition capability for image-processing applications such as robotic vision, medical X-ray analysis, and metrology. The image sensing area measures 8 mm horizontally and 8 mm vertically; the image-area diagonal measures 11.3 mm, and the sensor has 8-µm square pixels. The image area contains 1000 active lines with 1000 active pixels per line. The dark reference signal can be obtained from 10 dark reference lines located between the image area and the storage area, 28 dark reference pixels located at the left edge of each horizontal line, and 8 dark reference pixels located at the right edge of each horizontal line.

The storage section of the TC281 contains 1010 lines with 1036 pixels per line. The area is protected from exposure to light by a metal layer. Photoelectric charge that is generated in the image area of the sensor can be transferred into the storage section in less than 110 milliseconds.

CCDs

Device	Format	Size	Pixel Size (µm)	Active Pixels (HxV)
TC253	Frame Transfer/NTSC	1/3 inch	7.4 x 7.4	658 x 496
TC237B	Frame Transfer/NTSC	1/3 inch	7.4 x 7.4	658 x 496
TC281	Frame Transfer	2/3 inch	8.0 x 8.0	1000 x 1000
TC241	Frame Transfer/NTSC	2/3 inch	11.5 x 27	754 x 244
TC255P	Frame Transfer/NTSC	1/4 inch	10 x 10	324 x 243

After image capture is complete (integration time), the image readout is accomplished by transferring charge, one line at a time, into the serial register located below the storage area. The serial register contains 1036 active pixels and 9 dummy pixels. The maximum serial-register data rate is 40 megapixels per second. If the storage area needs to be cleared of all charge, charge may be quickly transferred across the serial registers into the clearing drain located below the register.

A high performance bulk charge detection (BCD) structure converts charge from each pixel into an output voltage. A low-noise, two-stage, source-follower amplifier further buffers the signal before it is sent to the output pin. A readout rate of 30 frames per second is easily achievable with this device.

The blooming-protection of the sensor is based on an advanced lateral-overflow-drain (ALOD) structure. The antiblooming function is activated when a suitable dc bias is applied to the overflow-drain pin. With this type of blooming protection, it is also possible to clear the image area of charge completely. This is accomplished by providing a single 10-V pulse of at least 1-ms duration to the overflow-drain pin.

The TC281 uses TI's advanced virtual-phase (AVP) technology, the advanced lateral-overflow-drain (ALOD) structure, and the BCD detection node. These features provide the TI image sensing devices with a high blue response, high near-IR sensitivity, low dark current, high photoresponse uniformity, and single-phase clocking. The TC281 is characterized for operation from –10°C to 45°C.

TC241

The TC241 is a frame-transfer CCD image sensor designed for use in single-chip B/W NTSC TV applications. The device is intended to replace a 2/3-inch vidicon tube in applications requiring small size, high reliability, and low cost.

The image-sensing area of the TC241 is configured into 244 lines with 780 elements in each line. Twenty-four elements are provided in each line for dark reference. The blooming-protection feature of the sensor is based on recombining excess charge with charge of opposite polarity in the substrate. This antiblooming is activated by supplying clocking pulses to the antiblooming gate, which is an integral part of each image-sensing element.

The sensor is designed to operate in an interlace mode, electronically displacing the image-sensing elements by one-half of a vertical line during the charge integration period in alternate fields, effectively increasing the vertical resolution and minimizing aliasing. The device can also be run as a 754 (H) x 244 (V), non-interlaced sensor with significant reduction in the dark signal.

A gated floating-diffusion detection structure with an automatic reset and voltage reference incorporated on-chip converts charge to signal voltage. A low-noise, two-stage, source-follower amplifier buffers the output and provides high output-drive capability.

The TC241 is built using TI's virtual-phase technology, which provides devices with high blue response, low dark current, high photoresponse uniformity, and single-phase clocking. The TC241 is characterized for operation from –10°C to 45°C.

TC255P

The TC255P is a frame-transfer CCD designed for use in B/W NTSC TV and special-purpose applications where low cost and small size are desired.

The image-sensing area of the TC255P is configured in 243 lines with 336 elements in each line. Twelve elements are provided in each line for dark reference. The blooming-protection feature of the sensor is based on recombining excess charge with charge of opposite polarity in the substrate. This antiblooming is activated by supplying clocking pulses to the antiblooming gate, which is an integral part of each image-sensing element.

The sensor can be operated in a non-interlaced mode as a 324 (H) x 243 (V) sensor with low dark current. The device can also be operated in an interlaced mode, electronically displacing the image-sensing elements during the charge integration in alternate fields, and effectively increasing the vertical resolution and minimizing aliasing.

One important aspect of this image sensor is its high-speed image-transfer capability. This capability allows for an electronic-shutter function comparable to interline-transfer and frame-interline-transfer sensors without the loss of sensitivity and resolution inherent in those technologies.

The charge is converted to signal voltage with a 12 µV per electron conversion factor by a high-performance charge-detection structure with built-in automatic reset and a voltage-reference generator. The signal is buffered by a low-noise, two-stage, source-follower amplifier to provide high output-drive capability.

The TC255P uses TI's virtual-phase technology, which provides devices with high blue response, low dark signal, high photoresponse uniformity, and single-phase clocking. The TC255P is characterized for operation from –10°C to 45°C.

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