NOM02B4-DR11G

200DPI Contact Image Sensor Module with Binary Output

ON Semiconductor®

http://onsemi.com



IMAGE SENSOR MODULE B4
CASE MODAJ

Description

The NOM02B4−DR11G contact image sensor (CIS) module integrates a red LED light source, 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 256 mm wide with a scanning rate of 410 μsec/line. The analog output signal is processed by a digitizing comparator referenced to an externally supplied voltage level to produce a serial digital output. The NOM02B4−DR11G 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
- 256 mm Scanning Width at 8 dots per mm Resolution
- 410 μsec/Line Scanning Speed @ 5.0 MHz Pixel Rate
- Two−Level Tracking Digital Output
- Differential LVDS Input and Output Signals
- Supports B4 Paper Size at up to 52 Pages per Minute
- Red LED Light Source
- Wide Dynamic Range, Low Power
- Compact 272.0 mm x 24.3 mm x 21.5 mm Module Housing
- Light Weight 2.4 oz Packaging
- These Devices are Pb−Free, Halogen Free/BFR Free and are RoHS Compliant

Applications

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

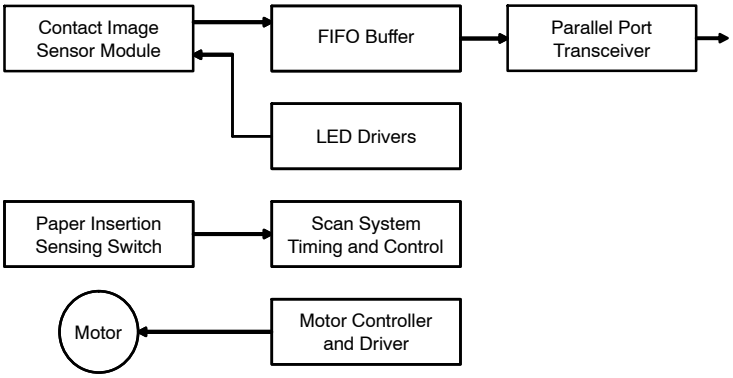


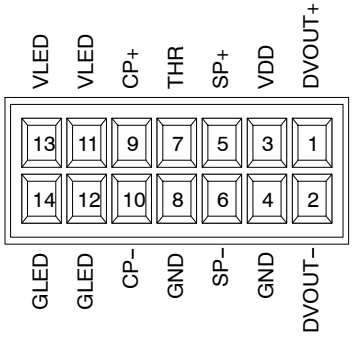
Figure 1. Typical Scanner Application

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.

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Table 1. ORDERING INFORMATION

Part Number	Package	Shipping Configuration
NOM02B4−DR11G	(Pb−Free)	100 per packing carton

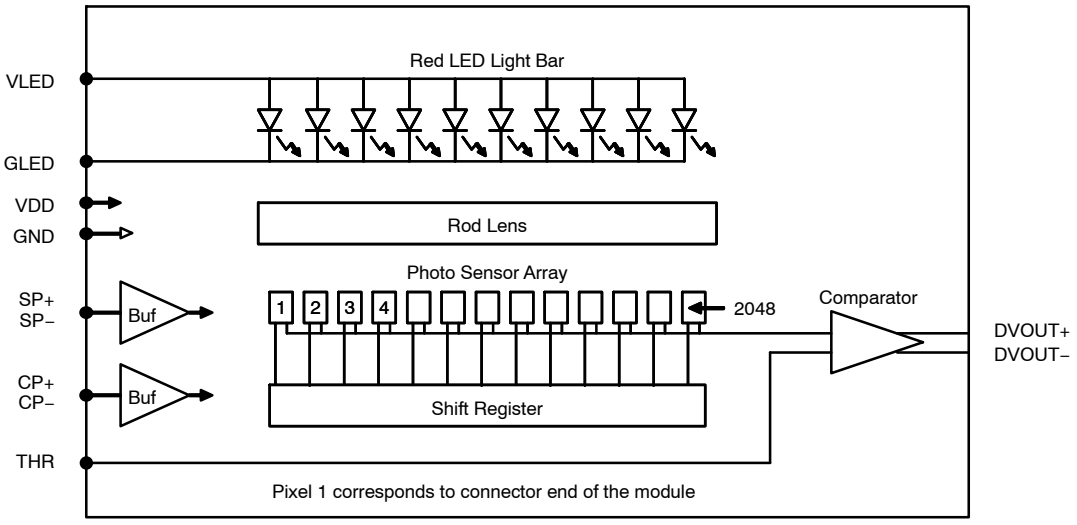


Figure 2. Simplified Block Diagram

Table 2. PIN FUNCTION DESCRIPTION

Pin	Pin Name	Description
1	DVOUT+	Digital Video Output (+)
2	DVOUT−	Digital Video Output (−)
3	VDD	+5 V power supply
4	GND	Ground
5	SP+	Shift register start pulse (+)
6	SP−	Shift register start pulse (−)
7	THR	Reference voltage input
8	GND	Ground
9	CP+	Sampling clock pulse (+)
10	CP−	Sampling clock pulse (−)
11	VLED	Power supply for the LED light source
12	GLED	Ground for the LED light source
13	VLED	Power supply for the LED light source
14	GLED	Ground for the LED light source

Table 3. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Power supply voltage	V_{DD}	7	V
	V_{LED}	6	V
Power supply current	I_{LED}	980	mA
Input voltage range for SP±, CP±	V_{in}	−0.5 to V_{DD} + 0.5	V
Input voltage range for THR	V_{in_thr}	0 to V_{DD}	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 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}	4.5	5	5.5	V
	V_{LED}	4.5	5	5.5	V
Power supply current	I_{DD}	86	96	106	mA
	I_{LED}	630	650	670	mA
Low level input voltage for SP±, CP±	V_{IL}	0	0	0.8	V
High level input voltage for SP±, CP±	V_{IH}	4.5	5.0	V_{DD} + 0.3	V
Threshold voltage level	V_{THR}	1.2	1.75	2.3	V
Low level output voltage (digital output level for dark)	V_{OL}		0.8		V
High level output voltage (digital output level for white)	V_{OH}		4.0		V
Line scanning rate (Note 4)	T_{int}	372	410	1024	μs
Clock frequency (Note 5)	f	2.0	5.0	5.5	MHz
Clock period	t_o	182	200	500	ns
Clock pulse width (Note 6)	t_w	46	50	125	ns
Clock pulse high duty cycle	DC_{CP}	20	25	75	%
Start pulse width (Note 6)	t_{wSP}	150	180	480	ns
Start pulse setup time	t_{su}	20			ns
Start pulse hold time	t_h	20			ns
Prohibit crossing time (Note 7)	t_{prh}	20			ns
Clock to Video output propagation delay rising	t_{pcor}	115			ns
Clock to Video output propagation delay falling	t_{pcof}	20			ns
Operating Temperature	T_{op}	0		50	°C
Operating Humidity, Non−Condensing	H_{op}	10		60	%

2. Refer to Figure 3 for more information on AC characteristics
3. V_{LED} directly affects illumination intensity, which directly affects DV_{OUT}.
4. T_{int} is the line scanning rate or integration time. T_{int} is determined by the interval between two start pulses. The clock is proportional to T_{int}.
5. Main clock frequency (f) corresponds to the video sampling frequency.
6. Min, Typ, Max specifications reflect operation at the corresponding Min, Typ, Max clock frequency.
7. Prohibit crossing time is to insure that two start pulses are not supplied in the same scan line time. SP may only be active high during one falling edge of CP for any given scan.

Table 5. PHYSICAL SPECIFICATIONS

Parameter	Symbol	Typ	Unit
Scan width	PD_w	256	mm
Number of Photo Detector Arrays	PDA_n	32	arrays
Number of Photo Detectors	PD_n	2048	elements

Table 6. PHYSICAL CHARACTERISTICS

Parameter	Symbol	Min	Typ	Max	Unit
Pixel pitch	PD_{sp}		125		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	634		644	nm

Table 7. ELECTRO−OPTICAL CHARACTERISTICS TEST CONDITIONS

Parameter	Symbol	Value	Unit
Power supply voltage	V_{DD}	5.0	V
	V_{SS}	−5.0	V
	V_{LED}	5.0	V
Clock frequency	f	5.0	MHz
Clock pulse high duty cycle	DC_{CP}	25	%
Line scanning rate	T_{int}	410	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}	0.8	1.0	1.2	V
Bright output non−uniformity (Note 9)	U_p	−30		30	%
Bright output non−uniformity total (Note 10)	U_{ptotal}			60	%
Adjacent pixel non−uniformity (Note 11)	U_{padj}			25	%
Dark output voltage (Note 12)	V_d			1500	mV
Dark non−uniformity (Note 13)	U_d			60	mV
Modulation transfer function at 50 line pairs per in (lp/in) (Note 14)	MTF_{50}	40			%
Modulation transfer function at 100 line pairs per in (lp/in) (Notes 14, 15)	MTF_{100}	20			%

8. $V_{pavg} = \Sigma\ V_{p(n)}/2048$, where
   V_p is the pixel amplitude value for a bright signal defined as a white document with LEDs turned on,
   n is the sequential pixel number in one scan line.
9. $U_p = [(V_{pmax} - V_{pavg})/V_{pavg}]$ x 100%, or $[V_{pavg} - V_{pmin})/V_{pavg}]$ x 100%, whichever is greater, where
   V_{pmax} is the maximum pixel voltage of any pixel at full bright
   V_{pmin} is the minimum pixel voltage of any pixel at full bright
10. $U_{ptotal} = [(V_{pmax} - V_{pmin})/V_{pavg}]$ x 100%,
11. U_{padj} = MAX $[\ |\ (V_{p(n)} - V_{p(n+1)})\ |\ /\ V_{p(n)}]$ x 100%, where
    U_{padj} is the nonuniformity in percent between adjacent pixels for a bright background
12. V_d is the pixel amplitude value for a dark signal defined as a black document with LEDs turned off
13. $U_d = V_{dmax} - V_{dmin}$, where
    V_{dmax} is the maximum pixel voltage of any dark pixel with the LEDs turned off
    V_{dmin} is the minimum pixel voltage of any dark pixel with the LEDs turned off
14. MTF = $[(V_{max} - V_{min})/(V_{max} + V_{min})]$ x 100%, where
    V_{max} is the maximum output voltage at the specified line pairs per inch (lp/in)
    V_{min} is the minimum output voltage at the specified lp/in
15. For information only.

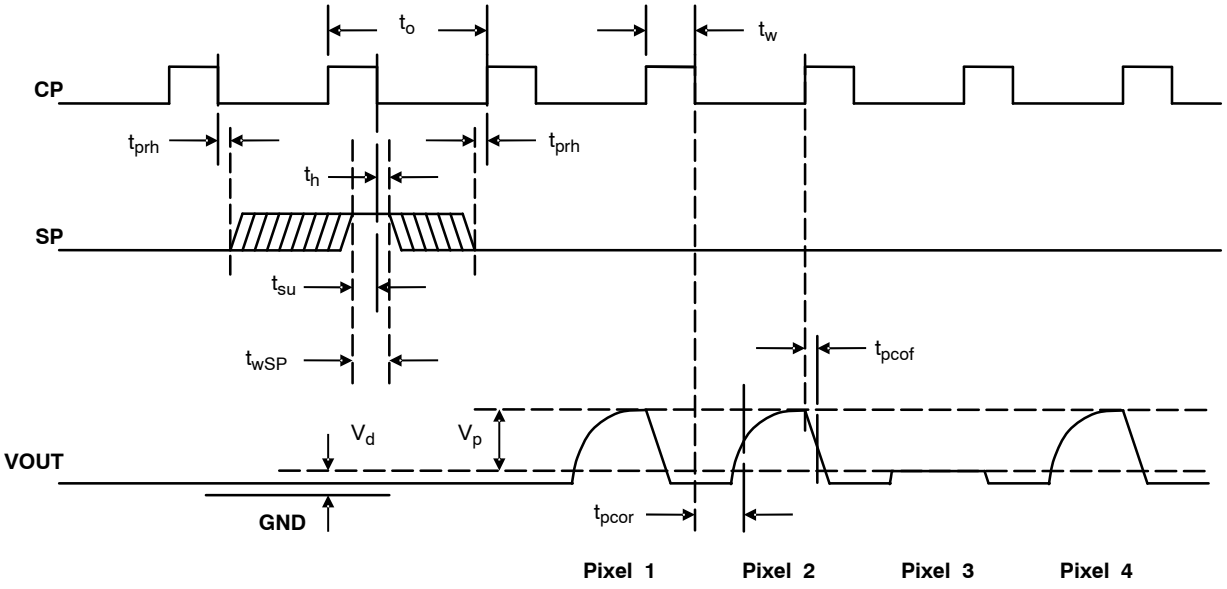


Figure 3. Timing Diagram

DESCRIPTION OF OPERATION

Functional Description

The NOM02B4−DR11G module consists of 32 contact image sensors, each with 64 pixel elements, that are cascaded to provide 2048 photo−detectors with their associated multiplex switches and double−buffered digital shift register that controls its sequential readout. The analog pixel signal is proportional to the exposure on the corresponding picture elements on the document. A comparator digitizes the analog pixels into a serial binary bit stream as each pixel is compared to the external reference voltage THR as shown in Figure 2. In operation, the sensor module produces a binary one for each pixel with a voltage above THR and a binary zero for each pixel with a voltage below THR. The DVOUT signal outputs 2048 pixels for each scan line. The first bit shifted out from DVOUT during each scan represents the first pixel on the connector end of the module.

A pictorial of the NOM02B4−DR11G cross section view is shown in Figure 4. 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 an integrated LED light 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 source from dust.

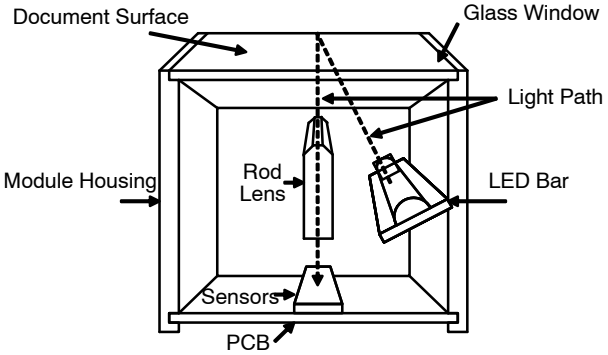


Figure 4. Module Cross Section View

Digital Video Output

The NOM02B4−DR11G module only presents a digital output, however module performance is best understood by analyzing the analog nature of the internal circuitry. Characterization of the analog signal is presented in Table 4.

Connector Pin Out Description

Connections to the module are via a 9.14x25.40mm 14−pin connector (AMP part number 103308−2) located at one end of the module as shown in the package drawing on page 8. The location of pin number 1 is indicated on the package drawing.

Scanner Applications

A typical use of the NOM02B4−DR11G module in scanner applications is shown in Figure 6. 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.

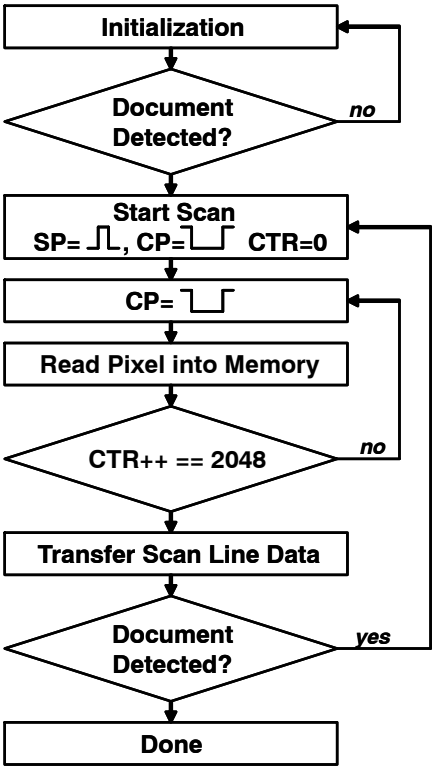


Figure 5. Typical Scanner Algorithm

Figure 5 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 clock pulse 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.

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.

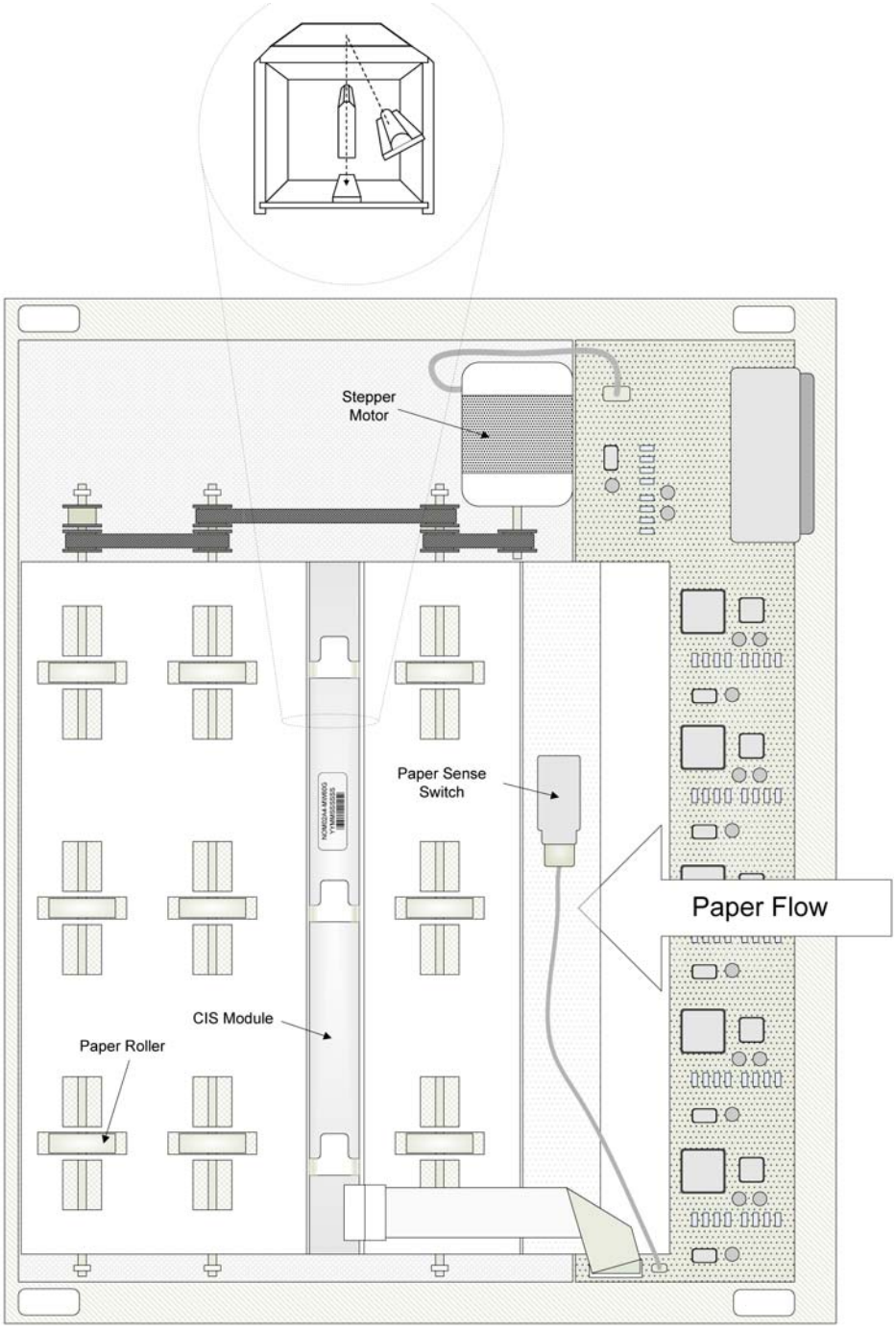
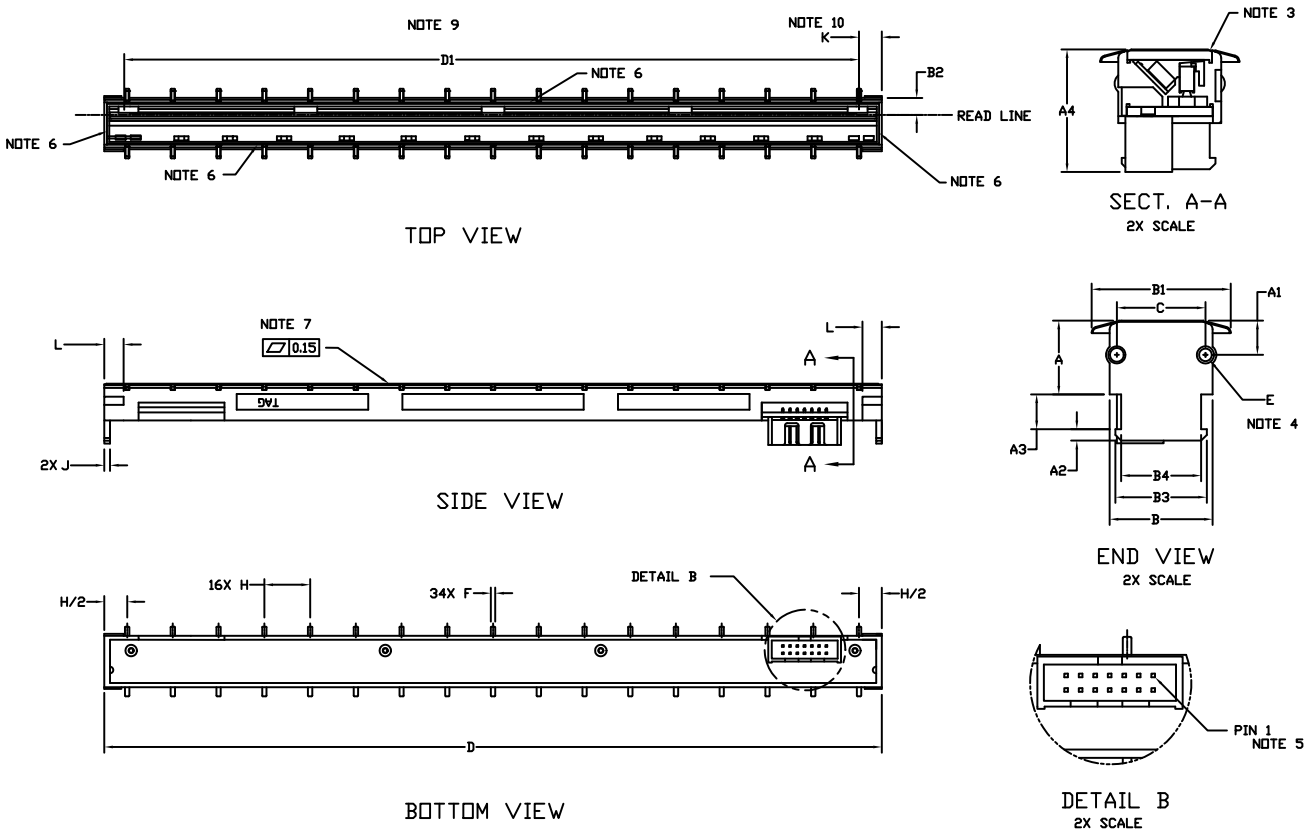


Figure 6. Typical Scanner Assembly

PACKAGE DIMENSIONS

IMAGE SENSOR MODULE B4
CASE MODAJ
ISSUE O

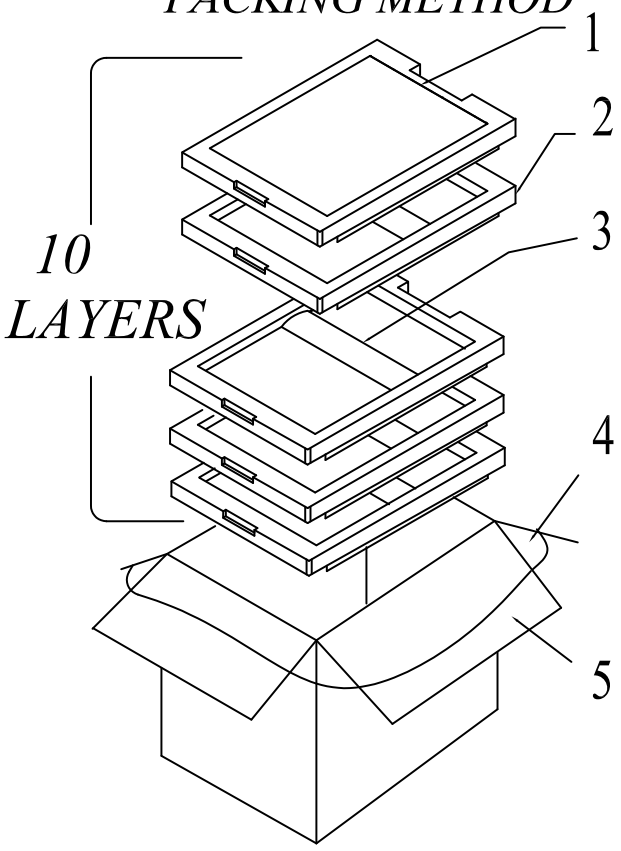


DIM	MILLIMETERS MIN	MAX
A	12.60	13.20
A1	5.63	5.93
A2	1.90	2.10
A3	5.98	6.18
A4	21.45 REF	
B	17.70	18.30
B1	24.32 REF	
B2	5.50	6.50
B3	15.85	16.15
B4	13.85	14.15
C	15.35	15.65
D	271.50	272.50
D1	256.00 REF	
E	2.05	2.35
F	1.51 REF	
H	16.00 REF	
J	2.00 REF	
K	7.00	9.00
L	6.80 REF	

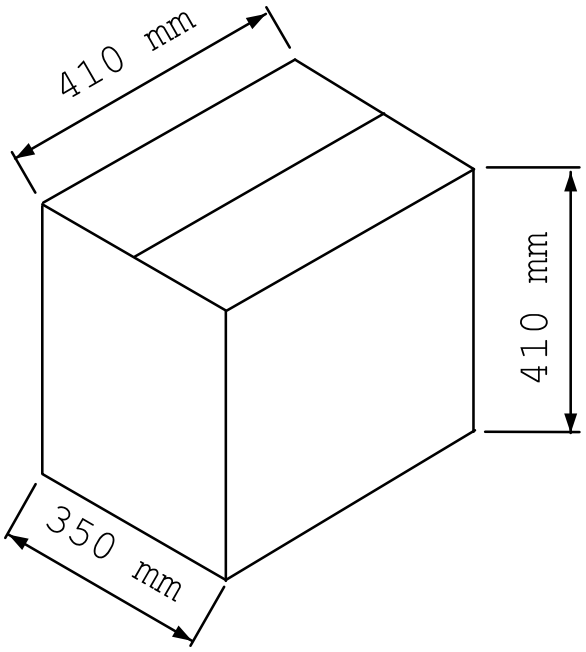
NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. LEADING EDGE OF THE APPROACH ANGLE ON THE GLASS IS LOWER THAN THE TOP OF THE HOUSING.
4. BORE DEPTH IS 6.0.
5. CONNECTOR, AMP MODEL NUMBER 103308−2, 2X7 PIN, PITCH 2.54.
6. GLASS IS GLUED ON ALL 4 SIDES.
7. GLASS THICKNESS IS 1.85.
8. USE M2.3 SELF TAPPING SCREWS FOR MOUNTING. TORQUE SCREWS BETWEEN 1.80 KGF−CM AND 2.00 KGF−CM.
9. DIMENSION D1 DENOTES THE SCAN LENGTH.
10. DIMENSION K DENOTES THE POSITION OF THE FIRST PIXEL.

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*

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