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## PI216MC-DR 200DPI CIS Two Level Digital Output Module Engineering Data Sheet

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### Key Features

- Light source, lens, and sensor are integrated into a single module
- 8 dpm resolution, 88 mm scanning length
- Up to 176  $\mu$ sec/line scanning speed, with 4 MHz pixel rate (See Table 3, Note 3.)
- Wide dynamic range
- Two-Level Tracking Digital Output (“Dynamic Threshold Digitizer”)
- 660 nm light source (other colors available)
- Compact size  $\cong$  13 mm x 25.6 mm x 102 mm
- Low power
- Light weight

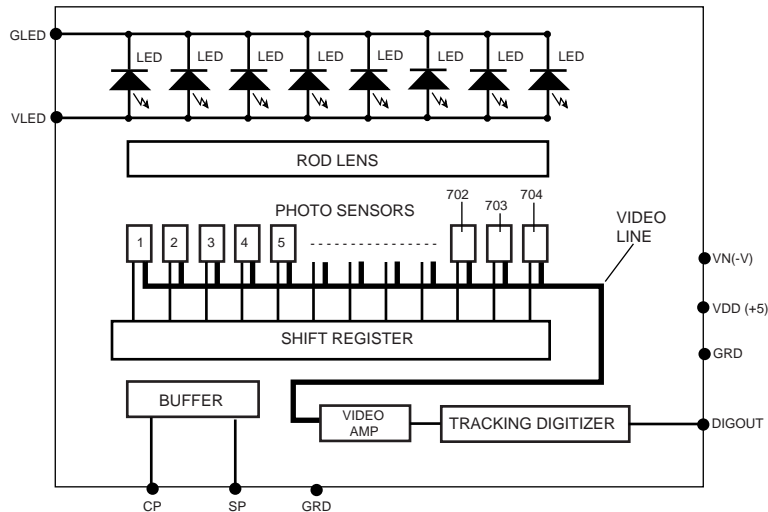
### General Description

The PI216MC-DR is a contact image sensor, CIS, module with an additional on board circuit that digitizes the analog pixels from the CIS image sensor to a “background-tracking”, two-level digital output signal. It is based on CIS module, the PI209M-A6 manufactured by PIC, but with a shorter read length of 88 mm. Hence, its performance is equivalent to the PI209M-A6 that uses MOS image sensor technology to gains its high-speed performance and high sensitivity. The PI216MC-DR is suitable for scanning documents with width of 88 mm and with resolution of 8 dots per millimeter. Its has broad applications, but it was especially designed for the following areas:

- Where data compression is required, such as in data transmissions.
- Where component pin-out count must be kept to a minimum.

The background-tracking-digitizing circuits in the PI216MC-DR have been referred to as the “dynamic threshold” two-level A/D converter. For the purpose of describing the module’s characteristics this “dynamic threshold” processing circuit shall herein be referred to as the “tracking digitizer”.

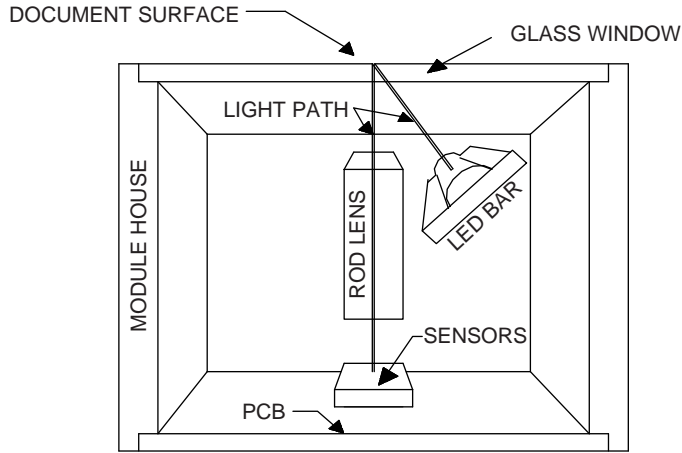
## Module Description



**FIGURE 1. BLOCK DIAGRAM OF PI216MC-DR MODULE**

The PI216MC-DR module consists of 11 sensors that are cascaded to provide 704 photo-detectors with their associated multiplex switches, and a digital shift register that controls its sequential readout. Mounted in the module is one-to-one graded-indexed micro lens array that focuses the scanned documents to image onto its sensing plane. A buffer amplifier amplifies the video pixels from the image sensors and passes them to analog digitizing circuit, where the video pixels are converted to digital signal and passed to output of the module. See Figure 1, the block diagram of the PI216MC-DR module.

Illumination is by means of an integrated LED light source. All components are housed in a small plastic housing with a cover glass which acts as the focal point for the object being scanned and protects the imaging array, the micro lens assembly, and the LED light source from dust. The pictorial of PI216MC-DR cross section is shown in Figure 2.



INSIDE PICTORIAL OF MODULE  
FIGURE 2.

I/O to the module is an 8-pin flex cable connector (See I/O Connector, under Specifications) located on one end of the module. The connector is on the top of the module with the glass window facing down and it is located on the opposite side of the module. See the Mechanical Housing under Mechanical Structure.

### Circuit Description and Operation

See Figure 3 a simplified block diagram of the analog tracking digitizer. Fundamentally, the tracking digitizer transforms the signal output from a CIS module existing on the

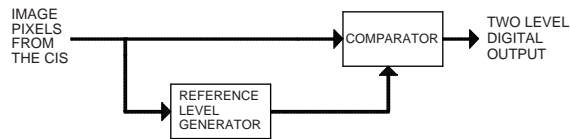


FIGURE 3. ANALOG SIGNAL REFERENCE GENERATOR AND A SINGLE BIT COMPARATOR

market today. It takes the analog signal from the CIS section of PI216MC-DR and derives a tracking background reference signal. Then this reference is compared against the output signals from the CIS section. The resulting signal from the comparison produces a two-level digital signal that is high when the pixel signal is brighter than the background and remains at zero as long as the signal is darker than the background signal.

Figure 1, PI216MC-DR block diagram depicts the two basic circuits, the CIS (image sensors and video amplifier) and the tracking digitizer. In the CIS section, the module has 11 serially concatenated PI3004B image sensors, accordingly, the image sensors will span one scanning-read line width that is 11 sensor times 64 pixel elements/sensor, or 704 pixel elements.

In operation the module produces the analog image pixel signals that are proportional to exposure on the corresponding picture element on the document (the video signal) then passes the signal to the tracking digitizer. In turn, the digitizer processes the analog image pixels to digital image pixels. The analog image pixels, at test point TV, are separated into two signals. One generates the reference signal and the other remains unmodified. These unmodified image pixels are applied to one of the input of the comparator. The reference signal is applied to the second input of the comparator. The results of the comparison are the digital image pixels. This digital output is produced in two levels, determined by the difference between the background reference signal and the analog image pixels. A digital pixel output of value “one” represents the analog image pixel that is brighter than the background and digital pixel level of value “zero” represents the image pixel that is darker than background.

## Specifications

### I/O Connector

The table of pins and their functions are listed in Table I, Pin Configuration.

Pin Number	Symbol	Names and Functions
1	DIGOUT	Digital Video Output
2	Vdd (+5 V)	Ground; 0 V
3	Vn (-5 V)	Negative power supply
4	SP	Start Pulse for the shift register
5	GRD	Ground; 0 V
6	CLOCK	Clock for the shift register
7	GLD	Return for the LED light source
8	VLED	Power in for the LED light source.

Table 1. Pin configuration

The connector is a 8-pin 1-mm surface mount flex input, Molex 52207-0890.

### Inputs:

There are five inputs:

- Clock is on Pin 6 of the I/O Connector. This is main clock input into the CIS Module.
- SP is on Pin 4. This is the start clock input to the CIS Module.

- VDD is on Pin 2. This is a + 5 Volts supply.
- VN is on Pin 3. This is a – 5 Volts supply.
- VLED is on Pin 8. This is a +5 Volts supply for the LED light source.

Note: Power return for the LED light source is GLED on Pin 7 and the ground return for the CIS modules is pin 5.

Video Output:

DIGOUT is on pin 1 of the I/O connector. This is the digital video output from the CIS module. Reflection off the dark target produces a digital signal of “0” level, while the white reflection off the white target produces a digital level of “one”. The amplitudes of the white and dark are listed in the table below:

Electro-Optical Characteristics (25° C)

Table 2. Electro-optical characteristics at 25° C.

Parameter	Symbol	Parameter	Units	Note
Number of photo detectors		704	elements	
Pixel to pixel spacing		125	µm	
Line scanning rate	Tint <sup>(1)</sup>	352	µsec	@ 2.0 MHz clock frequency
Clock frequency	f	2.0	MHz	
Bright output	Digital Video	>3.5	Volts	
Dark output	Output Signal	<0.8	Volts	

(1) The Tint is specified with a 2.0 MHz clock frequency. In operation the time constants in the reference generator is set to match the initial exposure time, hence the time constant will determine the optimum integration time. Note the integration time is also a function of the clock frequency. Accordingly it is highly recommended that the parameters be factory adjust for the specific applications. Although the specification is shown nominally at 2.0 MHz, the maximum clock frequency is 4.0 MHz.

Table 3. Recommended Operating Conditions (25 °C)

Item	Symbol	Min	Mean	Max	Units
Power Supply	Vdd		5.0		V
	Vn.		-5.0		V
	VLED		5 <sup>(1)</sup>		V
	Idd		85		mA
	Ivn		15		mA
	ILED		300		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			4.0	MHz
Clock pulse high duty cycle		25			%

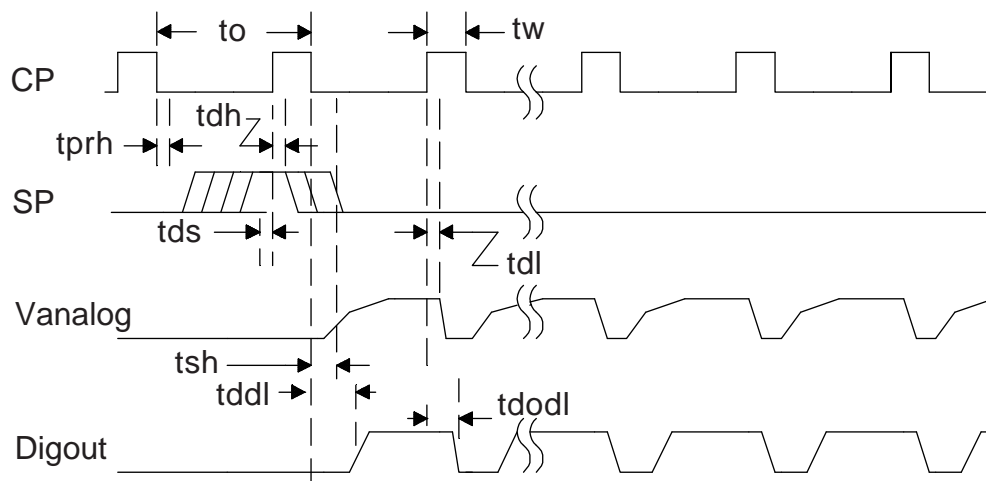
Clock pulse high duration	Clock	62.5 <sup>(2)</sup>			ns
Integration time	Tint	0.176 <sup>(3)</sup>			ms
Operating temperature	Top		25	50	°C

Note:

- (1) VLED sources are also available from 5 to 24 Voltages.
- (2) Clock pulse high is specified at 4.0 MHz at 25% duty.
- (3) The Tint is specified with the maximum 4.0 MHz clock frequency. In operation the time constants in the reference generator is set to match the initial exposure time, hence the optimum integration time will be set by optimum integration time. Accordingly it is highly recommended that the parameters be factory adjust for the specific applications

### Switching Characteristics (25°C)

The switching characteristics for the I/O clocks are shown in Figure 4, Module Timing Diagram. The timing parametric values and their symbols are given in the Table 4.



MODULE TIMING DIAGRAM  
FIGURE 4.

Table 4. Switching Parameter and Timing Symbol Definition

	Symbol	Min.	Typical	Max.	Units
Clock cycle time	$t_o$		0.50		$\mu$ s
Clock pulse width	$t_w$	62.5			ns
Clock duty cycle		25		50	%
Prohibit crossing time of Start Pulse	$t_{prh}$	15			ns
Data setup time	$t_{ds}$	20			ns
Data hold time	$t_{dh}$	20			ns

Signal delay time	tdl	50			ns
Signal settling time	tsh			120	ns
Digital Signal Delay	tddl		60		ns
Digital Signal Off Delay	tdodl		20		ns

Table 5 Absolute Maximum Rating:

Parameter	Symbols	Maximum Rating	Units
Power supply voltage	Vdd	10	V
	Idd	100	mA
	Vn	-10	V
	In	30	mA
	VLED	5.5	V
	ILED	400	mA
Input clock pulse (high level)	Vih	Vdd – 0.5	V
Input clock pulse (low level)	Vil	-0.8	V

Table 6 Operating Environment

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

## Setup and Adjustments

### The Clock Rate and Integration Time:

This was factory set to a specific application. See note 1 under Table 2, Electro-optical characteristics at 25° C.

The clock frequency was set to 2.0 MHz.

The total integration time was set to 360 µsec.

### The Required Power.

The required power is slightly greater than the specified values in Table 3.

#### Circuit Power:

Positive Supply: +5 Volts @ 90 mA

Negative Supply: -5 Volts @ 20 mA

LED Power: +5 Volts @ 300 mA

## Adjustments

### General Location of Test, Adjustment and Monitor Points

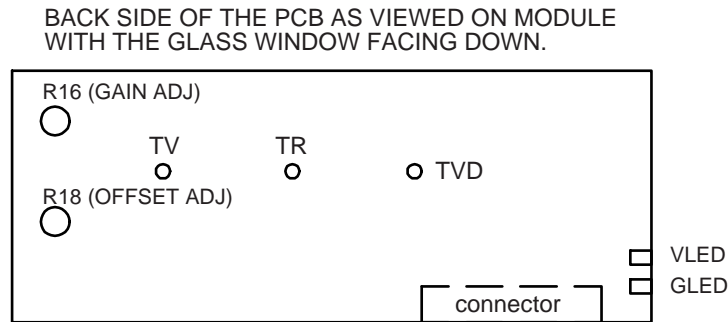


FIGURE 5. PI216MC-DR PCB MONITOR AND TEST POINTS

Figure 5, PI216MC-DR PCB MONITOR AND TEST POINTS, shows the pictorial layout of the controls and the tests points. These adjustment potentiometers and the test points are shown relative to the connector and to the output pads for LED light power. This is a bird's eye view of the PCB's backside with the glass window of the module facing down on the documents.

Test point labeled TV is for the analog image pixels, just as it is produced at the output of the CIS array section, and prior to its entry into the tracking digitizer circuit.

Test point labeled TR is the output of the tracking reference level from the tracking digitizer circuit.

Test point labeled TVD is the digital output from the comparator.

Offset adjust, R18, is a screw driver adjustment potentiometer that is accessed through adjustment hole as viewed in figure 5.

Gain adjust, R16, is a screw driver adjustment potentiometer that is accessed through the hole as it is viewed in figure 5.

#### There are only two adjustments:

These adjustments will be pre-adjusted to the customer's specific application at the factory, therefore, in general will not require adjustments by the user. Test point TV is probed with a scope to monitor the analog image pixel levels. The probe should be



grounded as close to the CIS module as possible. If possibly right on the ground input lead, pin 5, of the I/O connector.

Analog Zero signal adjust (OFFSET ADJ) as it is shown in Figure 5. This pot is adjusted to place the dark level of the analog image pixel signal to approximately 1.0 Volts. Normally adjusted with intended targets.

Analog Gain adjust, "GAIN", is adjusted greater than 2.5 and less then 3.0 Volts with the CIS imaged on a standard white target similar to the standard white copy or typing paper.

### Mechanical Structure

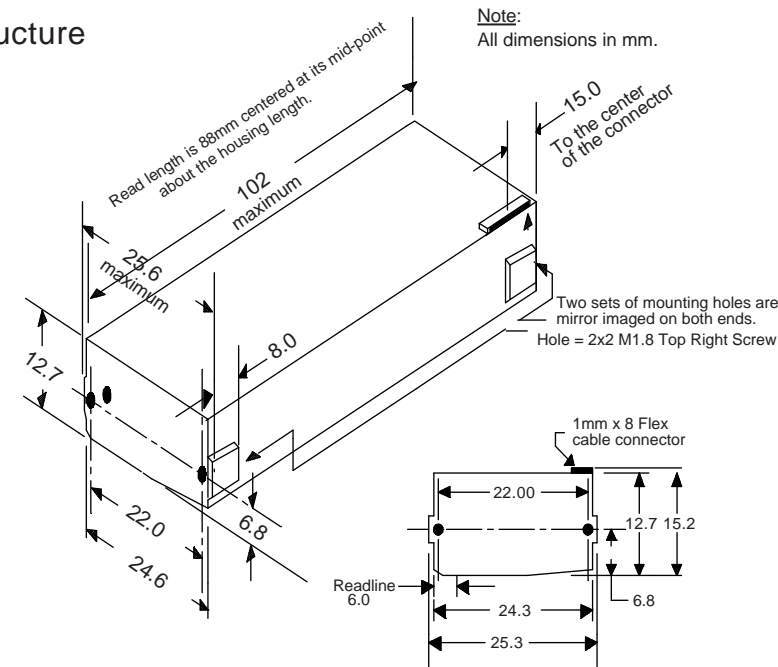


FIGURE 6. MECHANICAL STRUCTURE

Figure 6 is pictorial of the PI216MC-DR. It shows the mechanical dimensions of the housing and its mounting hole locations.

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