

OPTICON

Auto-focus Imager Engine

MDI 2000



This manual provides specifications for the MDI 2000
2D imager scan engine with auto-focus.

Specifications Manual

All information subject to change without notice.

Document History

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SUPPORT

USA

Phone: 800-636-0090

Email: support@opticonusa.com

Web: www.opticonusa.com

Europe

Email: support@opticon.com

Web: www.opticon.com

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1. Abstract

This manual provides specifications for the MDI 2000 auto-focus imager scan engine.

2. Overview

The MDI 2000 is a compact imager scan engine with an auto-focus function that enables high-speed scanning of linear (1D) and 2D symbologies for the first time in the industry. The MDI 2000 includes the following features:

- **High-Speed Scanning**
Customized High-speed/ultra-sensitive CMOS image sensor at the maximum of 80 fps and the fastest shutter speed in the industry enable high-speed scanning without being affected by hand movement.
- **Reading both high resolution and super deep barcodes**
With an embedded liquid lens in the scan engine, the MDI 2000 is able to read both high resolution and super deep barcodes.
- **High-Speed Auto-Focus**
High-speed CMOS image sensor uses laser light for distance range to enable high-speed auto-focus. When environmental conditions make using distance range with laser light impossible, focus adjustment will be done using the contrast method.
- **World's fastest image processing speed**
Compact, energy-saving and high-speed ASIC enables a smooth response by processing vast amount of information transferred from the mega-pixel CMOS image sensor in a very short time.
- **Various Settings**
It is possible to change symbology settings, scanning settings, communication settings, and other feature settings by sending commands.
- The MDI 2000 complies with the Restriction of Hazardous Substances (RoHS).

Supported symbologies:

Linear (1D)

JAN/UPC/EAN, incl. add-on
 Codabar/NW-7
 Code 11
 Code 39
 Code 93
 Code 128
 GS1-128 (EAN-128)
 GS1 Databar (RSS):
 Omnidirectional/ Truncated/
 Stacked/Limited Expanded
 IATA
 Industrial 2of5
 Interleaved 2of5
 ISBN-ISSN-ISMN
 Matrix 20f5
 MSI/Plessey
 UK/Plessey
 S-Code
 Telepen
 Tri-Optic

Postal

Chinese Post Matrix 2of5
 Intelligent Mail Barcode
 Korean Postal Authority Code
 POSTNET

2D

Aztec Code
 Chinese Sensible Code
 Codablock F
 Composite Component (CC)
 CCA,CCB (With any of the EAN.UCC
 system symbols, based on Micro
 PDF417), CCC (With UCC/EAN128,
 based on PDF417)
 Data Matrix (ECC 0-140, ECC200)
 Maxi Code (mode 0 - 5)
 Micro PDF417
 Micro QR Code
 PDF417
 QR Code

3. Physical Features

3.1. Dimensions

Camera module: W 27.1 mm x D 13.5 mm x H 13.2 mm

Decoder board: W 18.5 mm x D 30.3 mm x H 4.8 mm

3.2. Weight

Camera module: 6 grams (max.)

Decoder board: 4 grams (max.)

4. Environmental Specifications

4.1. Operating Temperature and Humidity

Temperature: -20 to 55° C

Humidity: 5 to 85% RH

4.2. Storage Temperature and Humidity

Temperature: -40 to 70° C

Humidity: 5 to 85% RH

4.3. Ambient Light Immunity

Scanning performance is guaranteed when the range of illumination on a barcode surface is between zero and the following values:

Incandescent light	10,000 lx
Fluorescent light	10,000 lx
Sunlight	100,000 lx

Conditions

Barcode Sample: PDF417 with 0.254mm resolution

PCS:	0.9
Resolution:	0.254 mm
Symbology:	PDF417
Quiet Zone:	10 mm
N/W Ratio:	1:2.5
Distance:	60 mm
Angle (see note below):	$\alpha = 0^\circ \beta = 15^\circ \gamma = 0^\circ$
Curvature:	$R = \infty$
Power Supply Voltage:	3.3 V

Direct light or specular reflection light from a source should be prevented from entering the acceptance area.

Note: α , β and γ respectively represent pitch, skew and tilt. Please see section 6 for how these values are defined.

5. Electrical Specifications

5.1. Absolute Maximum Ratings

Parameter	Symbol	Value	Unit
Power supply voltage (VCC to GND)	V _{CC}	3.9	V
Input voltage	V _{IN}	-0.3 to V +0.3	V
Output current	I _O	±4	mA

5.2. Recommended Operating Conditions

Item	Symbol	Min	Typ	Max	Unit	Conditions	
Power supply voltage ¹	V _{CC}	3.15	3.3	3.45	V		
Rush current peak ²	I _{PK}		6	7	A		
Input voltage	H level	V _{IH}	2.4	-	V _{CC} +0.3	V	
	L level	V _{IL}	-0.3		0.9	V	
Output voltage	H level	V _{OH}	2.8	-		V	I _{OH} =-4mA
	L level	V _{OL}			0.5	V	I _{OL} = 4mA

5.3. Consumption Current with Default Settings

When the scan engine is configured to “Prior snapshot ON” and “Snapshot and decoding parallelism ON.”

Parameter	Symbol	Min	Typ	Max	Unit
Operating current	I _{OP}	—	240	300	mA
Stand-by current	I _{STB}	—	70	100	mA
Power-down current ³	T _{SLP}	—	15	25	mA

¹ Input connector.

² V_{CC} is supplied by a direct-current power of 10 A, measured using a current probe. If it is necessary to decrease the impressed current, please supply the power slowly.

³ When configured with the SLEEP command or power-down mode.

5.4. Power Mode Transition

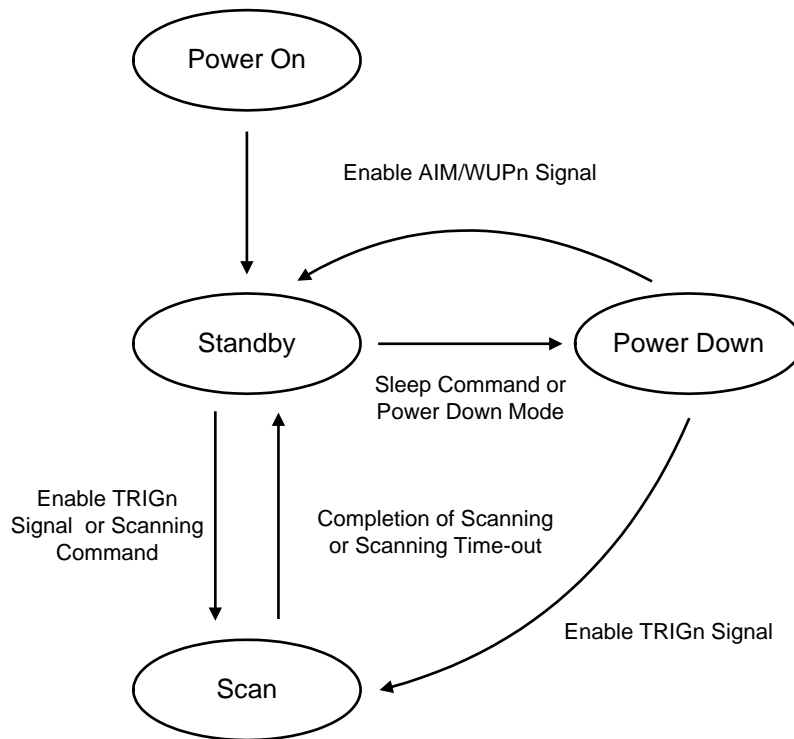


Figure 1: Power mode transition

When in Power Down mode, the MDI 2000 automatically enters the powered-down state from Power On.

When the MDI 2000 is in Power Down mode, the MDI 2000 is switched to Standby mode by receiving the AIM/WUPn signal. If there is no event to switch the MDI 2000 to other modes after the AIM/WUPn signal is turned off, the MDI 2000 enters Power Down mode again after the Standby mode times out.

If the MDI 2000 enters a powered-down state while using a USB COM interface, it may cause defects with the operation of a Windows device driver.

6. Optical Specifications

6.1. Imager Scanning

Parameter	Specification	Unit
Scan method	CMOS area sensor (Black and white)	—
Scan rate	80	fps
Range of readable pixels	900 (H) x 512 (V)	pixel
Light emitting element for aiming/distance ranging (Laser diode)	Red laser diode	
Peak wavelength	650	nm
Maximum radiation output	1	mW
Auxiliary LED for lighting (LED 1)	InGaP Red LED	
Peak wave length	645	nm
Directivity angle 2 ½	60	°
Maximum radiation output	5040	mcd
View angle (approximate)	Horizontal: 40 Vertical: 23	°

6.2. Imager Output

Item	Specification
Image data format	Windows Bitmap, JPEG, TIFF
Shades of gray	256, 16, 2
Range of output image	Select in horizontal and vertical scale.
Resolution of output image	Full, 1/2, 1/3, 1/4
Interface of output image	RS-232C, USB-VCP
Transmission time	USB-VCP (Full speed) About 4 sec RS-232C (115.2 kbps) About 120 sec Conditions: Shades of gray: 256 Resolution: full

6.3. Auto Focus

The imager scan engine requires 100 ms to capture the image with auto focus after trigger ON.

6.3.1. Measurement

A laser spot will measure the distance between the reading window and the surface of the image (barcode) to determine the focus adjustment.

If laser measurement is impossible because of the particular environmental conditions such as ambient light immunity, the focus adjustment method automatically switches to measurement with contrast.

This measurement function enables accurate AF operation of the liquid lens that is embedded inside the imager scan engine.

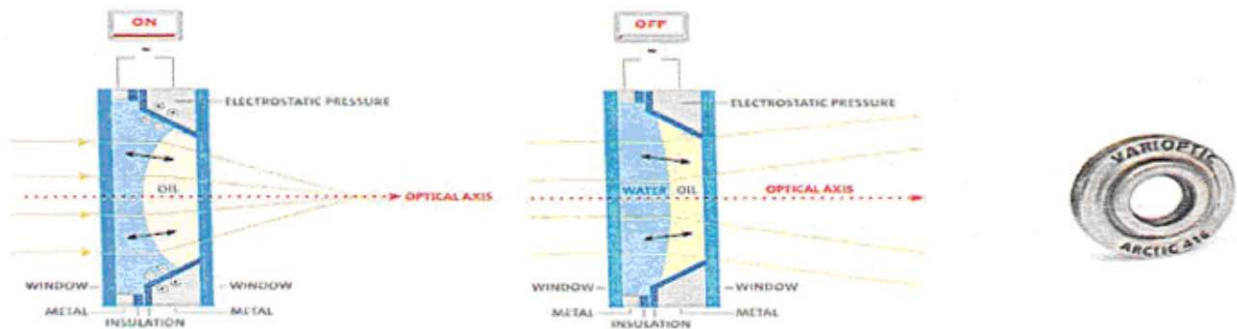


Figure 2: AF operation by liquid lens

7. Technical Specifications

Scanning is enabled by aiming at the center of a barcode with laser light. When scanning from a distance, ambient light that is reflected to the scanning field may affect scanning performance.

The conditions for technical specifications are as follows, unless otherwise specified in each section.

Conditions

Ambient temperature and humidity	Room temperature (5 to 35° C) Room humidity (45% to 85% RH)
Ambient light	1000 to 1500 lx (on the surface of a barcode)
Background	Barcode = black Space = white Margin = white Background of label = black
Power supply voltage	6.0 V
Decoding test	Carry out 10 scanning tests. Approve the performance when decoding is successful in 70% of the tests.

7.1. Test Samples: 1D Symbologies

Code 39 (resolution 0.0762 and 0.127 mm) and JAN codes used for the tests are OPTOELECTRONICS test samples printed by a normal printer. (NW ratio = 1:1.25)

Code 39

Resolution	Symbology	PCS	Size (mm)	Digits
0.0762 mm	Code 39	0.9	8 x 10	5
0.127	Code 39	0.9	11 x 10	4
0.254 mm	Code 39	0.9	14 x 10	2
1.0 mm	Code 39	0.9	56 x 30	2

JAN

Resolution	Symbology	PCS	Size (mm)	Digits
0.26 mm	13-digit JAN	0.9/0.45	25 x 19	13
0.26 mm	8-digit JAN	0.9	17.5 x 15.5	8
0.33 mm	13-digit JAN	0.9	31.5 x 25.0	13

7.2. Test Samples: 2D Symbologies

PDF417

Resolution	Error Correction	PCS	Size (mm)	Characters
0.254 mm	Level-4	0.9	26 x 16.5	17
0.127 mm	Level-4	0.9	13 x 8	17

QR Code (Model - 2)

Resolution	Error Correction	PCS	Size (mm)	Characters
0.381 mm	M	0.9	12 x 12	44
0.127 mm	M	0.9	4 x 4	44

Data Matrix

Resolution	Model	PCS	Size (mm)	Characters
0.254 mm	ECC200	0.9	6 x 6	40
0.169 mm	ECC200	0.9	4 x 4	40
0.127 mm	ECC200	0.9	3 x 3	40

Micro QR

Resolution	Model	PCS	Size (mm)	Characters
0.212 mm	L	0.9	5 x 5	11

7.3. Print Contrast Signal (PCS)

0.45 or higher (over 70% of reflectivity of space and quiet zone).

$$PCS = \frac{\text{Reflectance of white bar} - \text{Reflectance of black bar}}{\text{Reflectance of white bar}}$$

Scanning performance may decline if dirt or scratches mar the optical window. Keep the optical window clean.

Conditions

MRD	32% and higher (with over 70% reflectivity of space and quiet zone.)
Distance	120 mm from the case front of a camera module.
Barcode test sample (1D and 2D)	PDF417 Resolution 0.254 mm; PCS 0.45

7.4. Minimum Resolution

Resolution	Symbology
0.127 mm	Code 39 & PDF417
0.169 mm	Data Matrix
0.212 mm	Micro QR Code

7.5. Scan Area and Resolution

7.5.1. Depth of Field

The depth of field is measured from the case front of a camera module.

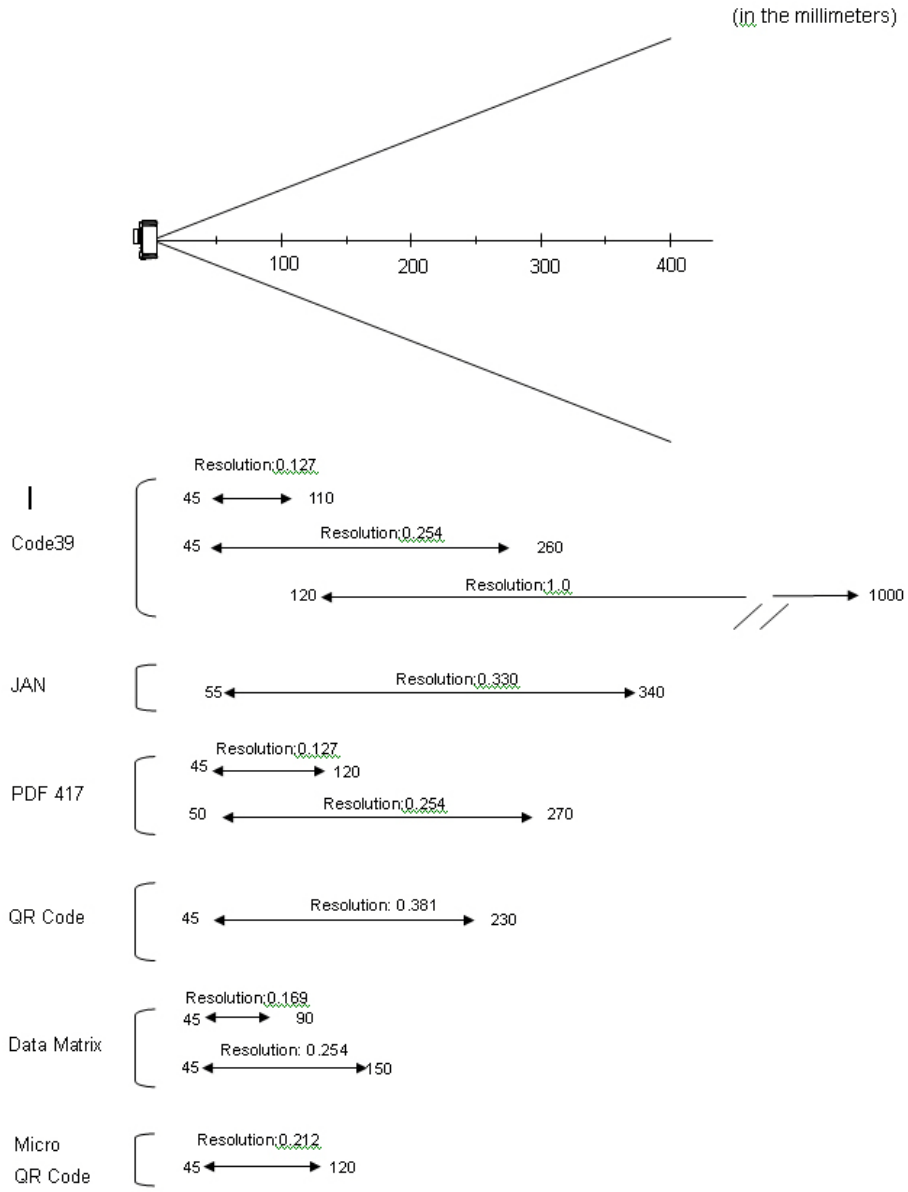


Figure 3: The depth of a decoding field

Symbology	Resolution (mm)	Decode Depth (mm)	PCS
Code 39	0.127	45–110	0.9
	0.254	50–260	
	1.0	120–1000	
JAN 13	0.33	55–340	0.9
PDF417	0.127	45–120	0.9
	0.254	50–270	
QR Code	0.381	45–230	0.9
Data Matrix	0.169	50–90	0.9
	0.254	45–150	
Micro QR Code	0.212	45–120	0.9

Conditions

N/W ratio 1:2.5
 Angle $\alpha = 0^\circ, \beta = 15^\circ, \gamma = 0^\circ$
 Curvature $R = \infty$

7.6. Pitch, Skew, and Tilt

7.6.1. Pitch Angle

$\alpha = \pm 50^\circ$

7.6.2. Skew Angle

Skew angle: $\beta = \pm 50^\circ$

7.6.3. Tilt Angle

$\gamma = 360^\circ$

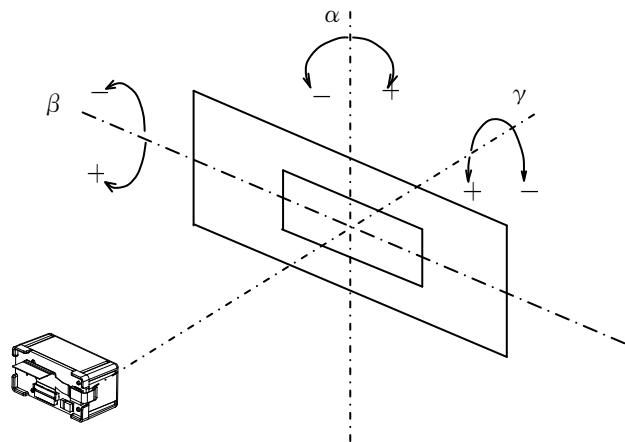


Figure 4: Pitch, skew, and tilt angles

Conditions

Barcode Sample: Code 39 and PDF417 with 0.245 mm resolution

Distance 120 mm from the case front of a camera module

Label PCS = 0.9, Resolution = 0.245 mm, Quiet Zone = 10 mm

Angle Curvature: $R = \infty$ The calculation of pitch and tilt angles is based on the formula of skew angle being $\beta = +15^\circ$ **7.7. Curvature**

With 8-digit JAN/UPC/EAN barcodes, decoding performance is guaranteed when $R \geq 15$ mm.

With 13-digit JAN/UPC/EAN barcodes, decoding performance is guaranteed when $R \geq 20$ mm.

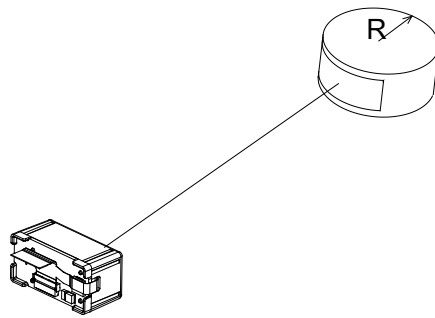


Figure 5: Curvature

Scanning performance may fail due to the specular reflection of the illumination LED when the reflectivity is high. To improve scanning performance in such cases, scan the barcode with a scan angle of 15 degrees or scan the barcode with the illumination LED turned off. When scanning a barcode with illumination LED turned off, confirm that the ambient lighting intensity is higher than 500 lux, or scanning performance may decline. Scanning performance may also decline due to the reflectance of room lights on a camera.

Conditions

Barcode Sample: JAN barcode

PCS = 0.9, Resolution = 0.254 mm, Quiet Zone = 10 mm

Distance 60 mm from the mask of a camera module

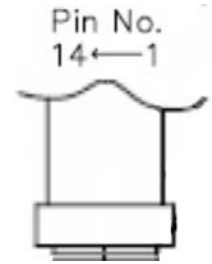
Angle Skew Angle $\beta = +15^\circ$

8. Interface Specifications

8.1. Interface Signals

Connector used was produced by Hirose Electric Company, Ltd.

Product No.: FH33-14S-0.5SH(10) (Bottom contact)



No.	Signal			State	Note
	Name	Function	I/O		
1	DWNLDn	Download control signal	In	L: Download mode H: Non-operating	Check the signal as soon as the power is supplied and enables updates of software.
2	Vcc	Power input	In		
3	GND	System ground			
4	RxD	Received data signal	In		Asynchronous data from the host system
5	TxD	Transmitted data signal	Out		Asynchronous data to the host system
6	CTS	Communication control signal from host system	In		Request for a data output from the host system
7	RTS	Communication control signal to host system	Out		Request for a data output from the MDI 2000
8	POWERDWN	Power down of MDI 2000	Out	L: Normal H: Power Down	
9	USB+		In/Out		USB 1.1
10	USB-		In/Out		
11	AIM/WUPn	When in Power Down State: Recovery from Power Down State	In	L: Recover from Power Down H: No Action	
		When not in Power Down State: Aiming Control	In	L: Aiming Laser On H: Aiming Laser Off	
12	TRIGn	Trigger On	In	L: Start Operation H: No Action	Command signal for reading images and decoding operation.
13	Vcc	Power Input	In	3.3V±5%	
14	GND	System Ground			

8.2. Interface Circuit

Signal	Circuit Configuration
DWNLDn, AIM/WUPn, TRIGn	
CTS, RxD	
POWERDWN, RTS, TxD	
USB-	
USB+	

9. Integration Specifications

9.1. Camera Module and Decoder Board

The nonvolatile memory of a MDI 2000 decoder board contains information concerning the sensor chip of the MDI 2000 camera module. This information is vital to the scanning and image acquisition operations of the MDI 2000. The camera module and decoder board are a set and must both be integrated into your products.

9.2. Connection between a Camera Module and Decoder Board

TBD

Manufacturer	TBD
Product No	TBD
Cable Length	TBD
Signal Connection	TBD

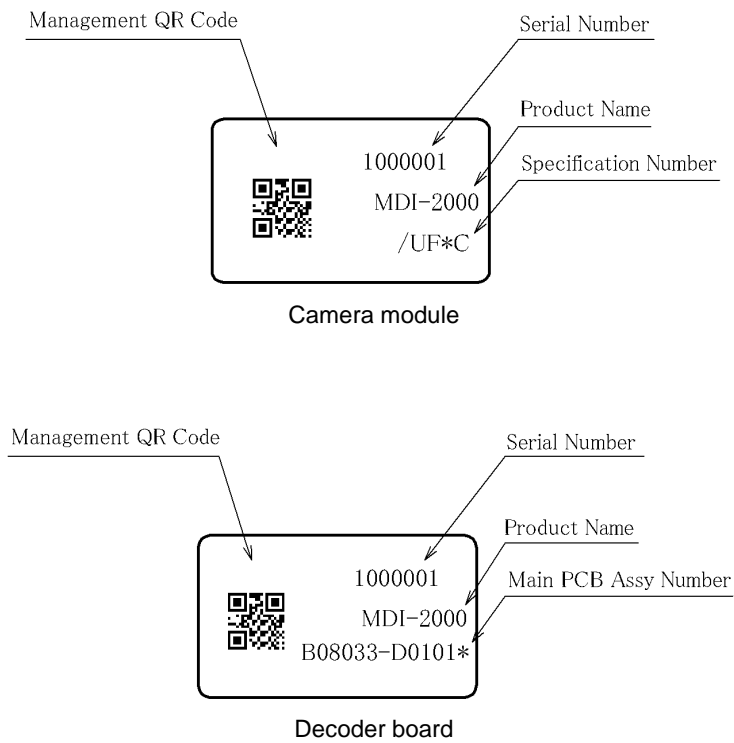
9.3. Connection between a Decoder Board and the Host System

Please use a cable developed in accordance with specifications provided by the connector manufacturer to connect an MDI 2000 decoder board with the host system.

Manufacturer	Hirose Electric Co., Ltd.
Product No	FH33-14S-0.5SH(10)(14-pin)
Cable Length	70 mm (maximum)

10. Serial Number

The serial number appears on the following labels, which are to be attached to camera modules and decoder boards.



Left side	Management Quick Response Code (QR Code), For administrative use
Top	Serial number
Center	Product name
Bottom	Camera module: Specifcation number Decoder board: Main PCB Assy Number

Figure 6: Serial number diagrams

Serial numbers are seven-digit numbers and start from number 0000001 regardless of batch.

11. Packaging Specifications

11.1. Collective Packaging Specification

Size of the package after assembly: 335 (W) x 290 (D) x 185 (H) mm

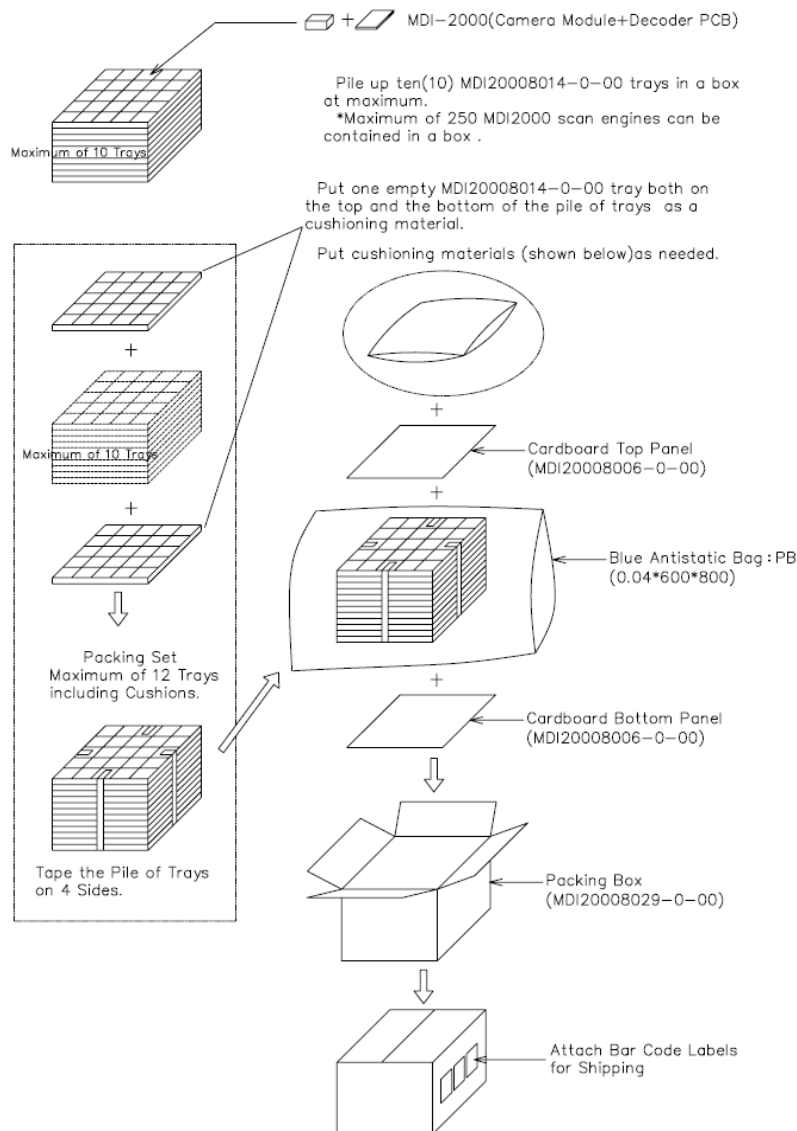


Figure 7: Packaging

The model number, the number of products in the box, and the name of the manufacturer must be displayed on the packing box.

Note: The “RO” mark labeled on the package tray or package box guarantees that the applicable product has passed our test of RoHS restrictions compliance (the restriction of the use of certain hazardous substances in electrical and electronic equipment, 2002/95 EC). However, this document does **not** have any legal weight in the European Union.

12. Durability

12.1. Electrical Noise

12.1.1. Scanning Symbologies

No malfunction occurred when sinusoidal electrical noise (50 Hz -100 kHz, <0.1 Vp-p) was added to the power supply line.

Conditions

Scan method: Continuous scanning

Barcode Sample: PDF417 with 0.254 mm resolution

PCS	0.9
Resolution	0.254 mm
Symbology	9-digit PDF417
N/W Ratio	1:2.5
Distance	120 mm from a case front of a camera module
Angle	$\alpha = 0^\circ \beta = 15^\circ \gamma = 0^\circ$
Curvature	$R = \infty$
Power Supply Voltage	3.3 V

12.1.2. Acquisition of Image Data

There was no outstanding noise or misalignment in acquired images when sinusoidal electrical noise (50 Hz to 100 kHz, smaller than 20 mVp-p) was added to the power supply line.

Notes

There may be a case where the electrical noise affects the quality of captured images. The signal processing system of the MDI 2000 is especially designed for the purpose of scanning symbologies, not for the acquisition of image data. Therefore, the quality of images captured by the MDI 2000 may be lower than that of digital cameras in general.

12.2. Shock

No malfunction occurred after the following drop test.

Drop Test: Put the MDI 2000 inside an appointed dummy case and dropped it facing its top, bottom, front, back, left, right, top-left, top-right, bottom-left and bottom-right from the height of 1.5 m to a concrete floor. The shock test was done once in each direction.

12.3. Vibration

No malfunction occurred after the following vibration test.

Vibration Test: Increase the frequency of the vibration from 12 Hz to 200 Hz with accelerated velocity 3.3 G for over ten minutes. Continued this routine for two hours in X direction, two hours in Y direction, and four hours in Z direction.

13. Reliability

MTBF (Mean Time Between Failures) of this product is 50,000 hours.

The estimate of MTBF is based on standard operation of the product within the recommended temperature range and without extreme electronic or mechanical shock.

14. Regulatory Compliance

14.1. Laser Safety

The scanner emits laser beams.

IEC 825-1/EN 60825-1: Laser class 2

FDA CDRH Laser class II. Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to laser notice No. 50 dated June 24, 2007.

Class II laser devices are not considered to be hazardous when used for their intended purpose. Avoid staring into the laser beam.

14.2. LED Safety

Lamp classification: IEC62471:2006 Exempt Group

All LED-based products are in the exempt" group and are safe under reasonably foreseeable operating conditions. Do not stare into the beam.

14.3. RoHS

RoHS: The restriction of the use of certain hazardous substances in electrical and electronic equipment, 2002/95 EC.

15. Mechanical Drawing

15.1. Camera Module and Decoder Board

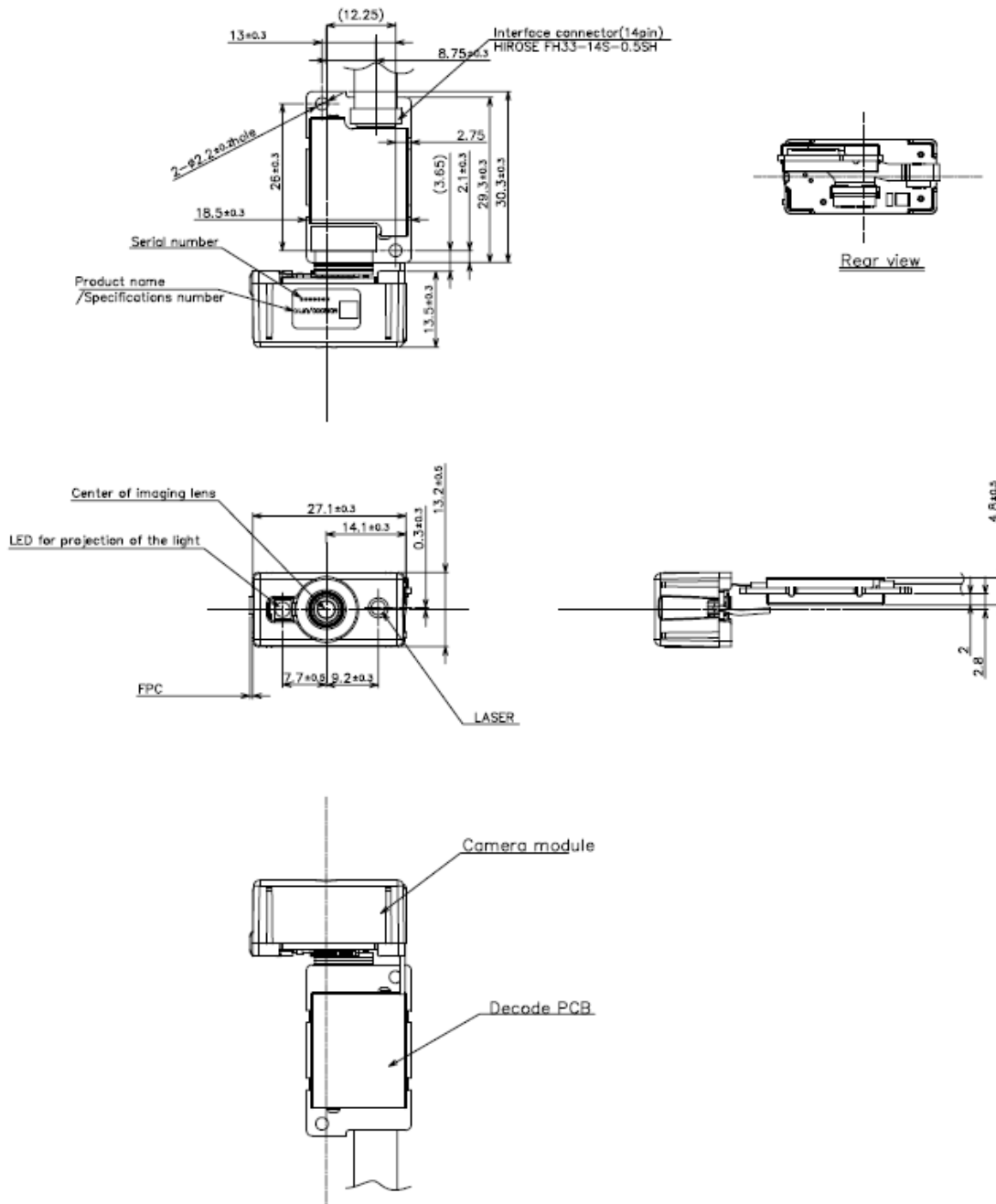


Figure 8: Camera module and decoder board