AMI SEMICONDUCTOR

Peripheral Imaging Corporation

PI324MC-A4
300DPI CIS Module
Engineering Data Sheet

Key Features

- Light source, lens, and sensor are integrated into a single module
- 11.8 dpm resolution, 216 mm total scanning length(2592 pixels long)
- Two Independent Analog Outputs(Split into two section of 1248 pixels and 1344 pixels)
- Up to 270µsec/line scanning speed with Red Light Source
- Wide dynamic range
- RED LED light source
- Compact size ≅ 14 mm x 19 mm x 232 mm
- Low power
- Light weight

General Description

The PI324MC-A4 is a CIS module. It is a dual-analog-output contact image sensor, using MOS image sensor technology for high-speed performance and high sensitivity. The PI324MC-A4 is suitable for scanning A4 size (216 mm) documents with 11.8 dots per millimeter resolution. Applications includes fax machines, game systems, variety of mark readers, and other automation equipment requiring document scanners.

Functional Description

The PI324MC-A4 imaging array consists of 27 sensors, PI3021 produced by Peripheral Imaging Corp. The sensor is a monolithic chip with an array of 96 photo sensing elements, of which 27 are cascaded to provide 2592 photo-detectors. Additionally, these chips gives the users the readout flexibility in selecting their desired data format. These cascaded chips are segregated into two electrically independent sections of 13 chips and 14 chips, but they are still contiguously aligned in a single row. See Figure 1, the module's block diagram. This configuration lends to a positional stream of video pixels whether they are read in parallel or sequentially from the two output ports, i.e., at the end of the first section's array, pixel number 1247, the following 1st pixel of the second section continues as position 1248 and sequences up to pixel 2592 or the end, pixel 1344 of the end second section.

Each chip contains a set of multiplex switches, and a digital shift register to control the chips sequential readout. Additionally, the chips contain a chip selection switch that is interrogated in a sequence as each predecessor chip completes its scanning process. Since this module has two output ports from two independently controlled section of chips, to operate both sections, the users are required to enter a set of control clocks and power into each section through the two provided connectors located on each end of the module.

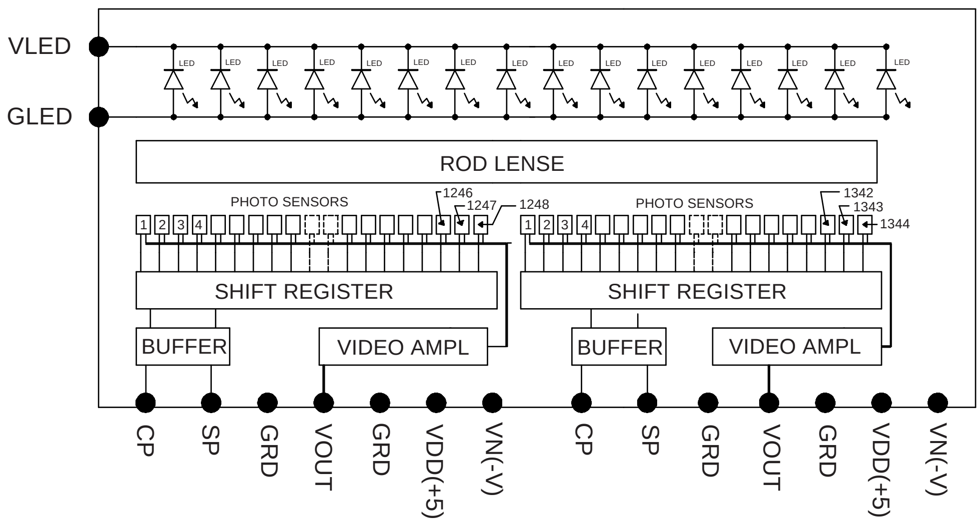
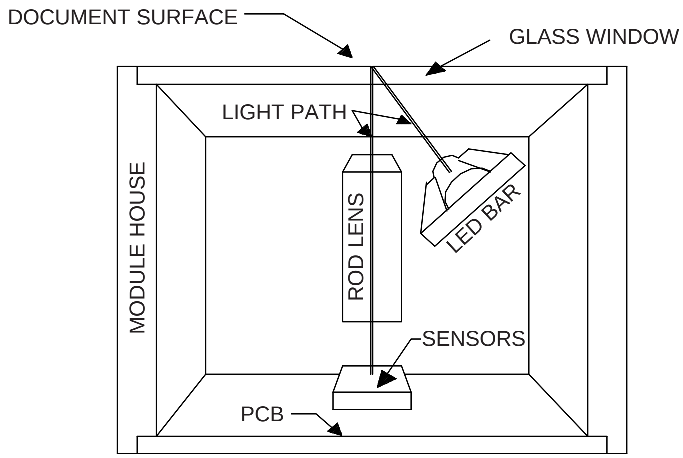


Figure 1. PI324MC-A4 module block diagram.
(See Table 1 for pin-out designation)

Located on the next page is Figure 2 depicting a cross sectional pictorial of the module. Mounted in the module is one-to-one graded indexed micro lens array that focuses the scanned documents' image onto the chip's sensing line. The sensing line is located along the module's sensor axis, known as the read line. These photon images are transformed into proportional video charges and processed by two on-board amplifiers. The video signal from the amplifier transmits a sequential stream of video pixels to video output pin of the PI324MC-A4 module. Also mounted in housing is a LED light source. Figure 2 shows LED bar and its illumination path. The path traces the ray from the LED and reflected from the document and focused through the ROD lens and onto the sensors. All these components are housed in a small plastic housing with a cover glass. The cover glass serves as window with outside surface as the focal point for the image on the document. It also serves to protect the imaging array, the micro lens assembly, and the LED light source from dust.



INSIDE PICTORIAL OF MODULE

Figure 2. PI324MC-A4 Cross Section

I/O Designation

There are two connectors located at the ends of the modules. The outline of the module in Figure 5 of the mechanical section illustrates these connector locations. With the module window facing down on flat surface and with the viewer looking down on backside of the module, the connectors are located on each end of the module with their pins pointing toward the viewer. The connectors for section 1 has 12 pins and is located on the right hand side. The part number is JAE IL-Z-12P-S125L3-E. Its pin numbers and designations are in Table 1A. Pin Configuration For Section 1 Connector.

Pin Number	Symbol	Names and Functions
1	Vout1	Analog Video Output
2	Gnd	Ground; 0V
3	Vdd (+5V)	Positive power supply
4	Vn (-5V)	Negative power supply
5	Gnd	Ground; 0V
6	SP1	Shift register start pulse
7	Gnd	Ground; 0V
8	CP	Sampling clock pulse
9	GLED	Ground for the light source; 0V
10	VLED	Supply for the light source
11	LED(future)	Supply for future LED source
12	LED(future)	Supply for future LED source

Table 1A. Pin Configuration For Section 1 Connector

The connector for section two has 8 pins and is located on the left hand side. The part number is JAE IL-Z-8P-S125L3-E. The pin numbers and designations for the connector are listed in Table 1B. Pin Configuration For Section 2 Connector.

Pin Number	Symbol	Names and Functions
1	Vout2	Analog Video Output
2	Gnd	Ground; 0V
3	Vdd (+5V)	Positive power supply
4	Vn (-5V)	Negative power supply
5	Gnd	Ground; 0V
6	SP2	Shift register start pulse
7	Gnd	Ground; 0V
8	CP	Sampling clock pulse

Table 1B. Pin Configuration For Section 2 Connector

Absolute Maximum Rating

Parameter	Symbols	Maximum Rating	Units
Power supply voltage	Vdd	7	V
	Idd	70	mA
	Vn	-15	V
	In	20	mA
	VLED	6.0	V
	ILED	0.65	A
Input clock pulse (high level)	Vih	Vdd +.5	V
Input clock pulse (low level)	Vil	-0.5	V

Note, these are the absolute maximums and are not to be used in prolonged operation.
Table 2. Absolute Maximum Ratings

Operating Environment

Operating temperature	Top	0 to 50	^{0}C
Operating humidity	Hop	10 to 85	%
Storage temperature	Tstg	-25 to+75	^{0}C
Storage humidity	Hstg	5 to 95	%

Table 3. Operating Environment

Electro-optical characteristics at 25°C.

Parameter	Symbol	Parameter	Units	Note
Total Number of photo detectors		2592	elements	The sum of both sections
Number detectors in Section 1		1248	elements	
Number of detectors in Section 2		1344	elements	
Pixel to pixel spacing		84.7	µm	
Line scanning rate	Tint[1]	270	µsec	@ 5.0 MHz clock frequency
Clock frequency[2]	f	5.0	MHz	
Bright output voltage[3]	Vpavg	1.0	Volts	
Bright output nonuniformity[4]	Up	<+/-30	%	
Adjacent pixel nonuniformity[5]	Uadj	<25	%	
Dark nonuniformity[6]	Ud	<100	mV	
Dark output voltage[6]	Vd	<150	mV	Average dark level from the video reset level.
Typical Modulation transfer function[7]	MTF	50	%	

Table 4. Electro-optical characteristics at 25° C.

Definition:

(1) Tint: Line scanning rate or integration time. Tint is determined by the interval of two SP, start pulses. The line scan time is determined by the longest array with both section 1 and 2 operating in parallel. Longest array is section 2, with 1344 pixels, running at 5MHz pixel rate.

(2) f: main clock frequency,

(3) Vpavg = $\sum$ Vp(n)/1248 for section 1 and Vpavg = $\sum$ Vp(n)/1344 for section 2,

where: Vp(n) is the peak value of any n^{th} pixel in a give scan.

This level is factory adjusted with an internal potentiometer after setting the scan times to a the minimum allowable for a fixed clock frequency. In this case, ≈ 275µsec at 5MHz clock frequency. This value is then used as reference to adjust the dark level and to call out the dark uniformity, see note 6 on dark uniformity.

(4) Up is defined as follows: Upmax = [(Vpmax - Vpavg) / Vpavg] x 100% or Upmin = [(Vpavg - Vpmin) / Vpavg] x 100%

where: Vpmax=the maximum value of the peak n^{th} video pixel, Vp(n),
and: Vpmin = the minimum value of the peak video n^{th} video pixel, Vp(n).
Up = +/-30% is selected from the greater absolute value of Upmax of Upmin. If |Upmax| > |Upmin| then Up = +|Upmax| is selected, if |Upmin| > |Upmax| then Up = -|Upmin| is selected. In either case, |Upmax| + |Upmin| ≤ 60%.

(5) Upadj = MAX[| (Vp(n) - Vp(n+l) | / Vp(n)] x 100%
Upadj is the nonuniformity percentage pixel to pixel

(6) See the discussion on dark uniformity, Ud.

(7) See the section on MTF Discussion and Graph.

Dark Uniformity, Ud

Figure 3, Definition of the Video Pixel in the Light and in the Dark, exemplifies the definitions of the terminology which are used to explain the video signal characteristics. Dark uniformity is defined as Ud = Vdmax - Vdmin; Where Vdmax and Vdmin are the maximum and minimum voltage of Vd, the average dark level of total pixels in scan line when the LED light is turned off. Vd is measured from Reset Level and this amplitude between the dark level and this reset level is call PEDESTAL. The pedestal level is caused by resetting operation of pixel. Although the pedestal remains constant for a constant clock frequency, the Reset Level will very from ground, because the dark level, Vd, is factory adjusted to ground (zero volts).

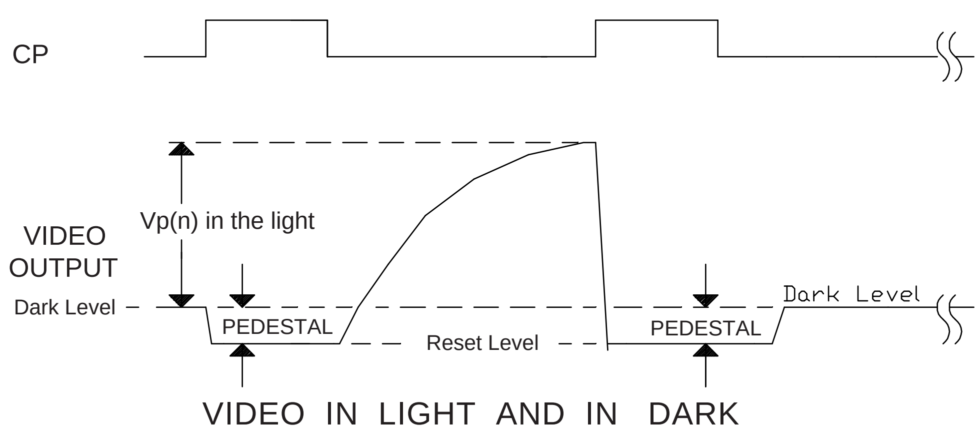


Figure 3. Definition of the Video Pixel in the Light and in the Dark

MTF Graph and Its Discussion

See Figure 4 MTF versus Distance. This graph essentially shows the working depth of focus. Since this module is a 300DPI module, a pixel density of 300 pixel per inch, the MTF was measured with a 150 DPI or a 75 line-pair per inch optical bar pattern. The test were conducted a pixel rate of 2.5MHz.

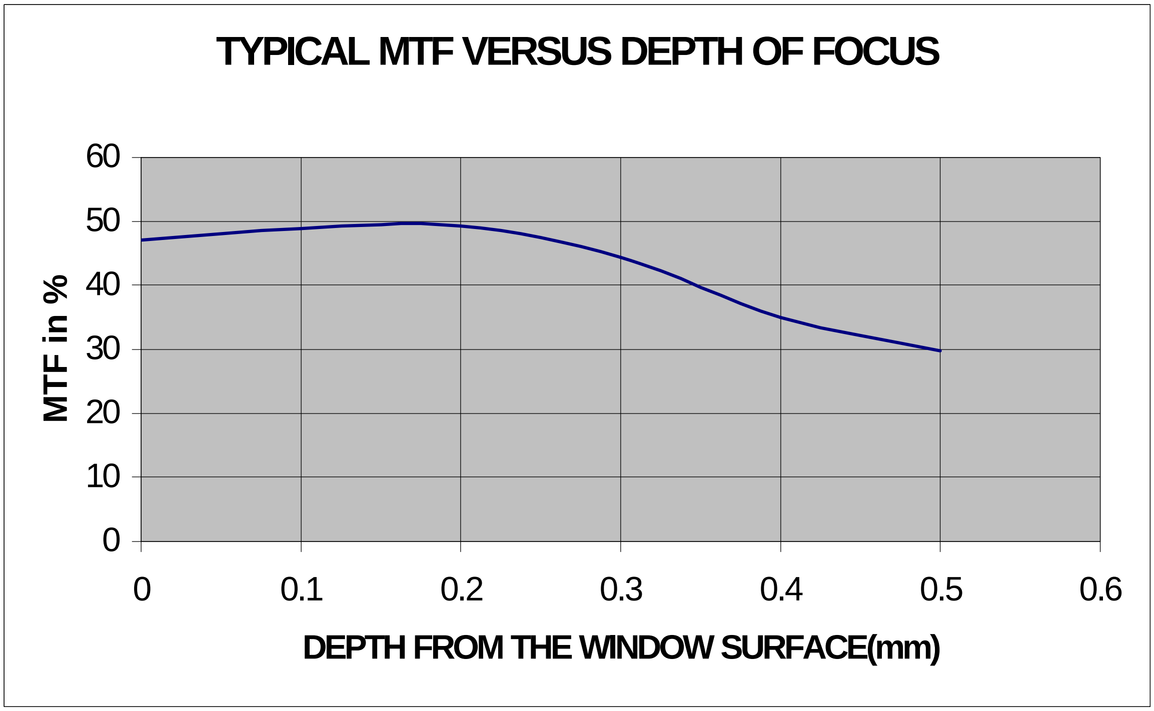


Figure 4. MTF versus Distance

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

MTF={[Vp(n)+Vp(n+1)]/2-[Vp(n+2)+Vp(n+3)]/2}/{[Vp(n)+Vp(n+1)]/2+[Vp(n+2)+Vp(n+3)]/2}

Where n is 1, 2, ...2592th, Vp(n) is the signal amplitude of the nth pixel.

Recommended Operating Conditions (25° C)

Item	Symbol	Min	Mean	Max	Units
Power Supply	Vdd	4.5	5.0	5.5	V
	Vn.	-4.5	-5	-12	V
	VLED		5.0	5.5	V
	Idd(1&2)		35	55	ma
	Ivn (1&2)		6.0	10.0	ma
	ILED		460	600	ma
Input voltage at digital high	Vih	Vdd-1.0	Vdd-.5	Vdd	V
Input voltage at digital low	Vil	0		0.8	V
Clock frequency	f			5.5	MHz
Clock pulse high duty cycle		25			%

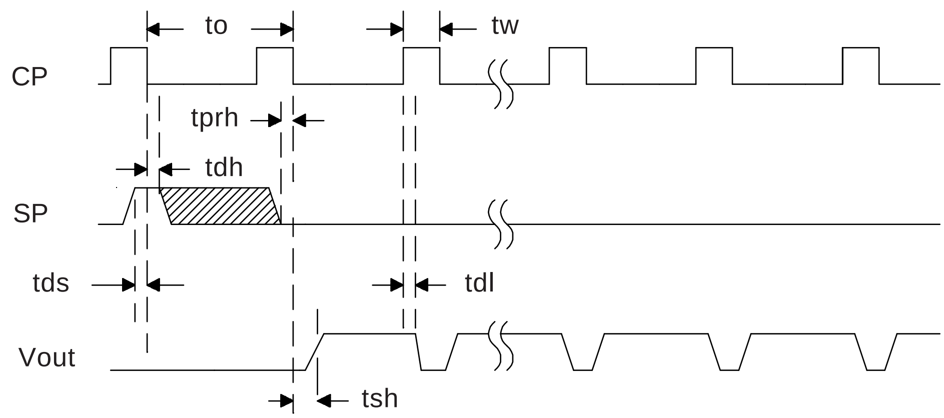
Clock pulse high duration		50			ns
Integration time	Tint(1)	0.270		5.0	ms
Operating temperature	Top		25	50	^{0}C

Note: Minimum Tint is measured with the longest array.

Table 5. Recommended Operating Conditions (25 °C)

Switching Characteristics (25° C)

The timing diagram for both arrays, section 1 and section 2 are shown in Figure 5. Timing Diagram for both Section 1 and Section 2.



MODULE TIMING DIAGRAM

Figure 5. Timing Diagram for both Section 1 and Section 2.

The switching characteristics for the I/O clocks are labeled symbolic acronyms for each corresponding clock's switching edges. The corresponding times for these symbols are given in the following Table 6.

Item	Symbol	Min.	Typical	Max.	Units
Clock cycle time	to	0.20		4.0	µs
Clock pulse width	tw	50			ns
Clock duty cycle		25		75	%
Prohibit crossing time of Start Pulse	tprh	15			ns
Data setup time	tds	20			ns
Data hold time	tdh	20			ns
Signal delay time	tdl	50			ns
Signal settling time	tsh	120			ns

Table 6. Symbol Definitions for the Timing Diagram

PI324MC-A4 Module and Its Mechanical Dimensions

Figure 6 is an overview drawing of the module. If a detailed drawing is desired, especially for a design in application, a full size drawing is available upon request.

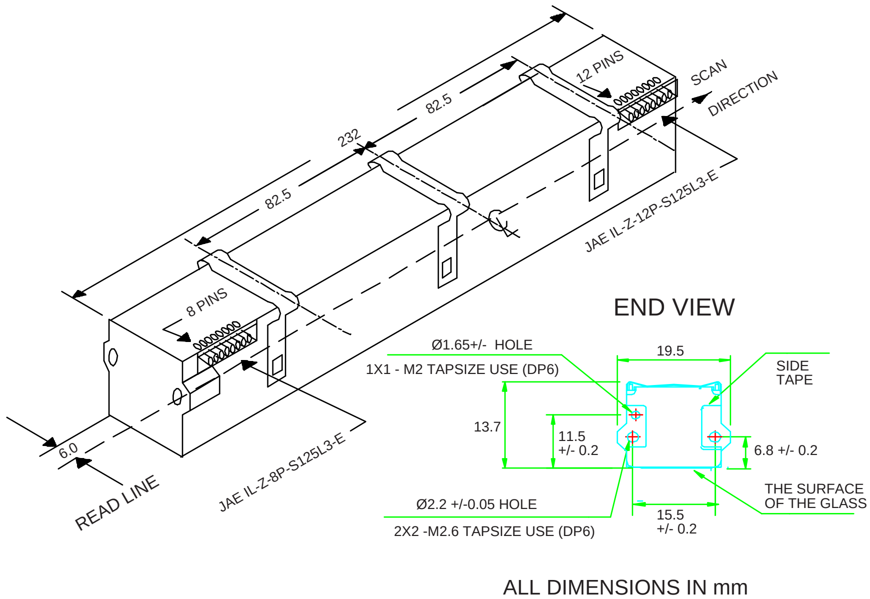


Figure 6. Mechanical Overview of the Module