NOM04A4-MR11G

600/400/300/200 DPI Ultra High-Speed Contact Image Sensor Module

ON Semiconductor®

www.onsemi.com

IMAGE SENSOR
MODULE A4
CASE MODBS

Description

The NOM04A4−MR11G contact image sensor (CIS) module integrates dual red LED light sources, lens and image sensor in a compact housing. The module is designed for document scanning, mark reading, gaming and office automation equipment applications and is suitable for scanning documents up to 216 mm wide. Three parallel analog video outputs are used to achieve an ultra high−speed scanning rate of 86.4 μsec/line at 400 dpi. The NOM04A4−MR11G module employs proprietary CMOS image sensing technology from ON Semiconductor to achieve high−speed performance and high sensitivity.

Features

- Light Source, Lens and Sensor are Integrated into a Single Module
- 600/400/300/200 dpi Selectable Resolution
- 216 mm Scanning Width
- 86.4 μsec/line Scanning Speed for 400 dpi @ 16.0 MHz Clock Speed
- Three Parallel Analog Video Outputs with Integrated Amplifiers
- Supports A4 Paper Size
- Dual Red LED Illumination Light Guides
- Wide Dynamic Range
- Single 3.3 V Power Supply
- Low Power
- Compact 248 mm x 34.5 mm x 25 mm Dust−free Module Housing
- Light Weight 4.8 oz Packaging
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Mark Readers including Gaming, Balloting and Test Scoring Machines
- Document Scanning
- Office Automation Equipment

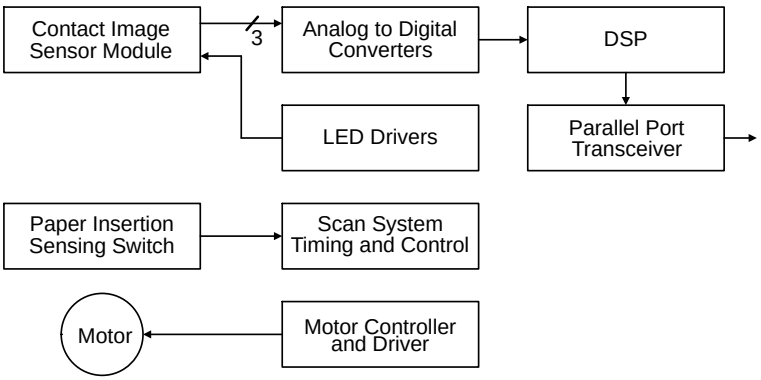
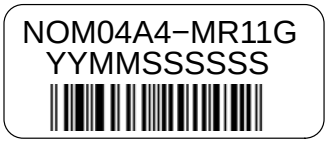


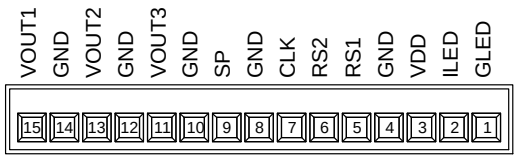
Figure 1. Typical Scanner Application

TAG MARKING



YY = Year
MM = Month
SSSSSS = Serial Number

CONNECTOR PIN ASSIGNMENT



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

© Semiconductor Components Industries, LLC, 2016

Table 1. ORDERING INFORMATION

Part Number	Package	Shipping Configuration	Temperature Range
NOM04A4−MR11G	MODBS (Pb−free)	100 per Packing Carton	0°C to 50°C

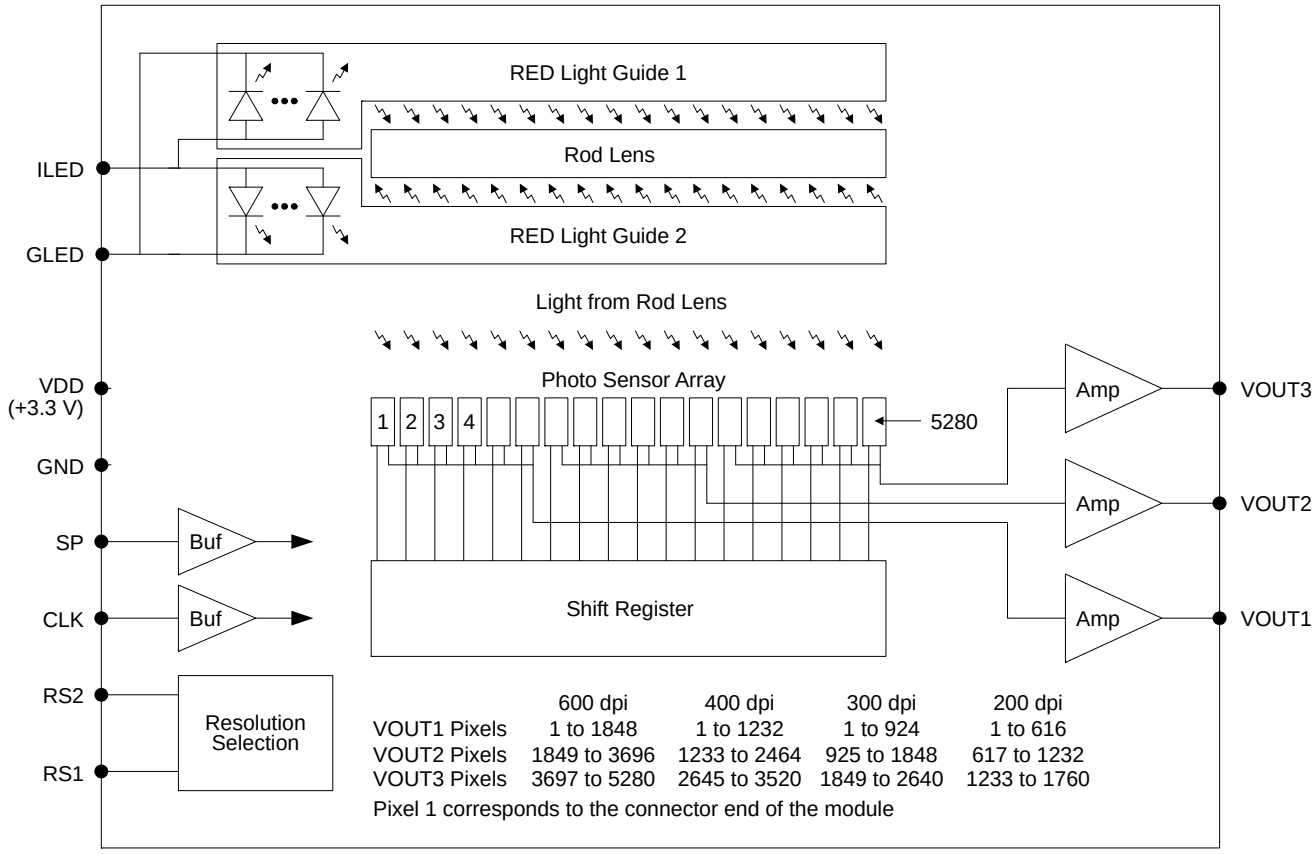


Figure 2. Simplified Block Diagram

Table 2. PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description
1	GLED	Common cathodes (ground) for the LED light source
2	ILED	Common anodes for the LED light source
3	VDD	+3.3 V power supply
4	GND	Ground
5	RS1	Resolution Select 1
6	RS2	Resolution Select 2
7	CLK	Clock Input
8	GND	Ground
9	SP	Shift Register Start Pulse
10	GND	Ground
11	VOUT3	Analog Video Output 3
12	GND	Ground
13	VOUT2	Analog Video Output 2
14	GND	Ground
15	VOUT1	Analog Video Output 1

Table 3. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Power supply voltage	VDD	4	V
	VLED	7	V
Power supply current	ILED	150	mA
Input voltage range for SP, CLK	V_{in}	−0.5 to Vdd+0.5	V
Storage Temperature	T_{STG}	−20 to 75	°C
Storage Humidity, Non−Condensing	H_{STG}	10 to 90	%
ESD Capability, Contact Discharge (Note 1)	ESD_{HBM}	±2	kV

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. This module assembly has been ESD tested to IEC61000−4−2 (HBM) Contact Discharge.

Table 4. RECOMMENDED OPERATING RANGES (Unless otherwise specified, these specifications apply T_A = 25°C) (Note 2)

Parameter	Symbol	Min	Typ	Max	Unit
Power supply voltage (Note 3)	VDD	3.1	3.3	3.5	V
	VLED			6	V
Power supply current	I_{DD}			600	mA
	I_{LED}			120	mA
Low level input voltage for SP, CLK	V_{IL}	−0.3	0	0.6	V
High level input voltage for SP, CLK	V_{IH}	2.8	VDD	VDD + 0.3	V
Line scanning rate, 600 dpi (Note 4)	T_{int_600}	124.9			μs
Line scanning rate, 400 dpi (Note 4)	T_{int_400}	86.4			μs
Line scanning rate, 300 dpi (Note 4)	T_{int_300}	67.2			μs
Line scanning rate, 200 dpi (Note 4)	T_{int_200}	47.9			μs
Clock frequency (Note 5)	f	0.5		16.0	MHz
Clock period (Note 6)	t_o	62.5		2000	ns
Clock pulse width (Note 6)	t_w	31.25			ns
Clock pulse high duty cycle (Note 7)	DC_{CLK}	45	50	55	%
Start pulse setup time (Notes 6, 8)	t_{su}	20			ns
Start pulse hold time	t_h	25			ns
CLK rise time (Notes 6, 9)	t_{r_CLK}			31.25	ns
CLK fall time (Notes 6, 9)	t_{f_CLK}			31.25	ns
Start pulse rise time (Notes 6, 9)	t_{rSP}			31.25	ns
Start pulse fall time (Notes 6, 9)	t_{fSP}			31.25	ns
Pixel sample time (Notes 10, 11)	TS				ns
Resistive load on VOUT (Note 11)	R_L	50			kΩ
Capacitive load on VOUT (Note 11)	C_L			130	pF
Operating Temperature	T_{op}	0		50	°C
Operating Humidity, Non−Condensing	H_{op}	10		60	%

2. Refer to Figure 4 for more information on AC characteristics
3. VLED directly affects illumination intensity, which directly affects VOUT.
4. Tint is the line scanning rate or integration time. Tint is determined by the interval between two start pulses. The clock is proportional to Tint.
5. Main clock frequency (f) corresponds to the video sampling frequency.
6. Assumes a 50% duty cycle.
7. Defined as the ratio of the positive duration of the clock to its period.
8. The shift register loads on the falling edge of CLK, therefore setup and hold times (tsu, th) are needed to prevent loading of multiple start pulses. This would occur if SP remains high during two fallings edges of the CLK signal. See Figure 4.
9. Clock rise time should match clock fall time. Maximum rise/fall times correspond to slower clock frequencies.
10. Pixel should be sampled when output is stable between falling and rising edge of the clock, system dependent.
11. Applies to VOUT1, VOUT2 and VOUT3 which have identical electrical characteristics.

Table 5. PHYSICAL SPECIFICATIONS

Parameter	Symbol	Typ	Unit
Scan width	PD_w	216	mm
Number of Photo Detector Arrays	PDA_n	20	arrays
Number of Photo Detectors, 600 dpi	PD_{n_600}	5280	elements
Number of Photo Detectors, 400 dpi	PD_{n_400}	3520	elements
Number of Photo Detectors, 300 dpi	PD_{n_300}	2640	elements
Number of Photo Detectors, 200 dpi	PD_{n_200}	1760	elements
Number of Photo Detectors for VOUT1, VOUT2, VOUT3, 600 dpi	$PD_{n1,2,3\_600}$	1848/1848/1584	elements
Number of Photo Detectors for VOUT1, VOUT2, VOUT3, 400 dpi	$PD_{n1,2,3\_400}$	1232/1232/1056	elements
Number of Photo Detectors for VOUT1, VOUT2, VOUT3, 300 dpi	$PD_{n1,2,3\_300}$	924/924/792	elements
Number of Photo Detectors for VOUT1, VOUT2, VOUT3, 200 dpi	$PD_{n1,2,3\_200}$	616/616/528	elements

Table 6. SPECIFICATIONS

Parameter	Symbol	Min	Typ	Max	Unit
Pixel pitch, 600 dpi	PD_{sp_600}		42.33		μm
Pixel pitch, 400 dpi	PD_{sp_400}		63.45		μm
Pixel pitch, 300 dpi	PD_{sp_300}		84.60		μm
Pixel pitch, 200 dpi	PD_{sp_200}		127		μm
Inter−array spacing	PDA_{sp}	150	180	210	μm
Inter−array vertical alignment	PDA_{vxp}	−40	0	40	μm
Red LED peak wavelength	λ_p	610	640	670	nm

Table 7. ELECTRO−OPTICAL CHARACTERISTICS TEST CONDITIONS

Parameter	Symbol	Value	Unit
Power supply voltage	VDD	3.3	V
Power supply current	ILED	120	mA
Clock frequency	f	16.0	MHz
Clock pulse high duty cycle	DC_{CP}	50	%
Line scanning rate (400 dpi)	T_{int}	86.5	μs
Resistive load on VOUT (Note 12)	R_L	50	kΩ
Capacitive load on VOUT (Note 13)	C_L	150	pF
Average output voltage swing (Note 14)	V_{avg}	1.0	V
Operating Temperature	T_{op}	25	°C

12. Resistive load connected between VOUT and VREF. VREF typically has a lower noise level than VSS.
13. Capacitive load connected between VOUT and VSS.
14. The average output voltage Vavg is defined as the voltage difference between the average pixel level in the light and the average pixel level in the dark. It should be adjusted to approximately 1.0 V by adjusting the LED intensity, unless stated otherwise.

Table 8. ELECTRO−OPTICAL CHARACTERISTICS
(Unless otherwise specified, these specifications were achieved with the test conditions defined in Table 7)

Parameter	Symbol	Min	Typ	Max	Unit
Bright analog output voltage (Note 15)	V_{pavg}	2.0	2.1	2.2	V
Bright output non−uniformity (Note 16)	U_p	−35		35	%
Bright output non−uniformity total (Note 17, 18)	U_{ptotal}			70	%
Adjacent pixel non−uniformity (Note 19)	U_{padj}			35	%
Reference voltage output	V_{ref}	1.0	1.1	1.2	V
Dark output voltage (Note 20)	V_d	V_{ref} − 0.1	V_{ref}	V_{ref} + 0.1	V
Dark non−uniformity (Note 21)	U_d			250	mV
VOUT dark subtracted (Note 22)	V_{ds}	0.9	1.0	1.1	V
Individual rms pixel noise, 400 dpi (Note 23)	N_p			15	mV
Modulation transfer function at 100 line pairs per in (lp/in) (400 dpi) (Note 24)	MTF_{400}	40			%

15. Vpavg = Σ Vp(n)/3520 for 400 dpi, where
    Vp is the pixel amplitude value of VOUT in volts for a bright signal defined as a white document with LEDs turned on,
    n is the sequential pixel number in one scan line.
16. Up = [(Vpmax – Vpavg)/Vpavg] x 100%, or [Vpavg – Vpmin)/Vpavg] x 100%, whichever is greater, where
    Vpmax is the maximum pixel voltage of any pixel at full bright
    Vpmin is the minimum pixel voltage of any pixel at full bright
17. Uptotal = [(Vpmax – Vpmin)/Vpavg] x 100%.
18. Uptotal specification exclusion TBD.
19. Upadj = MAX [| (Vp(n) – Vp(n+1) | / Vp(n)] x 100%, where
    Upadj is the nonuniformity in percent between adjacent pixels for a bright background
20. Vd is the pixel amplitude value of VOUT in volts for a dark signal defined as a black document with LEDs turned off
21. Ud = Vdmax – Vdmin, where
    Vdmax is the maximum pixel voltage of any dark pixel with the LEDs turned off
    Vdmin is the minimum pixel voltage of any dark pixel with the LEDs turned off
22. The difference of Vpavg and Vd
23. Individual rms pixel noise is defined as the standard deviation of each pixel in the dark. This parameter is measured at the sensor output and can be considered output referred noise.
24. MTF = [(Vmax – Vmin)/(Vmax + Vmin)] x 100%, where
    Vmax is the maximum output voltage at the specified line pairs per inch (lp/in)
    Vmin is the minimum output voltage at the specified lp/in

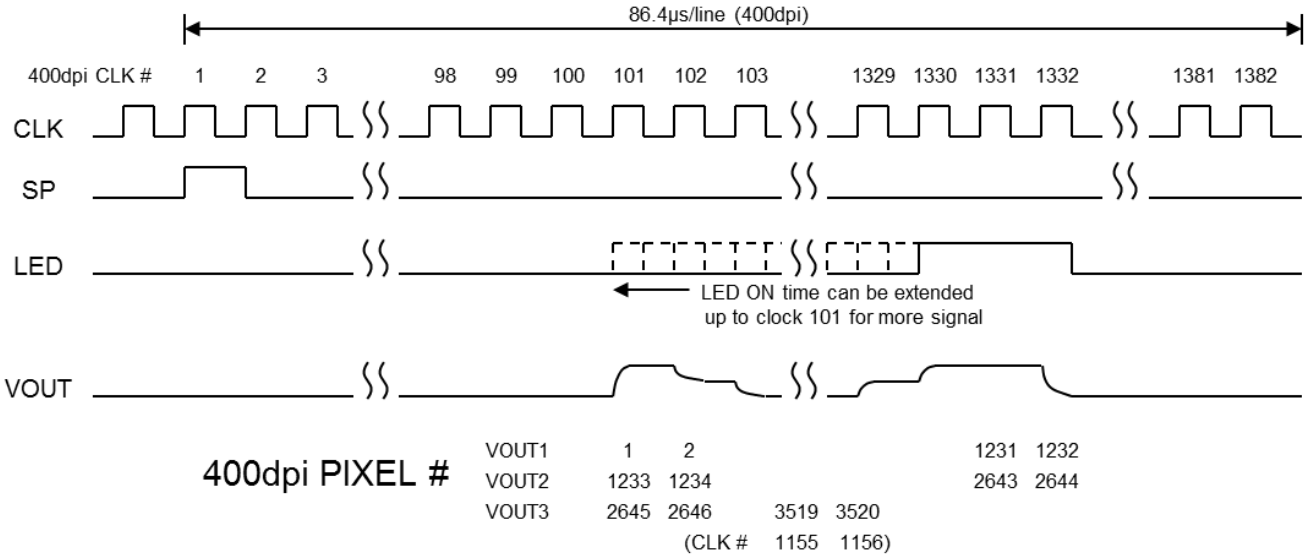


Figure 3. Overall Timing Diagram for 600/400/300/200 dpi Modes

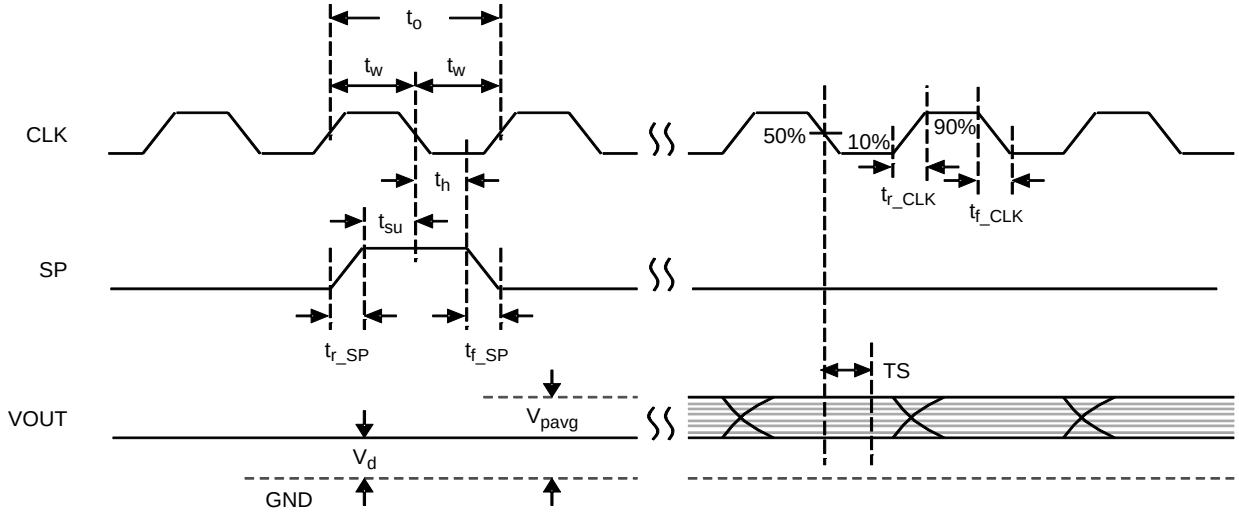


Figure 4. Rise and Fall Times for 600/400/300/200 dpi Modes

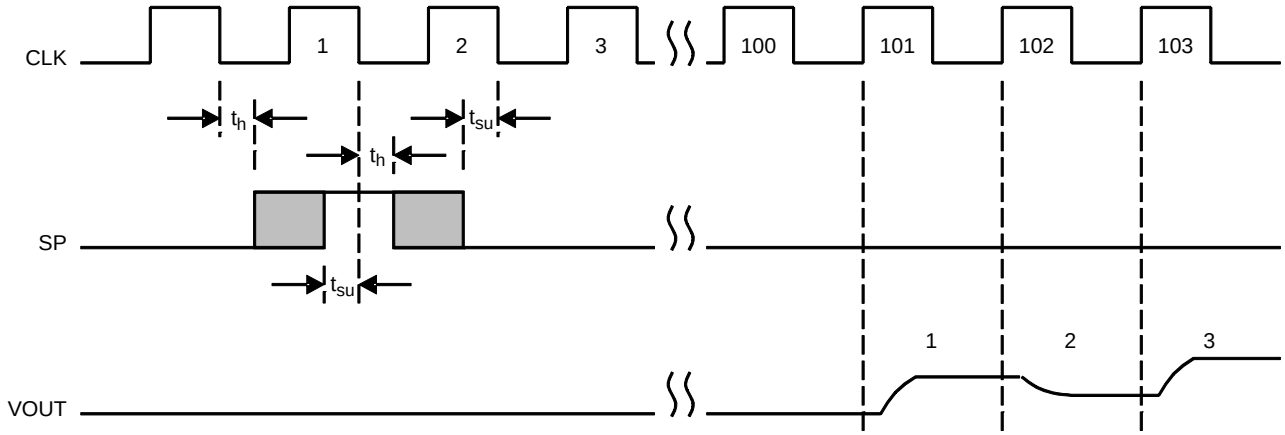


Figure 5. SP Timing to the First Pixel for 600/400/300/200 dpi Modes

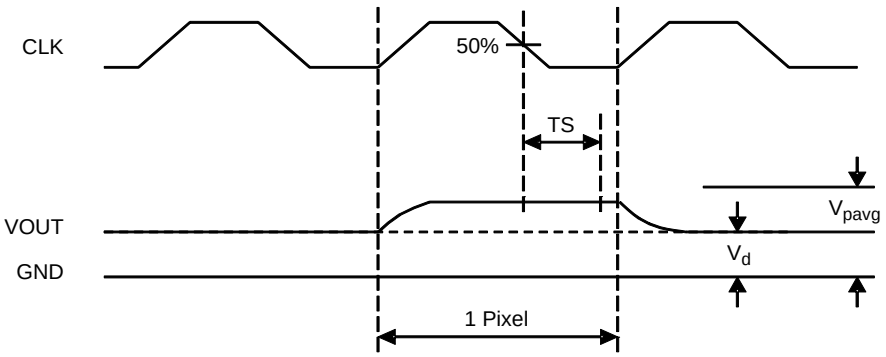


Figure 6. Pixel Timing for 600/400/300/200 dpi Modes

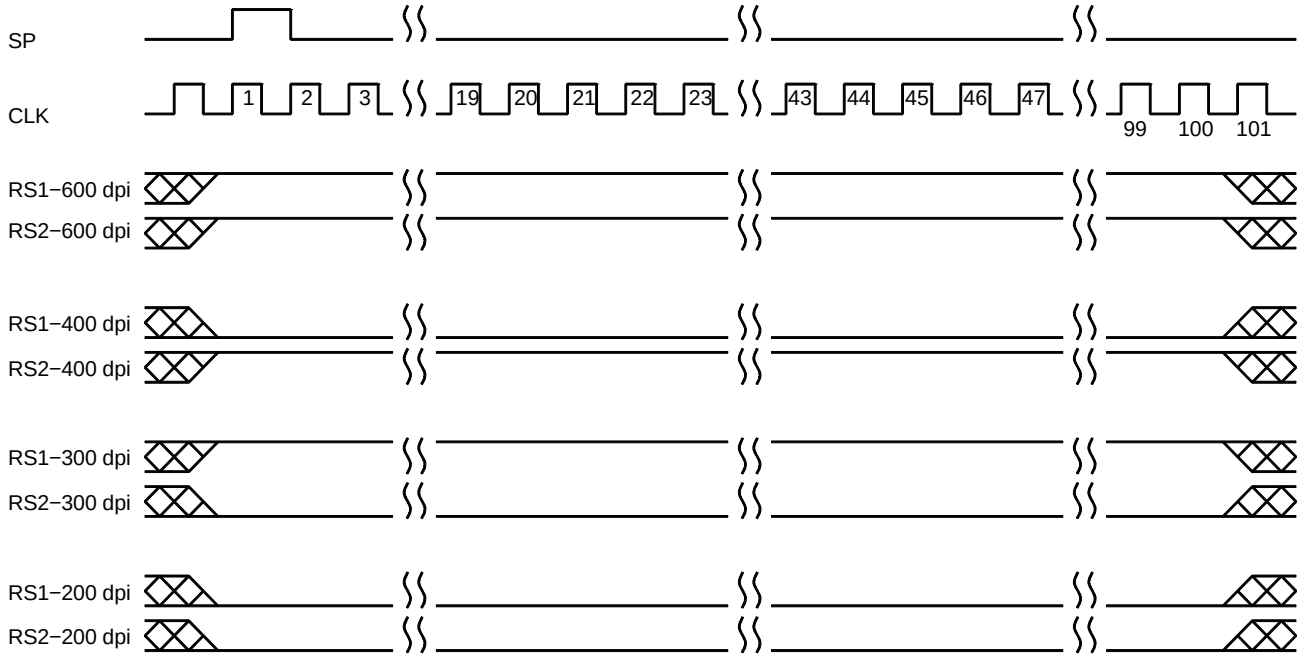


Figure 7. Resolution Selection

Description of Operation

Functional Description

The NOM04A4−MR11G module consists of 20 contact image sensors, each with 264/176/132/88 effective pixel elements, that are cascaded to provide 5280/3520/2640/1760 total effective photo−detectors with their associated multiplex switches and three double−buffered digital shift registers that control its sequential readout. Three buffer amplifiers amplify the video pixels from the image sensors and output the three analog video signals of the module as shown in Figure 2.

In operation, the sensors produce analog voltage signals for each image pixel proportional to the exposure on the corresponding picture elements on the document. VOUT1 and VOUT2 have 7 chips for each section while VOUT3 has 6 chips. The first analog value shifted out from VOUT1 during each scan represents the first pixel on the connector end of the module.

A pictorial of the NOM04A4−MR11G cross section view is shown in Figure 8. Mounted in the module is a one−to−one graded−index micro lens array that focuses the scanned document image onto the sensing plane. Illumination is accomplished by means of the integrated dual LED light guide sources. All components are housed in a small plastic housing, which has a glass cover. The top surface of the glass acts protects the imaging array, micro lens assembly and LED light guide source from dust. The black paint under the glass has been added to reduce the amount of stray light that could have been introduced to the sensors due to light reflections and system setup.

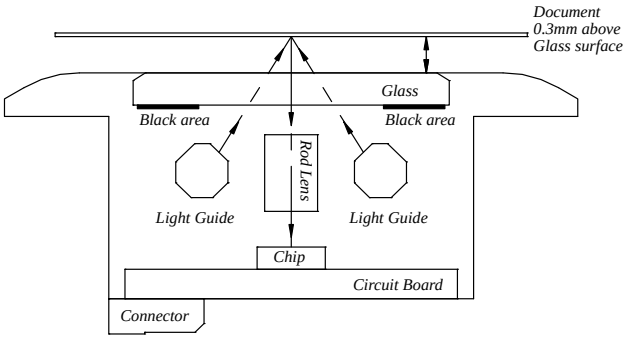


Figure 8. Module Cross Section View

Module Timing Considerations

Figure 3 shows the initialization of the module scan line for the 600 dpi, 400 dpi, 300 dpi and 200 dpi modes. The scan line cycle starts when SP is captured on the falling edge of the clock input (CLK). During the first 100 clock cycles following the SP pulse, all the image sensor pixels cycle through their pre−scan initialization process that reduces FPN and reset noise. During this process VOUT1, VOUT2 and VOUT3 each clock out 100 inactive pixels before the first active pixel is clocked out. There needs to be 50 clocks between when the last pixel has been read out and the next SP signal goes high.

Figure 4 and Figure 5 detail the timing of the CLK, SP, and VOUT signals in further detail, they have the same timing requirements for the 600, 400, 300 and 200 dpi modes. The

rise and fall times are listed in Table 4. In Figure 5, note that clock 101 is the first active pixel, as the first 100 clocks produce dummy pixels (the output of the first 100 clocks should not be used for any purpose such as black level clamping).

The analog VOUT signals are internally sampled on the rising edge of clock and latched by hold circuits on the falling edge of clock. The application should sample the VOUT signals when the signals are stable between the falling and rising edge of clock as shown in Figure 6.

Selective Resolution

The select resolution inputs RS1 and RS2 are used to select between 600/400/300/200 dpi modes. Resolution changes must be made prior to the SP pulse and held constant during the first 100 clocks as shown in Figure 7.

- 600 dpi, RS1 is held high (VDD) and RS2 is held high (VDD)
- 400 dpi, RS1 is held low (VSS) and RS2 is held high (VDD)
- 300 dpi, RS1 is held high (VDD) and RS2 is held low (VSS)
- 200 dpi, RS1 is held low (VSS) and RS2 is held low (VSS)

Resolution changes must be made prior to the SP pulse & hold constant during the first 100 clocks.

Connector Pin Out Description

Connections to the module are via a 2.9 x 17mm 15−pin connector (JST part number SM15B−SRSS−TB(LF)(SN)) located at one end of the module as shown in the package drawing on page 11. The location of pin number 1 is indicated on the package drawing.

Scanner Applications

A typical use of the NOM04A4−MR11G module in scanner applications is shown in Figure 10. The document to be digitized is fed into the scanner where a sensor detects its presence. The scanner then operates the motor to move the paper under the contact image sensor module. The module illuminates the paper with internal LEDs and the image sensor pixel array detects the amount of reflected light and simultaneously measures a full line of pixels which are sampled and transferred to a FIFO for storage and conversion to a parallel output format. Once the pixel line is processed, the motor advances the paper and the next scan line is captured.

Figure 9 outlines the basic steps in the scanner control sequence. First the circuits are initialized and the scanner waits for a document to be detected, usually by a paper sensing switch. Then a start pulse and 100 clock pulses are supplied to capture a line image. At the next clock pulse the first pixel value appears on the output. The pixel can be stored in a local line buffer memory. Subsequent clocks cause the remaining pixels to be shifted out and stored in the line buffer. Once the complete line has been shifted out it can be transferred to the host application and the system advances the paper and the line scan process repeats until the paper sensing switch indicates the document has passed completely through the scanner.

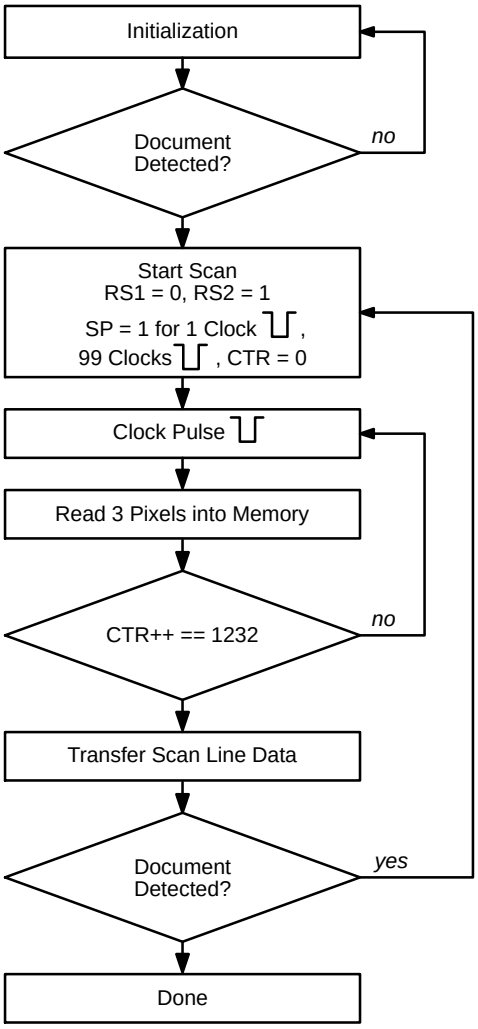


Figure 9. Typical Scanner Algorithm (400 dpi)

Device Marking and Barcode Description

Each module is marked with a tag that contains the part number, a number combining the manufacturing date code and serial number and a barcode. The barcode presents the date code and serial number in Interleave 2 of 5 barcode format as follows

YYMMSSSSSS

where YY is the year,
MM is the month, and
SSSSSS is the serial number.

Glass Lens Care

Precautions should be taken to avoid scratching or touching the glass lens. The glass lens may be cleaned with alcohol.

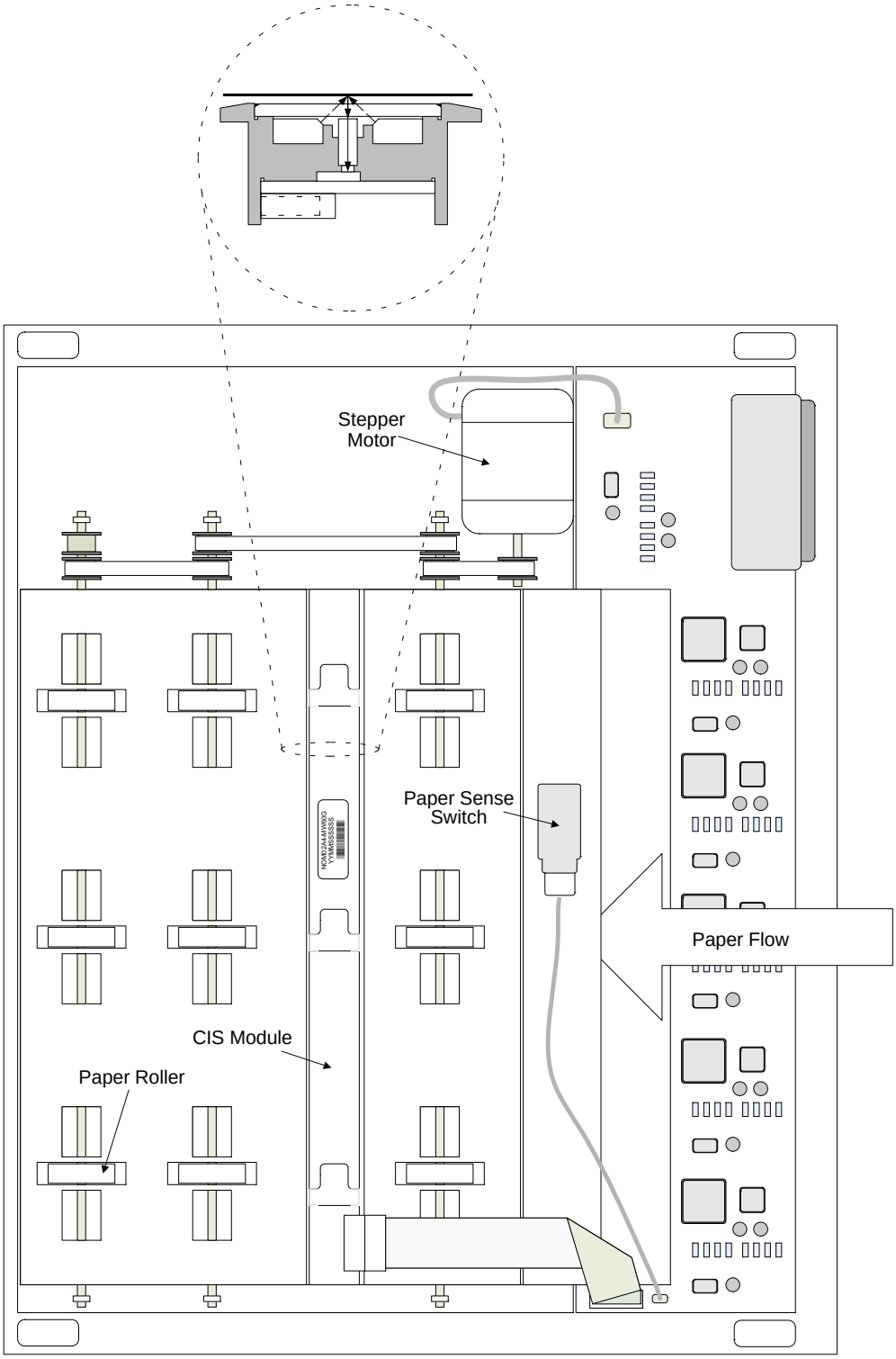
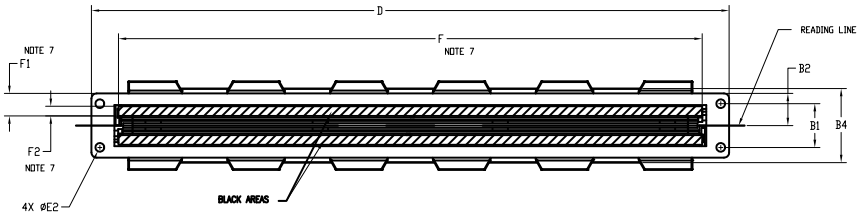


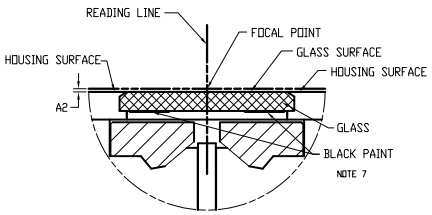
Figure 10. Typical Scanner Assembly

PACKAGE DIMENSIONS

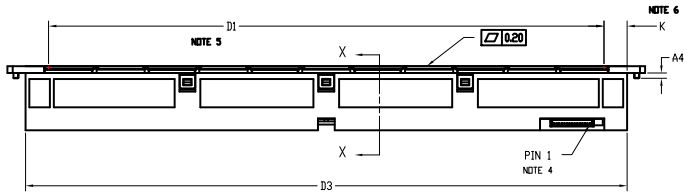
IMAGE SENSOR MODULE
CASE MODBS
ISSUE O



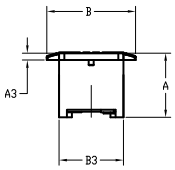
TOP VIEW



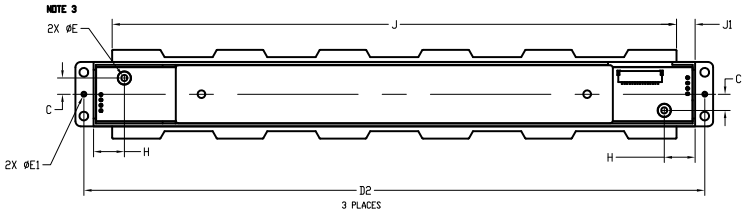
DETAIL A



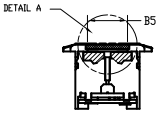
SIDE VIEW



END VIEW



BOTTOM VIEW



SECTION X−X

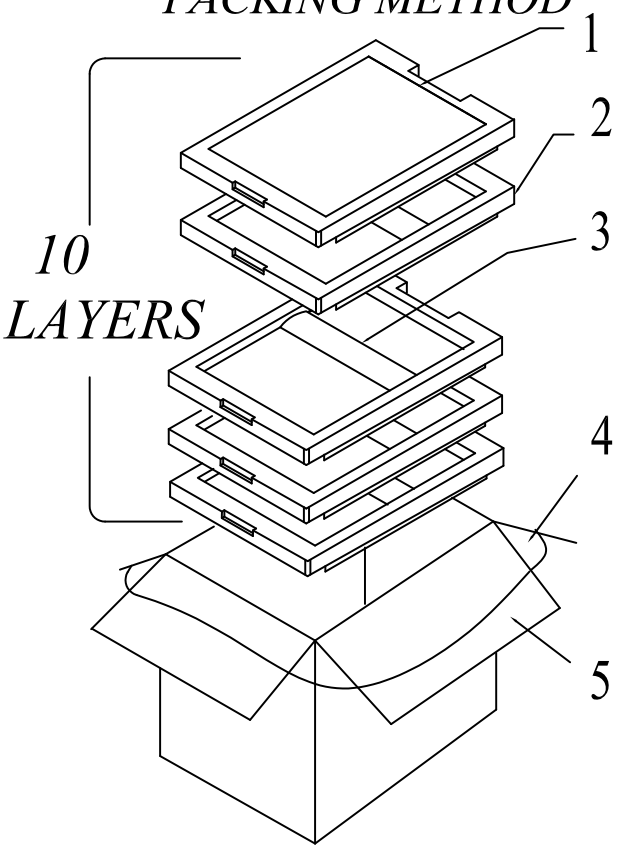
DIM	MILLIMETERS	
	MIN.	MAX.
A	24.65	25.35
A2	0.30 REF	
A3	2.65	2.75
A4	1.70	2.30
B	34.20	34.80
B1	16.90	17.10
B2	12.20	12.80
B3	24.70	25.30
B4	28.50	29.10
B5	15.60 REF	
C	6.10	6.50
D	247.50	248.50
D1	215.00	217.00
D2	241.30	241.70
D3	233.50	234.50
E	2.30	2.50
E1	1.60	1.90
E2	3.30	3.50
F	226.70	227.30
F1	8.30	9.30
F2	3.50	4.10
H	11.80	12.20
J	219.50 REF	
J1	7.25 REF	
K	8.50	9.50

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. BORE DEPTH IS 5.00 ±1.00.
4. CONNECTOR JST SM15B-SRSS-TB OR EQUIVALENT, 1 X 15 PIN, PITCH 1.00.
5. DIMENSION D1 DENOTES THE SCAN LENGTH.
6. DIMENSION K DENOTES THE POSITION OF THE FIRST PIXEL.
7. DIMENSIONS F, F1, AND F2 DENOTE THE POSITION OF BLACK PAINT ADDED TO REDUCE THE AMOUNT OF STRAY LIGHT THAT MIGHT REACH THE SENSORS.

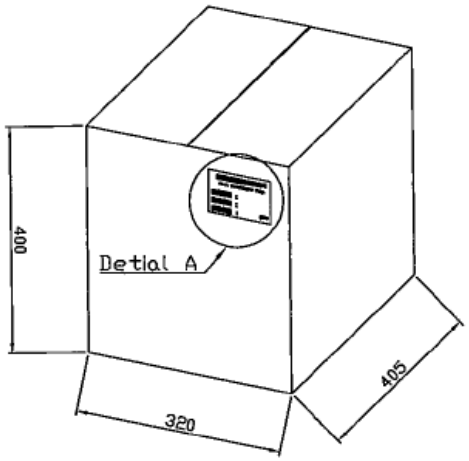
NOM04A4−MR11G

PACKING DIMENSIONS

PACKING METHOD



PACKING COMPLETE



NO.	*NAME*	*MATERIAL*
1	*Shockproof Pad*	*EPE*
2	*Packing Tray*	*POLYFOAM*
3	*Conduct Electricity Sheet*	*PE + CONDUCTIVE SHEET*
4	*Waterproof Bag*	*PE*
5	*Packing Box−Carton*	*KRAFT PAPER*

ON Semiconductor and ON are trademarks of Semiconductor Components Industries, LLC dba ON Semiconductor or its subsidiaries in the United States and/or other countries. ON Semiconductor owns the rights to a number of patents, trademarks, copyrights, trade secrets, and other intellectual property. A listing of ON Semiconductor's product/patent coverage may be accessed at www.onsemi.com/site/pdf/Patent−Marking.pdf. ON Semiconductor reserves the right to make changes without further notice to any products herein. ON Semiconductor makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does ON Semiconductor assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation special, consequential or incidental damages. Buyer is responsible for its products and applications using ON Semiconductor products, including compliance with all laws, regulations and safety requirements or standards, regardless of any support or applications information provided by ON Semiconductor. "Typical" parameters which may be provided in ON Semiconductor data sheets and/or specifications can and do vary in different applications and actual performance may vary over time. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. ON Semiconductor does not convey any license under its patent rights nor the rights of others. ON Semiconductor products are not designed, intended, or authorized for use as a critical component in life support systems or any FDA Class 3 medical devices or medical devices with a same or similar classification in a foreign jurisdiction or any devices intended for implantation in the human body. Should Buyer purchase or use ON Semiconductor products for any such unintended or unauthorized application, Buyer shall indemnify and hold ON Semiconductor and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that ON Semiconductor was negligent regarding the design or manufacture of the part. ON Semiconductor is an Equal Opportunity/Affirmative Action Employer. This literature is subject to all applicable copyright laws and is not for resale in any manner.

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
19521 E. 32nd Pkwy, Aurora, Colorado 80011 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5817−1050

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative