
PI227MC-A4 / PI228MC-A4 / PI229MC-A4 CIS Module 200DPI CIS Sensor Engineering Data Sheet

Key Features

- Light source, lens, and sensor are integrated into a single module
- Ultra-High-Speed
- Four parallel analog video outputs clocked at 5.0MHz.
- 90 μ sec/line scanning speed @ 5.0MHz clock rate with optional light sources, selected from the option of three above modules.
- 8 dpm resolution, 216 mm scanning length
- Wide dynamic range
- LED light source (selectable among the three above modules)
- Standard A4 size \cong 14mm x 19 mm x 232 mm
- Low power
- Light weight

General Description

The PI227MC-A4, PI228MC-A4 and PI229MC-A4 are a family of CIS modules. As a family group they are called PI227/228/229 modules. They are long contact image sensor modules, using MOS image sensor technology for high-speed performance and high sensitivity. They contain their own complete optical system including the light source, accordingly, they make a very compact imaging system. The four parallel video outputs gives these family of CIS modules their high speed performances. They all possess identical electrical circuit components, as well as the mechanical and optical components, except for their LED light sources. Accordingly they differ in their specification because the different light sources limits the effective high speed performance. The three modules are suitable for scanning A4 size (216 mm) documents with 8 dots per millimeter resolution.

Applications include document scanning, mark readers, gaming and office automation equipment.

Functional Description

Each of the three modules in the family, PI227/228/229, consist of four major components. The first of them is the PCB on which the 27 imaging chips, PI3020, are bonded. These sensor chips, produced by Peripheral Imaging Corporation, are monolithic devices with 64 photo sensing elements. Each of twenty seven chips are complete self contained scanning chips and have their control circuits integrated in the chips, so that they can be cascaded to provide 1728 photo-elements module. The PI3020 chips are integrated with the photo sensors' associated multiplex switches, a digital shift register and chip selection switch. The chip's shift register sequentially clocks out the integrated image charges from each sensing elements and passes them through the chip-select switch and out onto the video line. The chip-select switches are sequentially switched as each of the predecessor chip completes its scan. These 27 sensors, bonded on a PCB, are grouped into 4 sub-cascaded sections. Each contiguously cascaded chips section are connected on separate video lines, accordingly providing four video outputs VOUT1, VOUT2, VOUT3 and VOUT4. Before the signal charges from the four video lines appear at their respective outputs they are converted to signal voltages by four on-board buffer amplifiers, one for each of its corresponding video section. The first three sections VOUT1, VOUT2, and VOUT3 have 7 sensor chips, while the VOUT4 has 6 sensor chips. Since each sensor chip have 64 pixels, there are a total of 1728 pixels. See Figure 1. PI227/228/229 Module Block Diagram.

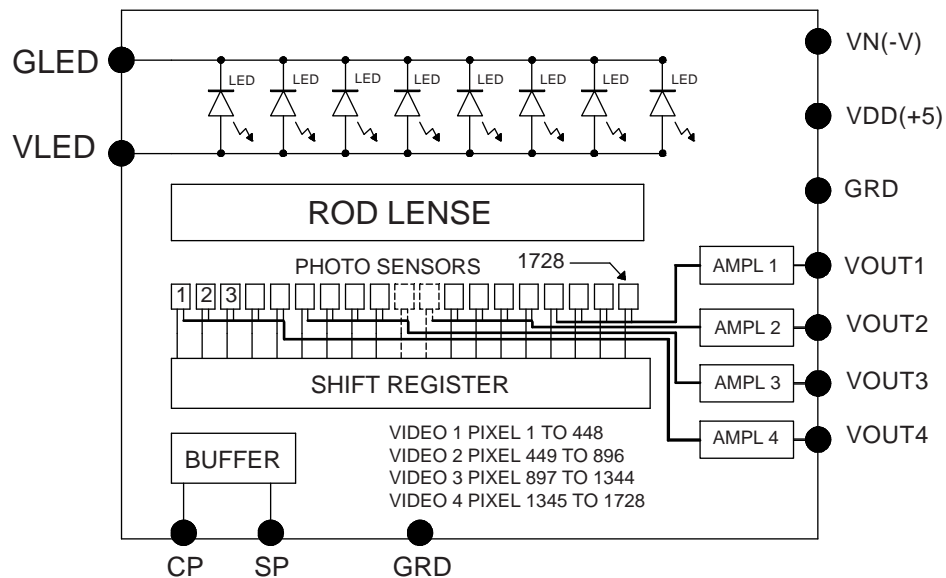
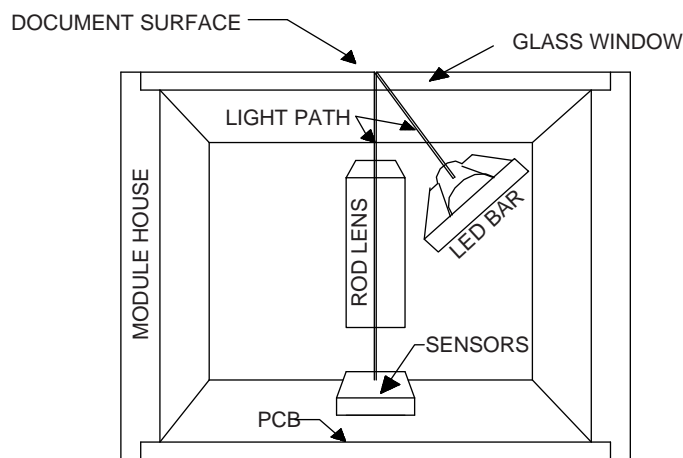


Figure 1. PI227/228/229 Module Block Diagram
(See Table 1 for pin-out designation)

Mounted in the module housing, along with the PCB, is the second major component, it is a one-to-one graded indexed micro lens array that focuses the scanned documents' image onto the sensing line of the sensor chips. The third major component, mounted in the module, is the LED light source. See Figure 2. The PI227/228/229's Cross Sectional View. This pictorial cross section shows the LED Bar light source and its illumination path as it reflects the image from the document and focuses through the ROD lens on to its image sensing line of the sensing chips. All components are housed in a small plastic housing and covered with the fourth major component, a glass window. This cover glass not only serves to protect all of the critical components within the housing from dust, but also serves a minor role in the optical system. Together with rest of the module's optical system, the module is adjusted to obtain the optimum depth-of-focus. See the paragraph on MTF Graph and Its Discussions.



INSIDE PICTORIAL OF MODULE

Figure 2. PI227/228/229's Cross Section

I/O Designation

I/O to the module is a 12-pin connector located on one end of the module. See Figure 5. Module's Mechanical Overview. Table 1 lists the pin numbers and their designations for the I/O connector. It is JAE IL-Z-12P-S125L3-E connector.

Pin Number	Symbol	Names and Functions
1	VOUT1	Analog Video Output 1
2	VOUT2	Analog Video Output 2
3	GND	Ground; 0V
4	VOUT3	Analog Video Output 3
5	VOUT4	Analog Video Output 4
6	Vdd	Positive power supply

7	SP(START)	Shift register start pulse
8	GND	Ground; 0V
9	CP(CLOCK)	Sampling clock pulse
10	Vn	Negative power supply
11	GLED	Ground for the light source; 0V
12	VLED	Supply for the light source

Table 1. Pin configuration

Module Versus LED Light Source

Table 2 lists the module's model and its corresponding LED Light Source.

Module	LED Light Source
PI227MC-A4	660 nm RED LED Bar
PI228MC-A4	High power Yellow-Green LED Bar
PI229MC-A4	Low power Yellow-Green LED Bar

Table 2. Module Vs LED Light Source

Absolute Maximum Rating:

Table 3A shows the absolute maximum ratings. The parameters are common to all three modules. Table 3B shows the absolute maximum ratings that are different among the three modules.

Parameter	Symbols	Maximum Rating	Units
Power Supply	Vdd	7	V
	Idd	100	ma
	Vn	-15	V
	In	35	ma
Input clock pulse (high level)	Vih	Vdd – 0.5V	V
Input clock pulse (low level)	Vil	-0.5	V

Note: These parameters are absolute maximums do not operate under these conditions.

Table 3A. Electrical Absolute Maximum Rating

Parameter	Symbols	Maximum Rating			Units
Power Supply: LED light source	Module	PI227MC-A4	PI228MC-A4	PI229MC-A4	
	VLED	6.0	6.0	6.0	V
	ILED	0.7	1.30	1.30	A

Note: These parameters are absolute maximums do not operate under these conditions.

Table 3B. LED Power Absolute Maximum Rating

Environmental Specifications

Operating temperature ⁽¹⁾	Top	0 to 50	°C
Operating humidity ⁽¹⁾	Hop	10 to 90	%
Storage temperature ⁽¹⁾	Tstg	-20 to+75	°C
Storage humidity ⁽¹⁾	Hstg	10 to 90	%

Table 4. Operating and Storage Environment

Note (1) These are standard specifications for the CIS modules.

Electro-Optical Characteristics (25 °C)

Table 5A is the electro-optical characteristics common all three modules. Table 5B, 5C and 5D show the different characteristics for each of the three LED light source.

Parameter	Symbol	Value	Units	Notes
Total number of photo detectors		1728	Elements	
Section 1, 2, & 3 number of photo detectors		448	Elements	
Section 4 number of detectors		384	Elements	
Pixel-to-pixel spacing		125	µm	

Table 5A. Common Electro-Optical Characteristics

PI227MC-A4		660 RED LED		
Parameter	Symbol	Value	Units	Note
Line scanning rate	Tint ⁽¹⁾	90	µsec	@ 5.0 MHz clock frequency
Clock frequency ⁽²⁾	Fclk	5.0	MHz	
Bright output voltage ⁽³⁾	Video Output	1.0	Volt	
Bright output nonuniformity ⁽⁴⁾	Up	<+/-30	%	
Dark nonuniformity ⁽⁵⁾	Ud	<40	mV	
Dark output voltage ⁽⁶⁾	Dark Level (DL)	<60	mV	
Modulation transfer function ⁽⁷⁾	MTF	>40	%	

Table 5B. PI227MC-A4 Electro-Optical Characteristics

See notes below Table 5D.

PI228MC-A4 High Power Yellow-Green LED				
Parameter	Symbol	Value	Units	Note
Line scanning rate	Tint ⁽¹⁾	90	µsec	@ 5.0 MHz clock frequency
Clock frequency ⁽²⁾	Fclk	5.0	MHz	
Bright output voltage ⁽³⁾	Video Output	0.5	Volt	
Bright output nonuniformity ⁽⁴⁾	Up	<+/-30	%	
Dark nonuniformity ⁽⁵⁾	Ud	<40	mV	
Dark output voltage ⁽⁶⁾	Dark Level (DL)	<60	mV	
Modulation transfer function ⁽⁷⁾	MTF	>40	%	

Table 5C. PI228MC-A4 Electro-Optical Characteristics

See notes below Table 5D.

PI229MC-A4 Low Power Yellow-Green LED				
Parameter	Symbol	Symbol	Units	Notes
Line scanning rate	Tint ⁽¹⁾	150	µsec	@ 3.0 MHz clock frequency
Clock frequency ⁽²⁾	Fclk	3.0	MHz	
Bright output voltage ⁽³⁾	Video Output	0.5	Volt	
Bright output nonuniformity ⁽⁴⁾	Up	<+/-30	%	
Dark nonuniformity ⁽⁵⁾	Ud	<40	mV	
Dark output voltage ⁽⁶⁾	Dark Level (DL)	<60	mV	
Modulation transfer function ⁽⁷⁾	MTF	>40	%	

Table 5D. PI229MC-A4 Electro-Optical Characteristics

Definition:

- (1) Tint is the line scanning rate or integration time. Tint is determined by the interval between two start pulses, SP.
- (2) Fclk: main clock frequency also equals the video sampling frequency.
- (3) Video output level is controlled with a voltage adjustment as well as the Integration time and LED light power.
- (4) $Up = [Vp(max) - Vpavg]/Vpavg \times 100\%$ or $[Vpavg - Vp(min)]/Vpavg \times 100\%$, whichever is greater is selected.
Where $Vp(max)$ = maximum pixel level and $Vp(min)$ = minimum pixel level.
and $Vpavg = \sum_{n=1}^{n=5184} Vp(n) / 5184$
- (5) $Ud = Vdmax - Vdmin$
 $Vdmin$ is the minimum output voltage with LED off.
 $Vdmax$ is maximum output voltage with LED on.
- (6) This level is measured from the reset level that is located between the pixels, during the pixel reset duration. The reset level is at or near ground, 0V. Note the gain is adjustable on each output. However, it is recommended that the gain should not be increased above the level where the reset ground level starts to increase above zero.
- (7) A graph of the typical MTF vs DOF is shown under discussion of MTF in Figure 5.

MTF Graph and Its Discussion

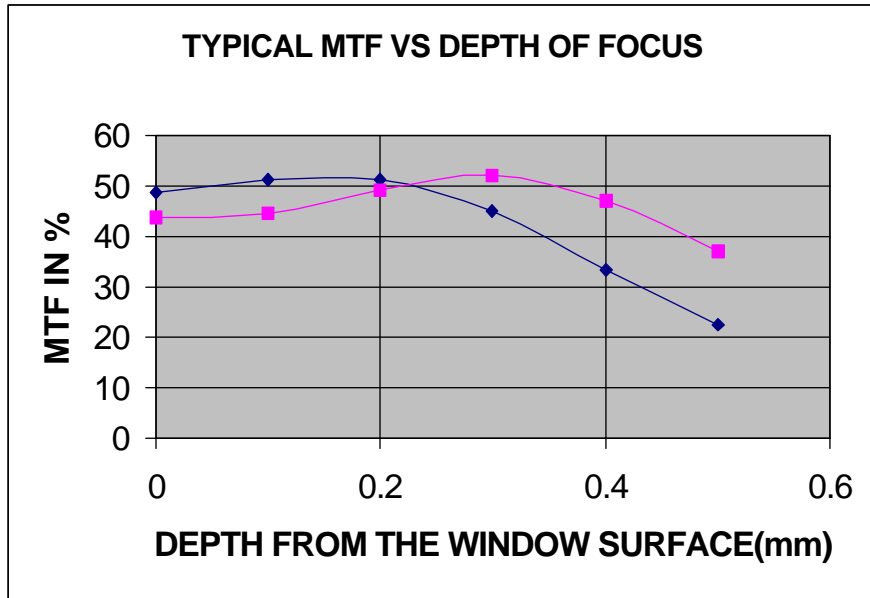


Figure 3. Typical MTF versus Distance

See Figure 3, Typical MTF versus Distance. This graph essentially shows the working depth-of-focus. Two curves indicates the spread among the modules. Note that MTF is greater than 40% out to distance greater than 0.4 mm from the glass surface. Since this module is a 200DPI module, a pixel density of 200 pixel per inch, the MTF was measured with a 100 DPI or a 50 line-pair per inch optical bar pattern. The test was conducted with pixel rate set to 2.5MHz.

The effective algorithm used in the measurements is as described by the following equation:

$$MTF = \frac{[V_p(n) + V_p(n+1)]/2 - [V_p(n+2) + V_p(n+3)]/2}{[V_p(n) + V_p(n+1)]/2 + [V_p(n+2) + V_p(n+3)]/2}$$

Where n is 1, 2,1728th, $V_p(n)$ is the signal amplitude of the nth pixel.

Operating Conditions (25 °C)

Item	Symbol	Min	Typical	Max	Units
Power Supply	Vdd (positive)	4.5	5.0	5.5	V
	Vn (negative)	-10	-5	-4.0	V
	Idd (positive)	60	66	75	ma
	In (negative) ⁽¹⁾	20	20	20	ma
Input voltage at digital high	Vih	Vdd-1.0	Vdd-.5	Vdd	V
Input voltage at digital low	Vil	0		0.6	V
Clock frequency	Fclk	0.2 ⁽²⁾		5.5 ⁽³⁾	MHz

Clock pulse high duty cycle			25		%
Clock pulse high duration		45.5	50		ns
Integration time	Tint	82	150		μs
Operating temperature ⁽⁴⁾	Top		25	50	°C

PI227MC-A4				
Parameter	Minimum	Typical	Maximum	
VLED		5.0	5.5	Volts
ILED		480	550	ma

PI228MC-A4				
	Minimum	Typical	Maximum	
VLED		5.0	5.5	Volts
ILED		650	950	ma

PI229MC-A4				
	Minimum	Typical	Maximum	
VLED		5.0	5.5	Volts
ILED		650	950	ma

Table 6. Recommended Operating Condition (25 °C)

Note (1) current is essential constant current with supply voltage.

Note (2) determined by the longest tolerable integration time. Because of leakage current build up, the integration time is recommended to be no greater than 10 ms.

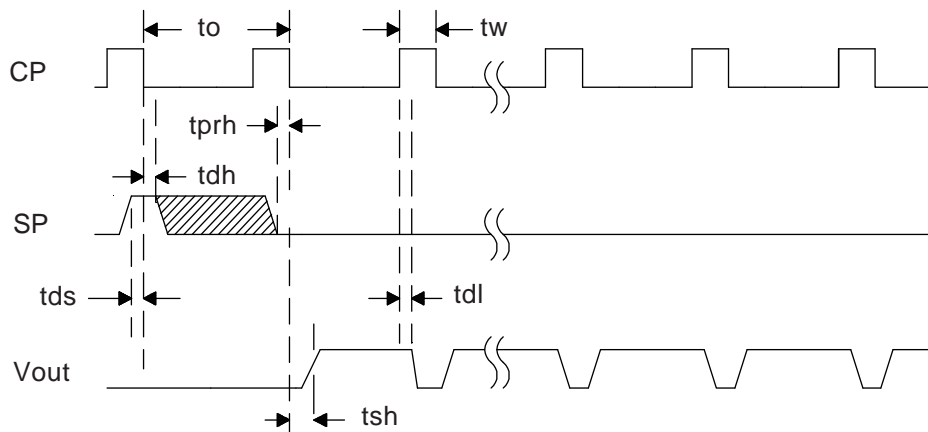
Note (3) the maximum call out is for the modules' electrical speed. Light Source still dictates the highest speed performance.

Note (4) this specification is a standard used by the CIS makers for the Fax Industry.

Switching Characteristics (25°C)

The Switching Characteristics (25°C) for the I/O clocks are shown in the diagram of Figure 4, on the following page. Each switch timing characteristic for each waveform is represented by their symbolic acronym. Each corresponding switching time is defined in the Table 7, located below Figure 4. Note: Only one video output is shown because all four videos have identical electrical characteristic. The only physical difference is in section 4 output, VOUT4. Section 4 has only 6 sensor chips, hence, its active scan is shorter by 64 pixels.

(See Figure 4 on the following page)



MODULE TIMING DIAGRAM

Figure 4

Item	Symbol	Min.	Typical	Max.	Units
Clock cycle time	t_o	0.20		4.0	μs
Clock pulse width	t_w	50			ns
Clock duty cycle		25		75	%
Prohibit crossing time of Start Pulse ⁽¹⁾	t_{prh}	0			ns
Data setup time	t_{ds}	20			ns
Data hold time	t_{dh}	0			ns
Signal delay time	t_{dl}	20			ns
Signal settling time	t_{sh}	100			ns

Table 7. Timing Symbol's Definition and Timing Values.

Note1:

"Prohibit crossing of start pulse" is to indicate that the start pulse should not be active high between any two consecutive clock pulse, specifically, between two consecutive low going clock pulses. See the timing diagram. All falling clock edges under a active high start pulse loads the internal shift register, therefore the start pulse must be active over only one falling clock edge. High start pulse over all rising clock edge is ignored by the shift register. One simple way to ensure that the start pulse will not be actively high during two consecutive falling clock edge is to generate the start pulse on a rising clock edge and terminate it on the following rising clock edge.

Mechanical Structure of the Module

The isometric sketch, Figure 5, of the housing shows the connector location, the approximate overall dimensions and its general geometric layout of the module. It is not intended for use as a design reference. The detailed drawing for the any of the PI227/228/229 Module Mechanical Overview is available upon request.

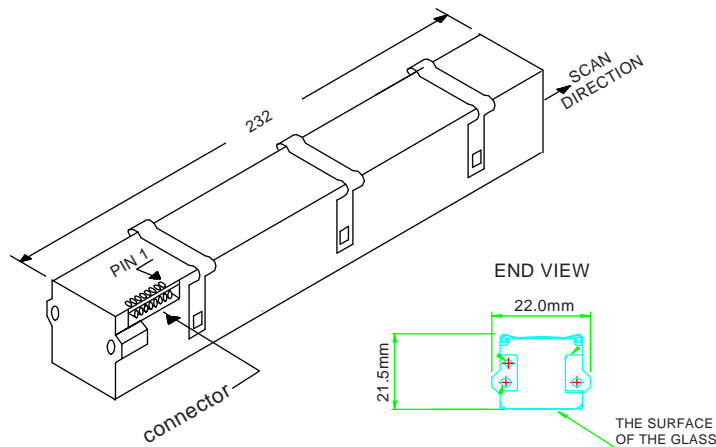


Figure 5. PI227/228/229 Module Mechanical Overview

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