- **High-Resolution, Bulk Charge Modulated Device (BCMD) Technology Image Sensor for NTSC Color Applications**
- **1/3-in Image Area Diagonal**
- **680 (H) x 500 (V) Active Elements in the Image-Sensing Area**
- **7.4-μm Square Pixels**
- **No Detectable Smear**
- **No Image Lag**
- **2000:1 Blooming Overload Capability**
- **Intrinsic Exposure Control**
- **Random Line Addressable**
- **Dual-Line Readout**
- **Dynamic Range: > 70 dB**
- **0 – 5-V Clocking Levels**

description

The Texas Instruments (TI™) TC286 is designed for use in single-chip color National Television Standards Committee (NTSC) TV, computer, and special-purpose applications requiring high picture quality, excellent antiblooming capability, electronic exposure control, and no smear.

The TC286 is a unique imaging device based on a MOS transistor structure with a buried photosite well. This structure integrated into a high-performance image sensor array is called a bulk charge modulated device (BCMD). The BCMD image sensor features an 1/3 inch diagonal image sensing area configured into 500 lines with 680 pixels in each line. Four lines on the bottom of the image area form dark references, and 22 elements on the left side, covered by a light shield, form the dark current reference elements used for dark current subtraction and dc level restoration. The image area measures 5.0 mm (horizontal) x 3.7 mm (vertical) with each pixel being 7.4 μm square.

The BCMD sensor requires 0 to 5-V CMOS-level clock signals for its operation, and all dc bias levels are within the range of 0 to 8 V. The image signal from the array is processed line by line in parallel. Vertical array addressing is used to transfer two complete lines of data into a line buffer during the horizontal blanking interval. In color applications, the dual-line readout significantly improves the sensor resolution above that of competitive devices of the same format. The line buffer is configured to store two lines of 680 elements. The TC286 employs an on-chip color filter arranged in a mosaic pattern. Two serial registers are used to read out the pixels. From the first register, a red pixel is read first and then a green pixel. This alternating pixel pattern continues until the line is read out. From the second register, a green pixel is read first and then a blue pixel. The green pixel is output at the same time a red pixel is output from the first register. Using this readout method, four pixels (one red, one blue, and two greens) can be used to form one color pixel for NTSC color applications.

The BCMD cell is a n-type buried-channel MOS transistor with an additional p-type well implanted under the transistor channel. The potential valley created serves as a storage place for photogenerated holes.

As light enters the silicon in the image-sensing area, free holes are generated and collected in the potential wells of the sensing elements. The holes change the potential profile of the device structure, which, in turn, affects the threshold of the MOS transistor. As current flows through the transistor, the threshold change is sensed as a source voltage variation of each of the transistors. The hole well is emptied or reset by applying a negative pulse to the drain of the transistor. The cell reset is complete with no residual carriers in the well and, therefore, no reset noise or image lag, both important features for low light level sensitivity of the cell.

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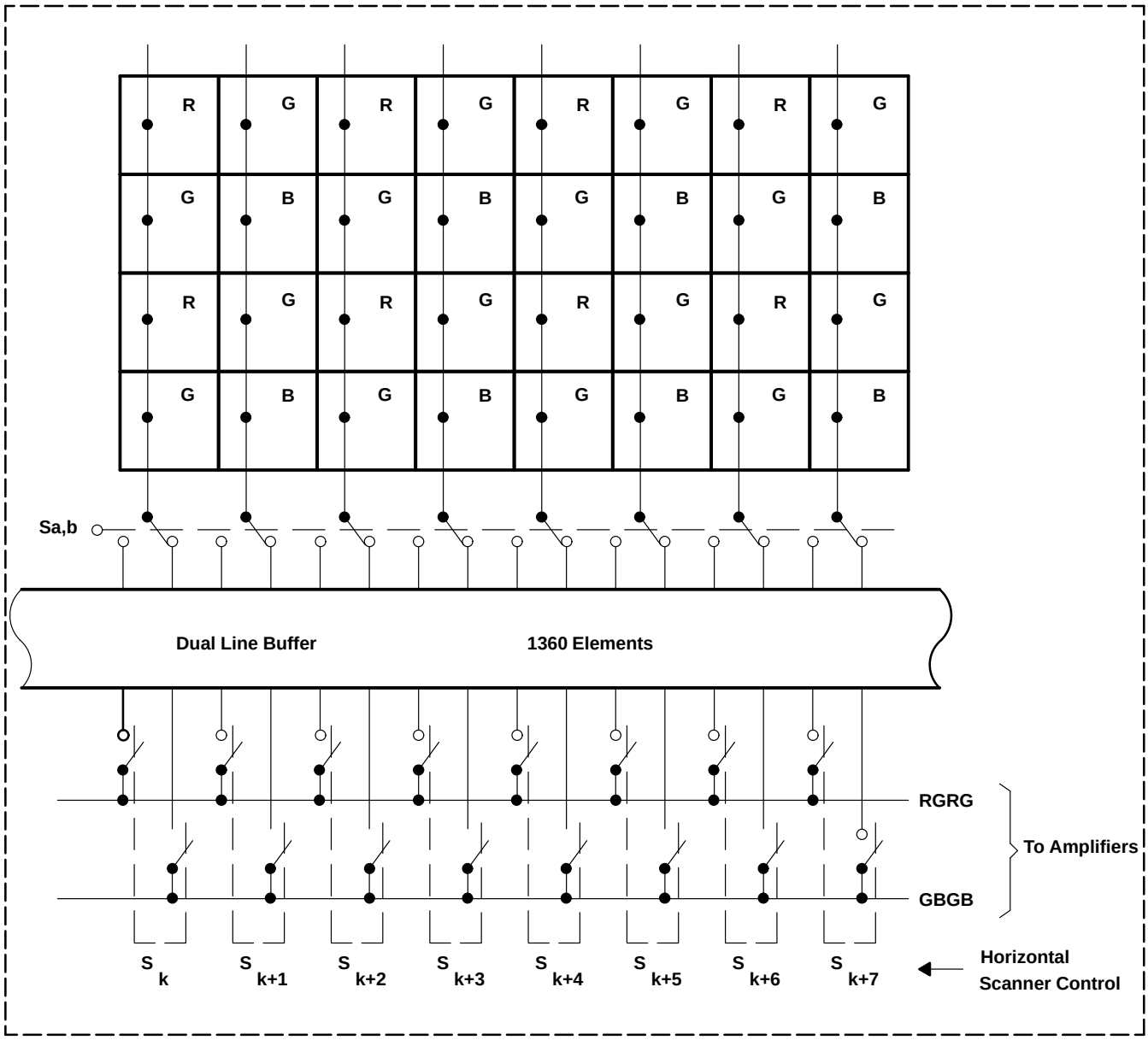
description (continued)

After each integration cycle, the image readout sequence begins by selecting an appropriate line pair in the image-sensing array and transferring its voltage signal into the line buffer in a sequential order during the horizontal blanking interval. During this transfer operation, photocell threshold nonuniformities are internally removed by a clamping and sampling process that results in uniform output levels. The stored signal is then read out of two serial registers.

The device intrinsic exposure control operates on a principle resembling the action of a mechanical focal plane shutter used in standard photographic cameras. The equivalent width of the shutter slit is defined electronically and is scanned across the sensor in a vertical direction. The maximum range of control available in the sensor is 288:1.

The TC286 is built using TI-proprietary advanced virtual phase (AVP) technology, which provides devices with high blue response, low dark signal, good uniformity, and single-phase clocking. The TC286 is characterized for operation from –10°C to 45°C.

functional block diagram



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Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
ADB	8	I	Antiblooming drain bias
B00	13	I	Vertical address bit 0
B01	12	I	Vertical address bit 1
B02	11	I	Vertical address bit 2
B03	10	I	Vertical address bit 3
B04	7	I	Vertical address bit 4
B05	6	I	Vertical address bit 5
B06	5	I	Vertical address bit 6
B07	4	I	Vertical address bit 7
B08	3	I	Vertical address bit 8
IBA	18	I	Amplifier bias current
IBP	32	I	Photosite bias current
PC1	26	I	Horizontal register 1
PC2	25	I	Horizontal register 2
PCP	31	I	Line clamp
PGB	9	I	Photocell gate bias
PIN	24	I	Horizontal register pulse
PRS	17	I	Reset clock
PS1	29	I	Sample and hold 1
PS2	28	I	Sample and hold 2
PST	27	I	Pixel strobe
VAS	14	I	Vertical address strobe
V_{DD}	1, 16	I	5-V substrate bias
VRF	30	I	Line clamp reference
VR1	21	O	Output reference 1
VR2	22	O	Output reference 2
V_{SS}	2, 15, 23	I	Ground
V01	19	O	Output 1
V02	20	O	Output 2

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operating conditions, clock levels = 0 to 5 V, dc bias = –5 V to 5 V, T_A = 25°C

PARAMETER	MIN	TYP	MAX	UNIT
Output impedance		500		Ω
Saturation output voltage		1000		mV
Saturation current		320		nA
Photosite charge capacity		100,000		e
Charge conversion factor		10		µV/e
Dark signal (@ 25°C)		1.5		nA/cm^2
Noise floor		32		e
Dynamic range		70		dB
Faceplate saturation (T = 2856°K)		20		lux
Response nonuniformity		< 2%		
Blooming overload range		> 2000 saturation		
Exposure control range		288:1		
Smear		0%		
Lag		0%		

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