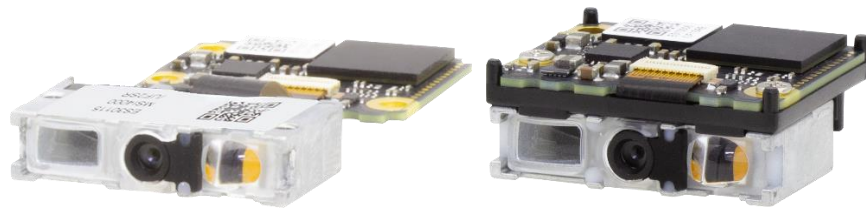


Integration Guide



MDI-4600

MDI-4700

Low Profile High-Performance 2D Scan Engine

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

Document History

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1 Abstract

This guide provides instructions for installing the MDI-4600 and MDI-4700 (hereafter called “scan engine”) and is intended for engineers who are responsible for integrating the scan engine into their product. To maximize performance and minimize problems, read this integration guide carefully and follow all instructions to properly integrate the scan engine. Following these recommended instructions will help to ensure that the scan engine will properly capture images. To further test image capturing, you should use image capturing tools to capture images. These tools are available from the Opticon website.

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-4600 SR and MDI-4700 SR	Standard range model (focus: 115 mm)
MDI-4700 HD	High density model (focus: 65 mm)
MDI-4700 UD	Ultra-High density model (focus: 45 mm)

About the 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 reflection (Section [2.1](#)) and 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. The reflection creates an overexposed spot on the left side of the image, which makes it much more difficult to decode the barcode. It is highly recommended that you check actual pictures made by the scan engine 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

To achieve the expected performance, the material and layout design of the exit window are important.

2.1 Exit Window Material

To help prevent reflection from the LED illumination off the exit window and degradation of the image by scratches and dirt, follow these recommendations to construct the exit window.

- 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 1 mm thick acrylic material.
- 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. This 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. Remove this protective sheet during 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:

MITSUBISHI CHEMICAL CO., LTD.:

Nitto Jushi Kogyo Co., Ltd.:

FUKUVI Chemical Industry CO., LTD.:

Shinkolite

Clarex Precision Thin Sheet

HARZLAS AR

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. So, the exit window must be positioned so that the reflection is minimal and is not directed into the camera. Make sure that the distance and inclination of the exit window is within the range specified below.

2.2.1 Installing the Exit Window at Short Range

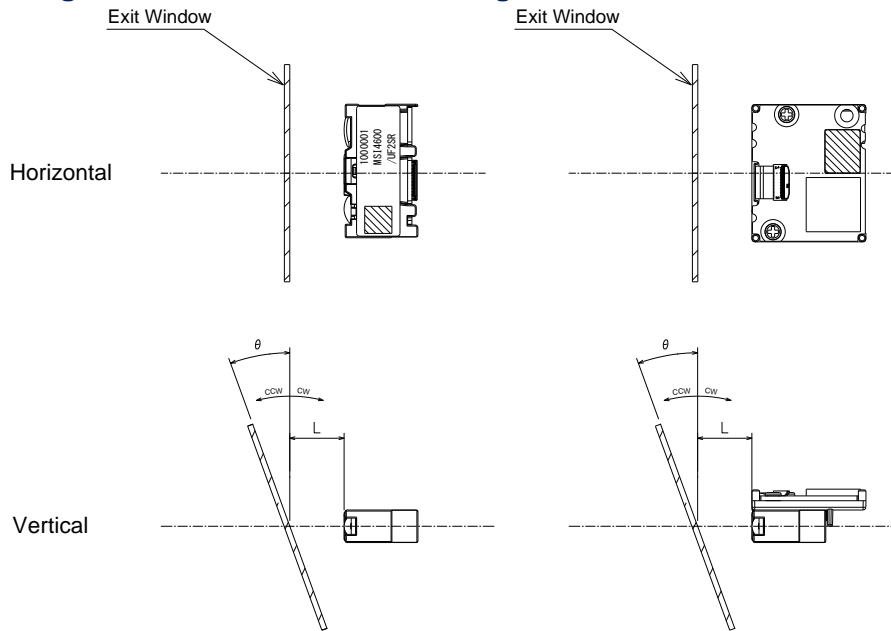


Figure 1: Exit Window Placement of the MDI-4600 and MDI-4700

The next tables show the recommended mounting position of the window if both sides are AR coated and if there is no AR coating.

Conditions

Window: 1 mm acrylic sheet

Conditions: Visually check reflection by taking images with the scan engine in a dark room 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, $\theta_{CW} = 0^\circ$ 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	$\geq 35^\circ$	$\geq 30^\circ$	$\geq 30^\circ$

- To accommodate the dimensional tolerances of the mounting holes, make sure there is a minimum clearance of 1 mm between the scan engine and the exit window.
- Use of AR coated material for the exit window is recommended.
- External light is not factored in.
- To make sure there is no reflection from the LED illumination off the exit window, acquire images from the scan engine.

2.2.2 Installing the Exit Window at Far Range

When installing the scan engine at a far range from the exit window, LED illumination appears at the exit window when the scan engine is placed as indicated in the next drawing. To avoid reflection from the LED, tilt the scan engine and exit window about 18 degrees vertically.

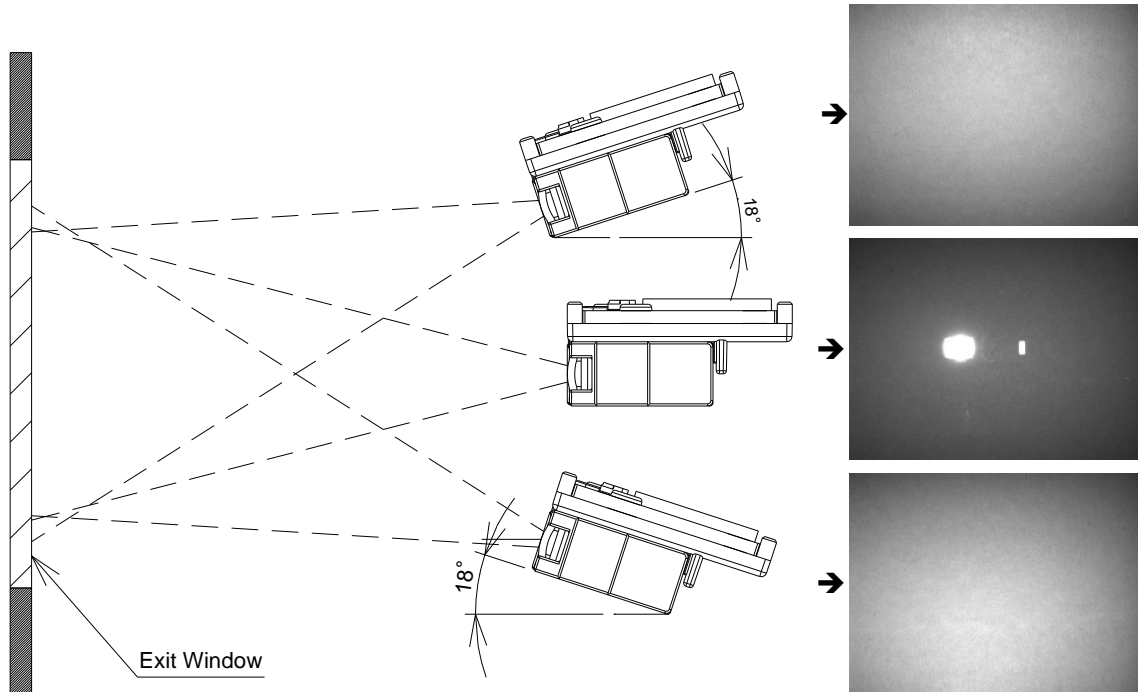


Figure 2: Exit Window and Angle of the MDI-4600 and MDI-4700

Note: Reflection varies depending on the exit window material and distance. Make sure to obtain the actual image and evaluate the angle.

3 Exit Window Size

These issues may interfere with the success of scanning barcodes:

- 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.
- Specular (mirror-like) reflection can occur in the target barcode depending on how it is presented to the scan engine.

This chapter describes the distance and inclination limitations for the exit window to avoid these issues.

3.1 Window Size and Optical Path Clearance

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

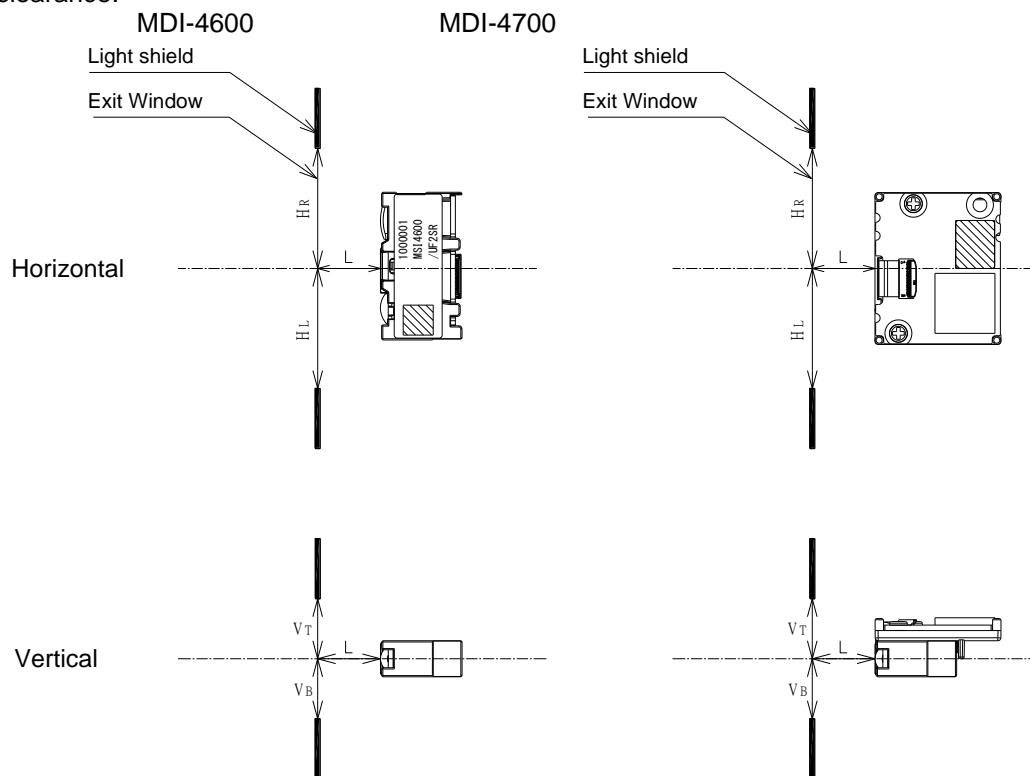


Figure 3: Window Size and Optical Path Clearance

The next 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 Optical Path Clearance

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 Optical Path Clearance

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 and manifests as darker edges in the image. Confirm this condition visually by acquiring images from the scan engine in the design phase.

3.2 Optical Path

Install the exit window so that there is 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.

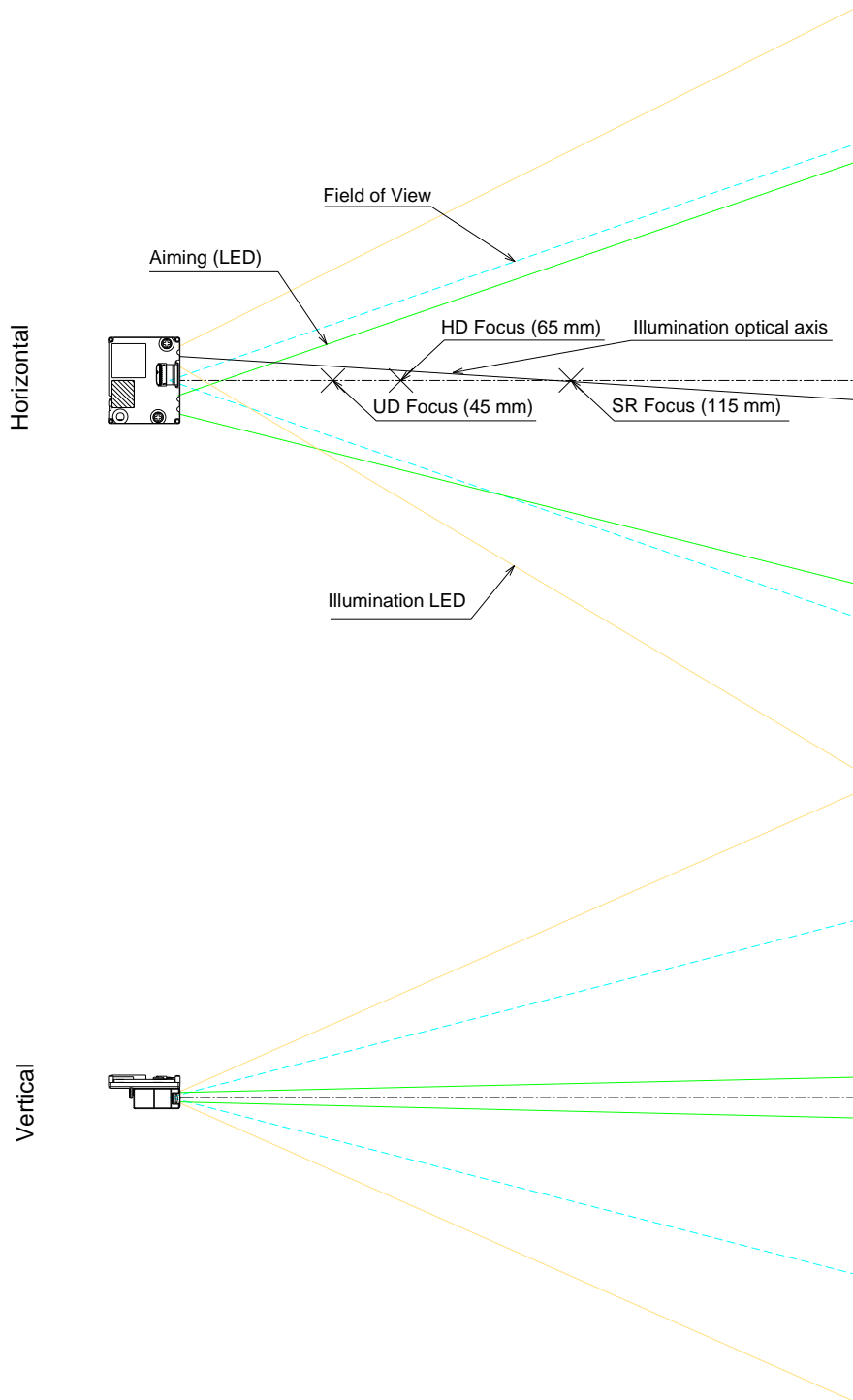


Figure 4: MDI-4700 Optical Path

- 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.

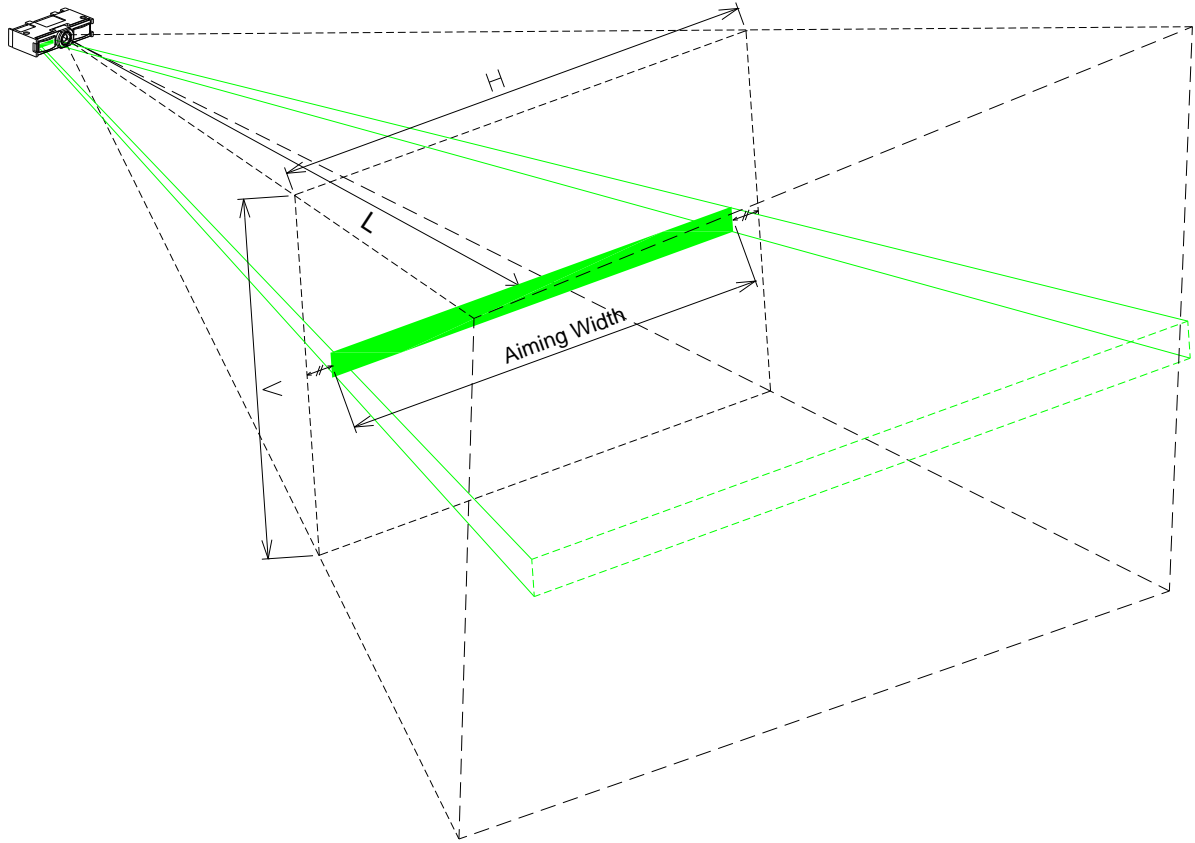


Figure 5: MDI-4600 and MDI-4700 Field of View and Aiming

L: Distance from the 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

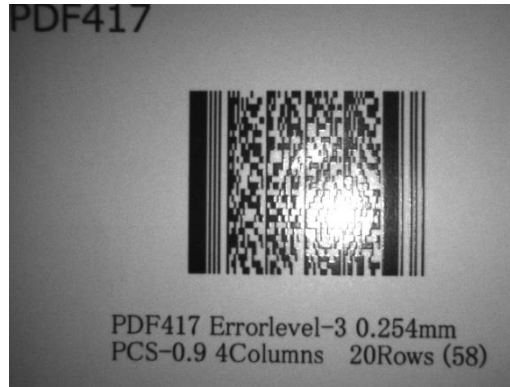
- The indicated field of view should not be obstructed by any part of the housing.

3.4 Scanned Media and Placement

When an object is scanned, specular reflection of the LED illumination and intense ambient light may occur.

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 can be avoided when an angle is created between the scan engine and the target label as shown in the next figure. 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, the target label becomes more difficult to read.

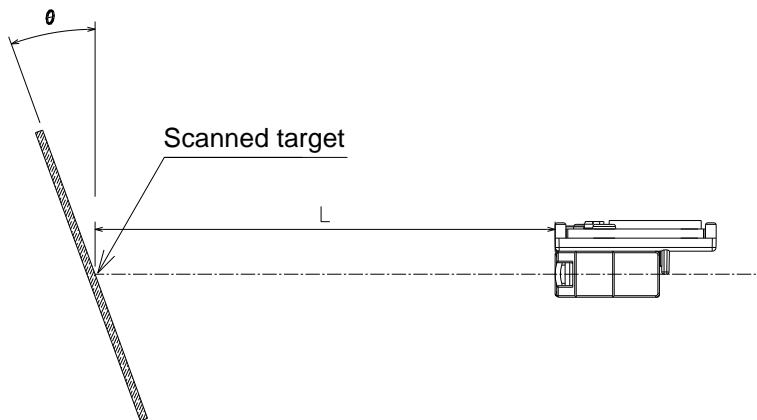


Figure 6: Inclination of Scanned Target

4 Installation

This chapter describes practical guidelines for the mechanical installation of the scan engine. This chapter is divided in two parts:

- Recommended installation of the MDI-4600 (camera module and separate decoder board)
- Recommended installation of the MDI-4700 (internal decoder)

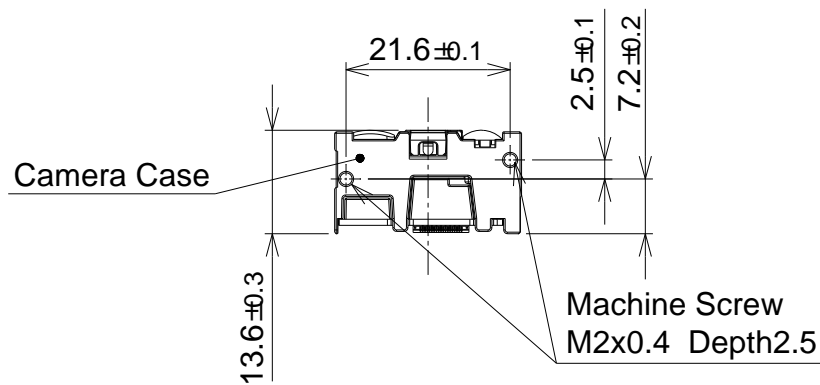
4.1 Installation Recommendations for the MDI-4600 and MDI-4700

Follow these installation recommendations:

- 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, because it contains precise optical elements.
- Make sure to electrically ground the case of the MDI-4600.

4.1.1 MSI-4600 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.



[Unit: mm]

Figure 7: MSI-4600 Mounting Holes

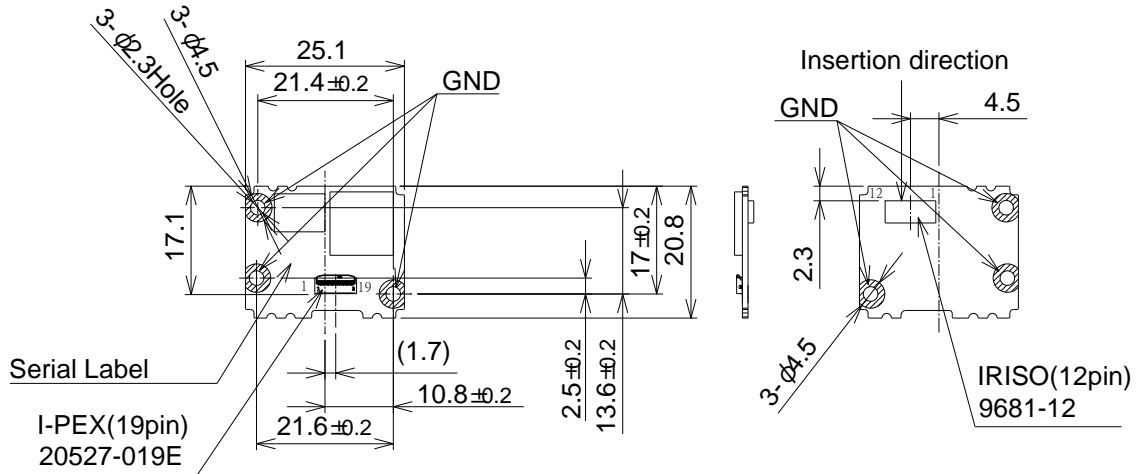
4.1.2 DBM-4600 Installation

Follow these installation recommendations:

- Do not screw the decoder board directly on to a PCB. Use spacers or screw pillars.
- The decoder board may become hot, especially when the auto trigger is used. Make sure that there are no heat sensitive parts close to the decoder board.
- Make sure the size of the screw head does not exceed the diameter of the mounting landing.
- Make sure to electrically ground the DBM-4600 mounting holes.

DBM-4600 Decoder Module Installation Recommendations

Screw size: M2



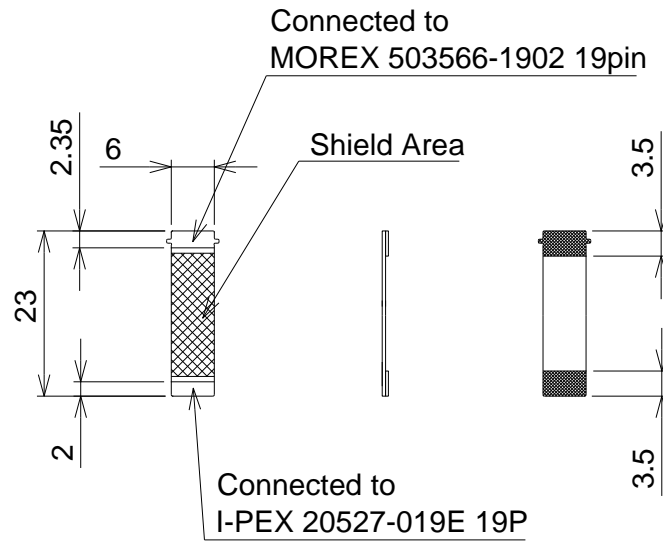
[Unit: mm]

Figure 8: Decoder Board Mounting Holes

4.1.3 Camera FPC Installation Recommendations

Follow these installation recommendations:

- 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.
- Note that the connector on the decoder side and the connector on the camera side are two different 19-pin connectors:
 - Camera side: 19-pin
 - Decoder side: 19-pin
- Use the Opticon supplied FPC cable.



[Unit: mm]

Figure 9: FPC Drawing

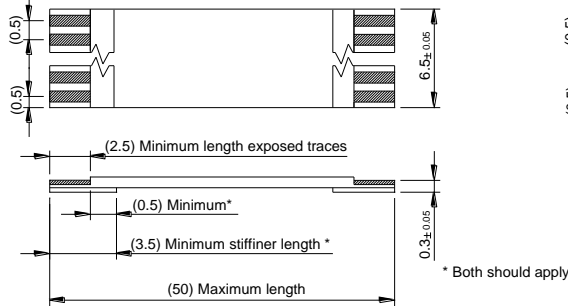
4.1.4 Camera FPC Installation

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

The next drawings contain the specifications, as well as descriptions on how to assemble the camera module to the decoder board and how to connect the decoder board to a target PCB.

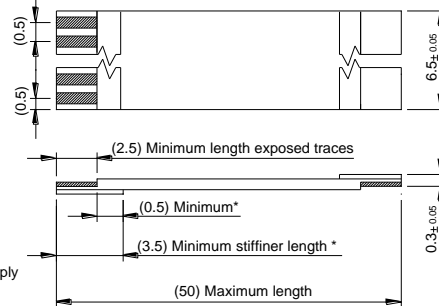
Type A

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

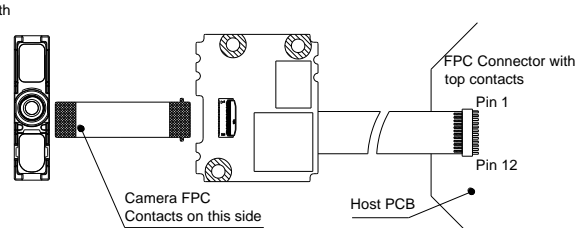
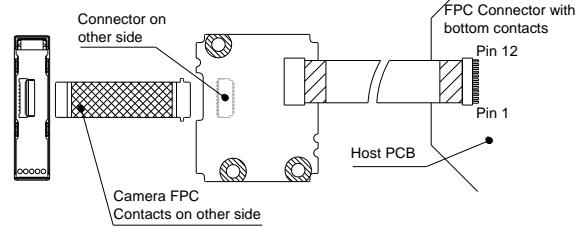


Type B

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



Type A



Type B

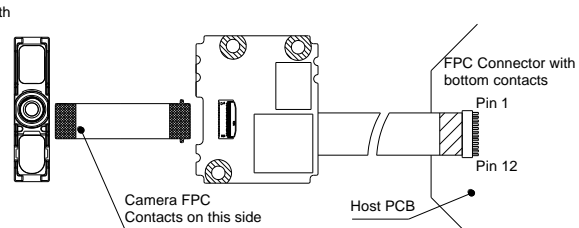
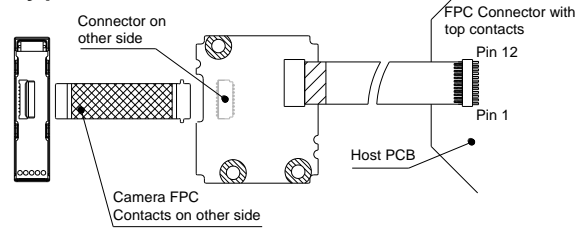


Figure 10: MSI-4600 and DBM-4600 FPC/FCC Installation

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 previous drawing to see which connector to use. In either case the connector should have 12 pins with a 0.5 mm pitch and should accept an FFC cable with a thickness of 0.3 mm.

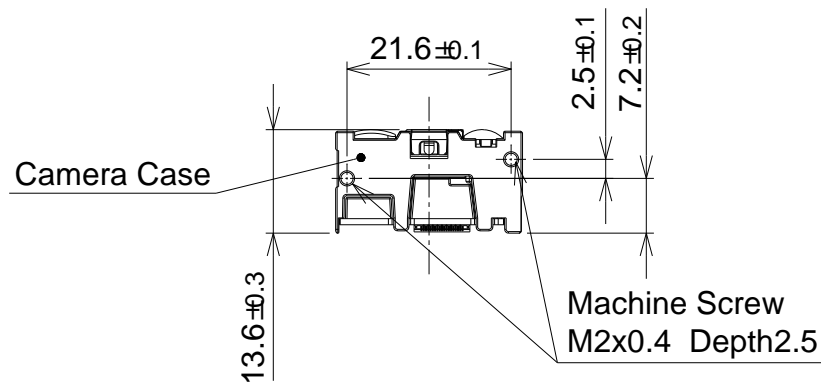
4.2 Installation Recommendations for the MDI-4700

Follow these additional installation recommendations for the MDI-4700:

- 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. Direct shock is likely to damage camera module, because it contains precise optical elements.

4.2.1 MDI-4700

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.



[Unit: mm]

Figure 11: MDI-4700 Mounting Holes

4.2.2 FFC Cable and Connector

There are two types of FFC cables that can be used to connect the MDI-4700 to a target PCB. One with contacts and 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.

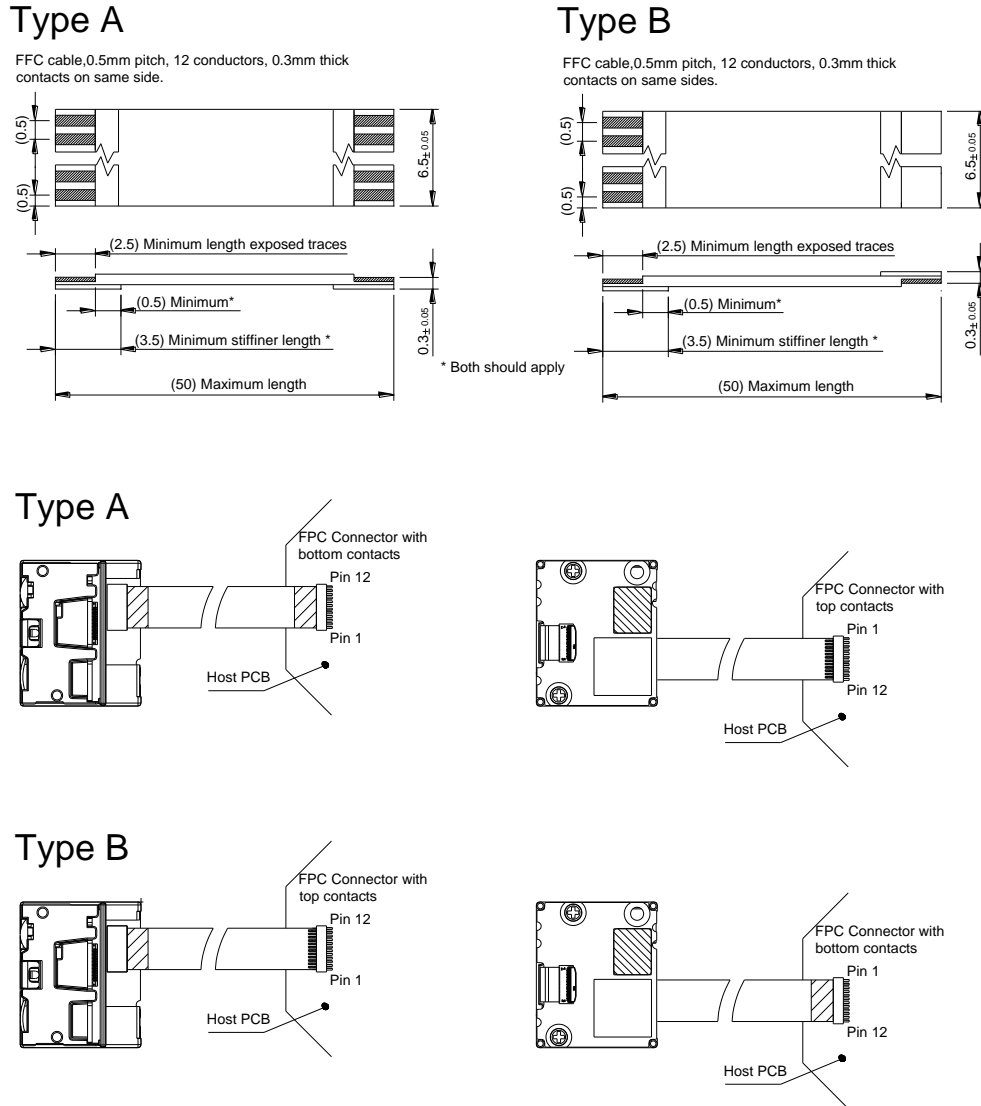


Figure 12: MDI-4700 FCC Installation

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 previous drawing to see which one should be used. In either case the connector should have 12 pins with a 0.5 mm pitch and should accept an FFC cable with a thickness of 0.3 mm.

Additional recommendations:

- 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

Follow these recommended handling conditions for incorporating the scan engine into your device:

- To avoid damage to the electronic components from electrostatic discharge, use anti-static measures, such as wearing a grounded hand strap before handling the scan engine.
- Only hold the scan engine 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.
- To protect the imaging lens from dust, only install the scan engine in a clean environment.
- To avoid contaminating the optical elements, operators should always wear gloves.
- Do not drop the MDI-4xx0.

5 Mechanical Drawings

This chapter illustrates the mechanical drawings of the scan engine.

5.1 Drawing of the MDI-4600

5.1.1 Camera Engine (MSI-4600)

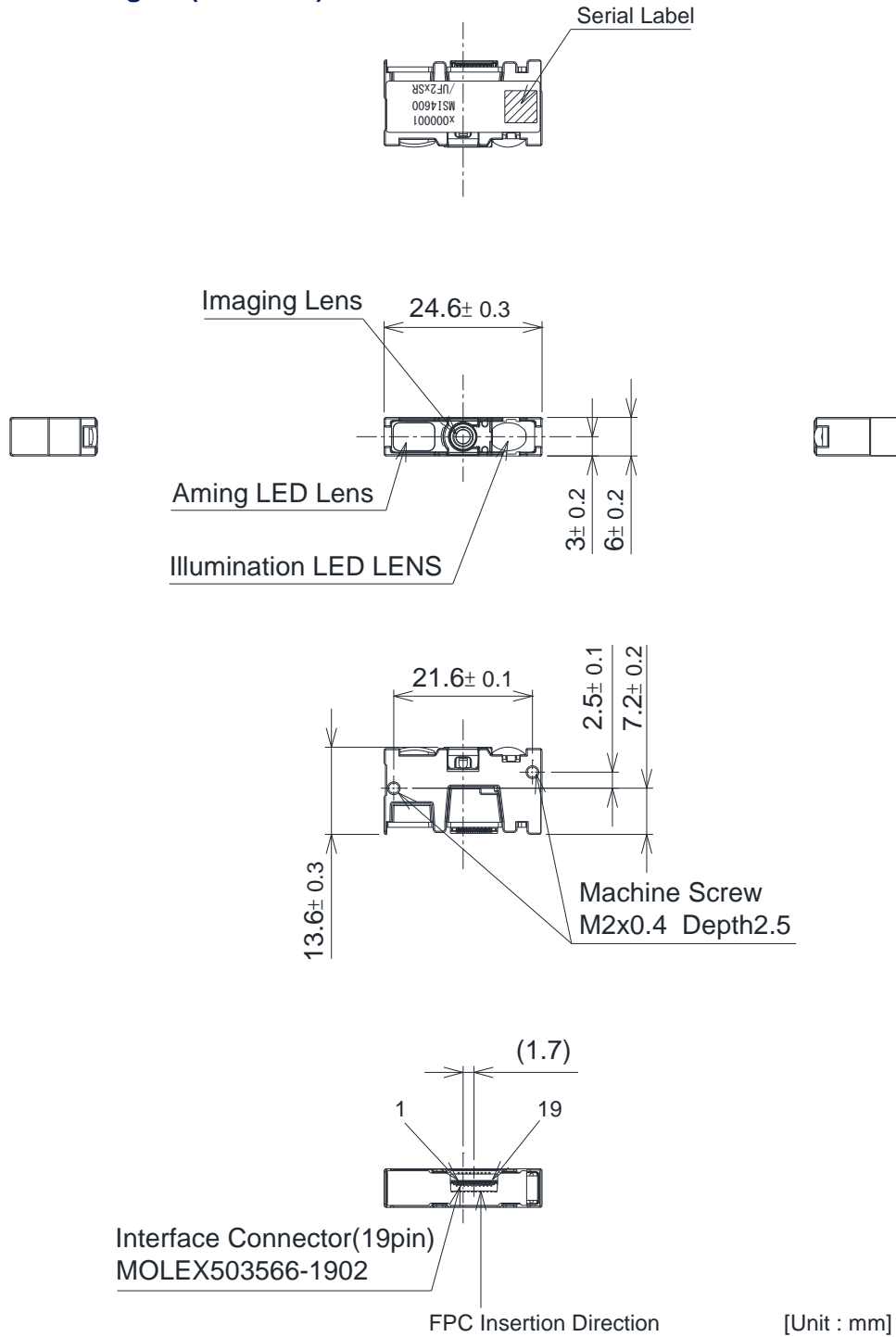


Figure 13: MSI-4600 Drawing

[Unit : mm]

5.1.2 Decoder Board (DBM-4600)

DBM-4600

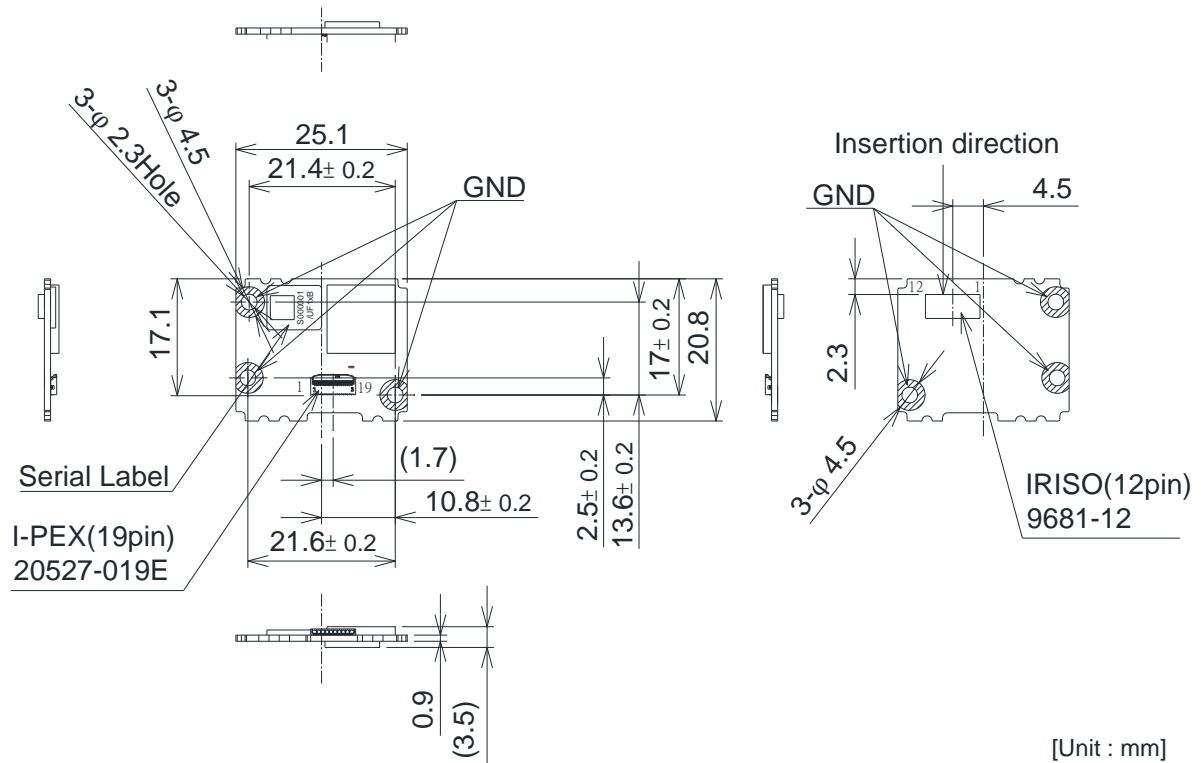


Figure 14: MDI-4600 Decoder Board Drawing

5.1.3 FPC (MDI-4600)

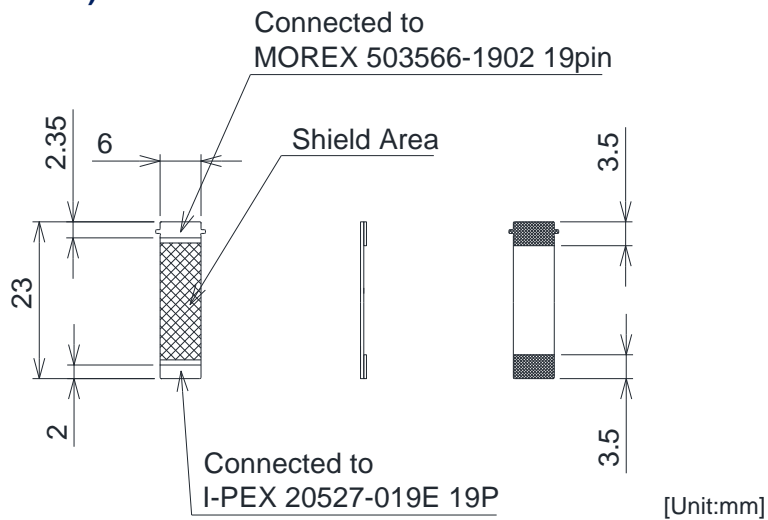


Figure 15: MDI-4600 FPC Drawing

5.2 Drawing of the MDI-4700

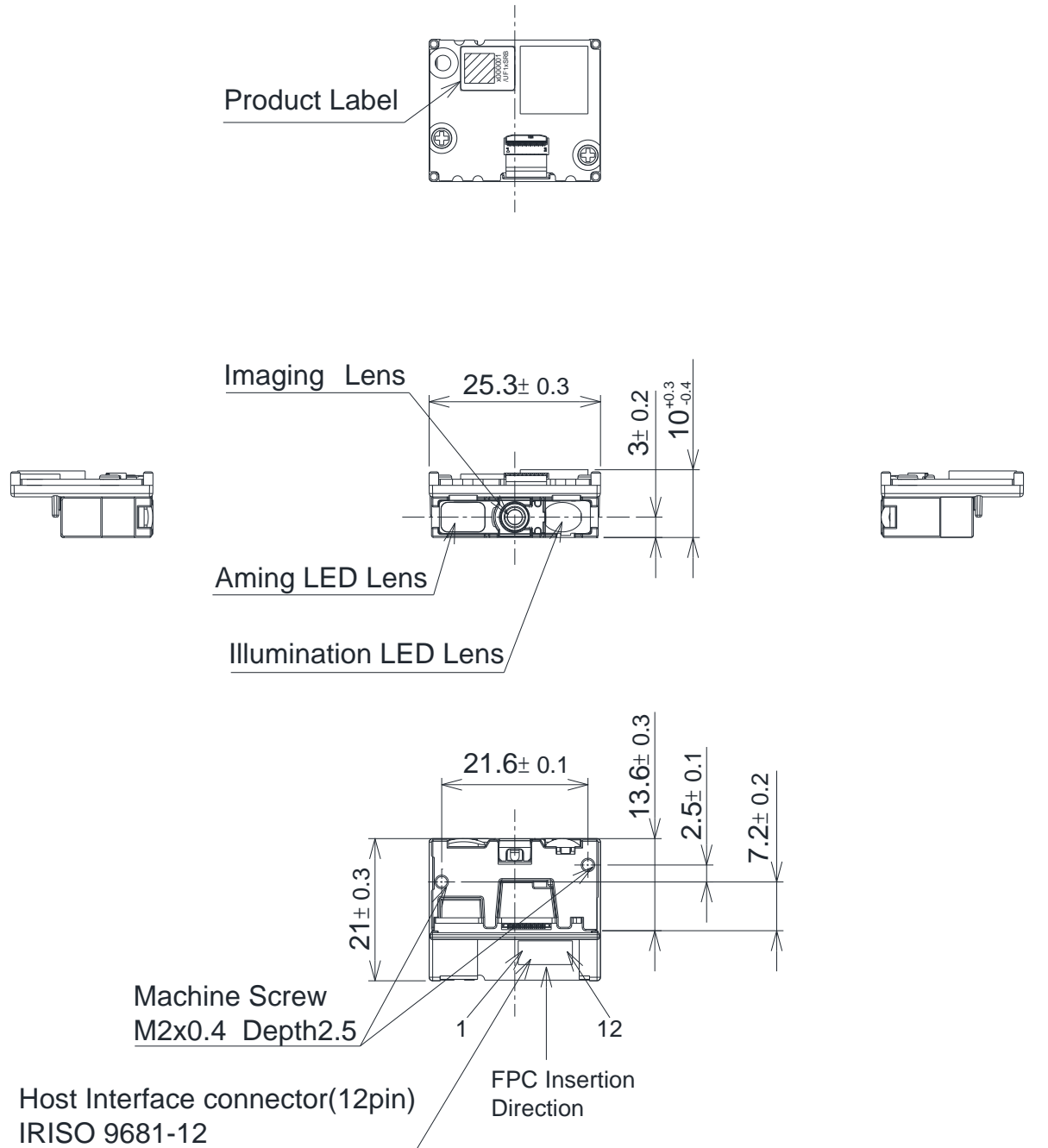


Figure 16: MDI-4700 Drawing

[Unit: mm]