

Single-Panel Liquid Crystal Optical Engine for Rear Projectors *Preliminary*

Description

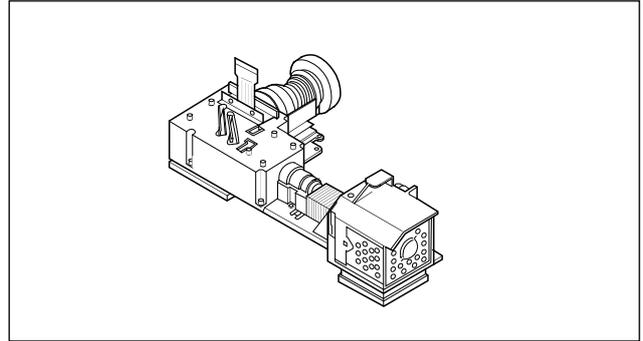
The DS001AKA is a single-panel liquid crystal optical engine for use in rear projectors, capable of full-color displays without color filters (CF).

This engine provides a wide aspect ratio of 16:9, such as those represented in HD.

The side-black function also allows an aspect ratio of 4:3 in the NTSC/PAL mode. Up/down and/or right/left inversion functions accommodate various mounting methods.

Short projection distances are made possible through the adoption of ultra-wide angle lenses. In addition, a projection lens floating mechanism delivers 30" to 60" projected images with minimal image distortion.

A high intensity discharge (HID) lamp ensures high luminance and low power consumption.



Features

- The number of active dots: 768,000
- Horizontal resolution: 600 TV lines
- NTSC/NTSC-WIDE/HD (band: 20MHz) mode selectable (PAL/PAL-WIDE mode also available through conversion of scanned dot numbers by an external IC)
- Up/down and/or right/left inverse display function
- Side-black function
- 16:9 and 4:3 aspect-ratio switching function
- Full-color display with CF-less projection system
- High luminance flux: normally-white 120 ANSIlm (typ.)
- Ultra-wide angle lenses for short projection distances (531mm/37", at 4.5% overscanning)
- Image distortion correction floating mechanism to support 30" to 60"
- Relative illumination: 70% or above
- Uses HID lamp (100W)

Engine Configuration

- HID lamp
- Lamp driver (DC 300V input)
- High-efficiency illumination system employing glass rods
- Separate RGB illumination systems using dichroic mirrors (DM)
- LCD panel mounting mechanism, adjustable along XYθ axes
- LCD panel (LCX011AM)

Dots

16:9 display: 1599.5 (H) × 480 (V) = 767,760 dots

4:3 display: 1199.5 (H) × 480 (V) = 575,760 dots

- Wide fixed focal length lenses for enlarged projection of LCD
- Silent fans for cooling

Applications

Liquid crystal rear projection TV/monitor

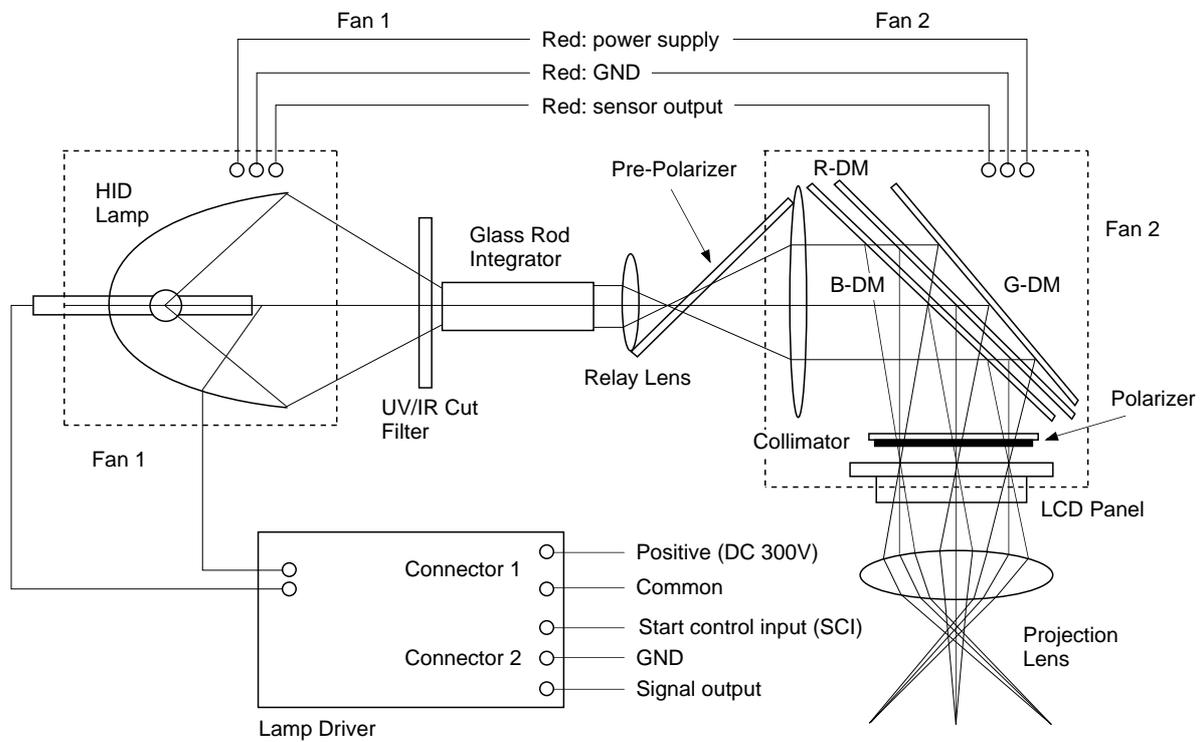
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Explanation of Basic Operation

- Apply DC 300V to the lamp driver.
- Light emitted by the lamp is focused by an elliptical reflector on a glass rod integrator, and is rendered homogeneous at the output end of the integrator.
- Light output from the integrator passes through a relay lens and collimator lens to become a collimated ray, which is color-separated by a group of dichroic mirrors.
- The color-separated rays are focused on the respective RGB dots by microlenses mounted on the LCX011AM, and distributed.
- After transmitting the panel, the light is enlarged and projected onto a screen by a projection lens.

For details of the LCD panel operation, please refer to the LCX011AM specifications.

Block Diagram



Pin Description and Operating Conditions

Ambient Temperature

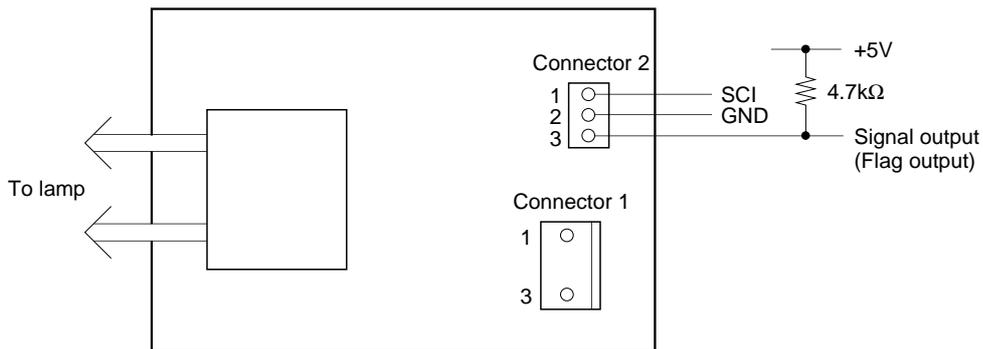
Optical engine unit (excluding lamp driver)

- Operating temperature Topr 0 to +50 °C
- Storage temperature Tstg -20 to +60 °C

Lamp driver unit

- Operating temperature Topr -5 to +65 °C (under forced air cooling)
- Storage temperature Tstg -40 to +85 °C

Lamp Driver Unit



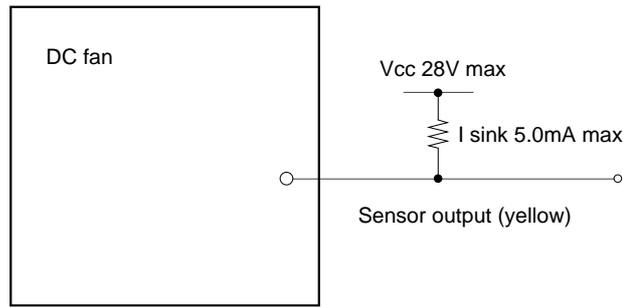
Pin Description

	Connector 1 DC power supply input	Connector 2 SCI (start control input) and signal output
1	positive (DC 300V)	start control input (SCI)
2	—	GND
3	common	signal output (flag output)
Connector type	JST (Japan Solderless Terminal) B 3B-PH-K	JST (Japan Solderless Terminal) B 2P3-VH-B

Operating Conditions

	Min.	Typ.	Max.	Unit	Remarks
Input voltage	220	300	390	V	
Power consumption	105	110	120	W	
Circuit loss	—	10	15	W	
Lamp output	95	100	105	W	
Lamp startup peak voltage	—	—	25	kV	
Start control input (SCI) Input voltage					
Lamp extinguish	—	—	1.0	V	Input current < 1.0mA Input current < 5.0mA
Lamp light	3.5	5.0	7.0	V	
Signal output (flag output) Output voltage					
Lamp extinguish	—	—	1.0	V	
Lamp light	3.5	—	—	V	

DC Fan Unit (Fan 1, Fan 2)



Pin Description

Item	Fan1, Fan2	Remarks
Red cable	power supply (positive)	rated 12V
Blue cable	GND	
Yellow cable	sensor output When revolving: low When restrained: high	restraint detection (open collector output)
Connector type	Housing MLX5102-03 Pin MLX5103-TL	mfg. by Morex

Operating Conditions

Fan 1

Item	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	10.5	12.0	13.5	V	
Power consumption	—	1.4		W	rated voltage
Current consumption when open	—	—	0.14	A	rated voltage
Current consumption when restrained	—	—	0.30	A	rated voltage
Sensor output					
Vcc	—	—	28	V	
Vcc (sat)	—	—	1.0	V	
I sink	—	—	5.0	mA	

Fan 2

Item	Min.	Typ.	Max.	Unit	Remarks
Supply voltage	10.5	12.0	13.5	V	
Power consumption	—	2.0		W	rated voltage
Current consumption when open	—	—	0.20	A	rated voltage
Current consumption when restrained	—	—	0.45	A	rated voltage
Sensor output					
Vcc	—	—	28	V	
Vcc (sat)	—	—	1.0	V	
I sink	—	—	5.0	mA	

For details of the LCD panel operating conditions and pin description, refer to the LCX011AM specifications.

Electro-optical Characteristics

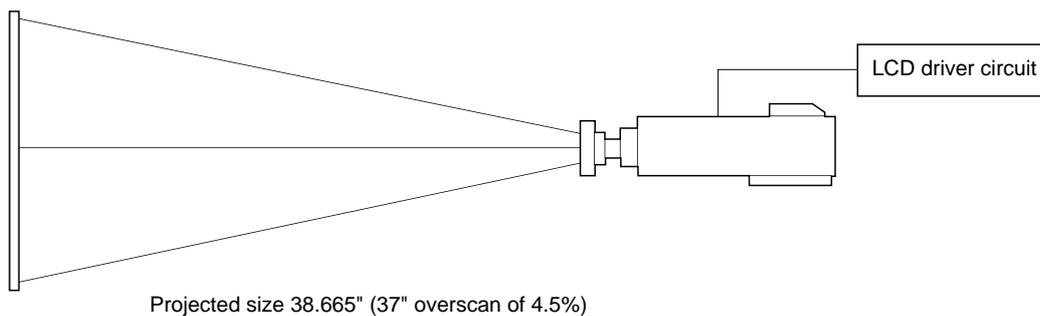
(Ta = 25°C)

Item		Symbol	Measurement method	Min.	Typ.	Max.	Unit	
Contrast ratio	25°C	CR25	1	130	200	—	—	
Luminous flux	25°C	L	2	—	120	—	ANSIIm	
Chromaticity	R	x	Rx	3	0.550	0.590	0.640	CIE standards
		y	Ry		0.300	0.340	0.380	
	G	x	Gx		0.300	0.340	0.380	
		y	Gy		0.580	0.620	0.660	
	B	x	Bx		0.125	0.155	0.185	
		y	By		0.040	0.070	0.100	
	W	x	Wx		0.250	0.290	0.330	
		y	Wy		0.300	0.340	0.380	
Color uniformity	W	x	ΔWx	4	—	0.005	0.040	
		y	ΔWy		—	0.010	0.040	

Basic Measurement Conditions

- (1) LCD driving voltage
 $HV_{DD} = 13.5V, VV_{DD} = 13.5V, AV_{DD} = 15.5V$
 $VVC = 7.0V, Vcom = 6.8V$
- (2) Lamp output
 100W
- (3) DC fan voltage
 12.0V common to Fans 1 and 2
- (4) Measurement temperature
 25°C unless otherwise specified.
- (5) Measurement point
 One point in the center of screen unless otherwise specified.
- (6) Measurement system
 Measurement system is as shown below.
- (7) Video input signal voltage V_{sig}
 $V_{sig} = 7.0 \pm VAC [V]$ (VAC: signal amplitude)

* Measurement system I



1. Contrast ratio

Contrast ratio (CR) is given by the following formula.

L(White): Surface illuminance of the screen at the input signal amplitude VAC = 0.5V

L(Black): Surface illuminance of the screen at VAC = 4.5V

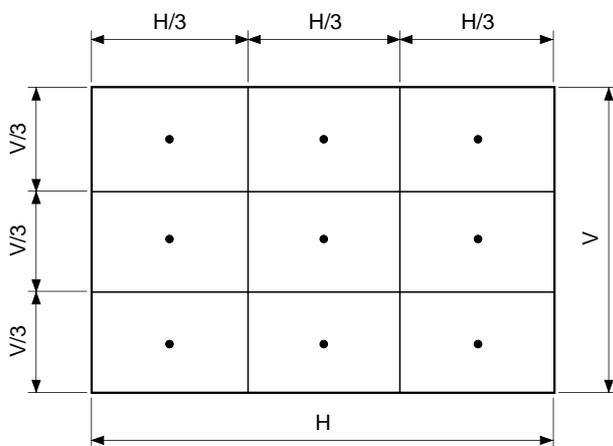
Both luminances are measured by System I.

$$CR = \frac{L \text{ (White)}}{L \text{ (Black)}}$$

2. Luminous flux

In measurement system I, the average of the luminance at the nine points specified in ANSI standards when the input signal amplitude VAC is 0.5V, multiplied by the effective display area, is computed.

$$L = \text{average illuminance at nine ANSI points (lm/m}^2\text{)} \times \text{effective display area (m}^2\text{)}$$



nine ANSI points: centers of each of the areas obtained by dividing the effective display area into nine smaller areas

3. Chromaticity

Raster modes of each color are defined by the representations at the input signal amplitude conditions shown in the table below.

System I uses chromaticity of x and y on the CIE standards here.

		Signal amplitude (VAC) supplied to each input		
		R input	G input	B input
Display raster	R	0.5	4.5	4.5
	G	4.5	0.5	4.5
	B	4.5	4.5	0.5

(Unit: V)

4. Color uniformity

In the measurement system I, the maximum values of the CIE color differences at the three points in the middle row of the nine ANSI points, measured at an input signal amplitude VAC of 0.5V, are used to compute the color uniformity.

$$\Delta Wx = x \text{ max} - x \text{ min}$$

$$\Delta Wy = y \text{ max} - y \text{ min}$$

For other electro-optical characteristics, refer to the LCX011AM specifications.

Optical Characteristics

The optical performance is specified for the following projection conditions.

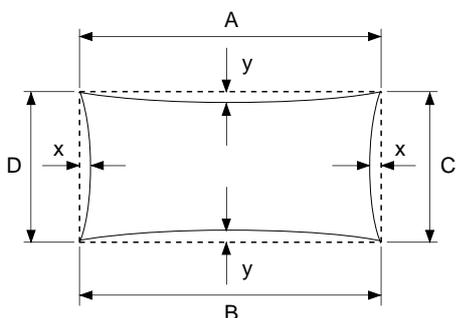
Projection Conditions

	Item	Setting value
1	Panel	1.43" (31.68mm × 17.76mm)
2	Panel shift	none
3	Dot pitch	19.8μm × 37.0μm
4	Maximum image height	18.16mm
5	Overscan	4.5% (NTSC)
6	Effective panel size	1.368" (30.316mm × 16.995mm)
7	Effective projection size	30 to 60"
8	Projection magnification	27.04×/37", fixed focus (including distortion)

Projection Lens Specifications (design)

	Item	Design value			Remarks
		at 37" projection	at 45" projection	at 60" projection	
1	Focal length	21mm ± 5%			
2	F number	1.5 ± 5%			
3	Back focus	19.52mm (at ∞)			in air
4	Conjugate length	698.16mm	812.18mm	1036.01mm	
5	Half angle of view	40.79°	40.84°	40.92°	
6	TV distortion*1				
	Up/down Right/left	0.124% 0.005%	0.444% 0.005%	1.112% 0.082%	
7	Lateral chromatic aberration vs. 550nm				
	470nm	to 0.5H	-8.0μm	-8.0μm	-7.8μm
		to 0.7H	-4.5μm	-4.6μm	-4.6μm
		to 0.9H	6.8μm	6.5μm	6.2μm
		to 1.0H	15.7μm	15.3μm	14.7μm
	605nm	to 0.5H	10.9μm	10.9μm	10.8μm
	to 0.7H	12.9μm	12.9μm	12.9μm	
	to 0.9H	11.9μm	12.0μm	12.2μm	
	to 1.0H	10.1μm	10.4μm	10.7μm	

*1 TV distortion is defined by the diagram and equations below.



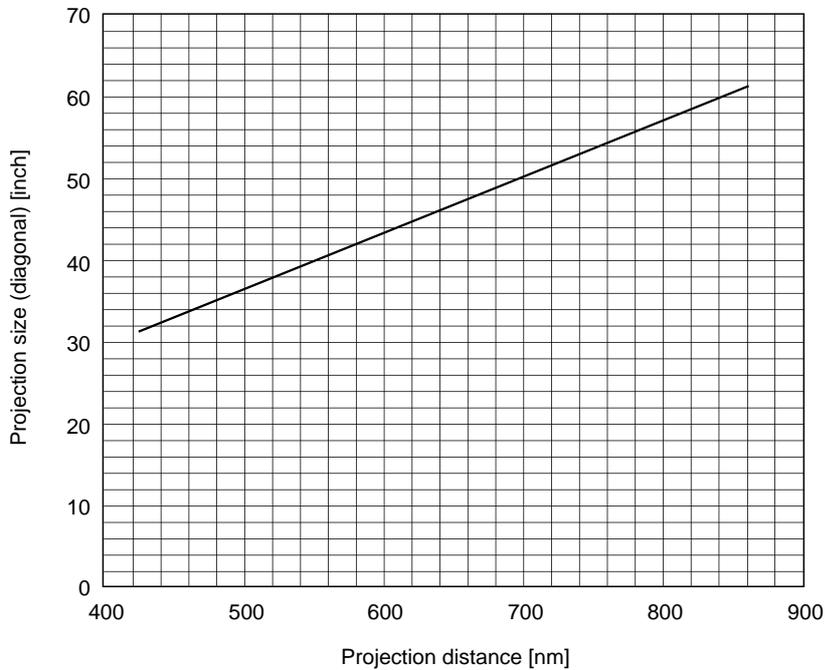
Right/left distortion = $(4x)/(A + B)$

Up/down distortion = $(4y)/(C + D)$

1. Focus adjustment

Loosen the screws (four) holding the projection lens in place, and adjust the eccentricity roller for focus adjustment to change the focus between 30" to 60".

Relation between projection size and projection distance*1



*1 The projection distance is the distance from the front edge of the projection lens to the screen.

2. Floating mechanism

The floating mechanism corrects for distortion between 30" to 60". At time of shipment, it is optimized for a diagonal of 37" (including 4.5% overscan), but the floating mechanism should be adjusted if the projection size is different and image distortion becomes prominent. Recommended values for different projection sizes are given below, but adjustments should be made such that image distortion is minimized.

Recommended floating mechanism settings

Projection size (diagonal) [inch]	Recommended floating mechanism setting
31.48	1
38.74	3
46.57	4.6
51.50	5.6
56.34	6.6
61.22	7.6

3. Registration

Adjustment of the LCD panel registration, expressed as a horizontal adjustment (Δh) and vertical adjustment (Δv), shall lie within a circle of radius 0.66mm.

$$\Delta h^2 + \Delta v^2 = (0.66\text{mm})^2$$

Servicing Parts

The following is a list of parts used in servicing.

	Part number	Name	Construction	Remarks
1	DS-A001	Lamp unit	lamp + lamp housing	
2	DS-A002	Lamp driver		
3	DS-A003	Polarizer unit	polarizer + holder	
4	DS-A004	Diffraction grating unit	diffraction grating + holder	
5	DS-A005	Projection lens		
6	DS-A006	FAN1		
7	DS-A007	FAN2		

Notes on Handling

(1) Cooling

- 1) This optical engine is provided with DC fans to cool the panel and lamp unit. However, the set should be designed for enough ventilation and convection to ensure sufficient cooling.
- 2) The lamp should under no circumstances be lit while the cooling DC fans are not operating. The cooling DC fans are provided with sensor output pins to detect operation, and the lamp driver is provided with start control input pins. The set should be designed so that if the cooling fans are not operating, the lamp driver does not operate.
- 3) When using a dust filter with ventilation orifices, reduced ventilation due to filter clogging can cause rises in temperature, possibly damaging the LCD or other components. The temperature of the optical engine should be controlled, and filters should be changed as appropriate.

(2) Lamp unit

- 1) In order to prevent burns and other accidents, do not directly touch the lamp housing while the lamp is lit or immediately after it has been extinguished.
- 2) Because of the extremely high focusing power of the ellipsoid reflector, if it is not installed in the specified position, damage to the engine or other problems may arise. Ensure that, if the lamp housing is not mounted in the specified position when changing the lamp, the lamp power supply will not operate.
- 3) Always use the included lamp driver to light the lamp. If the lamp is turned on and off repeatedly in short cycles, the lamp lifetime will be shortened.
- 4) The lamp is designed to be lit in a horizontal position. Ensure that the optical axis of the ellipsoid reflector is within $\pm 20^\circ$ of horizontal.
- 5) The lamp emits ultraviolet rays while lit and immediately after being extinguished. Be sure not to look directly at the lamp.

(3) Protection from dust and dirt

Image quality is significantly degraded by dust in the optical engine. Employ a set construction such that after dust is removed by a filter or other means during air cooling, air is blown into the optical engine.

- 1) Operate in clean environment.
- 2) Do not touch the surface of a projection lens and polarizer. The surfaces are easily scratched. When cleaning, use a clean-room wiper with isopropyl alcohol. Be careful not to leave stains on the surface.
- 3) Use ionized air to blow off dust at an optical engine.

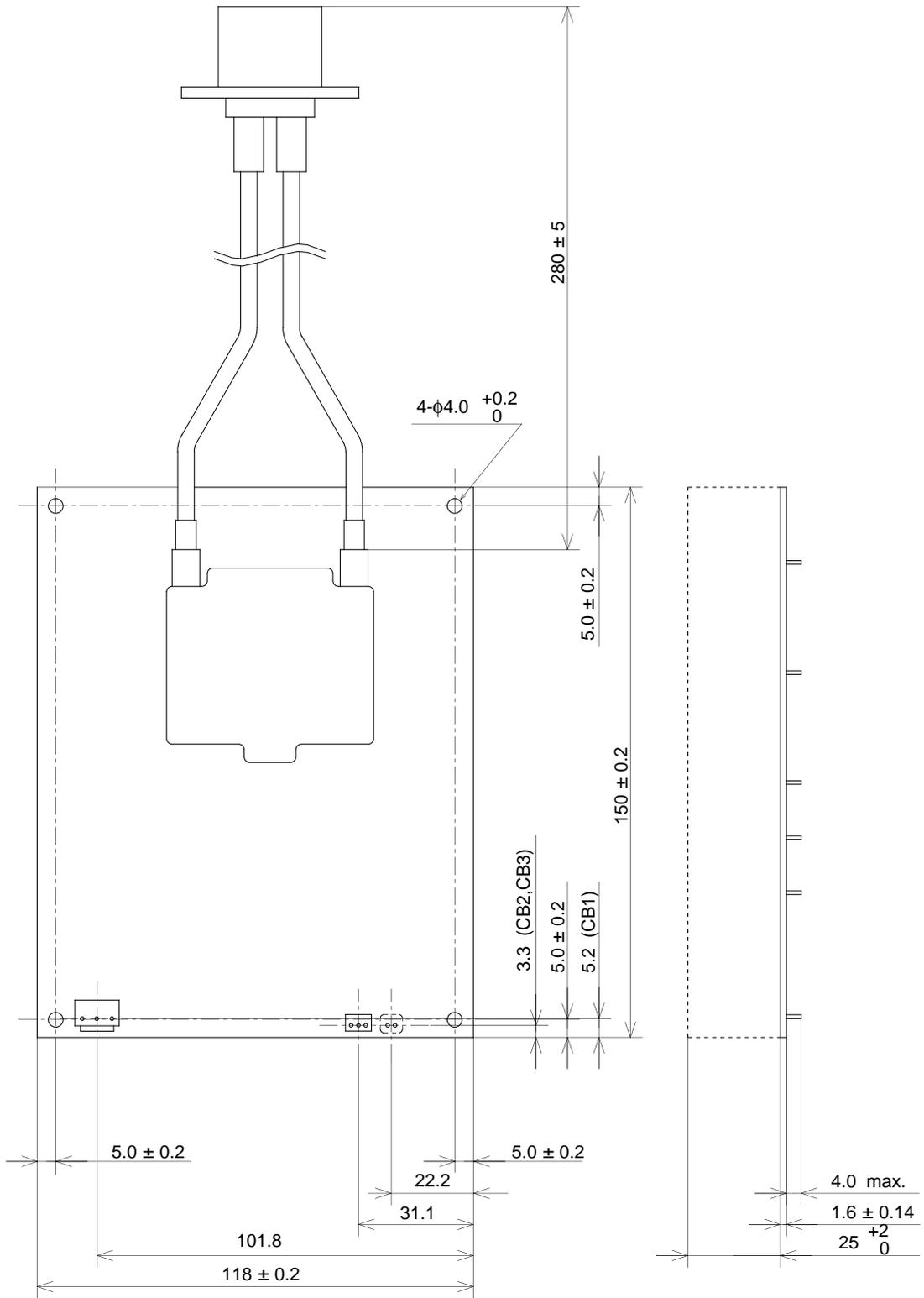
(4) Static charge prevention

- 1) Use non-chargeable gloves, or simply use bare hands.
- 2) Do not touch any electrodes.
- 3) Wear non-chargeable clothes and conductive shoes.
- 4) Keep optical engines away from any charged materials.
- 5) Use ionized air or some other means to discharge.

(5) Other handling precautions

- 1) The DM angles of this optical engine are adjusted to their optimal values, and should not be changed.
- 2) Do not remove or take apart the engine cover, projection lens, projection lens mount, relay lens, integrator support, or lamp housing.
- 3) Light emitted from the lamp and from the projection lens may harm the eyes. Do not look directly into the light from the lamp or lens.
- 4) Do not drop an optical engine.
- 5) Do not twist or bend an optical engine.
- 6) Keep an optical engine away from heat source.
- 7) Do not dampen an optical engine with water or other solvents.
- 8) Avoid to store or to use an optical engine in high temperature or in high humidity, which may result in optical engine damages.

Package Outline (lamp ballast unit) Unit: mm



Package Outline (optical engine unit)

Unit: mm

