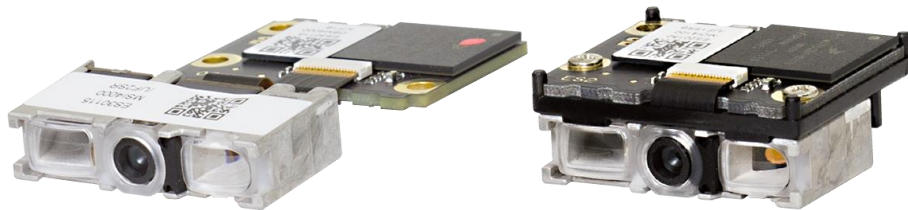


MDI-40x0/MDI-41x0

2D Imager



MDI-40x0

MDI-41x0

Integration Guide – Rev 3.0

The information in this document is subject to change without notice.

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2 nd	2018/06/11	-	-	Added the MDI-4x50
		5	2.2.2	Added Installing exit window at far range
3 rd	2024/08/28	-	-	Updated to new layout

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1 Abstract

This guide provides instructions for installing the MDI-4x00-SR/HD/UD (hereafter called “scan engine”) and is intended for engineers who are responsible for integrating the scan engine into their product. In order to maximize the performance and to minimize problems, read this integration guide carefully and integrate the scan engine in accordance with it. The instructions described in this guide are recommendations. Following them will help to ensure that the scan engine can properly capture images, but it is still advised to check some actual images that the scan engine makes with image capturing tools. These tools are available from the Opticon website.

Caution: The circuit board height of MDI-4x50 series is 0.3 mm smaller than MDI-4x00 series.

This manual has three main chapters:

Exit Window Material and Placement	Recommendations on the material and the placement of the exit window, in order to prevent the LED illumination from reflecting off the exit window.
Exit Window Size	Recommendation on the size of the exit window and the clearance for the optical path of the camera and LED illumination.
Installation	Detailed installation instructions.

This integration guide is for the following models:

MDI-4x00-SR Standard range model (focus: 115mm)
MDI-4100-HD High density model (focus: 65mm)
MDI-4100-UD Ultra-High density model (focus: 45mm)
Low power consumption version
MDI-4x50-SR Standard range model (focus: 115mm)
MDI-4150-HD High density model (focus: 65mm)
MDI-4150-UD Ultra-High density model (focus: 45mm)

1.1 Exit Window Material

Reflection from the LED light off the exit window can cause large overexposed areas in the images captured by the scan engine, and should be avoided at all times. This chapter gives recommendations for the material of the exit window that helps to prevent this (Section 2.1). It also describes the best position and inclination of the exit window (Section 2.2).

The picture below is taken from a scan engine with a poorly aligned exit window. It is clear to see what the reflection does to the image. The overexposed spot on the left side of the image makes it much harder, if not impossible, to decode the barcode in the image. It is highly recommended to check some actual pictures made by the scan engine in order to verify that there is no reflection from the LED after the engine has been installed. The software tools for image capture can be found on the Opticon website.



2 Exit Window Material and Placement

2.1 Exit Window Material

Below is a list of recommendations for constructing the exit window. These recommendations help to prevent reflection from the LED illumination off the exit window and help to prevent degradation of the image by scratches and dirt.

- For the best optical quality, use an acrylic material (cast or extruded)
- Select a high-quality achromatic acrylic material with a smooth, flat surface without scratches and dents.
- Use 1mm thick acrylic material with an anti-reflective (AR) coating applied to both sides.
- Apply an anti-scratch coating to the surface of the exit window to protect it from scratches during operation. Hard coated acrylic sheets are readily available. Such a coating greatly enhances anti-scratch properties without degrading the optical characteristics of the acrylic material.
- To protect the exit window from dust, stains, and scratches during assembly, most manufacturers cover the raw material with a protective sheet that stays attached during the entire production process of the exit window. This protective sheet should be removed in the final stage of the production process, before operation.
- After removing the protective sheet, use an ion blower to remove any dust that may have been attracted by static electricity.

Recommended acrylic material:

Nitto Jushi Kogyo Co., Ltd.
MITSUBISHI CHEMICAL CO., LTD.

Clarex Precision Thin Sheet
Shinkolite

2.2 Exit Window Placement

Reflection from the LED light off the exit window can cause large overexposed areas in the images captured by the scan engine. Therefore, it is important to position the exit window in such a way that the reflection is minimal and not directed into the camera. Make sure that the distance and inclination of the exit window is within the range specified in the following diagram and associated table.

2.2.1 Installing exit window at short range

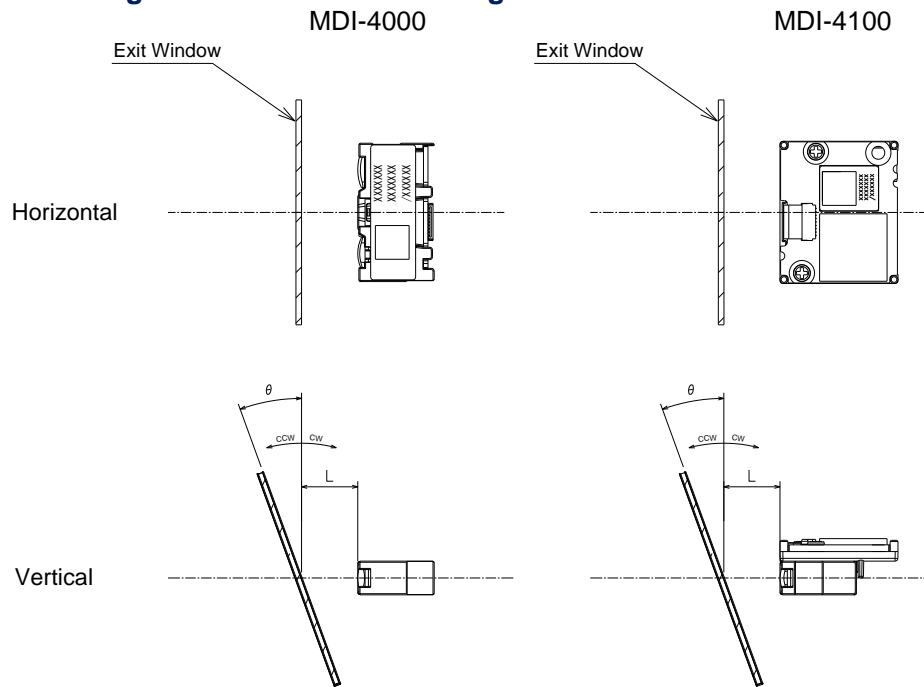


Figure 1: Exit Window Placement of the MDI-4x00

The following table shows the recommended mounting position of the window with 'both sides AR coated' and 'non AR coated'.

Conditions

Window 1 mm acrylic sheet

Conditions Visually check reflections by taking images with the scan engine in a darkroom with no light source and no reflecting objects.

Both sides AR coated

L	[mm]	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
θ_{CW}	[deg]	0°	$\geq 0^\circ$	$\geq 0^\circ$	$\geq 0^\circ$	$\geq 10^\circ$	$\geq 20^\circ$	$\geq 25^\circ$	$\geq 25^\circ$	$\geq 25^\circ$
θ_{CCW}	[deg]	0°	$\geq 0^\circ$	$\geq 0^\circ$	$\geq 0^\circ$	$\geq 10^\circ$	$\geq 20^\circ$	$\geq 25^\circ$	$\geq 25^\circ$	$\geq 25^\circ$

Recommended values: L = 1 mm, θ_{CW} = 0° and both sides AR coated.

Non AR coated

L	[mm]	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
θ_{CW}	[deg]	0°	X	X	X	X	X	$\geq 35^\circ$	$\geq 30^\circ$	$\geq 30^\circ$
θ_{CCW}	[deg]	0°	X	X	X	X	X	$\geq 35^\circ$	$\geq 30^\circ$	$\geq 30^\circ$

- Keep a minimum clearance between the scan engine and the exit window of 1mm because of the dimensional tolerances of the mounting holes
- Use of AR coated material for the exit window is recommended.
- External light is not factored in.
- Confirm that there is no reflection of the LED illumination off the exit window by acquiring images from the scan engine.

2.2.2 Installing exit window at far range

When installing the scan engine at a far range from the exit window, LED illumination will appear to the exit window if the scan engine is placed vertically to the exit window as following drawing. To avoid the reflection of LED, tilt the scan engine and exit window for about 18 degrees in vertically.

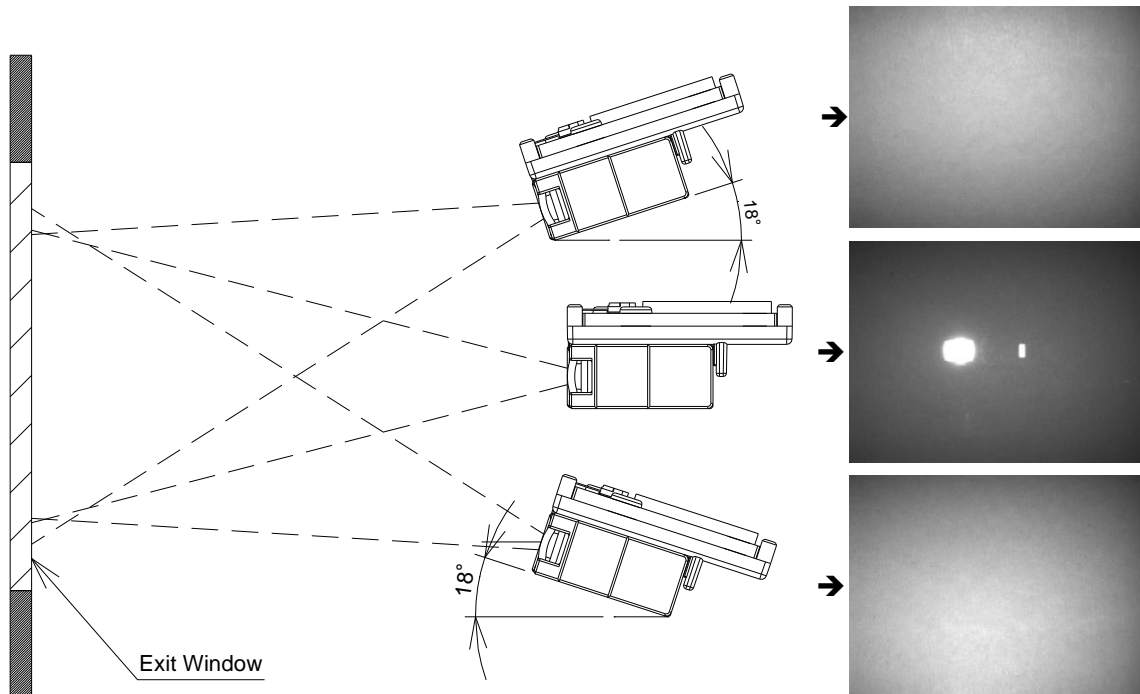


Figure 2: Exit Window and Angle of the MDI-4xx0

*Reflection varies depending on the exit window material and distance. Please actually obtain the image and evaluate the angle.

3 Exit Window Size

Vignetting (radial brightness or saturation fall-off) in the LED illumination and the captured image can occur depending on the size and position of the exit window. Additionally, specular (mirror like) reflection can occur in the target barcode depending on how it is presented to the scanner. This chapter describes the distance and inclination limitations for the exit window to avoid these problems.

3.1 Window Size and Optical Path Clearance

With respect to the optical path depicted below, provide an exit window with sufficient clearance.

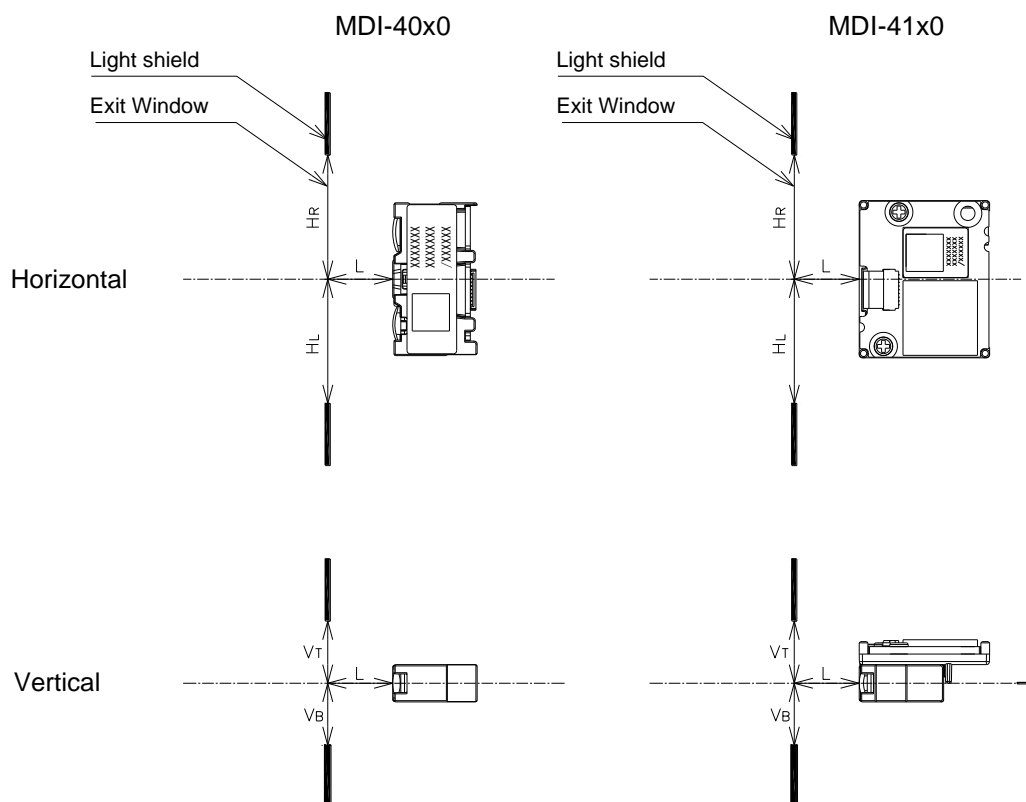


Figure 3: Window Size and Optical path Clearance

The following tables show the requirements for the horizontal and vertical optical path clearance. The light-shielding part should not reflect light (e.g. coated matte black).

Horizontal

L	[mm]	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
H _R	[mm]	≥11.8	≥12.0	≥12.3	≥12.5	≥12.8	≥13.1	≥13.3	≥13.5	≥13.8
H _L	[mm]	≥11.8	≥12.0	≥12.3	≥12.5	≥12.8	≥13.1	≥13.3	≥13.5	≥13.8

Vertical

L	[mm]	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
V _T	[mm]	≥2.5	≥2.7	≥3.0	≥3.2	≥3.5	≥3.7	≥3.9	≥4.2	≥4.4
V _B	[mm]	≥2.5	≥2.7	≥3.0	≥3.2	≥3.5	≥3.7	≥3.9	≥4.2	≥4.4

- Keep V_T equal to V_B and H_R equal to H_L.
- Vignetting is caused by insufficient exit window size. It manifests as darker edges in the image. Confirm this visually by acquiring images from the scan engine in the design phase.

3.2 Optical Path

Install the Exit Window with sufficient clearance for the field of view, LED illumination and LED aiming. Provide the Exit Window with sufficient clearance with respect to the optical path, as depicted below.

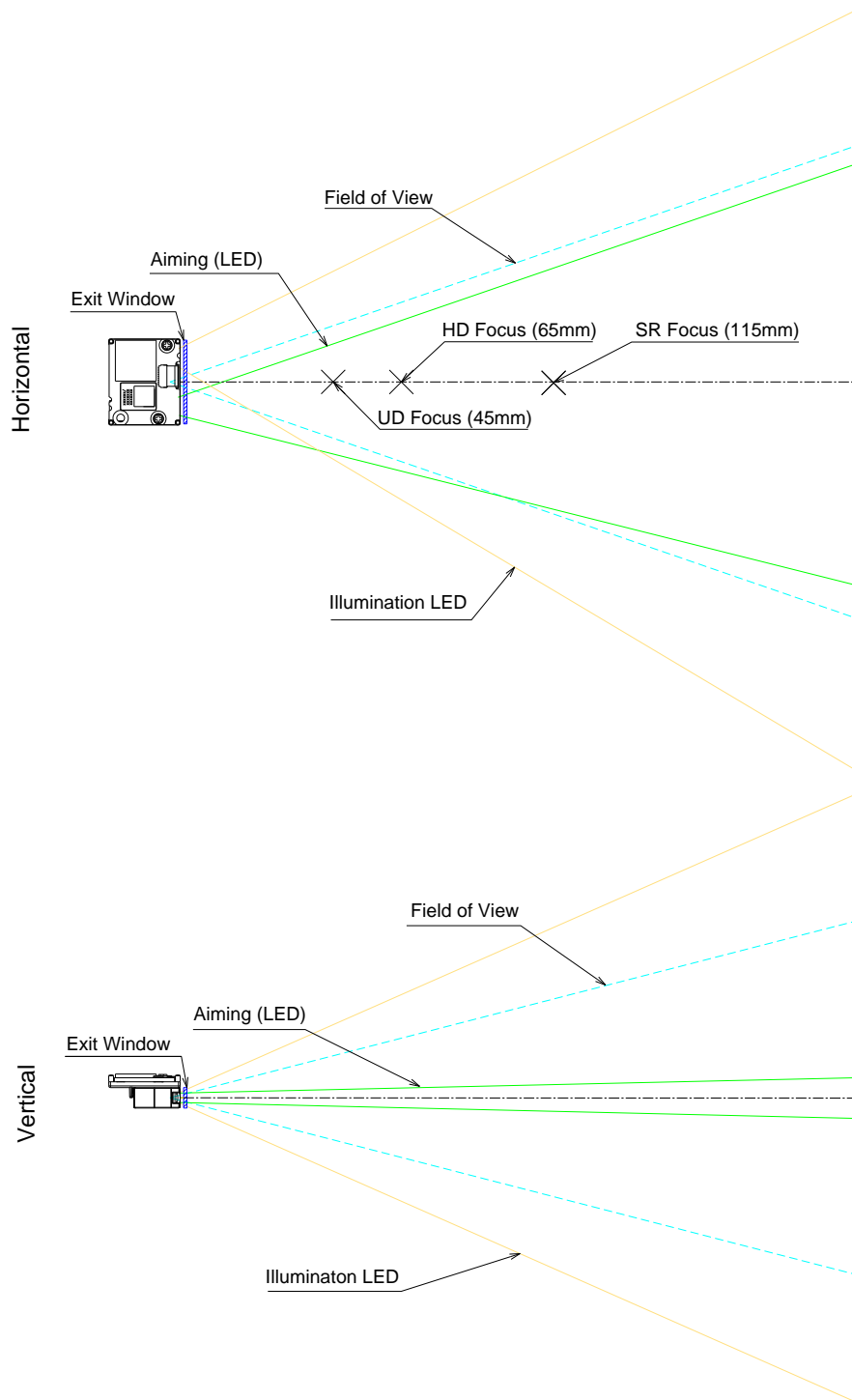


Figure 4: MDI-4100 Optical Path

- Refer to the 3D drawings for details of the optical path.
- Verify the details of the optical path with an actual device.

3.3 Field of View and Aiming

Install a frame with sufficient clearance for the field of view.

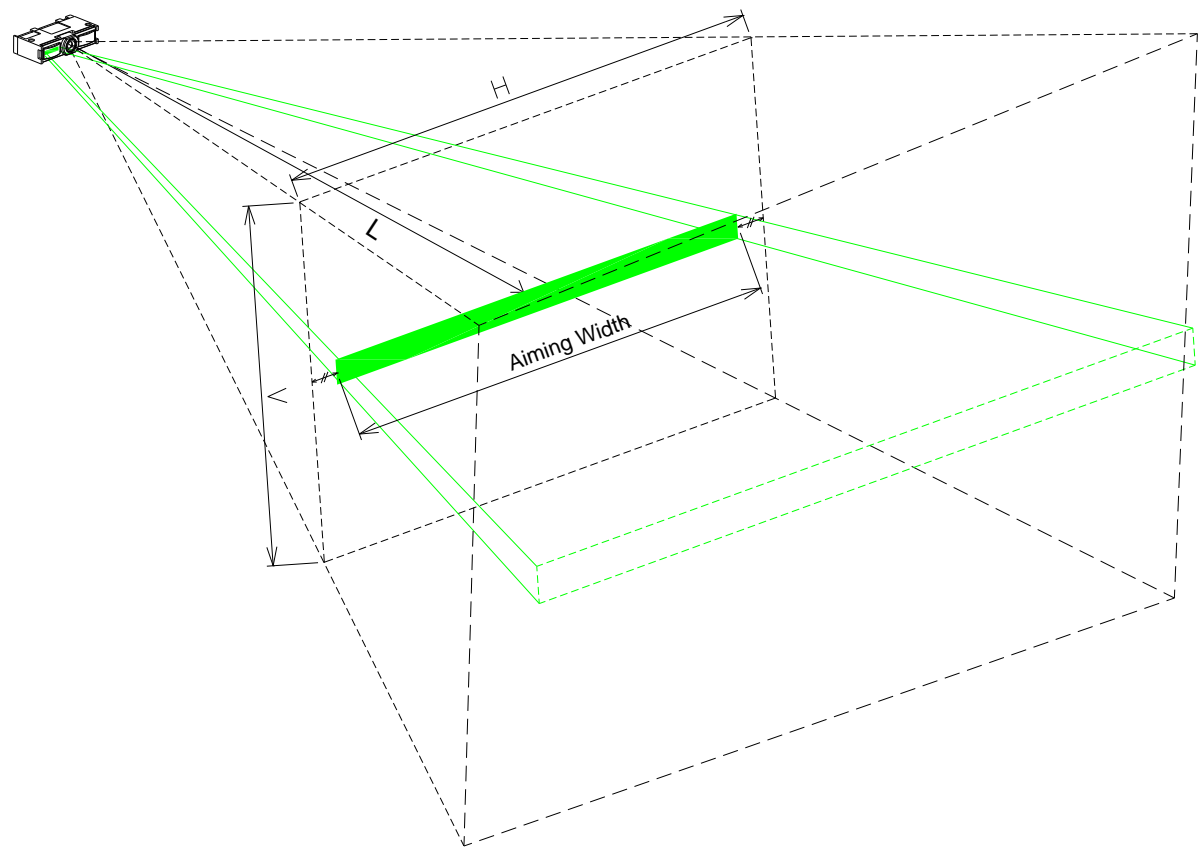


Figure 5: MDI-4xx0 Field of View and Aiming

- L Distance from front edge of the scan engine
- H Horizontal FOV
- V Vertical FOV

Field of View

L	[mm]	10	15	20	25	30	35	40	45	50
H	[mm]	13	16.5	20	21.5	27.5	31	35	38	42
V	[mm]	8	10	12	13	17	19	21	23.5	26

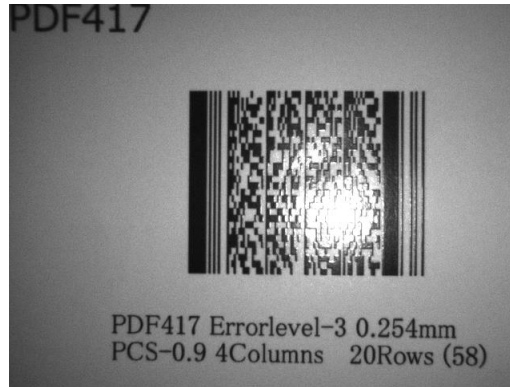
- The table above shows the field of view which should not be obstructed by any parts of a housing.

3.4 Scanned Media and Placement

When an object is being scanned, there are conditions where specular reflection of the LED illumination and intense ambient light can occur easily.

Problem: Glossy label

Specular reflection of the LED illumination from the scan engine can occur when the target label is on a highly reflective surface.



Solution:

Specular reflection does not occur when an angle is created between the scan engine and the target label as shown in the figure below. The conditions for the occurrence of specular reflection depend on the distance L and the inclination angle θ . The recommended inclination angle is about 15 degrees. Note that as the angle becomes bigger, it becomes more difficult to read the target label.

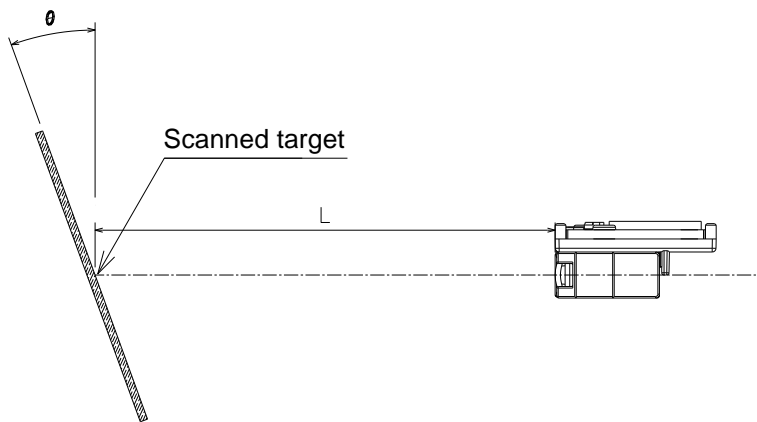


Figure 6: Inclination of Scanned Target

4 Installation

This chapter describes practical guidelines for the mechanical installation. This chapter is divided in two parts, one for the MDI-4000 (camera module and separate decoder board) and one for the MDI-4100(internal decoder).

4.1 Installation recommendations for the MDI-40x0

The installation recommendations are listed below.

- Mount the camera module to a material with high thermal conductivity, such as metal, especially when the auto-trigger is used.
- Mount the camera module using the screw holes on the bottom side.
- Make sure not to insert the screws deeper than the specified maximum depth.
- When installing the camera module, only the bottom surface of the camera module should be attached to a chassis.
- Keep enough clearance to avoid damage to the camera module in case the host device is dropped.
- Shock / impact resistance of the camera module to any acceleration applied via the bottom surface is specified up to a certain limit. Any other kind of mechanical stress is likely to damage the camera module, since it contains precise optical elements.
- The case of the MDI-40x0 should be electrically grounded.

4.1.1 MSI-4000 Installation

Screw type: M2 with a pitch of 0.4.
Maximum screw depth: 2.5 mm from the mounting surface of the scan engine.
Recommended torque: 15 Ncm.

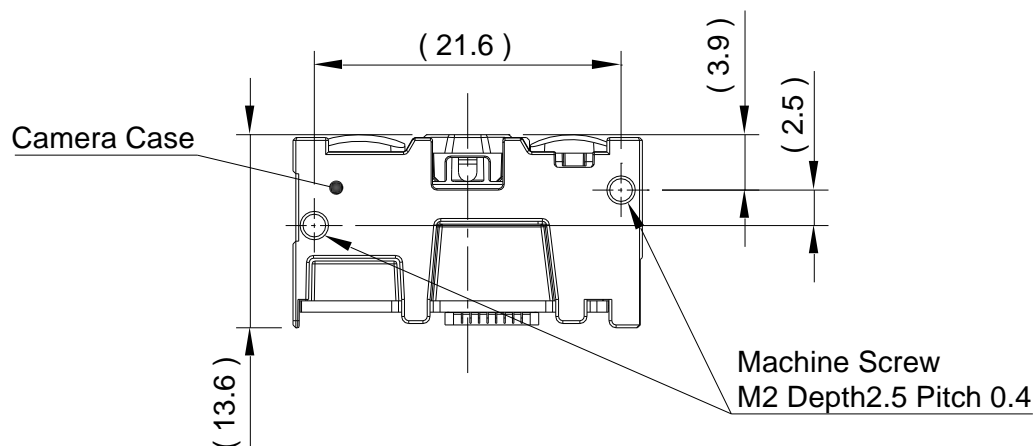


Figure 7: MSI-4000 Mounting Holes

4.1.2 DBM-40x0 Installation

- Do not screw the decoder board directly on a PCB. Use spacers or screw pillars instead.
- The decoder board may become hot, especially when the auto trigger is used. Make sure that there are not heat sensitive parts close to the decoder board.
- The size of the screw head must not exceed the diameter of the mounting landing.
- The DBM-40x0 mounting holes should be grounded.

DBM-40x0 Decoder module Installation recommendations

Screw size : M2

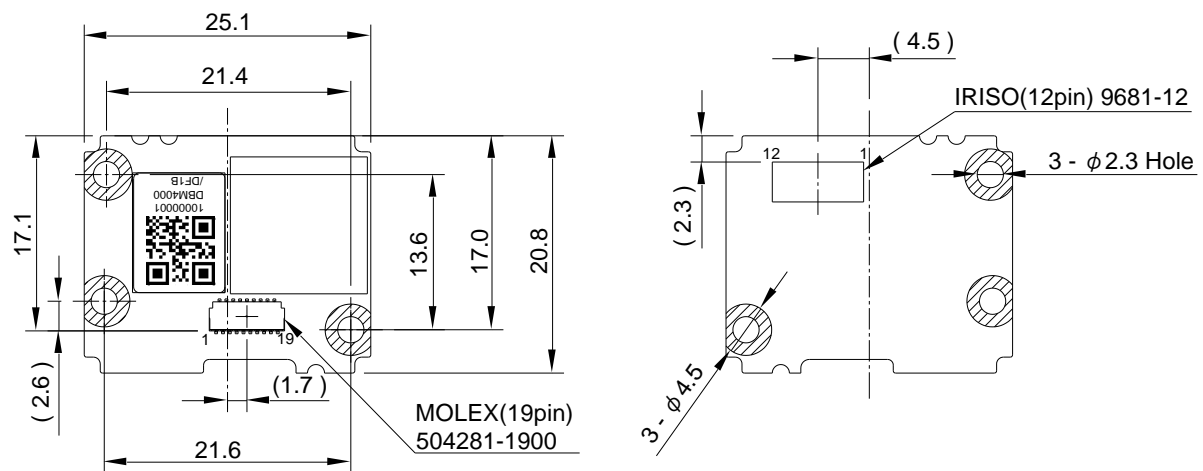
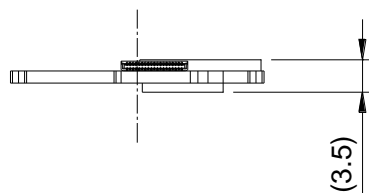


Figure 8: Decoder Board Mounting Holes

Height of the DBM-4000 and the DBM-4050

DBM-4000 and DBM-4050 has different circuit board thicknesses.

DBM-4000



DBM-4050

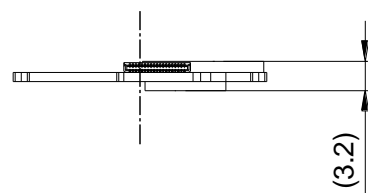


Figure 9: Height of the DBM-4000 and the DBM-4050

4.1.3 Camera FPC

- Do not bend the FPC abruptly.
- When inserting the FPC, make sure the connector is not in the locked configuration.
- Be careful not to apply any force to the FPC after the FPC is fastened.
- The connector of the decoder side is not the same as the camera side.
 Camera side 17pin
 Decoder side 19pin
- It is recommended to use the Opticon supplied FPC cable.

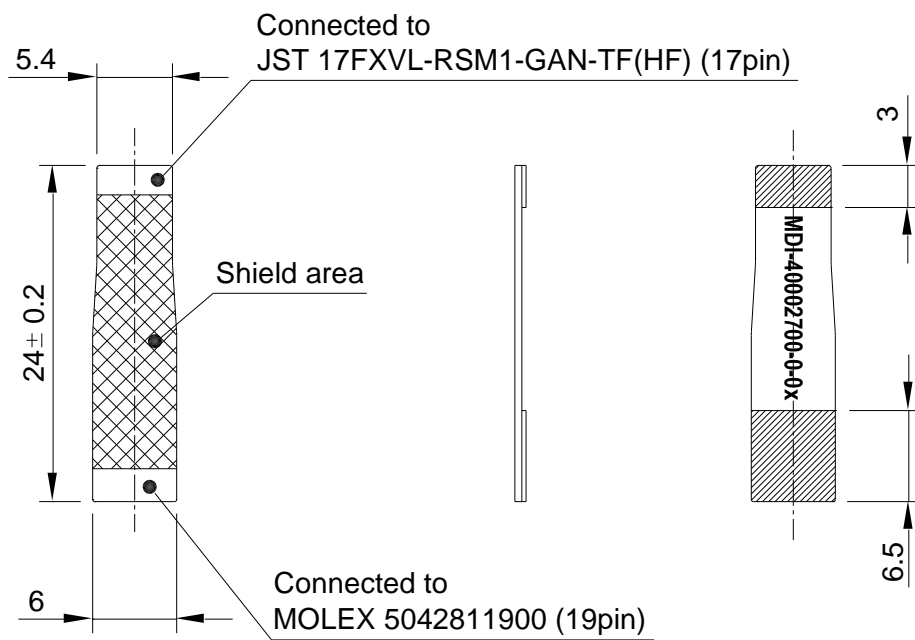


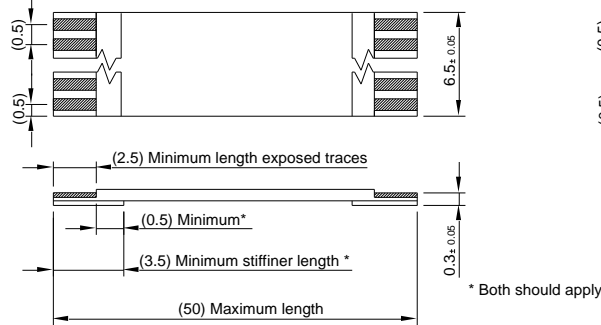
Figure 10: Drawing of the FPC

4.1.4 FFC and FPC installation

There are two types of FFC cables that can be used to connect the decoder board to a target PCB. One with contacts on the same side (Type A) and one with contacts on opposite sides (Type B). Below are the specs and a description on how to assemble the camera module to the decoder board and how to connect the decoder board to a target PCB.

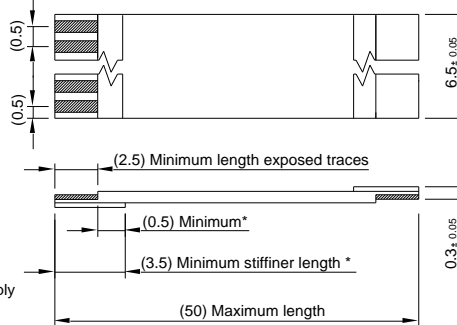
Type A

FFC cable, 0.5mm pitch, 12 conductors, 0.3mm thick contacts on same side.

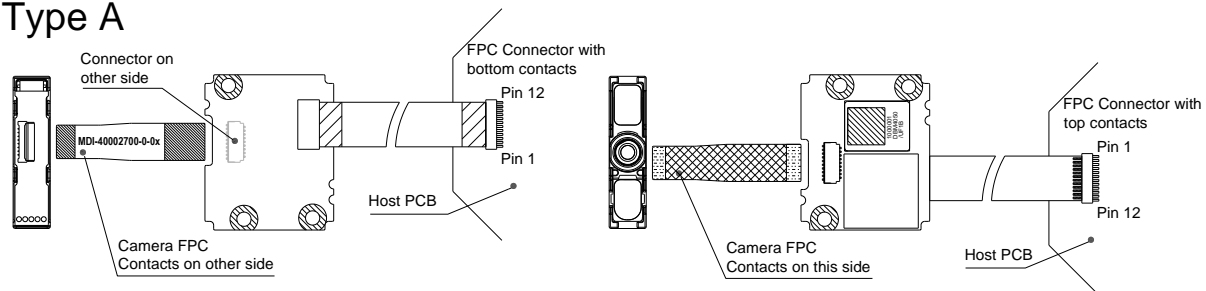


Type B

FFC cable, 0.5mm pitch, 12 conductors, 0.3mm thick contacts on same sides.



Type A



Type B

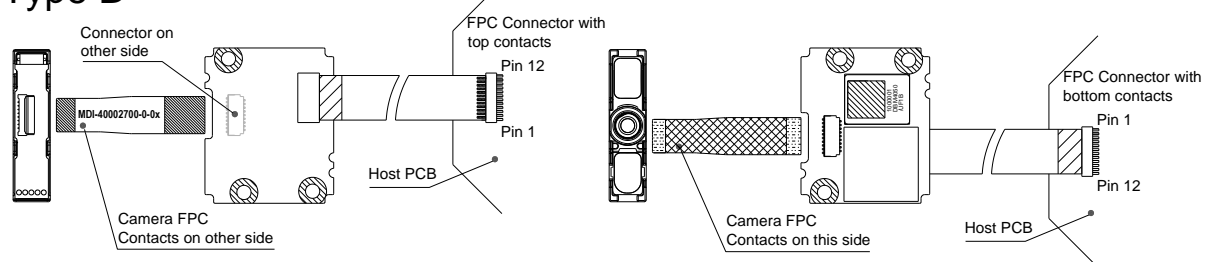


Figure 11: MSI-4000 and DBM-40x0 FPC/FCC installation.

Depending on the specific FFC cable and the orientation of the decoder board (relative to the target PCB), the FFC connector on the target PCB should be either one with top contacts or one with bottom contacts. Refer to the drawing above to see which should be used. In either case the connector should have 12 pins with a 0.5mm pitch and should accept an FFC cable with a thickness of 0.3mm.

4.2 Installation Recommendation for the MDI-41x0

The installation recommendations for the scan engine are listed below.

- Mount the scan engine to a material with high thermal conductivity, such as metal, especially when the auto-trigger is used.
- Do not insert screws further than the maximum specified depth.
- Keep enough clearance to avoid damage to the camera in case the host device is dropped.
- Shock / impact resistance of the camera module to any acceleration applied via the bottom surface is specified up to a certain limit. In case of direct shock however, the camera module will almost certainly be damaged since it consists of precise optical elements.

4.2.1 MDI-41x0

Screw type: M2 with a pitch of 0.4.
Maximum screw depth: 2.5 mm from the mounting surface of the scan engine.
Recommended torque: 15 Ncm.

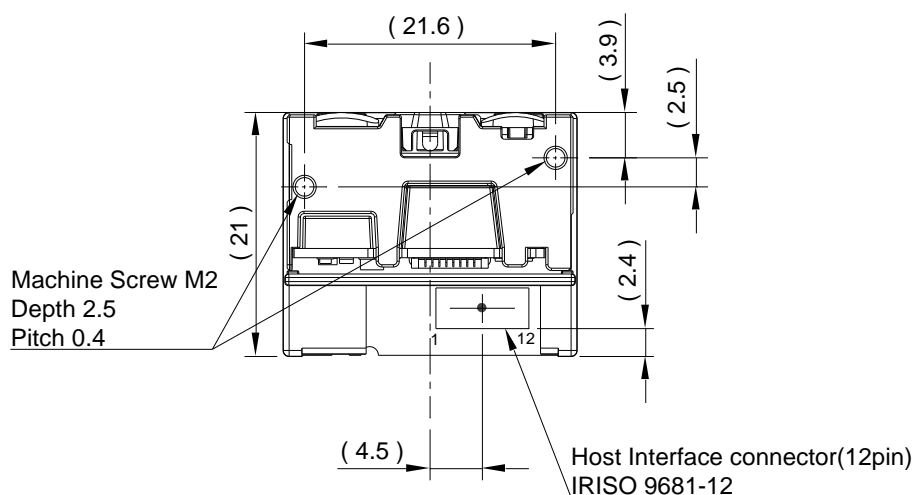
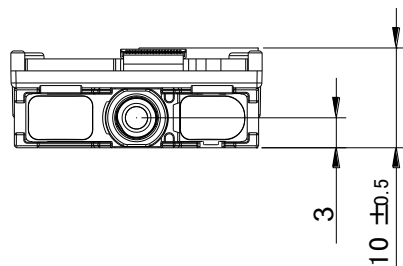


Figure 12: MDI-4100 Mounting Holes

Height of the MDI-4100 and the MDI-4150

MDI-4100 and MDI-4150 has different circuit board thicknesses.

MDI-4100



MDI-4150

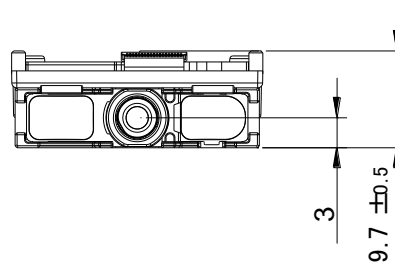


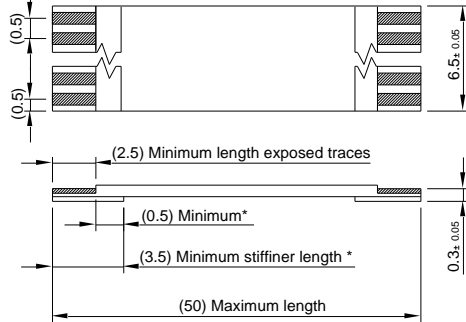
Figure 13: Height of the MDI-4100 and the MDI-4150

4.2.2 FFC Cable and Connector

There are two types of FFC cables that can be used to connect the MDI-4100 to a target PCB. One with contacts on the same side (Type A) and one with contacts on opposite sides (Type B). Below are the specs and a description on how to connect the decoder board to a target PCB.

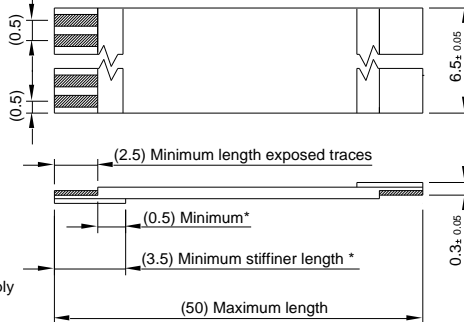
Type A

FFC cable, 0.5mm pitch, 12 conductors, 0.3mm thick contacts on same side.



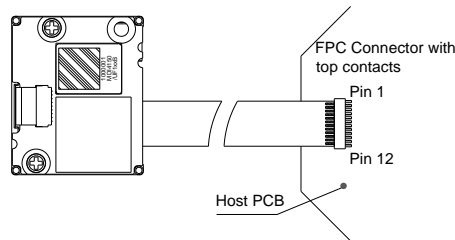
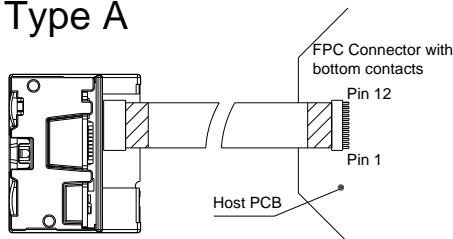
Type B

FFC cable, 0.5mm pitch, 12 conductors, 0.3mm thick contacts on opposite sides.



* Both should apply

Type A



Type B

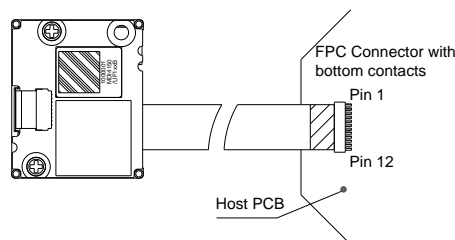
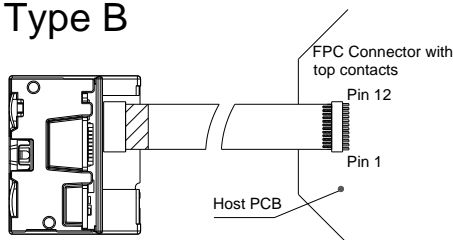


Figure 14: MDI-4100 FCC installation

Depending on the specific FFC cable and the orientation of the scan engine, the FFC connector on the target PCB should be either one with top contacts or one with bottom contacts. Refer to the drawing above to see which one should be used. In either case the connector should have 12 pins with a 0.5mm pitch and should accept an FFC cable with a thickness of 0.3mm.

- It is recommended to use a FFC but it is possible to use an FPC as well.
- When an FPC is used, it is recommended to use at least 60um copper thickness.
- When an FPC is used, it is recommended to use “polyimide and thermoset adhesive” as material for the reinforcing film.
- When an FPC is used, make sure the thickness and dimensions are within tolerance.

4.3 Handling Requirements

The recommended handling conditions for incorporating the scan engine into your device are shown below.

- Use anti-static measures such as wearing a grounded hand strap before handling the scan engine in order to avoid damage to the electronic components from electrostatic discharge.
- Hold the scan engine only by the case. Do not touch the circuit board or the front side of the scan engine.
- Do not touch the electronic components or the terminals on the circuit board.
- Installation in a clean environment is recommended in order to protect the imaging lens from dust.
- Operators should wear gloves to avoid contaminating the optical elements.
- Do not drop the MDI-4xx0.

5 Mechanical Drawings

This chapter describes mechanical drawing for the scan engine.

5.1 Drawing of the MDI-4000 and the MDI-4050

5.1.1 Camera (MSI-4000)

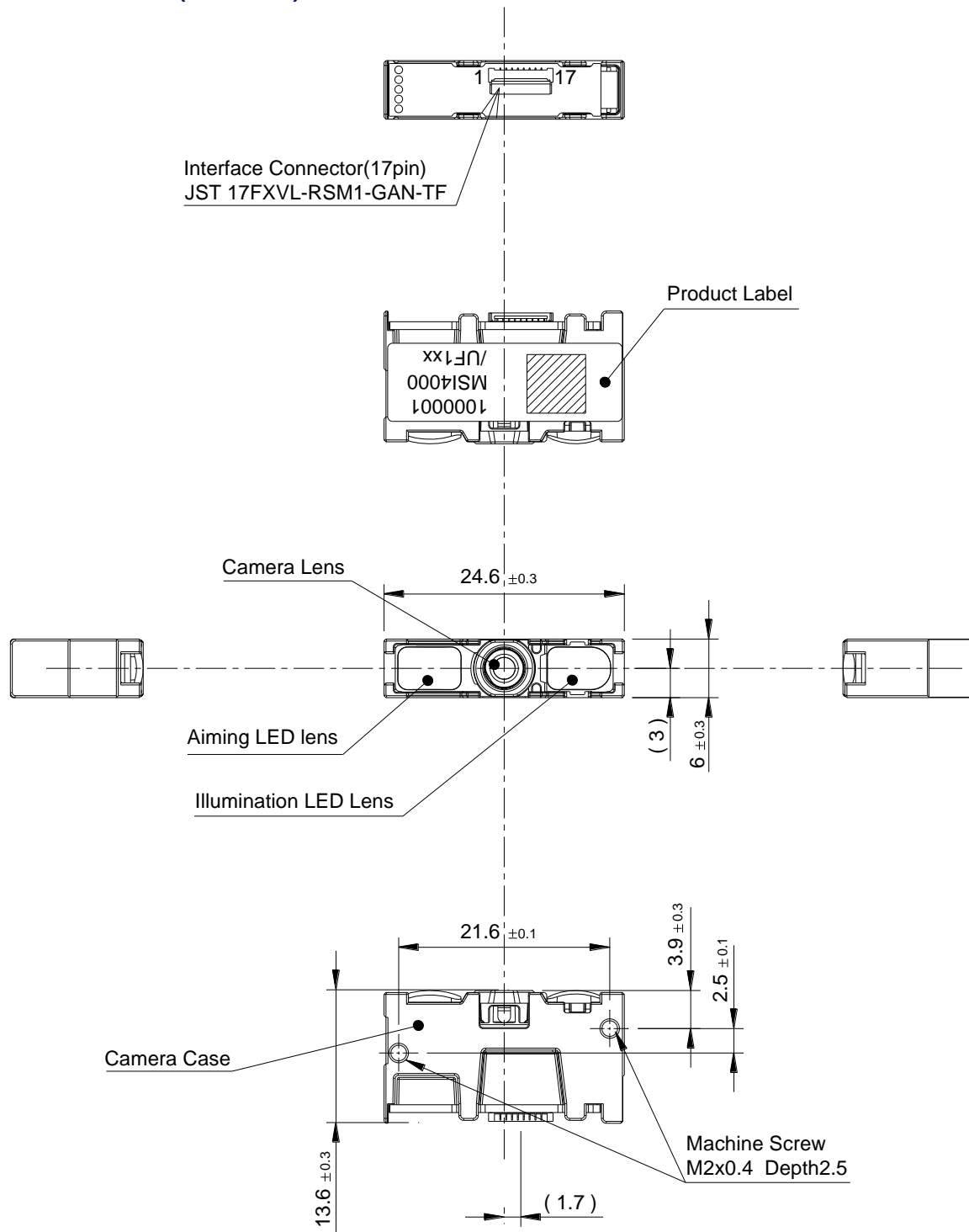


Figure 15: Drawing of the MSI-4000

5.1.2 Decoder Board (DBM-4000 and DBM-4050)

DBM-4000 and DBM-4050 has different circuit board thicknesses.

DBM-4000

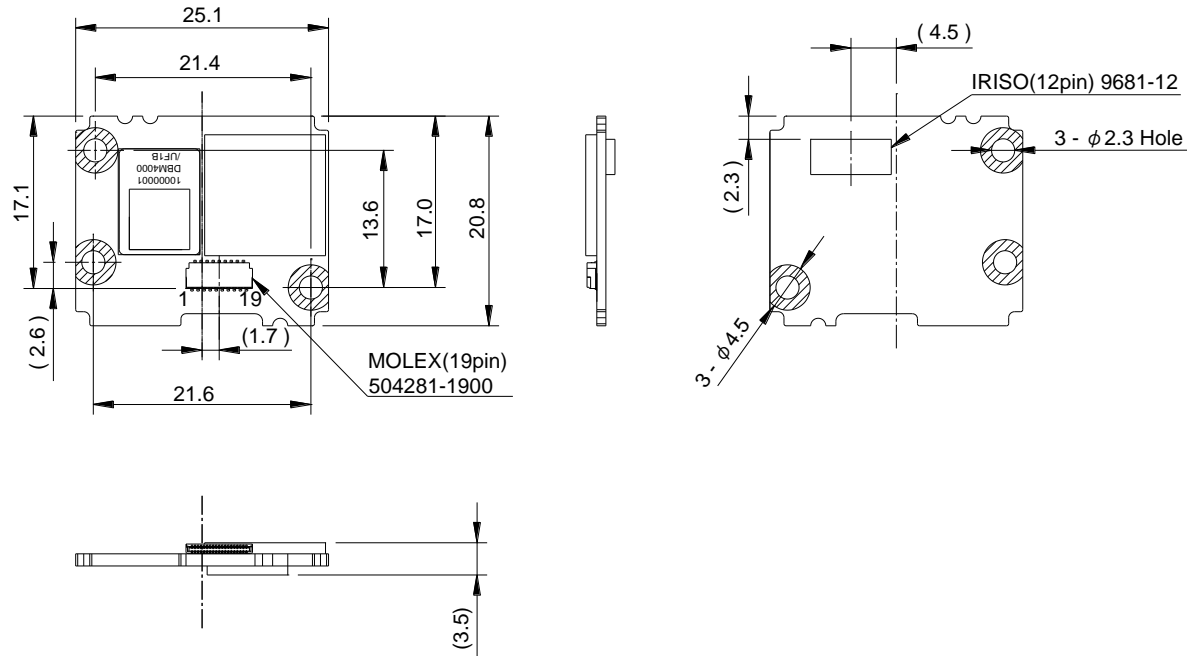


Figure 16: Drawing of the MDI-4000 Decoder Board

DBM-4050

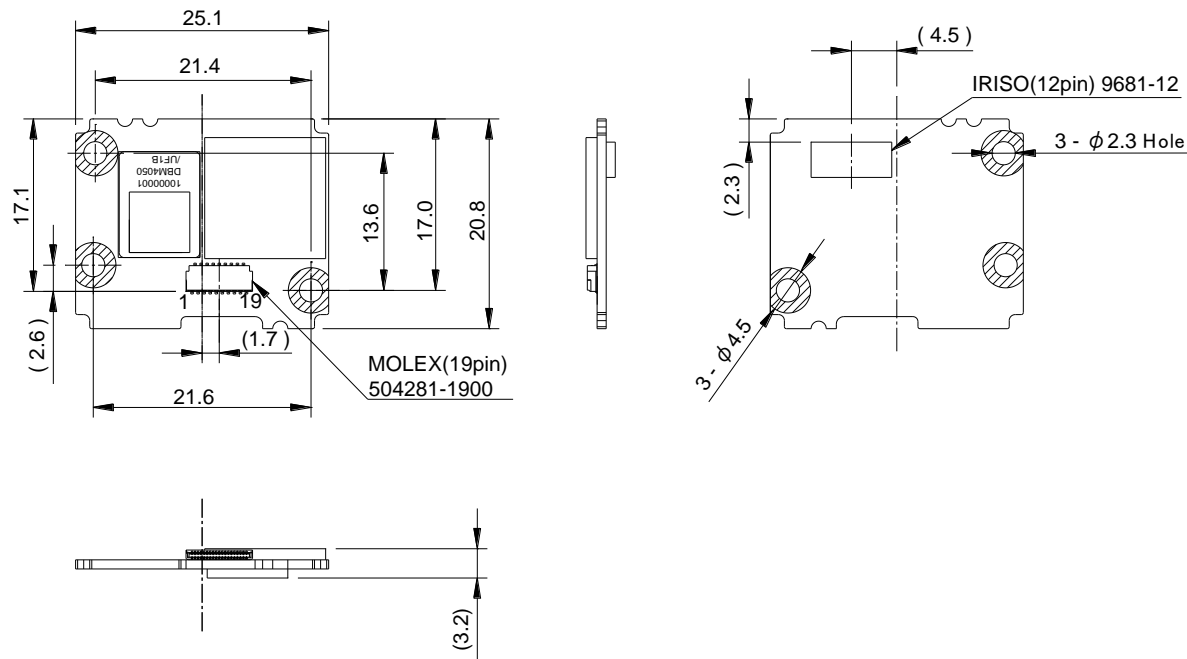


Figure 17: Drawing of the MDI-4050 Decoder Board

5.1.3 FPC

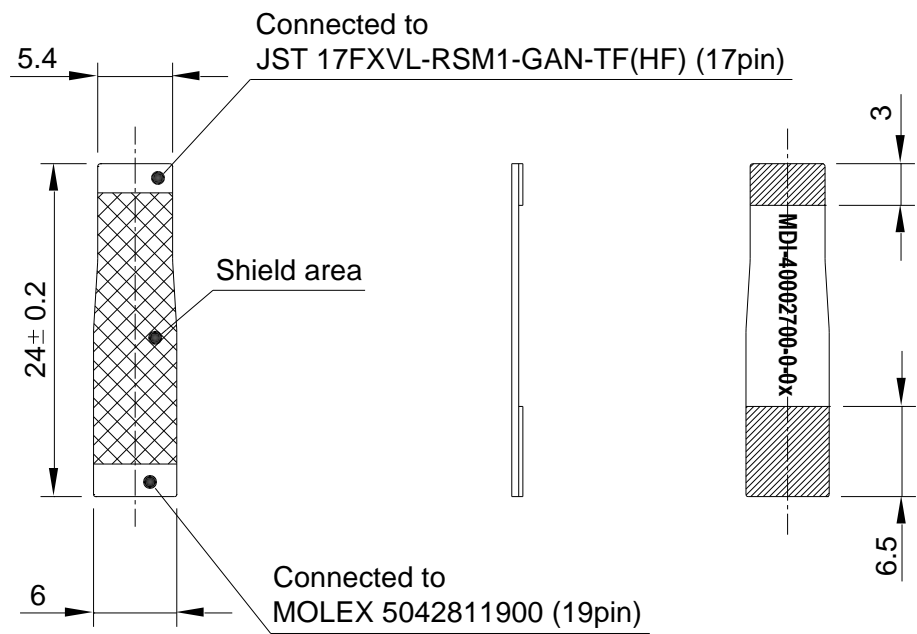


Figure 18: Drawing of the MDI-40x0 FPC

5.2 Drawing of the MDI-4100 and MDI-4150

MDI-4100 and MDI-4150 has different circuit board thicknesses.

5.2.1 MDI-4100

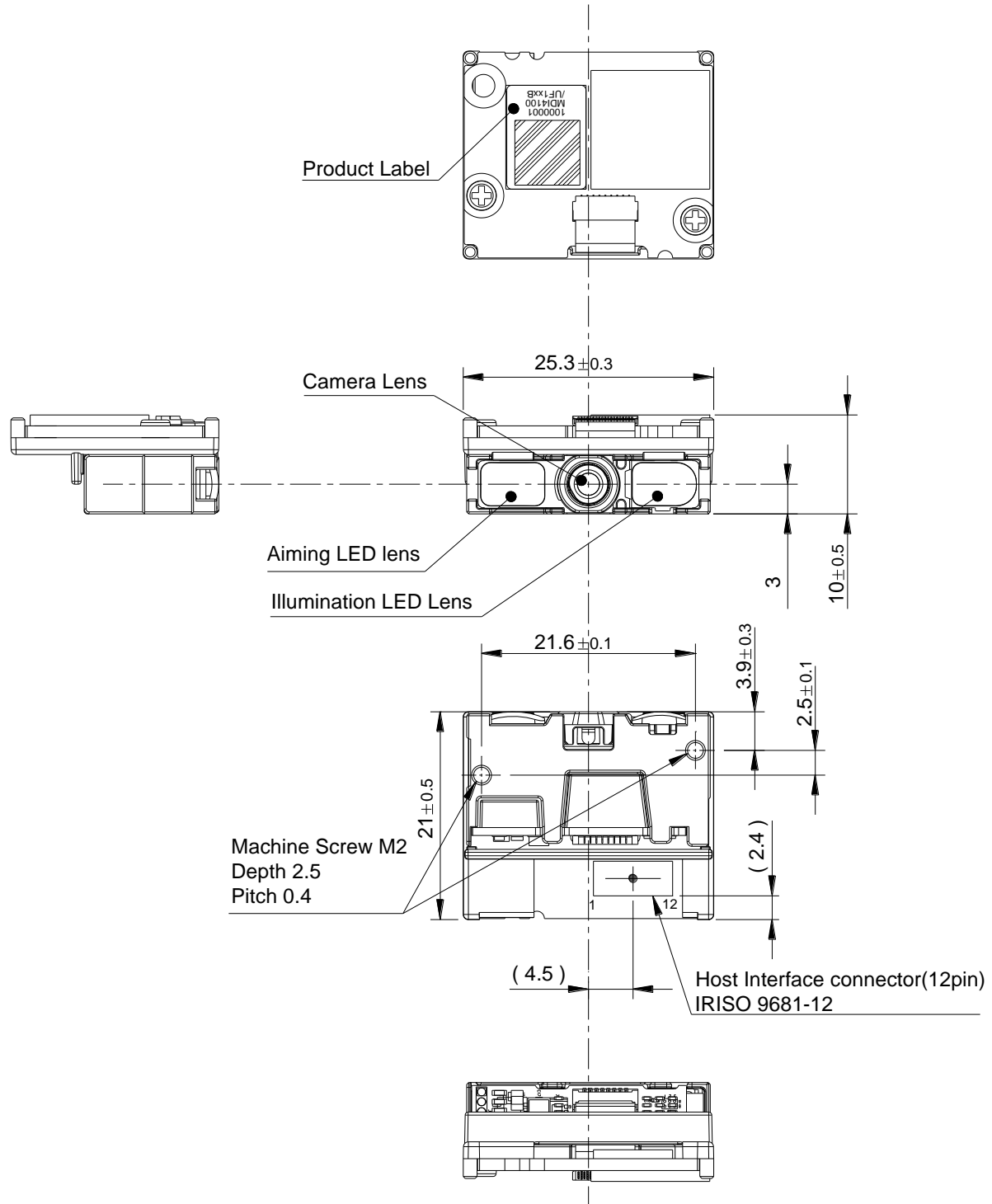


Figure 19: Drawing of the MDI-4100

5.2.2 MDI-4100

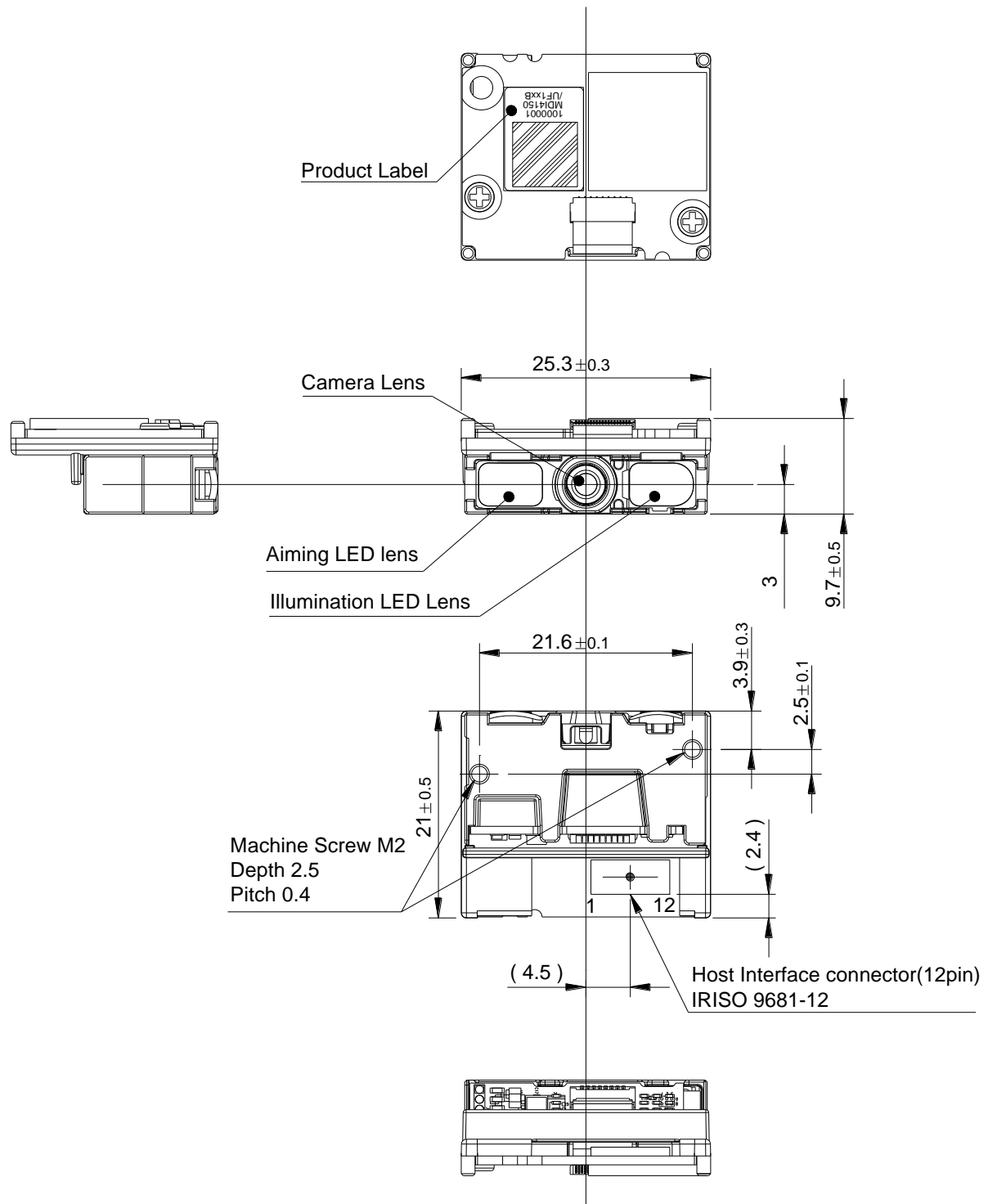


Figure 20: Drawing of the MDI-4150