NOM02A6-AR77G

200/100DPI Ultra High-Speed Contact Image Sensor Module

ON Semiconductor®

http://onsemi.com

IMAGE SENSOR MODULE A4
CASE MODBJ

Description

The NOM02A6−AR77G contact image sensor (CIS) module integrates a red LED light source, lens and image sensor in a compact housing. The module is designed for gaming, lottery tickets, mark reading and office automation equipment applications and is suitable for scanning documents up to 103 mm wide. The analog video output achieves an ultra high−speed scanning rate of 163 μsec/line. The NOM02A6−AR77G module employs proprietary CMOS image sensing technology from ON Semiconductor to achieve high−speed performance and high sensitivity.

Features

- Light Sources, Lens and Sensor are Integrated Into a Single Module
- 103 mm Scanning Width at 7.9/15.8 dots per mm Resolution
- 163 μsec/Line Scanning Speed for 200 dpi @ 5.5 MHz Pixel Rate
- Integrated Amplifier with Analog Video Output
- Supports A6 Paper Size at up to 318 pages per Minute
- Red LED Illumination Light Guide
- Wide Dynamic Range
- Compact 124.0 mm x 21.0 mm x 12.0 mm Module Housing
- Single 3.3 V Module Power Supply
- Low Power
- Light Weight 1.1 oz Packaging
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

- Gaming Machines and Lottery Tickets
- Mark Readers Including Balloting and Test Scoring
- Office Automation Equipment

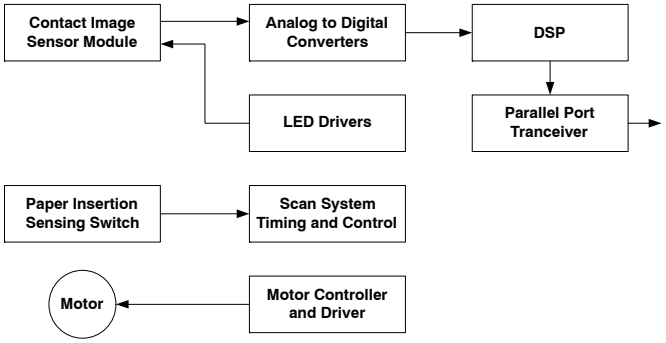
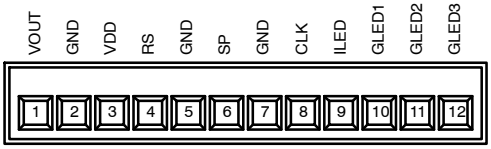


Figure 1. Typical Scanner Application

MARKING DIAGRAM

YY	= Year
MM	= Month
SSSSSS	= Serial Number
G	= Pb−Free Package

CONNECTOR PIN ASSIGNMENT



ORDERING INFORMATION

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

Table 1. ORDERING INFORMATION

Part Number	Package	Shipping Configuration
NOM02A6−AR77G	(Pb−Free)	160 per packing carton

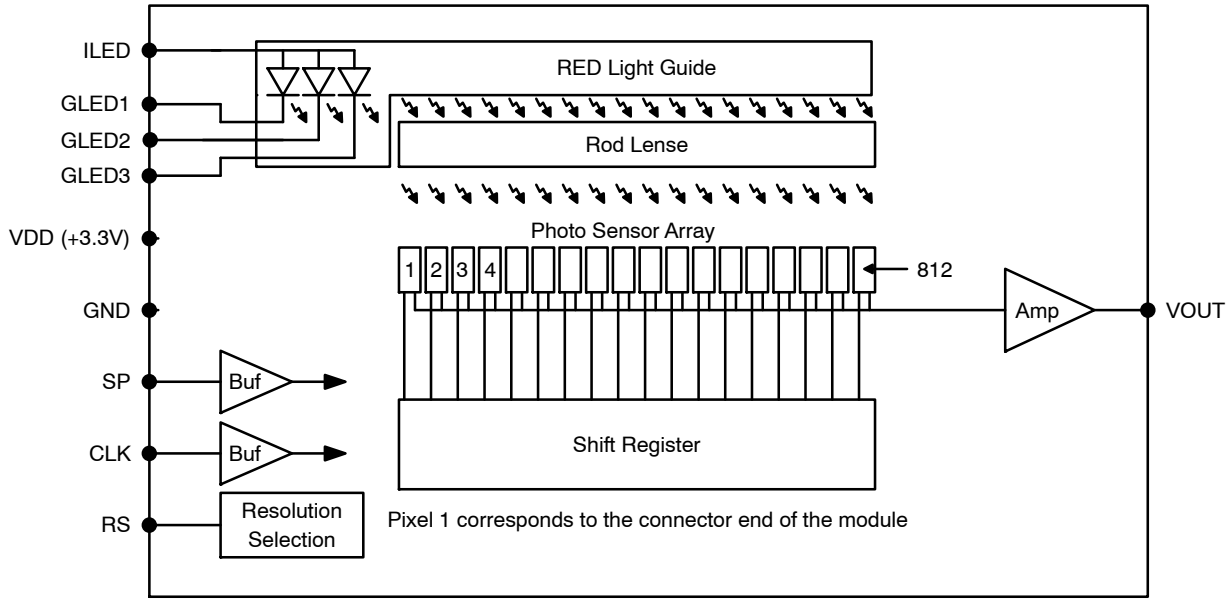


Figure 2. Simplified Block Diagram

Table 2. PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description
1	VOUT	Analog video output
2	GND	Ground
3	VDD	Power supply (+3.3 V)
4	RS	Resolution select control, hold high (VDD) for 200 dpi, hold low (Ground) for 100 dpl
5	GND	Ground
6	SP	Shift register start pulse
7	GND	Ground
8	CLK	Clock input
9	ILED	Common anodes for all red LEDs
10	GLED1	Cathode RED LED 1
11	GLED2	Cathode RED LED 2
12	GLED3	Cathode RED LED 3

Table 3. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Power supply voltage	V_{DD}	4	V
Power supply current	I_{DD}	17.4	mA
	I_{LED}	75	mA
Input voltage range for SP, CLK, RS	V_{in}	−0.2 to V_{DD} + 0.2	V
Storage Temperature	T_{STG}	−25 to 75	°C
Storage Humidity, Non−Condensing	H_{STG}	10 to 90	%
ESD Capability, Contact Discharge (Note1)	ESD_{HBM}	±2	kV

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

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)	V_{DD}	3.1	3.3	3.5	V
Power supply current	I_{DD}		14.5		mA
	I_{LED}			60	mA
Reference voltage (Note 4)	V_{REF}	1.10	1.20	1.30	V
Low level input voltage for SP, CLK, RS	V_{IL}			0.6	V
High level input voltage for SP, CLK, RS	V_{IH}	2.8	VDD	VDD + 0.2	V
Line scanning rate (Note 5)	T_{int}		0.163	2.0	ms
Clock frequency (Note 6)	f	0.5	5.5	6.0	MHz
Clock period	t_o	166.7	182	2000	ns
Clock pulse width (Note 7)	t_w	83.35	91	1000	ns
Clock pulse high duty cycle	DC_{CP}	40	50	60	%
Data setup time	t_{su}	20			ns
Data hold time	t_h	25			ns
Clock rise time	t_{r_CLK}	83.35		250	ns
Clock fall time	t_{f_CLK}	83.35		250	ns
Start pulse rise time	t_{r_SP}	83.35		250	ns
Start pulse fall time	t_{f_SP}	83.35		250	ns
Pixel rise time	P_{rt}			110	ns
Operating Temperature	T_{op}	0		50	°C
Operating Humidity, Non−Condensing	H_{op}	10		60	%

2. Refer to Figures 4, 5 and 6 for more information on AC characteristics
3. VDD directly affects illumination intensity, which directly affects VOUT.
4. VREF is fixed internally to control the dark video output bias level
5. Tint is the line scanning rate or integration time. Tint is determined by the interval between two start pulses.
6. Main clock frequency (f) corresponds to the video sampling frequency.
7. Min, Typ, Max specifications reflect operation at the corresponding Min, Typ, Max clock frequency.

Table 5. PHYSICAL SPECIFICATIONS

Parameter	Symbol	Typ	Unit
Scan width	PD_w	103	mm
Number of Photo Detector Arrays	PDA_n	7	arrays
Number of Photo Detectors	PD_{n_200}	812	elements
	PD_{n_100}	406	elements

Table 6. PHYSICAL CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Pixel pitch	PD_{sp}		126.9		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		640		nm

Table 7. ELECTRO−OPTICAL CHARACTERISTICS TEST CONDITIONS

Parameter	Symbol	Value	Unit
Power supply voltage	VDD	3.3	V
Power supply current	I_{LED}	60	mA
Clock frequency	f	5.5	MHz
Clock pulse high duty cycle	DC_{CP}	50	%
Line scanning rate	T_{int}	163	μs
Operating Temperature	T_{op}	25	°C

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 8)	V_{pavg}	2.4	2.5	2.6	V
Bright output non−uniformity (Note 9)	U_p	−35		+35	%
Bright output non−uniformity total (Note 10)	U_{ptotal}			70	%
Adjacent pixel non−uniformity (Note 11)	U_{padj}			35	%
Dark output voltage (Note 12)	V_d	1.1	1.2	1.3	V
Dark non−uniformity (Note 13)	U_d			200	mV
VOUT dark subtracted (Note 14)	V_{ds}	1.2	1.3	1.4	V
Individual pixel noise (rms) (Note 15)	N_p			10	mV
Image lag (Note 16)	IL			1	%
Modulation transfer function at 50 line pairs per in (lp/in) (Note 17)	MTF_{50}	40			%
Modulation transfer function at 100 line pairs per in (lp/in) (Notes 17 and 18)	MTF_{100}	20			%

8. Vpavg = $\sum$ Vp(n)/812 for 200dpi, 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.
9. Up = MAX [(Vpmax − Vpavg) / Vpavg x 100%], [(Vpavg − Vpmin) / Vpavg x 100%]
10. Uptotal = [(Vpmax − Vpmin)/Vpavg] x 100%,
11. 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
12. Vd is the pixel amplitude value of VOUT in volts for a dark signal defined as a black document with LEDs turned off
13. 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
14. Vds = Vpavg − Vd, where
    Vpavg is the average pixel level in the light
    Vd is the average pixel level in the dark.
    It should be adjusted to approximately 1.3 V by adjusting the LED intensity, unless stated otherwise.
15. Dark noise voltage is defined as the average of the standard deviation of each pixel at 200 scan lines in the dark
16. Image lag is defined as taking two subsequent line scans where the first readout occurs when the sensor is illuminated such that the imager output voltage is in saturation and the second readout occurs with zero irradiance falling on the sensor. For information only.
17. 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
18. For information only.

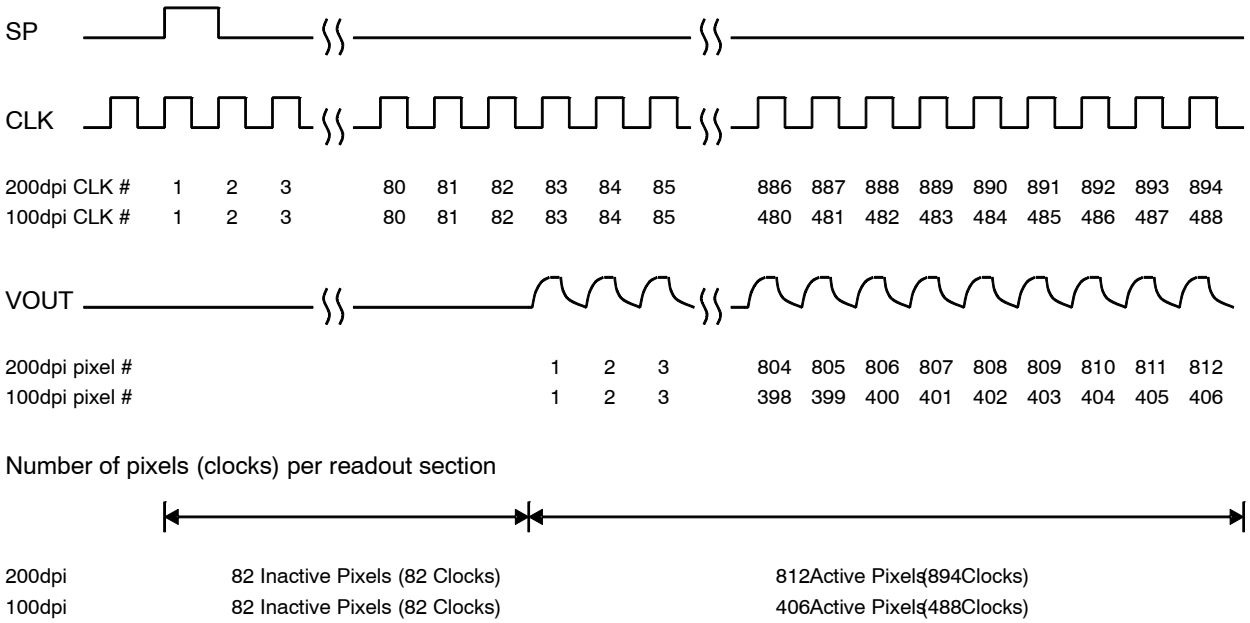


Figure 3. Overall Timing Diagram for 200/100 dpi Modes

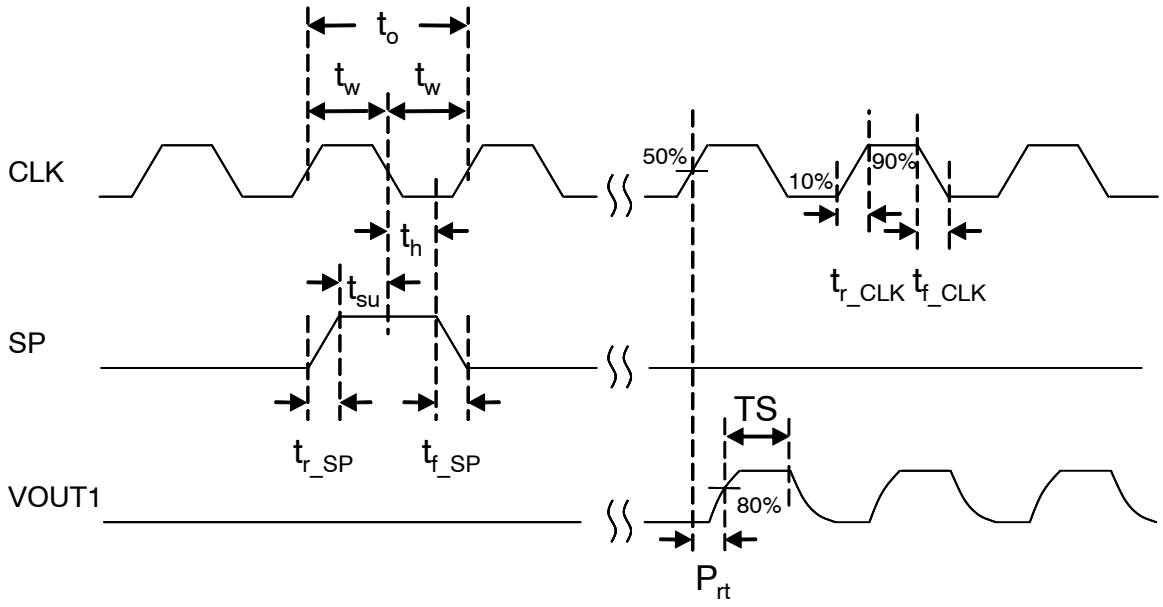


Figure 4. Rise and Fall Timing for 200/100 dpi Modes

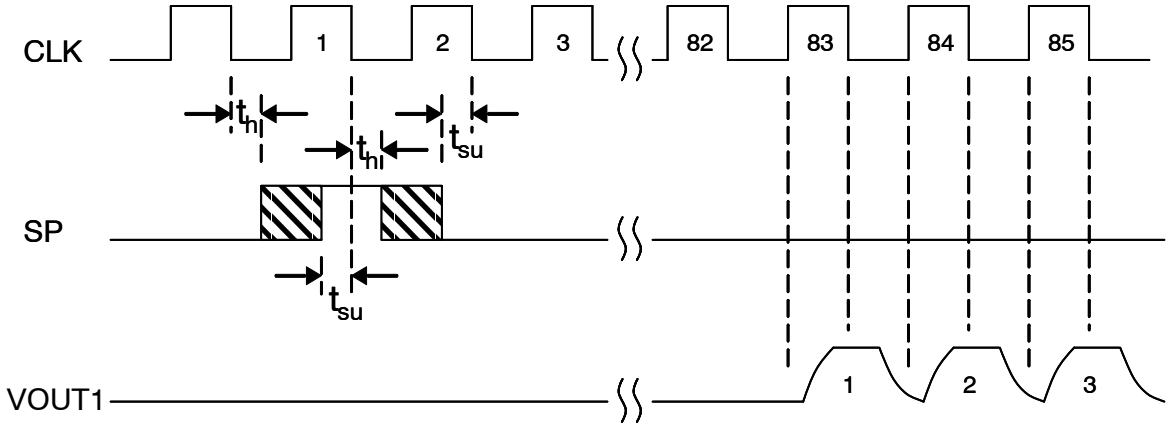


Figure 5. Timing of SP to First Pixel Sensor for 200/100dpi Modes

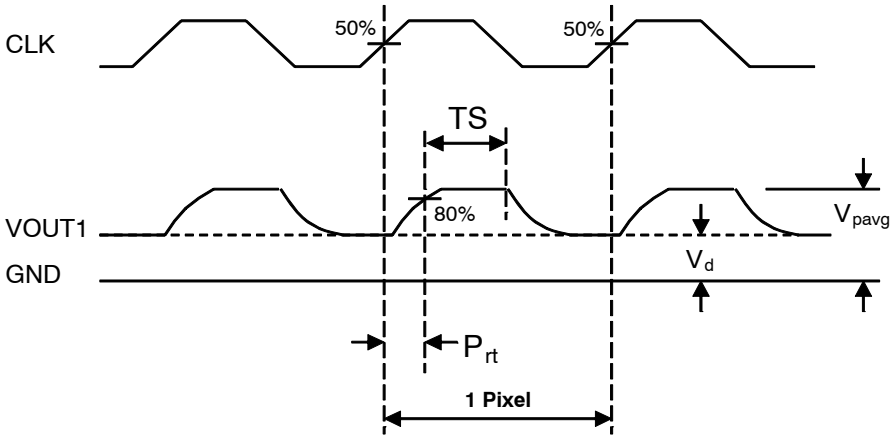


Figure 6. Pixel Timing for 200/100 dpi Modes

DESCRIPTION OF OPERATION

Functional Description

The NOM02A6−AR77G module consists of seven contact image sensors, each with 116 pixel elements arranged for 200 dpi operation or 58 pixel elements arranged for 100 dpi operation. The sensors are cascaded to provide 812 or 406 photo−detectors with their associated multiplex switches and a double−buffered digital shift register that control its sequential readout. A buffer amplifier amplifies the video pixels from the image sensors and outputs an analog video signal from the module as shown in Figure 2. In operation, the sensors produce analog image pixel signals (or video signals) proportional to the exposure on the corresponding picture elements on the document. The VOUT signal outputs 812 or 406 pixels for each scan line. As will be explained in more detail, 82 clock cycles are required to initialize a line scan. The first valid pixel is shifted out from VOUT on the 83rd clock cycle during each scan represents the first pixel on the other end of the module from the connector.

A pictorial of the NOM02A6−AR77G cross section view is shown in Figure 7. 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 integrated red LED light guide source. All components are housed in a small plastic housing, which has a glass cover. The top surface of the glass acts as the focal point for the object being scanned and protects the imaging array, micro lens assembly and LED light guide source from dust.

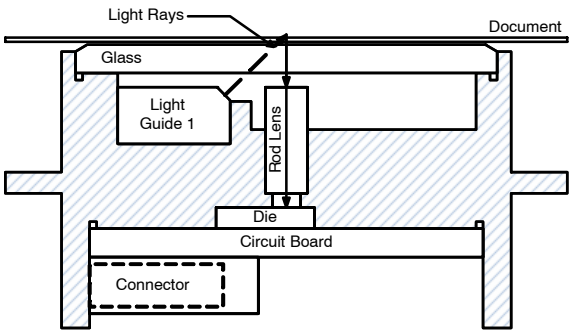


Figure 7. Module Cross Section View

Power Saving Mode

The NOM02A6−AR77G incorporates an internal power−saving feature. When a particular sensor is selected for read out, the sensor powers up the output amplifier and then powers it down when the read scan is completed.

Selective Resolutions

The resolution select input (RS) is used to select between 200 and 100 dpi modes.

- For 200 dpi, the RS input is held high (VDD)
- For 100 dpi, the RS input is held low (Vss)

In 200 dpi mode, all 812 pixels are clocked out. In the 100 dpi mode, pixels 1 and 2 are combined, 3 and 4 are combined and so on up to pixels 811 and 812 being combined. This will give a net pixel count of 406 pixels.

In the 100 dpi mode, one half of the pixel amplifiers and one half of the scanning register are disabled when compared to the 200 dpi mode. As a result, sensitivity in the 100 dpi mode will be twice that of the 200 dpi mode. The dpi readout time will be approximately half of the 200 dpi readout time. Unlike a CCD array, the 200 dpi and 100 dpi modes all operate at the same clock frequency.

Module Timing Considerations

Figure 3 shows the initialization of the module for the 200 dpi and 100 dpi modes. The scan line starts when SP is captured on the falling edge of the clock input (CLK). During the first 82 clock cycles following the SP pulse, all image sensor pixels cycle through their pre−scan initialization process that reduces FPN and reset noise. Hence the module will clock out 82 inactive pixels before its first active pixel is clocked out.

Figure 4 and 5 detail the timing of the CLK, SP and VOUT signals in further detail, they have the same timing requirements for the 200 and 100 dpi modes. The rise and fall times are listed in Table 5. In Figure 5, note that clock 83 is the first active pixel, as the first 82 clocks produce dummy pixels (the output of the first 82 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.

Connector Pin Out Description

Connections to the module are via a 3.5 x 16.75 mm 12−pin connector (Bison Advanced Technology part number 98441−12123) located at one end of the module as shown in the package drawing on page 10. The location of pin number 1 is indicated on the package drawing.

Scanner Applications

A typical use of the NOM02A6−AR77G module in scanner applications is shown in Figure 9. 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.

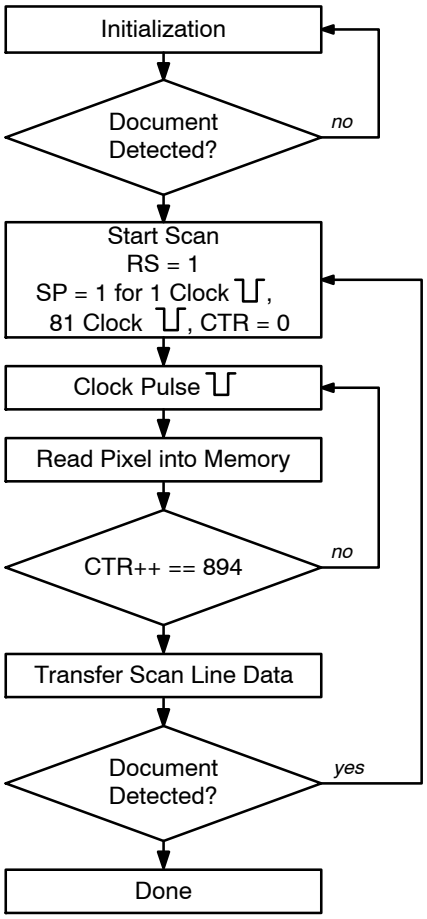


Figure 8. Typical Scanner Algorithm

Figure 8 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 global start pulse and series of clock pulses are supplied to capture a line image. After the appropriate number of clock pulses 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.

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.

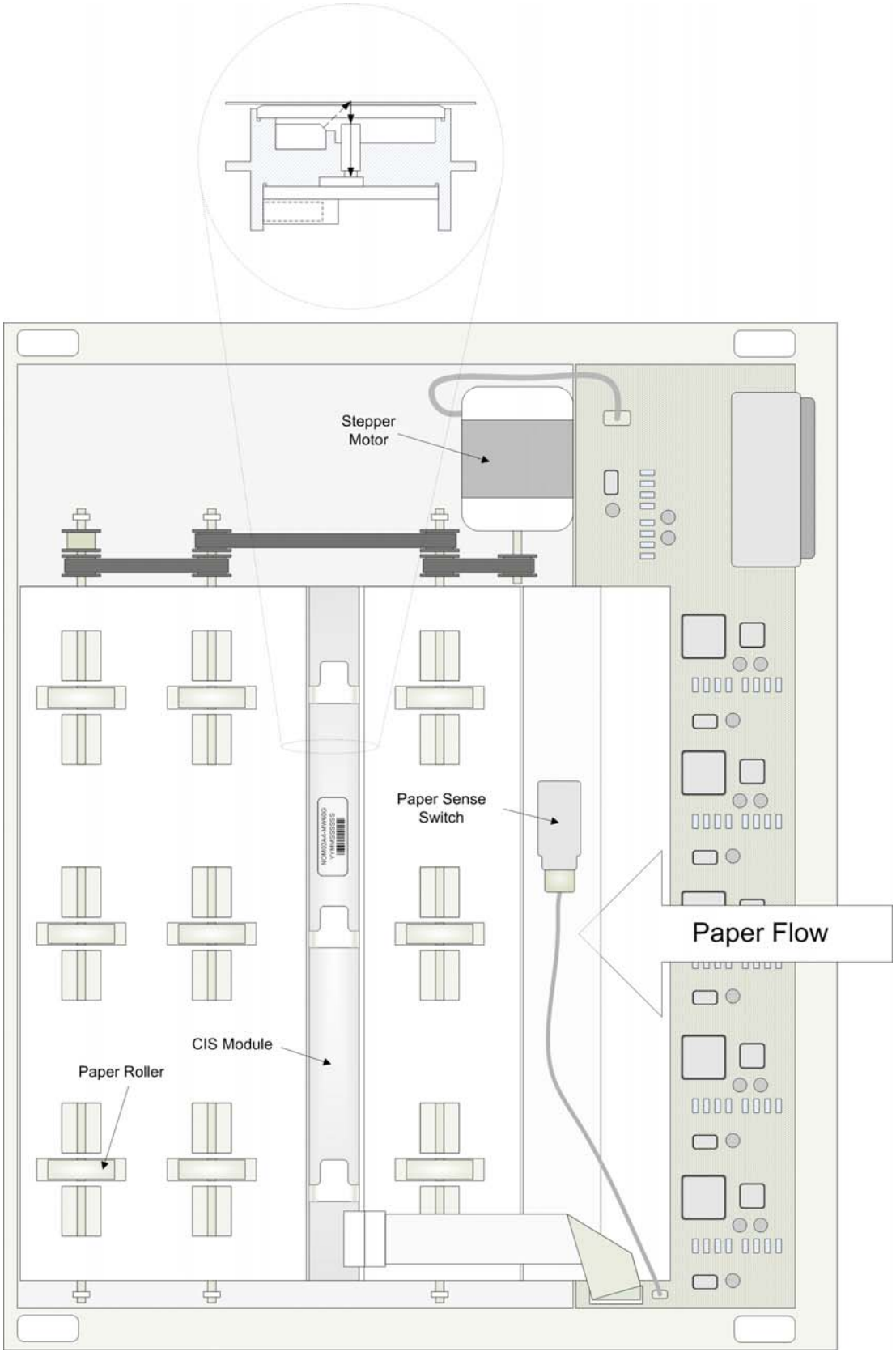
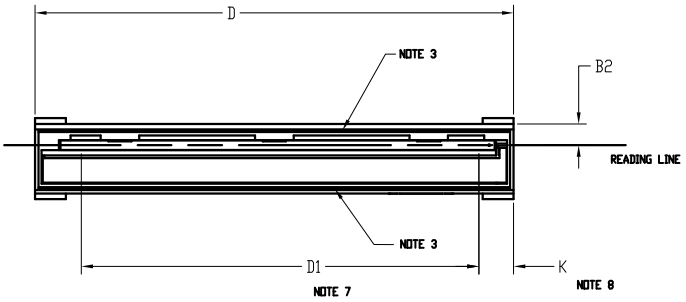


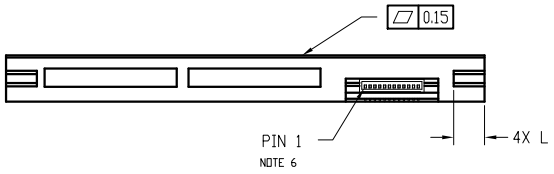
Figure 9. Typical Scanner Assembly

PACKAGE DIMENSIONS

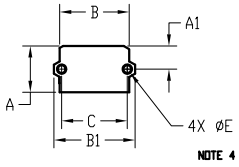
IMAGE SENSOR MODULE
CASE MODBJ
ISSUE O



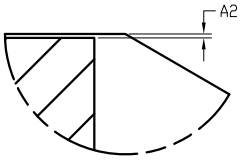
TOP VIEW



SIDE VIEW

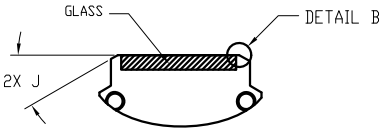


END VIEW



DETAIL B

BOTTOM VIEW



GLASS DETAIL

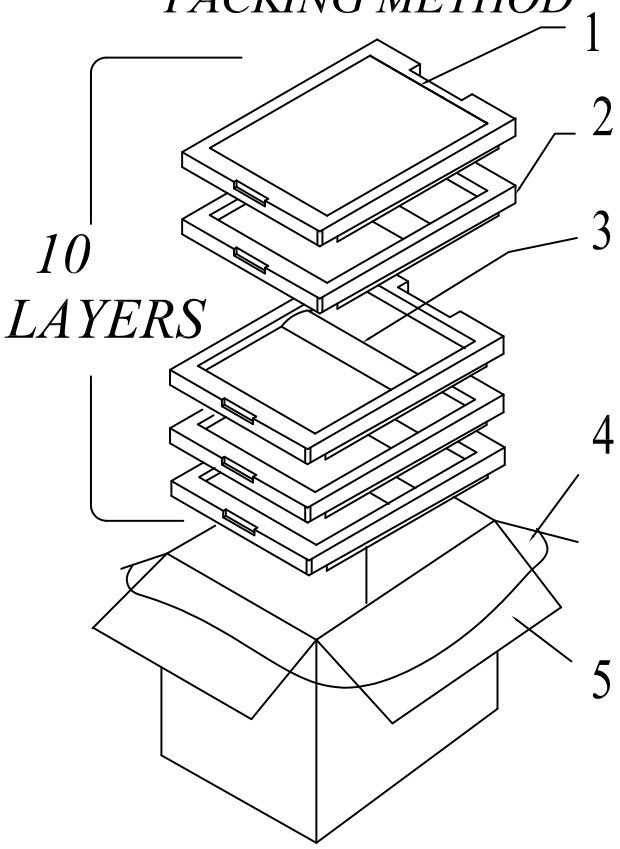
DIM	MILLIMETERS	
	MIN.	MAX.
A	11.50	12.50
A1	5.50	6.50
A2	0.11	−0.05
B	17.70	18.30
B1	20.70	21.30
B2	5.00	6.00
C	16.70	17.30
D	123.50	124.50
D1	103.00 REF	
E	1.90	2.10
J	30° REF	
K	8.00	10.00
L	7.70	8.30

NOTES:

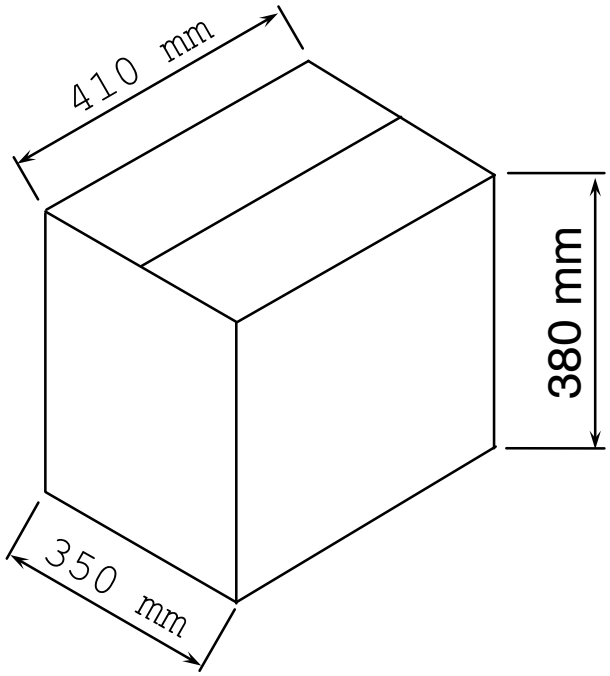
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS
3. GLASS IS GLUED ALONG THE 2 LONG SIDES. DIMENSION A4 DENOTES THE STEP BETWEEN THE GLASS AND THE HOUSING. THE GLUE FILLS THIS STEP CREATING A RAMP TO PREVENT PAPER JAMMING.
4. BORE DEPTH IS 6.00 ±0.50 WITH A 0.2 CHAMFER.
5. FOCAL POINT IS AT THE SURFACE OF THE GLASS.
6. CONNECTOR MOLEX 53048−1210 OR BISON 98401−1212 OR EQUIVALENT, 1 X 12 PIN, PITCH 1.25.
7. DIMENSION D1 DENOTES THE SCAN LENGTH.
8. DIMENSION K DENOTES THE POSITION OF THE FIRST PIXEL.
9. FOR MOUNTING, USE M2.3 SELF−TAPPING SCREWS WITH A TWIST FORCE SETTING OF 1.80−2.00 KFG−CM.
10. NEITHER DEFORMATION NOR TWISTING ALLOWED WHILE HANDLING THE MODULE.

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*

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
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