HarmonicDrive®

BEAM/SERVO

Galvanometer Scanner System

LSA-10A-30-D-130 Technical Document

(Scanner: LSA-10A-30/Driver: PSM-130)

- We thank you for purchasing the Galvanometer Scanner LSA Series System.
- Any mishandling or misuse of this product may result in unexpected accidents and shorten the life of the product. Please read this document thoroughly and use accordingly to ensure safe prolonged use.
- Product specifications are subject to change without notice for improvement purposes.
- Keep this manual in a convenient location and refer to it whenever necessary in operating or maintaining the units.
- The end user of the actuator should have a copy of this manual.

ISO14001

ISO9001

For Safe Use of the LSA and PSM Series Servo Systems

Warning Warning: Indicate anything that may cause loss of human life or serious physical injury if mishandled.

Caution Caution: Indicate anything that may cause serious physical injury or cause physical damage to the product if mishandled.

Limitation of Applications: The equipment listed in this document may not be used for the following applications:
*Space equipment *Aircraft & Aircraft Equipment *Nuclear Equipment *Household Apparatus *Vacuum equipment *Automobiles & Automotive Parts *Game Machines *Machines or Devices effecting directly the human body *Machines or devices to transport people *Instruments or Apparatus for special environments.
Please consult us if you intend to use the products in one of the areas mentioned above.
* If these products are used in equipment that may cause serious physical injury or loss of human life, please ensure adequate **safeguards** are in place to prevent accidents in case the output cannot be controlled due to damage of the product.

Precautions when Using the Scanner/Driver

Precautions for Designing Please read this Technical Document before designing.

Warning
If light beam such as lasers, etc. that may cause physical injury are used, please ensure adequate safeguards are in place to prevent accidents in case the scanner/driver becomes uncontrollable.

Caution
Please utilize in the following defined environment.
- The scanner is not sealed and must therefore only be used indoors, where the following conditions are provided:
  * Ambient Operating Temperature: 0°C to 40°C * Ambient Operating Humidity: 20% to 85% RH (non-condensing)
  * Vibration: Under 24.5 m/s^2 * No contamination by water, oil, or foreign matter * No corrosive, inflammable, or explosive gas

Caution
Please ensure proper protections from interference of noise and adequate installation.
- Interference of noise on the signal line may cause vibrations and malfunctions. Please ensure the following conditions.
  * Please separate from a power cable.
  * Please use the possible shortest cables for the LSA and PSM.
  * Please connect the ground terminals of the scanner and driver to a Type 3 ground at one point.

Operating Precautions Please read this Technical Document before operating.

Caution
Please do not directly connect the scanner's motor and sensor wires to the outlet.
- Please ensure that this equipment is not directly connected to a commercial power source. The scanner may breakdown and cause a fire.

Caution
Please do not apply a voltage to the scanner exceeding specifications.
- Applying an abnormal voltage or faulty wiring may cause the scanner to burnout or malfunction.

Caution
Please protect the scanner from impacting and shocking.
- Please do not bump the scanner as the sensor is directly connected to the scanner.
- The operation of the scanner cannot be assured if the sensor

Warning
Please do not pull the wire lead.
- Pulling the wire lead may damage the connected component and the scanner may run out of control.

Caution
Please do not apply excessive force to the output shaft.
- When attaching a mirror to the output shaft, please be careful not to apply excessive force to the output shaft.
- Accuracy cannot be guaranteed if the output shaft collapses due to applying excessive force.

Warning
Please do not change wiring while still plugged in.
- Please ensure that the power is off before removing wiring and disconnecting plug. There is a risk of shock and running out of control.

Warning
Please do not touch the circuits inside the equipment while plugged in. Electric shock may occur.

Warning
Please do not touch the attached heat sink while plugged in or within five minutes after disconnecting the power.
- There is a risk of burns as the heat sink becomes hot.

Caution
Please do not apply a voltage to the driver exceeding specifications.
- Applying an abnormal voltage or faulty wiring may cause the driver to burnout or malfunction.

Caution
Please do not conduct withstand voltage tests.
- Please do not conduct mega or withstand voltage tests. Doing so may damage the control circuits of the driver.

Disposal

Caution
Please dispose as industrial wastes.
- All products or parts have to be disposed as industrial wastes.

Table of Contents

Chapter 1 Overview of LSA Series

The LSA and PSM series are Galvanometer Scanner systems that can optically scan with quick response and high accuracy. Main characteristics of the systems based on compact motor technology and independently developed optical sensor technology, so the following applications are available: measurement devices, laser processing equipment, laser displays, shutters, laser markers, etc.

1-1 Main Characteristics

♦ Quick Response and High Torque/Inertia Ratio

The motor component of the scanner is a moving magnet system and the stator utilizes a core and coil configuration. This allows for a **heavy load/quick response**. The LSA and PSM devices are available for a wide torque range applications.

♦ Low Heat Generation (Low Drift)

The temperature rise caused by the quick-response/high-frequency scanner operation is minimal and results in **low drift**.

♦ High Accuracy/Environmentally Strong Scanner

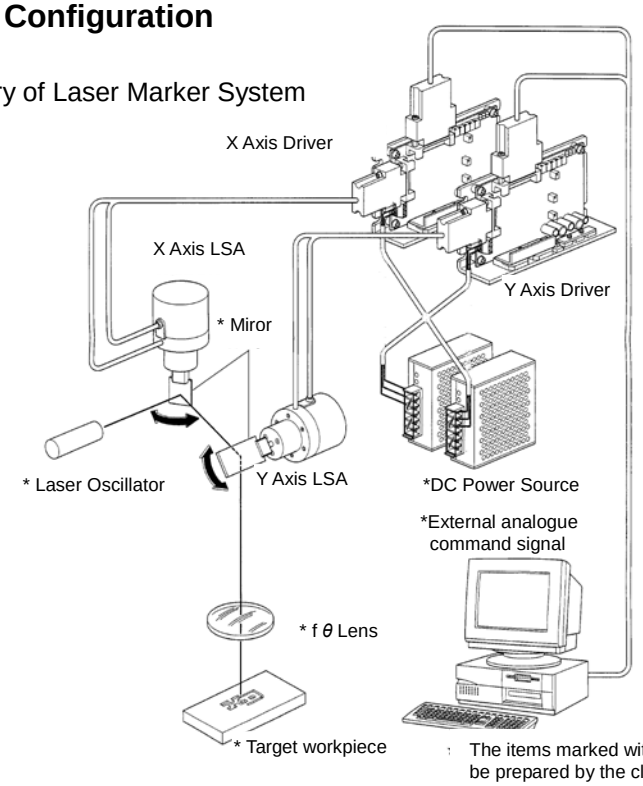
The sensor component of the scanner can position with high accuracy (system positioning repeatability: within ± 5μrad [1”]) as it utilizes an optical potentiometer independently developed by our company.
In addition, this sensor is strong against external electrical noise (increased S/N ratio) and is not affected by the exterior atmospheric environment.

♦ Adjustable Functions with Broad Ranging Applications

The driver maximizes the capacity of the combined scanner and possesses numerous adjustment functions to adjust to customers’ usage conditions.
In addition, we will adjust the drive if necessary based on the study of customer’s operating conditions and specifications.

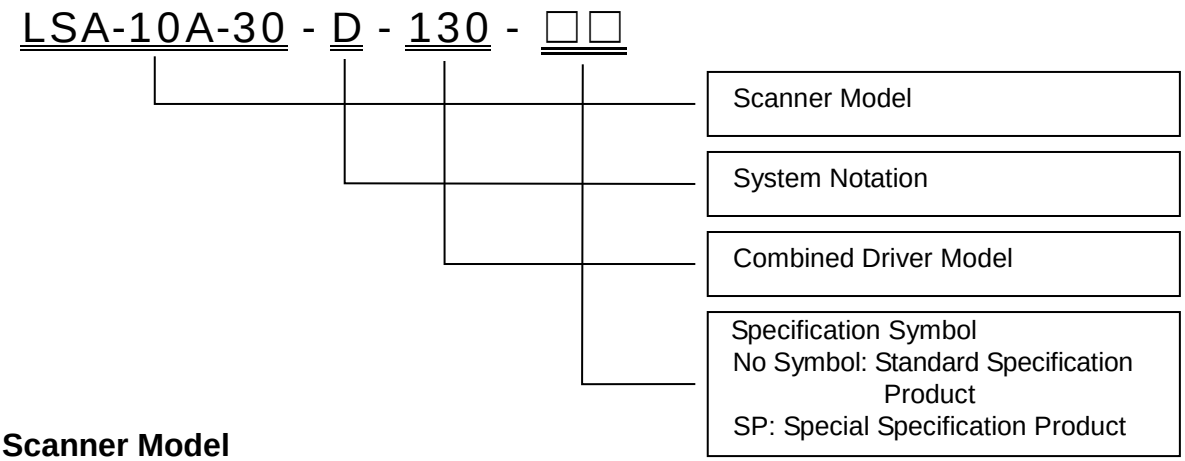
1-2 Example of Equipment Configuration

Reference Example: Summary of Laser Marker System



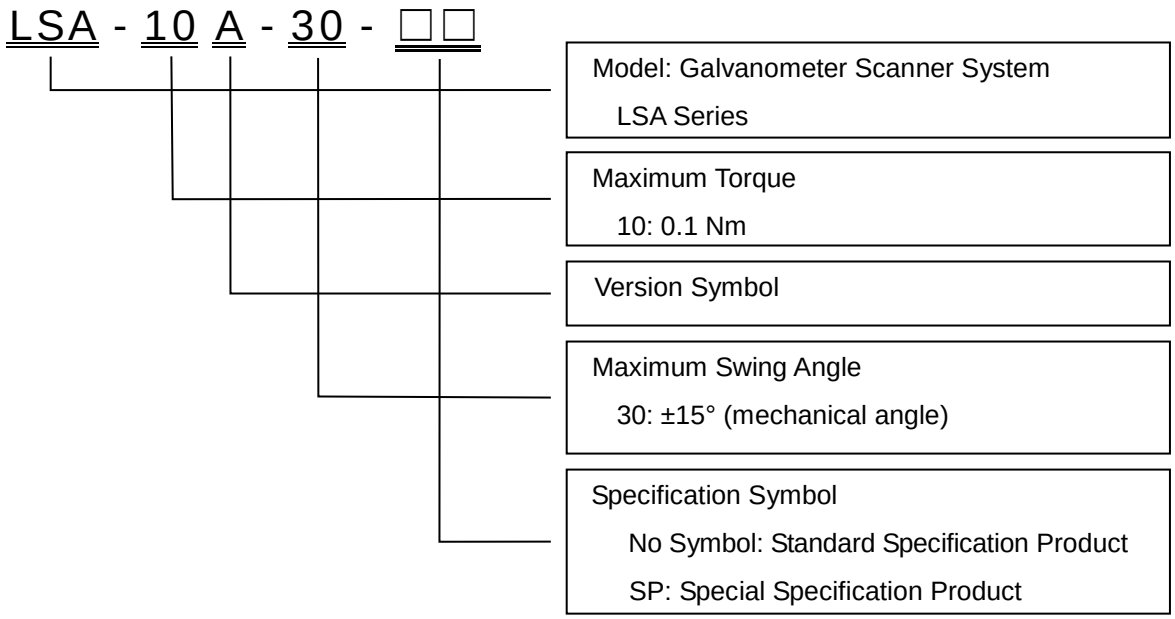
1-3 Scanner System LSA Series Model

The model name and symbols of the Galvanometer Scanner System are as follows.



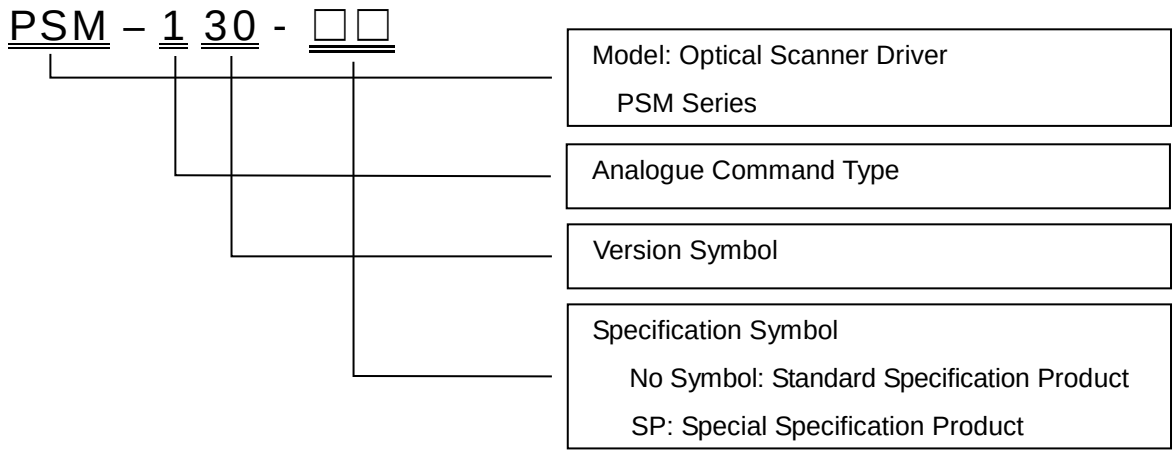
1-4 Scanner Model

The model name and symbols of the LSA Series Galvanometer Scanner are as follows.



1-5 Driver Model

The LSA Series Galvanometer Scanner is combined with the PSM series driver.
The model name and symbols of the PSM series driver are as follows.



Chapter 2 System Specifications

The specifications of the LSA-10A-30-D-130 scanner system are as follows. The angles within these specifications are all “mechanical angles”, unless specified otherwise.

2-1 System Configuration

The product configuration of the LSA-10A-30-D-130 is as follows.

Product Configuration	Model	Units	Remarks
Scanner	LSA-10A-30	1	
Driver	PSM-130	1	With accessories.
Load Device	—	1	Load device for adjustment

Our Galvanometer Scanner System can provide maximum response performance as it can be appropriately adjusted for our customer’s actual load device (such as mirror, etc.) and operating conditions. Our drivers are adjusted with the combination of scanner : driver (including adjustment specifications) : load device=1 : 1 : 1. Please utilize properly adjusted combinations.
Please refer to “Driver Labels and Seal Details” (4-13) to distinguish properly adjusted combinations.

♦ Caution when Using Driver

The driver needs to be adjusted for the actual load device attaching to the scanner (mirror, etc.) or for an artificial load device identical to the actual load device. The customer is responsible for preparing the load device.
Although we can evaluate and provide data for our load device for testing during the advanced testing stage, during the product shipment stage, the customer will be responsible for supplying the actual load device. They will be shipped after adjustment with the actual load device.

If the load device conditions (shape, moment of inertia, material, etc.) are changed, the adjustments of the driver’s internal constant needs to be changed. In this case, please provide us with details of any changes.
We will review the adjustment specifications. (There will be a charge for any adjustments after the product has been shipped.)

If there are big changes to the fixed adjustment conditions (even when there is no load on the drive) of the load device or the drive command, the scanner may oscillate unexpectedly. In this case, refer to the Over Position Alarm Output (4-4-6) and configure the sequence to turn off “Enable”.

Caution If the scanner **oscillates unexpectedly**, the driver resistance may **generate abnormal amounts of heat** and start to **smoke**. In this case, immediately cut the power source.

2-2 Main Specifications

<table>
<tr><th>No.</th><th colspan="2">Items</th><th>Specifications</th></tr>
<tr><td rowspan="2">1</td><td colspan="2">Repeatability of Positioning*1 [µrad]</td><td>±5</td></tr>
<tr><td colspan="3">Testing Conditions
Positioning seven times from arbitrary forward and backward positions respectively, and take the maximum deviation. Divide this by half and place a ± sign.
Utilize an auto-collimator and measure in a room temperature environment.
Waiting Time (including positioning time): within tens of seconds</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Temperature Drift</td><td>Offset Drift [µrad / °C]</td><td>30</td></tr>
<tr><td>Scale Drift [% / °C]</td><td>0.01</td></tr>
<tr><td>3</td><td colspan="2">Response Characteristics</td><td>Response characteristics based on the customer’s operating conditions will be confirmed on actual equipment during the advanced testing stage, as deemed necessary. The results will be presented as adjustment specifications*2. Representative characteristics are listed in Response Characteristics (2-3).</td></tr>
</table>

*1 Repeatability of Positioning refers to a value at a certain temperature and a short period of time, excluding drift.

*2 The selections of the applicable models may change in accordance with the customer’s operating conditions. **Therefore, please fill-in the “Optical Scanner Drive Form” (2-4) and contact our company before manufacturing the load devices or mounting parts.**

2-3 Response Characteristics

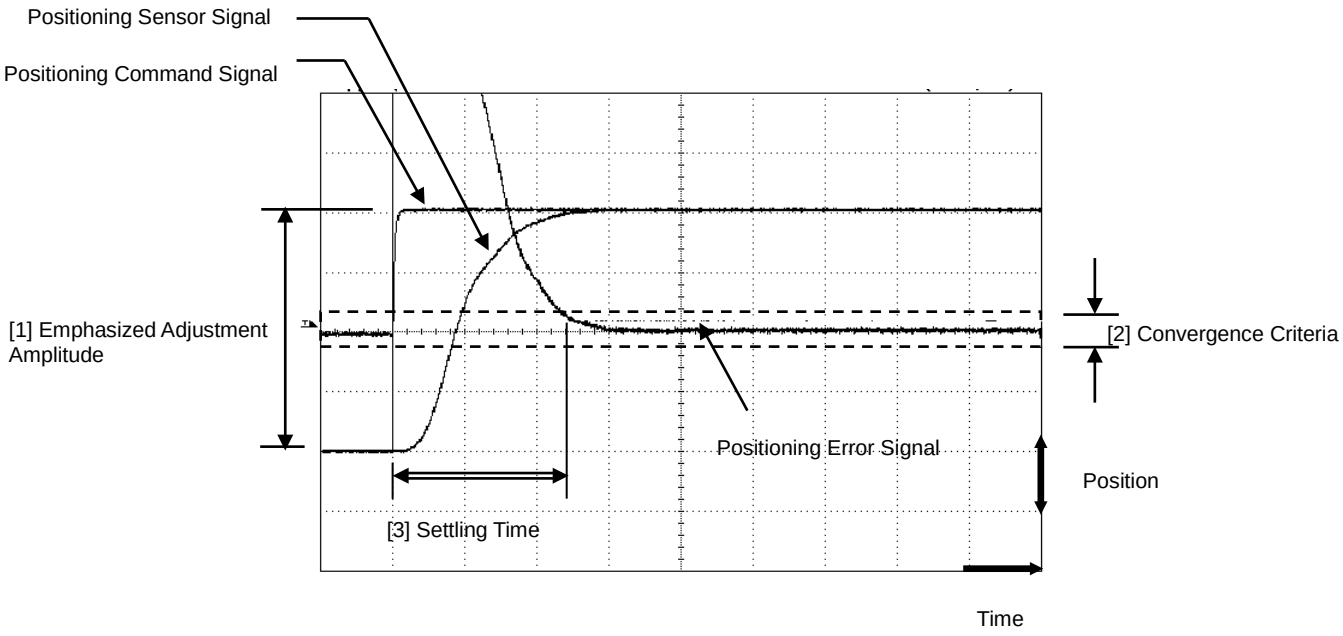
By specifying the operating conditions and adjusting appropriately the driver according to the conditions, the scanner system can provide an optimal performance for the focused characteristics. Therefore, the response characteristics are different for adjustments emphasizing on accuracy and adjustments emphasizing on response. In addition, if different conditions from adjusted operating conditions are utilized, the operation of the drive may become unstable.

Our scanner system is appropriately adjusted to the customer’s operating conditions and is fundamentally provided as a system. The explanation of the response characteristics of the rectangular and triangular wave drives are on the following pages Using this as reference, please fill out the your usage conditions in the “Optical Scanner Drive Form” (2-4) and submit this document to an agent or to our sales representative.

2-3-1 Response during Rectangular Wave Drive

The responses of the rectangular or trapezoid wave operations are important for utilizing the positioning operation. Generally, the trapezoid wave drive settles easier and is better for applications of fluctuating amplitudes, than the rectangular wave drive.
Rectangular wave drive is showed as an example as follows, and the conditions need to be considered are discussed.

♦ Rectangular Wave Drive Step Response Characteristic (example observed by oscilloscope)



[1] Emphasized Adjustment Amplitude (Unit: [°])
This indicates the optimally adjusted amplitudes during adjustment. Generally, the amplitudes with the most often used frequency are taken as the emphasized adjustment amplitudes. In case of large amplitude operation, the command waves of step inputs (stacking small amplitudes) or trapezoid wave inputs, etc. are utilized

- Response and stability are well balanced and optimal when the actual drive amplitude is equal to the adjustment amplitude.
- The gain can be raised and the Settling Time decreases as the size of the emphasized adjustment amplitude decreases.
- If the amplitudes are not constant, the largest amplitude has to be the emphasized adjustment amplitude.
- If a command with an amplitude larger than the emphasized adjustment amplitude is input, longer time is necessary for setting after reaching the command position. On the other hand, when a command with an amplitude smaller than the emphasized adjustment amplitude is input, the setting time will be identical to the setting time when the emphasized adjustment amplitude is input.

[2] Convergence Criteria (Unit: [°] or [arc-sec])
This indicates the width of the allowable positioning error that is for setting judgment for the commanded position. Generally, necessary and sufficient conditions of positioning accuracy are considered as convergence criteria. The device is adjusted to the shortest Settling Time as conditions are satisfied.

- For quick-response operation, the convergence criteria are set broadly and the gain is adjusted high. Although response increases, longer time is necessary till the device matches the commanded position.
- During accurate positioning operation, the convergence criteria are set narrowly and the gain is adjusted low. Although response decreases, the device matches the commanded position in a short amount of time.
- If the Settling Time is the same, the convergence criteria can be narrowed as the size of the

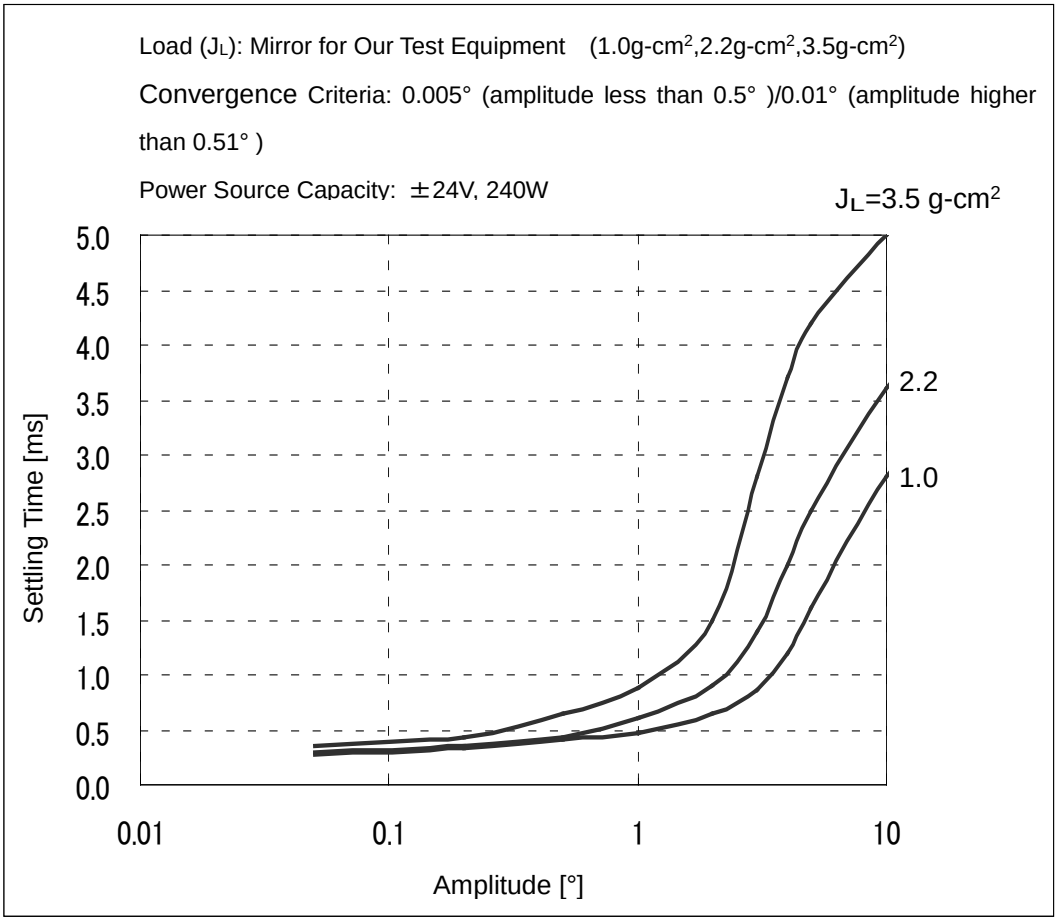
emphasized adjustment amplitude decreases.

[3] Settling Time (Unit: [ms] or [μs])
A completion of positioning is judged by the positioning error signal that is within the range of the convergence criteria. The Settling Time is the time from a command input to a completion of positioning Generally, adjustments are made ensuring the shortest Settling Time being satisfied within the other operating conditions .

[4] Drive Frequency (Unit: [Hz])
This indicates the actual drive frequency.

Please refer to “Supplementary Explanation of Optical Scanner Operating conditions Form” (2-4-1) for other features.

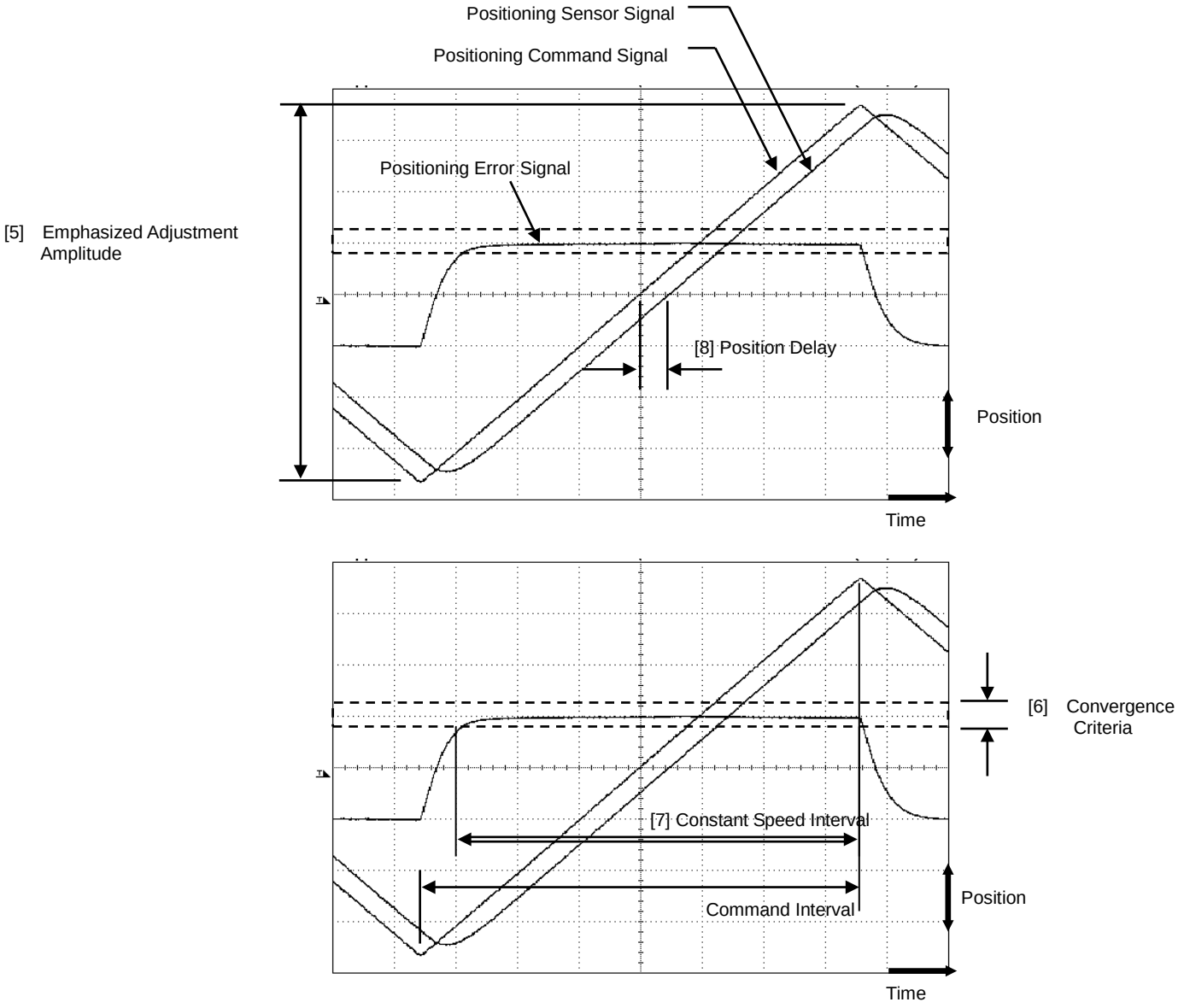
♦ Rectangular Wave Drive Response Characteristics (Settling Time for amplitudes with load moment of inertia as the parameter)



2-3-2 Triangular Wave Drive Response

Dynamic characteristics of keeping positioning error within the definite range are important for scanning operations. In the operations, the response characteristics of the saw-tooth wave drive or the triangular wave drive are important. It is necessary to adjust the conditions during the steep section of saw-tooth wave drive.
Here, the triangular wave drive is shown as a typical example, indicating conditions that need to be examined.

♦ Triangular Wave Drive Perspective of Response Characteristics (observed by oscilloscope)



[5] Emphasized Adjustment Amplitude (Unit: [°])
This indicates the optimally adjusted amplitudes during adjustment.

- Response and stability are well balanced and optimal when the actual amplitude is equal to the adjustment amplitude.
- The gain can be raised and the range of the constant speed is increased as the size of the emphasized adjustment amplitude decreases.
- If the amplitudes are not constant, the largest amplitude has to be the emphasized adjustment amplitude.

[6] Convergence criteria (Unit: [°] or [arc-sec])

This indicates the width of the allowable positioning error for following the positioning command signal. Generally, necessary and sufficient conditions of positioning accuracy are considered convergence criteria. The device is adjusted to the conditions that a range of constant speed is maximized.

- In case of quick operation, set the convergence criteria broadly and adjust the gain for extending the range of constant speed. In case of high accuracy operation, set convergence criteria narrowly.
- If the range of constant speed is the same, the convergence criteria can be narrowed as the size of the emphasized adjustment amplitude decreases.

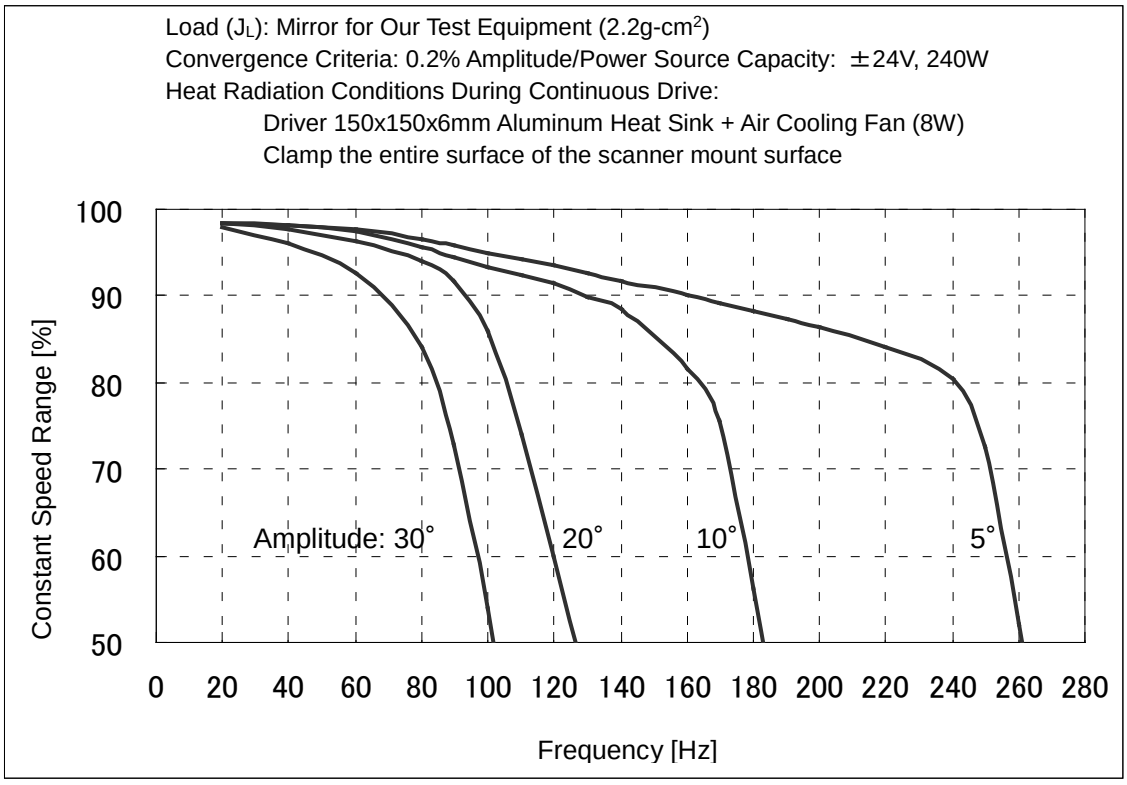
[7] Range of Constant Speed (Unit: [%])
Assuming that the positioning command signal is a constant slope, the portion of the positioning error signal being kept within the convergence criteria is a constant speed range. The proportion of the constant speed interval and the command interval is the constant speed range [%].
As the shaft rotates inverse direction in the triangular wave drive, positioning error immediately after inversion is large.

[8] Position Delay (Unit: [ms] or [μs])
This indicates time delays between positioning sensor signals and positioning command signals. Normally, position delay is measured at the position of the sensor origin point. (There may be fluctuations based on measurement positions.)

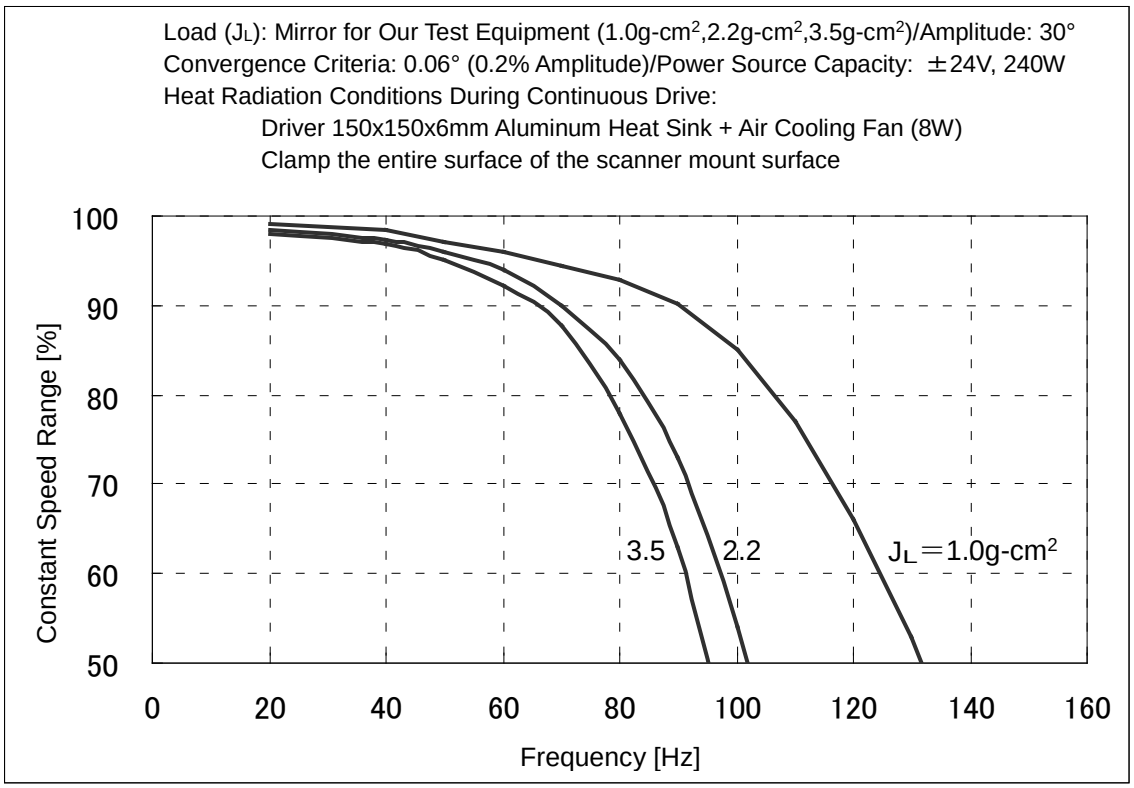
[9] Drive Frequency (Unit: [Hz])
This indicates the actual drive frequency.
As the frequency increases, the range of constant speed decreases.

Please refer to “Supplementary Explanation of Optical Scanner Operating conditions Form” (2-4-1) for other features.

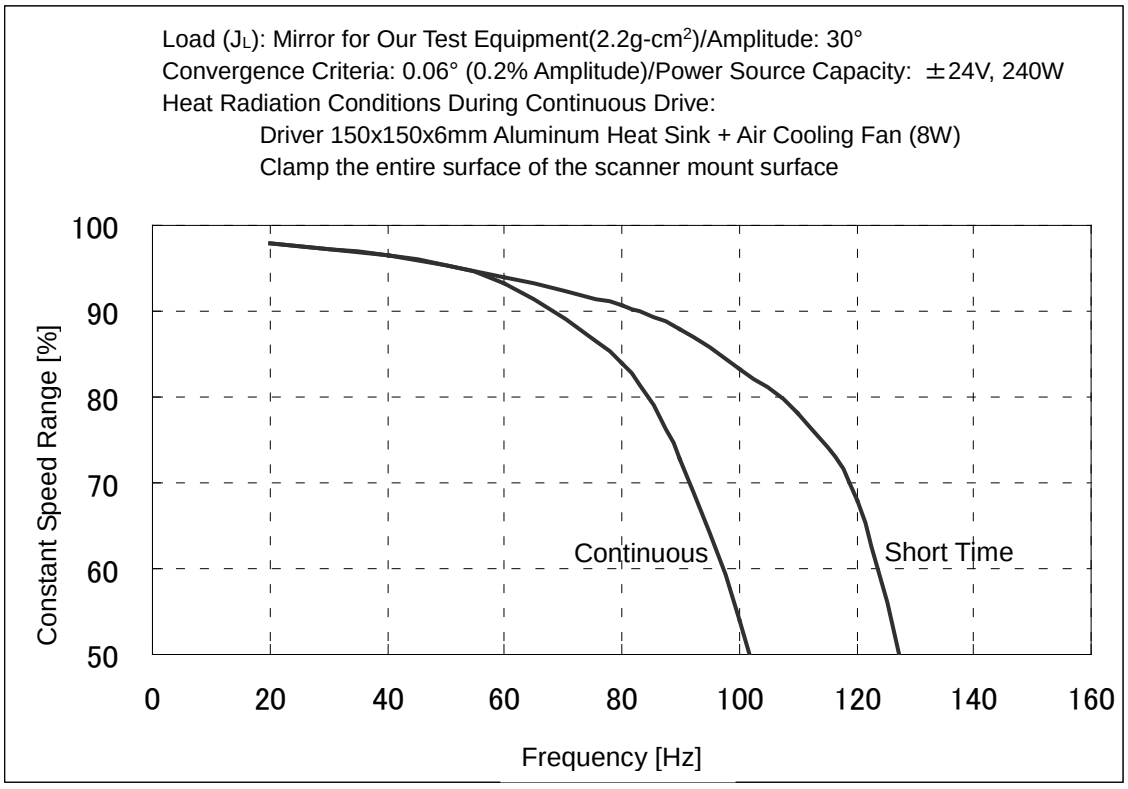
♦ Triangular Wave Drive Response Characteristics Example 1 (range of constant speeds vs. frequencies with amplitude as the parameter)



♦ Triangular Wave Drive Response Characteristics Example 2 (range of constant speeds vs. frequencies with moment of inertia as the parameter)



♦ Triangular Wave Drive Response Characteristics Example 3 (comparison of constant speed ranges vs. frequencies for continuous and short-time operation)



2-4 Optical Scanner Operating conditions Form

Requested Date:

Company Name		
Position/Title		
Name		
Address		
TEL/FAX	TEL: /FAX:	
E-mail		
Applications Please check the appropriate classification. In addition, please enter specific details.	Classifications ☐ Laser Processing ☐ Measurements ☐ Image Processing ☐ Laser Display ☐ Other	Details

Please refer to the technical data in 2-3 and 2-4-1 and enter the operating conditions. Based on these conditions we will submit the adjustment specifications, including the model selection. If necessary operating conditions are not indicated, the appropriate adjustment specifications may not be submitted.

Operating conditions

No.	Items	Specifications	Supplementary ([ ] refers to the technical data in 2-3 and 2-4-1)
(1)	Input Command Wave (Basic Waves)	☐ Rectangular Wave ☐ Trapezoid Wave ☐ Saw-Tooth Wave ☐ Triangular Wave ☐ Sine Wave	If the wave has a slope, please attach the slope data.
(2)	Emphasized Adjustment Amplitude	[°]	[1] [5] Sine Wave Conditions
(3)	Drive Frequency	[Hz]	[4] [9] Sine Wave Conditions
(4)	Convergence criteria (positioning accuracy)	[°] or [arc-sec]	[2] [6]
(5)	Settling Time	[ms] or [μs]	[3] Time after the input becomes constant during trapezoid wave drive.
(6)	Range of Constant Speed	[%]	[7] Please also list targeted slope during saw-tooth drive.
(7)	Position Delay	[ms] or [μs]	[8] Sine Wave Conditions
(8)	Amplitude Error	[%]	Output/Input Amplitude Error, Sine Wave Conditions
(9)	Load Moment of Inertia ($GD^2/4$)	[g-cm^2]	[10] May attach diagram (material) as a replacement
(10)	Maximum Amplitude	[°]	[11]
(11)	Voltage at Full Scale	Input Voltage: Amplitude during [Vp-p]: [°]	[12]
(12)	Extended Cable Distance Between Scanner and Driver	[m]	[14] No extension when blank.
(13)	Power Capacity (performance or capacity-emphasized)	[W]	[15] 240W when blank. Enter either performance or power capacity-emphasized.
(14)	Priority Characteristics		Please enter items to be emphasized.
(15)	Work (Optical Scanning) Range	[mm]	Reference Value
(16)	Distance of Work and Mirror	[mm]	Reference Value
(17)	Cable Length Between Power Source and Driver	[mm]	Reference Value
(18)	Others (including details of adjusted stamped labels)		If the entry space is insufficient, please attach as separate pages.

* Please list all angles as mechanical angles. * Please enter data on the copy of this form.

Space to be filled in by our company:

(Management No.:) (Sales Branch:) (Sales Representative:)

2-4-1 Supplementary Explanation of Optical Scanner Operating conditions Form

[10] Load Moment of Inertia (Unit: [g-cm^2])
This indicates the moment of inertia of the load device attached to the output shaft of the mirror, shutter, etc.

- The possibility of reducing settling time increases as the load moment of inertia decreases.
  Caution: If the rigidity of the load device is too low, the resonant frequency decreases. When the resonant frequency decreases correspond to the control zone, the response characteristics may be affected adversely. Please take into consideration moment of inertia and rigidity when designing the load device.

[11] Maximum Amplitude (Unit: [°])
This indicates the maximum range of movement while in use, including offset.

- The control range of LSA-10A is ±15° centered on the origin of the scanner (the position when input is 0V).

[12] Full Scale Voltage (Unit: [V])
This indicates the ratio between the input command voltage and the swing angle of the output shaft.

- If there is nothing specifically specified, the other conditions are taken into consideration and adjustments are made according to one of the following.
  a) Input Command Voltage: Positioning command signal (IN-MON) at 20Vp-p is 8.25V (corresponds to 30°) ± 5%
  b) Input Command Voltage: Positioning command signal (IN-MON) at 20Vp-p is 5.5V (corresponds to 20°) ± 5%
- Please refer to “Trimmer Function and Adjustable Range” (4-7) regarding adjustable range.
- Values change according to the scanner (angle sensitivity). a) and b) above are the values of LSA-10A-30.

[13] Offset Position (Unit: [V])
This indicates the offset of the origin of the scanner and the electric origin of the position command input.

- If there is nothing specifically specified, the command signal during 0V input is adjusted to 0V ±5mV (corresponding to ±0.018°).
  (LSA-10A Angle Sensitivity: if 0.275V/°)

[14] Extended Cable Distance Between Scanner and Driver (Unit: [meter])
This indicates the length of cable between the scanner and driver.
When extending the length, please use cable thickness over AWG22 for both the motor and sensor wiring. (As an option, a Extension cable [refer to 5-1] has been included.) If there is nothing specifically specified, make adjustments without utilizing the extension cable.

- If a Extension cable exceeding 2m is utilized between the scanner and driver, adjustments must be made with the Extension cable attached in advance.
- The allowed cable length of the sensor lead wire utilized with this scanner is 10m.
- Increasing the length of the sensor lead wire may increase noise, increasing the possibility that the scanner malfunction.

[15] Power Capacity (Unit: [W])
If power capacity is limited, please notify us of the power capacity used.
In addition, please notify us of whether the device is performance or power capacity-emphasized.

- The power source used in our adjustments is ±24V and 240W (AD240-24: COSEL).
  (We will select a power source closest to the expected power capacity among those available to our company and we will assess the device.)
- The cable length between the power source and the driver during our adjustments is 1m.

Chapter 3 Scanner Specifications

The specifications of the scanner (LSA-10A-30) are as follows.

3-1 Main Specifications

No.	Items			Specifications
1	Maximum Swing Angle (Control Range) (*1)		[°]	±15
2	Output Shaft Rotation Range (Stopper Range)		[°]	40
3	Rotor moment of inertia		[g-cm^2]	1.9
4	Torque Constant		[Nm/A]	0.0077
5	Coil Resistance		[Ω]	0.28±10% at 20℃
6	Coil Inductance		[mH]	0.098±10%
7	Sensor Linearity		[%]	±0.06 (Full Scale)
8	Sensor Angle Sensitivity		[V/°]	0.275±5%
9	Sensor Power Source Voltage		[V]	＋5±5%
				－15±5%
10	Sensor Consumption Current	＋5V ±5%	[mA]	90 Max
		－15V ±5%	[mA]	120 Max
11	Insulation Resistance (*2)	Motor Coil - Case	[MΩ]	100 (DC500V Mega)
		Sensor Power Source Common - Case	[MΩ]	100 (DC500V Mega)
12	Dielectric Strength (*2)	Motor Coil - Case	[V]/1min	AC500
		Sensor Power Source Common - Case	[V]/1min	AC500
13	Offset Drift		[μrad/°C]	25
14	Scale Drift		[%/°C]	0.005
15	Mass		[g]	180

*1 The origin (0°) position of the control range is the position when the sensor output voltage is at 0[V].

*2 Please do not conduct insulation tests on the sensor power source common - case.

3-2 Connector Specifications

Connectors Connected to Driver [Scanner Connector Model: DF18-10DS-2.5RC (Hirose)]

Pin.No.	Functions	Wire Color	Pin.No.	Functions	Wire Color
1	Motor (-)	Black	6	N.C.	－
2	Motor (+)	Red	7	Case Ground	Yellow
3	Power Source Common (*1)	Green	8	Sensor (-)	Brown
4	－15V	Black	9	Sensor (+)	White
5	＋ 5V	Red	10	Shield (*2)	Shield

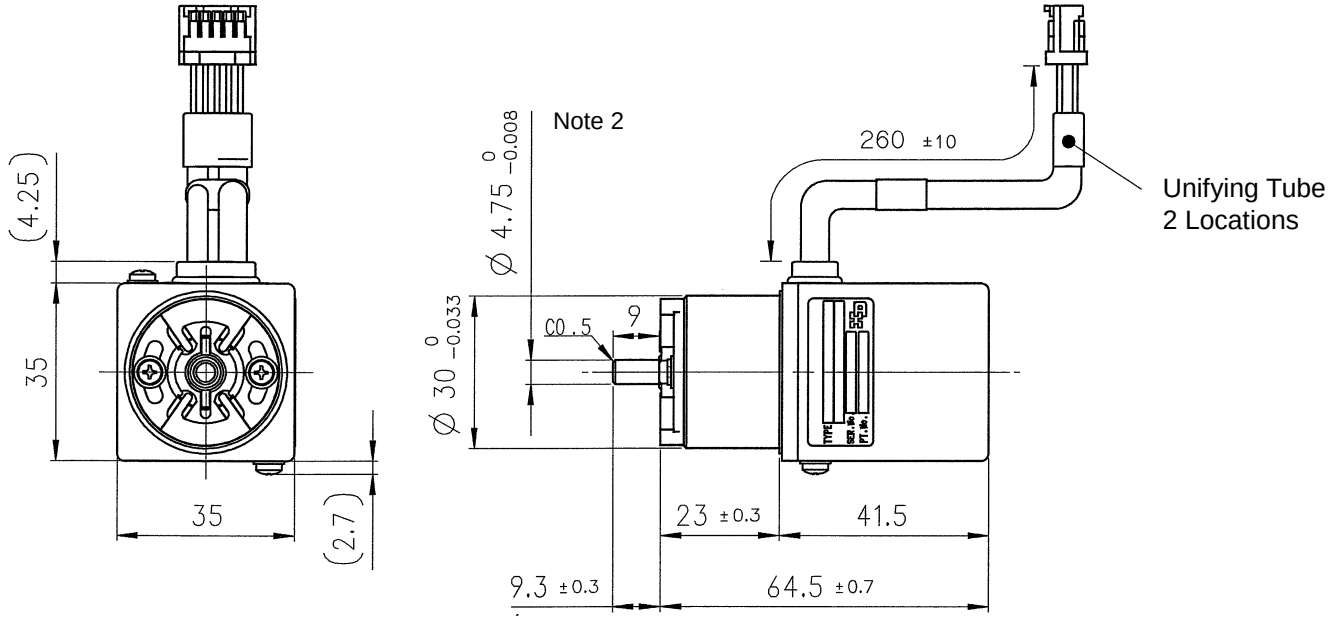
*1 Power source common is connected to the case ground through the capacitor(voltage endurance: 50V).

*2 The shield is not connected to the case.

3-3 Dimensions (Third Angle Method)

The dimensions of the LSA-10A-30 are as follows.

Unit: mm



Note 1: Please confirm the details of the dimension with the supplied specification diagram published by our company.

Note 2: When attaching the customer's load device, the screw may directly press against and scratch the output shaft during our adjustments. In this case, the precision of scratched section may be below the precision of the specifications.

3-4 Environmental conditions

The environmental conditions of the LSA-10A-30 are as follows.

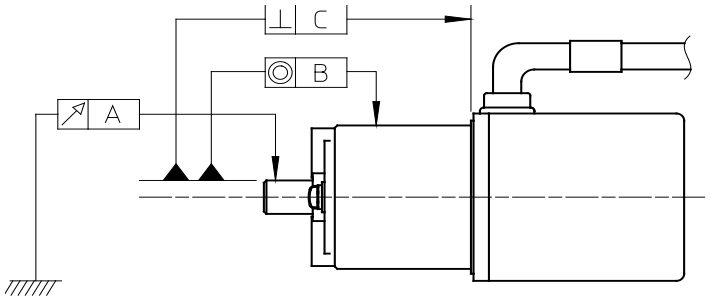
No.	Items		Specifications	Remarks
1	Operating	Temperature [°C]	0 ～ 40	
2		Humidity [%RH]	20 ～ 85	No condensation
3	Storage	Temperature [°C]	−10 ～ 70	
4		Humidity [%RH]	20 ～ 90	No condensation
5	Vibration Resistance (*1)	Vibration Acceleration [m/s^2]	24.5	
		Testing Conditions	Frequency: 10→1000→10 [Hz] Time: 1 Cycle 20 [min] No. of Times: 3 times each in x, y, and z directions.	
6	Shock Resistance (*1)	Vibration Acceleration [m/s^2]	294	
		Testing Conditions	Shock Time: 11 [ms] No. of Times: 3 times each in x, y, and z directions.	

*1 The vibration/shock resistance tests are to ensure there is no degradation in performance during non-operation period, but they do not guarantee the performance while operating.
Furthermore, please avoid applying shock directly to the output shaft.

3-5 Output Shaft Precision

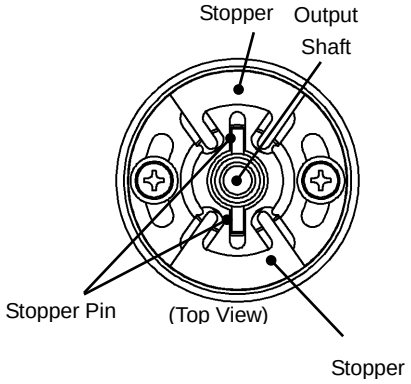
The output shaft precision of the LSA-10A-30 is as follows.

Measurement Point	Precision [mm]	Remarks
A	0.004	Output shaft run-out (range of maximum swing angle: ±15°) (Estimated value from a whole rotation measurements)
B	φ0.03	Parallelism of attachment area (φ30) and output shaft
C	0.05	Perpendicular of attachment face and output shaft



3-6 Stopper Mechanism

For protection during malfunctions, a stopper mechanism has been installed to restrict the rotation angle of the output shaft.
The angle of the output shaft starts to contact the stopper mechanism at a range of about 40°. The final shutdown angle by snap action is at a range of about 45°. The allowable torque of the stopper mechanism is 1.5[Nm]. If the strength exceeds the allowable torque, the attached stopper may become damaged and displaced. The control range (±15°) then may not be maintained.
The stopper mechanism is a protection mechanism during malfunctions. Refer to the over position alarm output (4-6-6) and configure the circuit to enable off(4-6-2). Ensure that stopper pin of the output shaft is not contacted to the stopper during normal operation.



3-7 Caution Regarding Scanner Installation

3-7-1 Structure of Output Shaft

As the output shaft is not an airtight structure, please take measures to ensure that dust does not penetrate the device. (Please take special caution when attaching the output shaft in an upright position.)

3-7-2 Scanner Cable

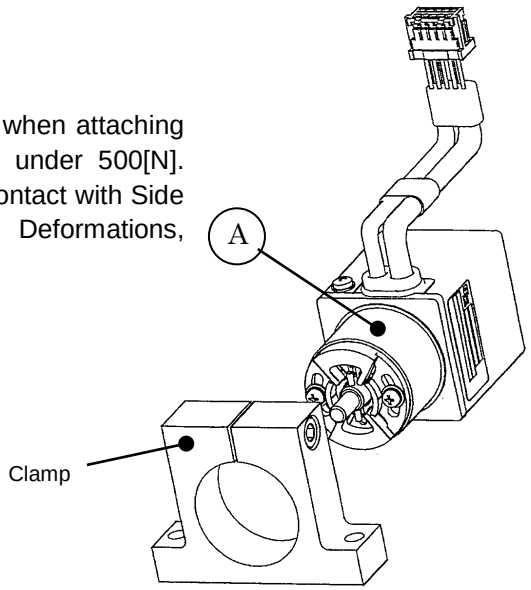
Please do not pull on the scanner cable with excessive force (exceeding 20[N]). The connector or and cable may become damaged. Please ensure there is sufficient length to the cable when connecting the device and ensure there is no tension on the cable. In addition, please ensure a sufficient bending radius (exceeding r=40 mm) when repeatedly bending the cable.

3-7-3 Caution When Attaching Scanner and Load Equipment

If the attachments to the scanner device or to the output shaft of the mirror's load device are inappropriate, the scanner will not sufficiently perform and may cause the device to malfunction. Please be cautious when attaching this device to the equipment.

♦ Attachting the Scanner Body to an equipment

Secure the clamp to Side A in the diagram on the right, when attaching with clamp. Please ensure that the clamp strength is under 500[N]. Please ensure that the screw does not directly come in contact with Side A when using other methods of securing attachments. Deformations, etc. may affect accuracy.



♦ Attaching the Load Device to the Output Shaft

For the driver combined with the customer's load device and adjusted by our company, please ensure the servo is turned on after installing the load device. Without a load, the Output Shaft will start to oscillate unexpectedly when the servo is turned on.

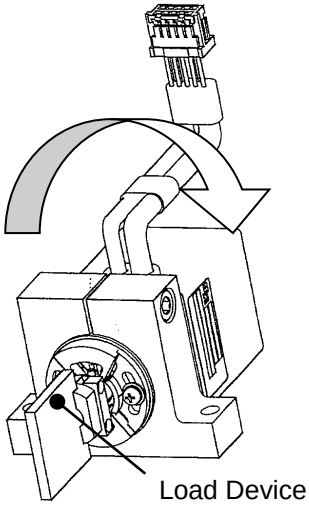
Caution

If the scanner starts to **oscillate unexpectedly**, the driver resistance may **generate abnormal amounts of heat and start to smoke**.
In this case, immediately cut the power source.

♦ Attachment Order to the Output Shaft of the Load Device

The following order is recommended when attaching the load device and deciding the position of the attachment.

(1) Secure the load device to the output shaft at a rough position with the stopper pin of the output shaft as a guide.
(2) Temporarily secure to the device and turn the servo on (input command: 0V)
(3) Determine the position by turning the scanner body while observing the device's laser light or image, then secure the equipment.



♦ Lubrication of the Scanner's Roller Bearing

Attention must be paid to the lubrication of the scanner's roller bearing during continuous small amplitude movement in the same location. The lubrication of the roller bearing can be more adequately maintained by periodical large amplitude moving(ideally, slow triangular waves) for lubrication. It is strongly recommended that the device is lubricated to the extent that it does not affect usage conditions.

Chapter 4 Driver Specifications

The specifications of the driver (PSM-130) are as follows.

4-1 Main Specifications

No.	Items		Specifications
1	Power Source Voltage	[V]	DC ±24±10%
2	Continuous Output Current	[A]	5
3	Instantaneous Maximum Output Current	[A]	25
4	Input Signal		- Position command input (±10V, differential input, impedance: 10kΩ) - Enable
5	Output Signal		- Monitor Output (positioning command signal, positioning sensor signal, positioning error signal) - Alarm
6	Protection Functions		- Protection when Enable OFF → ON - Protection when Power OFF - Prevents Power IC from overheating
7	Insulation Resistance (*1)	[Ω]	100M （DC500V）
8	Offset Drift	[μrad/°C]	5
9	Scale Drift	[%/°C]	0.005
10	Mass	[g]	160

*1 Please do not conduct insulation tests.

4-2 Protection Functions

No.	Name	Functions
1	Protection when Enable Off → ON (*1)	Prevents unstable operation when Enable OFF → ON (Controls swing angle within ±10° when Enable OFF → ON)
2	Protection when Power Off	Prevents unstable operation when Power ON → OFF (Controls swing angle within ±10° when Power ON → OFF)
3	Power IC Overheating Protection (*2)	Stops supplying power (shut down) to the scanner when the internal temperature of the Power IC is over Typ.160°C (surface temperature: Typ.130°C) and prevents further overheating. As the temperature of the Power IC decreases and falls below the threshold, the power is supplied again (auto return).

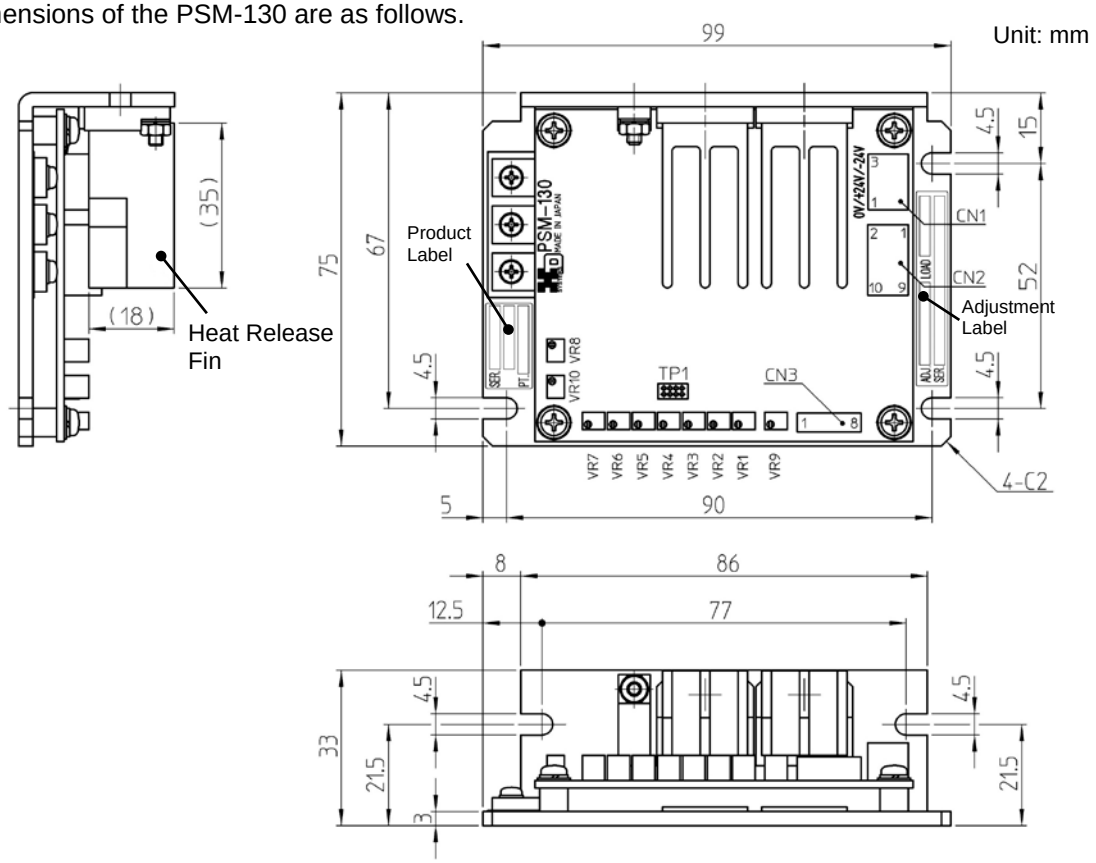
*1 Please do not turn the power on when Enable is on.

*2 The Power IC Overheating Protection is to protect against damage due to the heat from the driver. Intermittent instability may occur during beginning of shutdown and auto return.
Refer to Overheat Alarm Output (4-6-6) to form the sequence configuration of Enable OFF before operating the Power IC Overheating Protection.

4-3 Dimensions (Third Angle Method)

The dimensions of the PSM-130 are as follows.

Unit: mm



Note: Please confirm the details of the dimension with the supplied specification diagram issued by our company.

4-4 Environmental Specifications

The environmental specifications of the PSM-130 are as follows.

No.	Items		Specifications	Remarks
1	Operating	Temperature [°C]	0 ～ 40	
2		Humidity [%RH]	20 ～ 85	No condensation
3	Storage	Temperature [°C]	−10 ～ 70	
4		Humidity [%RH]	20 ～ 90	No condensation
5	Vibration Resistance (*1)	Vibration Acceleration [m/s^2]	24.5	
		Testing Conditions	Frequency: 10→1000→10 [Hz] Time: 1 Cycle 20 [min] No. of Times: 3 times each in x, y, and z directions.	
6	Shock Resistance (*1)	Vibration Acceleration [m/s^2]	294	
		Testing Conditions	Shock Time: 11 [ms] No. of Times: 3 times each in x, y, and z directions.	

*1 The vibration/shock resistance tests are to ensure there is no degradation in performance during non-operation period, but they do not guarantee the performance while operating.

4-5 Connector Specifications

The specification of each of the driver's connectors is as follows.

4-5-1 Input Power Source Connector (CN1)

Power Supply Connector [Driver Connector Model: B3P-VH(JST)]

Pin.No.	Input Voltage [V]
1	0
2	＋24
3	－24

Caution Errors in connecting the power may damage the driver or significantly shorten the life of the device.

4-5-2 Scanner Connector (CN2)

Connector Connecting the Scanner [Driver Connector Model: DF1B-10DP-2.5DSA (Hirose)]
Please refer to "Connector Specifications of Scanner" (3-2) for pin allocation of connector.

4-5-3 Input/Output Signal Connector (CN3)

Input/Output Connector Connecting the Upper Controller [Driver Connector Model: B8B-ZR-3.4 (JST)]

No.	Name	Function/Other
1	SIG IN（＋）	Positioning Command Signal Input (±10V Max) (*1)
2	SIG IN（－）	
3	IN－MON	Positioning Command Signal Monitor Output
4	POS－ERR	Positioning Error Signal Monitor Output
5	POS－OUT	Positioning Sensor Signal Monitor Output
6	GND	Signal Common
7	ENABLE	Enable Input
8	ALM	Over Position and Overheat Alarm Output

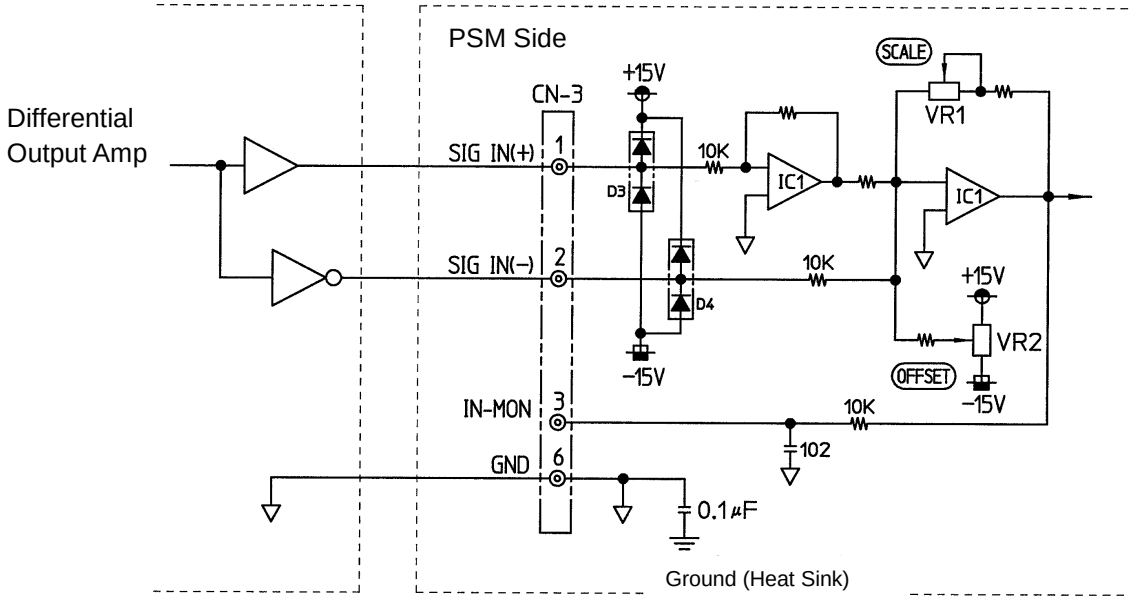
*1 Rotation is in the direction of CW when looking from the output shaft when applying the positive voltage to the SIG IN (+).

4-6 Input/Output Interface Specifications

4-6-1 Positioning Command Signal Input [SIG IN(+)/SIG IN(-)]

The differential input of the input impedance is 10k [Ω].
The scanner rotates in the direction of CW when looking from the output shaft when SIG IN (+) is a positive voltage and SIG IN (-) is a negative voltage. Examples of connections are as follows.

♦ Examples of the Connections when Positioning Command Signal is Differential Input

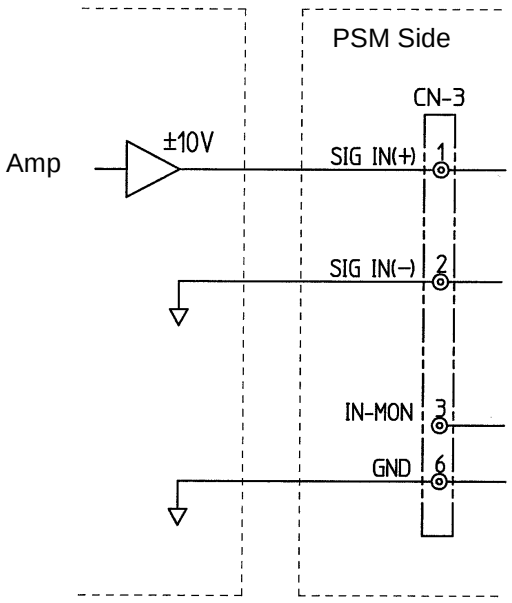


Differential Input Examples

	Pattern 1	Pattern 2	Pattern 3	Pattern 4	Pattern 5
SIG IN（+）	0V	+5V	0V	+5V	+4V
SIG IN（−）	0V	0V	+5V	−4V	−5V
Command Value	0V	+5V	−5V	+9V	−9V

*1 The heat sink and GND (↓) are connected through the capacitor (0.1μF).
*2 The standard voltage value within the table is the GND (↓) of the circuit diagram.

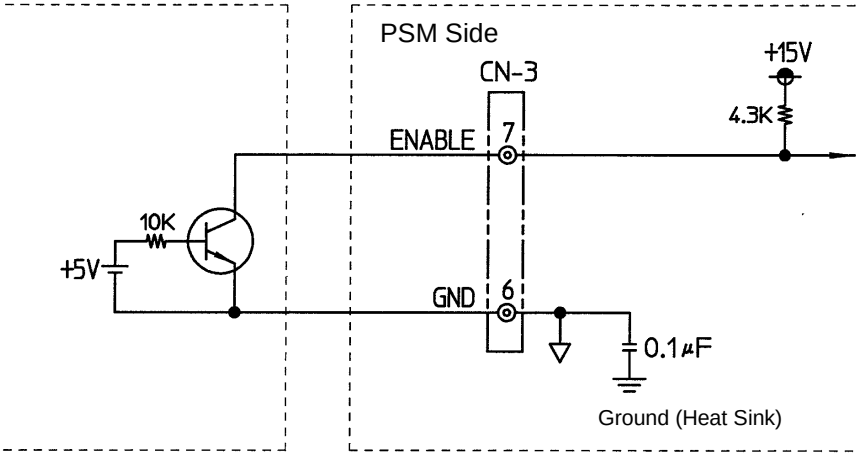
♦ Examples of the Connections when Positioning Command Signal is One Terminal Input



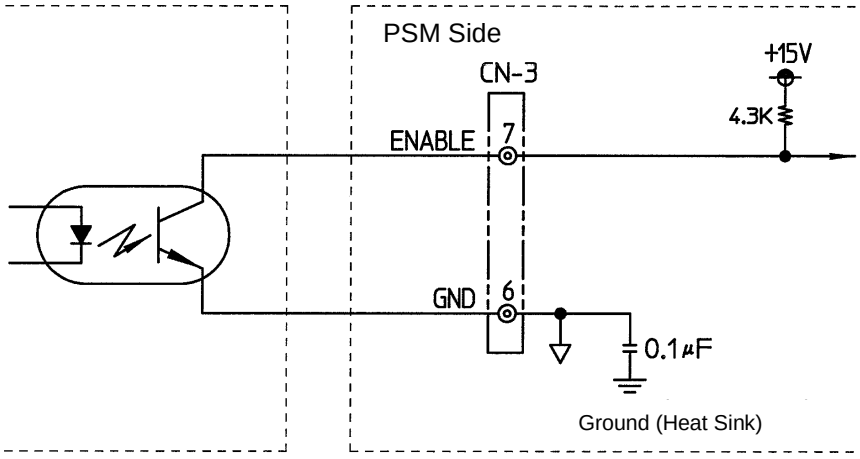
4-6-2 Enable Input (ENABLE)

The signal input of GND level will turn on the servo loop (motor maintains positioning) and the equipment is ready for operation. The servo loop will turn off (motor becomes free) while the signal input is high level (open). Examples of connections are as follows.

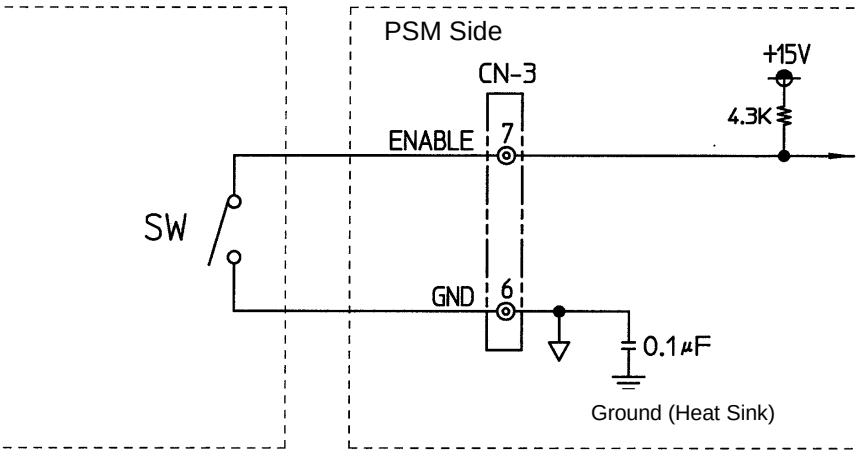
♦ Enable Connection Example 1



♦ Enable Connection Example 2



♦ Enable Connection Example 3



Note: Please do not turn on the power supply while ENABLE is ON

4-6-3 Positioning Command Signal Monitor Output (IN-MON)

This monitors the positioning command signal input to the driver.
The motor voltage for the input voltage signal is the voltage value converted by scale (VR.1) adjustments and the angle/voltage ratio is the same value as the sensor angle sensitivity indicated in the scanner specifications.

4-6-4 Positioning Sensor Signal Monitor Output (POS-OUT)

This monitors the scanner's positioning sensor signal output.
The angle/voltage ratio and the polarity are the same value as the sensor angle sensitivity indicated in the scanner specifications.

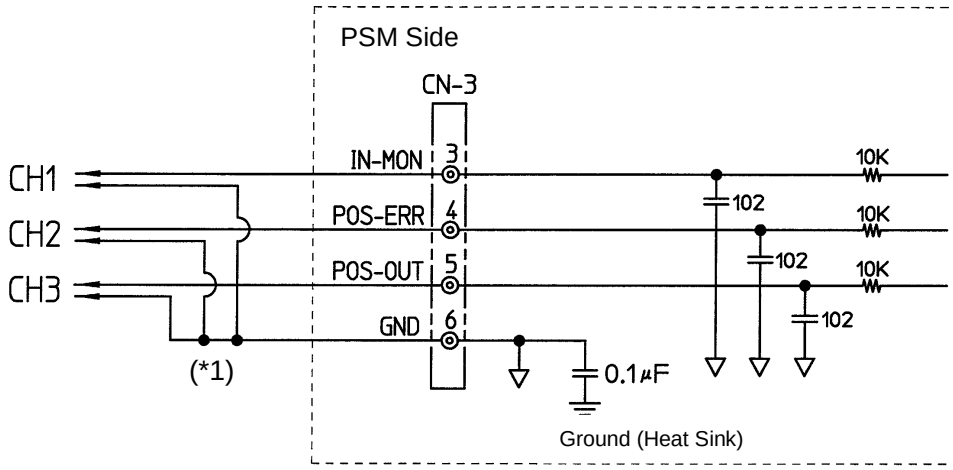
4-6-5 Positioning Error Signal Monitor Output (POS-ERR)

This monitors the difference of the output shaft operating positions for the changes in the positioning command signal input.
The positioning error signal monitor is indicated by the following formula as the difference in monitor signals between the positioning command signal and the positioning sensor signal.

$$V_{(POS\text{-}ERR)} = (V_{(IN\text{-}MON)} - V_{(POS\text{-}OUT)}) \times 2$$

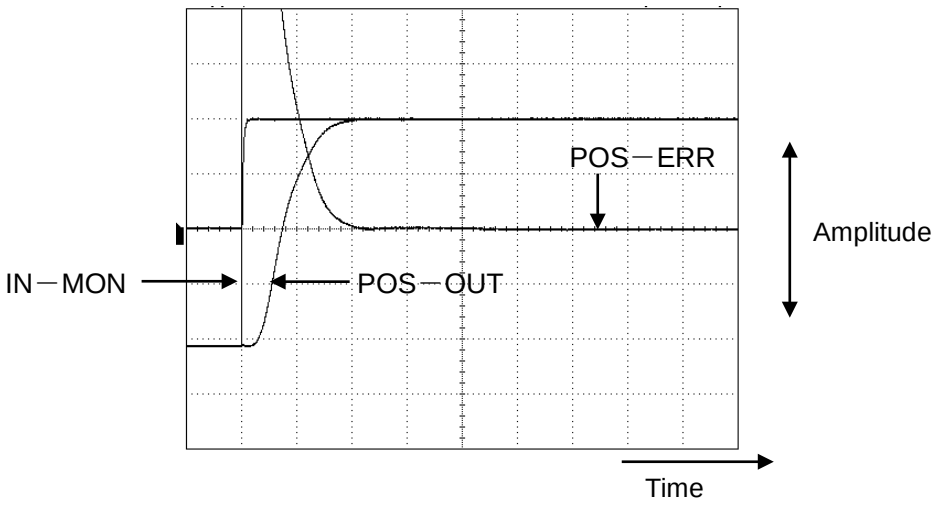
Examples of monitor connections are as follows.

♦ Monitor Output Connection Example



*1 When connecting to multiple monitor outputs, please ground one GND located close (within 500mm) to the connector (CN3).

♦ Examples of Observed Monitor Outputs (rectangular wave, example observed by oscilloscope)



4-6-6 Alarm Output (ALM)

The alarm output is the logical sum of the two outputs below.
Please have the sequence configuration to be Enable OFF during alarm output.

a) Over Position Alarm Output (OP-ALM)

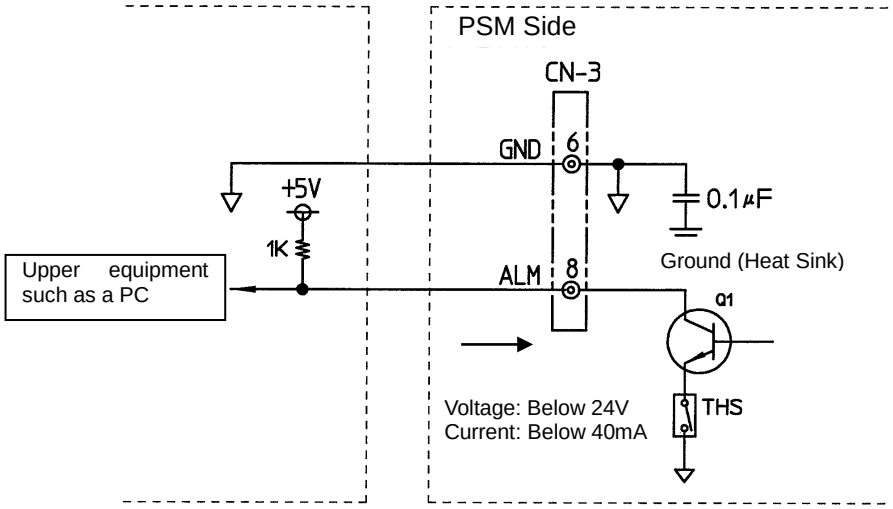
The output status based on the absolute values of the sensor angles is indicated in the following table.

Sensor Angles (Absolute Values)	Alarm Output Status
Less than 15.5°	ON
15.5° ～ 19°	ON → OFF
Over 19°	OFF

b) Over Heat Alarm Output (OH-ALM)

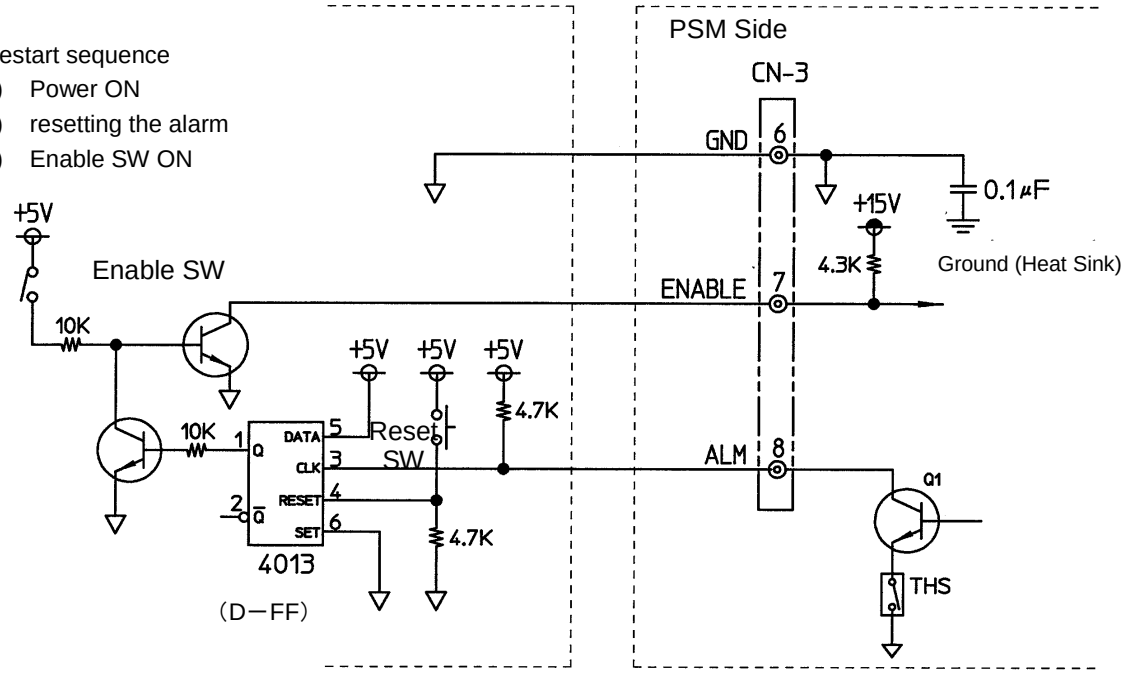
When the temperature of the detector attached to the heat sink of the driver exceeds the allowed value (Typ.80 ℃), the alarm output turns off. Examples of connections are as follows.

♦ Example of Connection when Monitoring Alarm Output Signals with upper Equipment



♦ Example of Connection when Maintaining Off Status of Servo during Alarm Output

Restart sequence
1) Power ON
2) resetting the alarm
3) Enable SW ON



4-7 Trimmer Function and Adjustable Range

The driver is adjusted according to the following trimmer functions.

VR.No.	Name	Function	Adjustable Range
VR.1	Scale	Adjusts the ratio between the input command voltage and the swing angle of the output shaft.	For 10V change of the input command, it is possible to adjust in the range of 2.2V (corresponds to 8.3°) - 4.4V (corresponds to 16.6°) at POS-OUT voltage . 12 revolutions trimmer (*1)
VR.2	Offset	Adjusts the misalignment in the scanner origin and the electric origin of the position command input.	When the scale is set at POS-OUT/ input command voltage: 4.125V (corresponds to 15°)/10V, POS-OUT is adjustable in the range of ±0.825V (corresponds to ±3°). 12 revolutions trimmer (*2)
VR.3	Damping (Damping Gain)	Adjusts the dumping gain of the control system.	12 revolutions trimmer
VR.4	P.Gain (Proportional Gain)	Adjusts the proportional gain of the control system.	12 revolutions trimmer
VR.5	HNF (High Frequency Notch Filter)	Decay of the high frequency resonance.	12 revolutions trimmer
VR.6	RC.ADJ. (Robust Adjustment	Fine tuning of the disturbance observer's gain.	12 revolutions trimmer
VR.7	OB.Gain (Disturbance Observer Gain)	Course adjustment of the disturbance observer's gain.	12 revolution trimmer
VR.8	I.Gain (Integration)	Adjusts the stationary positioning error.	12 revolutions trimmer
VR.9	LNF (Low Notch Field)	Decay of the low frequency resonance.	Possible Range of Adjustment: 4-10kHz 12 revolutions trimmer
VR.10	ITCC (Integration Time Constant)	Adjusts the Time Constant of the Integration	12 revolutions trimmer

Note1): Please refer to 4-3 Dimensions for the VR position on the board.

Note2): The adjustment range of the various trimmers is determined by the trimmer variable resistance + fixed resistance. If the adjustment specifications of the customer changes significantly, the fixed resistance may need to be changed.

*1 VR.1: The swing angle of the scale adjustment range is the value including the scanner's angle sensitivity error of ±5%. In addition, to ensure that scale is adjusted to the same swing angle of the adjustment specifications when shipping, the relationship with the positioning command signal has to be maintained during scale adjustment.

*2 VR.2: The offset changes the variable range according to the scale set value. In addition, the control range does not change at ±15°, centered on the origin of the sensor.

♦ Caution When Adjusting Trimmer

The drivers are shipped after they have been adjusted by our company. The various trimmers have been adjusted to meet the response characteristics (adjustment specifications) requested by the customers. If the customer has rotated the trimmers, aside from the scale (VR.1) and offset (VR.2), the response characteristics adjusted before shipping cannot be maintained. Please be careful.
In addition, if the trimmer is greatly off balance, the scanner may start to oscillate unexpectedly. In this case, immediately cut the power source.

Caution

If the scanner starts to **oscillate unexpectedly**, the driver resistance may **generate abnormal amounts of heat and start to smoke**. In this case, please immediately cut the power source.

When there are changes to the adjustment specifications after shipment, please consult with our company's sales office.
Our company will conduct studies regarding readjustments. (There will be a charge for any adjustments after the product has been shipped.)

4-8 Status Display

The LED (green) on the board will light when power is supplied.

4-9 The Check Pin on the Board

The following check pins are on the driver's board.
When monitoring the check pin, please utilize the probe with impedance over 1MΩ.
If the impedance is low, this may cause malfunctions.
(Please identify the silk print on the board regarding the check pin location.)

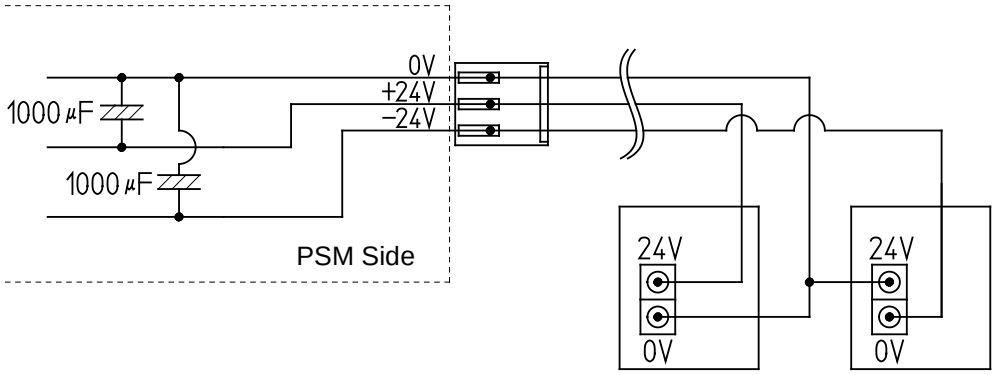
CP.No.	Specifications
CP1	Power Source Common
CP2	＋15V
CP3	－15V
CP4	＋5V
CP5	Sensor Signal Voltage (POS-OUT)
CP6	Dumping Signal
CP7	Motor Current Command
CP8	Motor Current Feedback
CP9	Motor Current Value (shunt resistance: 33mΩ)
CP10	Common of Motor Current

4-10 Power Source Connection

Please pay attention to the following points regarding the connection of the power source.

4-10-1 Measures to Avoid Voltage Drop in Power

The following diagrams are examples of connections when utilizing switching power sources.



As a measure to avoid voltage drop in power, please utilize the shortest and thickest lead wire possible when connecting the power source to the driver (recommended lead wire: over AWG22).

4-10-2 Selection of Power Capacity

The necessary power capacity varies greatly according to operating conditions (load moment of inertia, input command wave form, swing angle, frequency, etc.).
Measurements of the motor current based on the customer's operating conditions are conducted during the advanced testing stage. The data of the motor's maximum current value and the motor's effective current value will be presented. Please utilize this data as a guide for power source selection.

- Motor's Maximum Current Value: Guide for selecting the power source's maximum current
- Motor's Effective Current Value: Guide for selecting the power source's rated current

Furthermore, the power source used in our adjustments is ±24V、240W (refer to 2-4-1 [15]).

4-10-3 Caution When Connecting Power Source

Errors in connecting the power source of the driver may cause the following problems. Please pay sufficient attention when wiring.

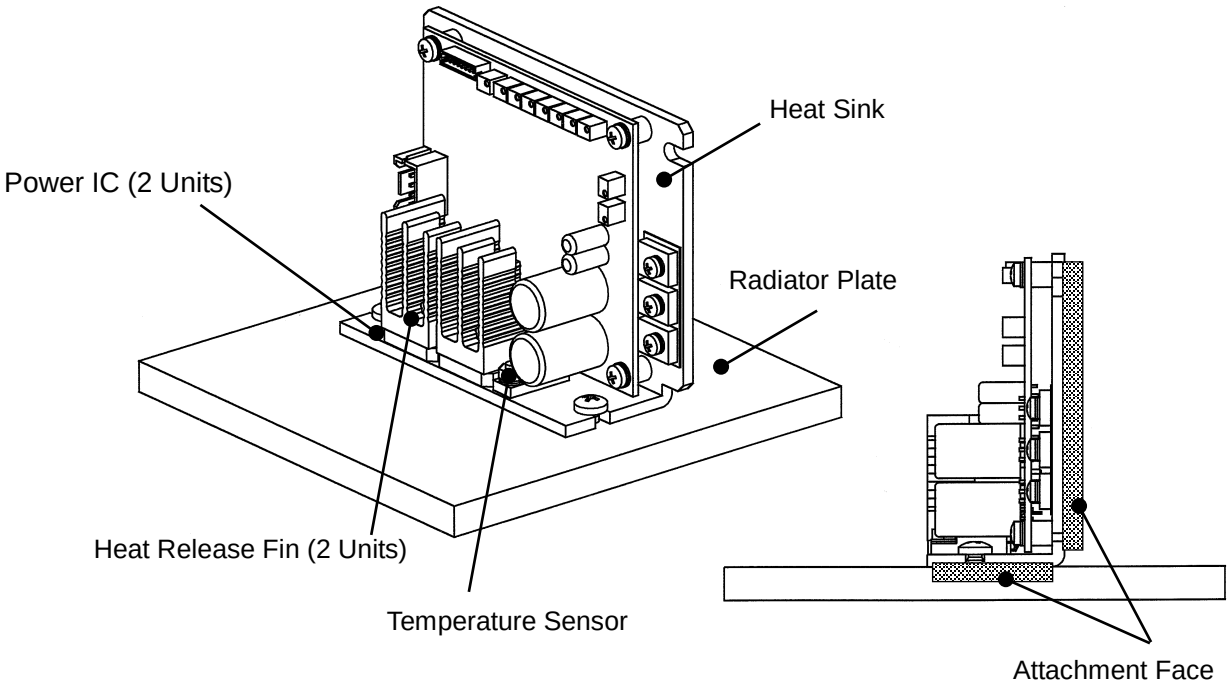
- If +24V and -24V are connected in reverse, the device will not start as there will be no current flowing to the driver even if the power source is turned on.

Caution

Wiring errors, aside from the one listed above (+24V and -24V connected in reverse), may damage the driver or significantly shorten the life of the device after the power source has been turned on.

4-11 Caution Regarding Driver Installation

The driver needs to release heat in response to operating conditions.
Please secure the heat sink attachment of the radiator plate to one of the two surfaces in the diagram below.
Furthermore, it is recommended that silicon grease is applied to the attachment surface when securing.
In addition, the heat sink and board circuit are connected through the condenser (0.1 μF).



- The temperature of the driver's Power IC rises according to the operating conditions (when large currents flow continuously, etc.) and the device may shut down due to Power IC Overheating Protection (4-2).
  Intermittent instability may occur during beginning of shutdown and auto return. Before the operation of the Power IC Overheating Protection in this case, refer to Overheat Alarm Output (4-6-6) to have the sequence configuration to be Enable OFF.
  Please conduct commands input and heat release process of the driver to ensure that the detector's temperature of the overheat alarm does not exceed the allowed value.

- The consumption current of the scanner is the smallest at the scanner's origin and increases with distance away from the scanner's origin, when suspending positioning. The temperature of the driver's Power IC increases according to the status of head release and the Power IC Overheating Protection may shutdown the device. When suspending the positioning at a specified position for a long time with the shutter etc, please try to suspend in the vicinity of the scanner origin.

- We will submit the heat release conditions that meet the customer's driving conditions during the advanced testing stage. In addition, the warm-up time is approximately 5 [min].

4-12 Driver Accessories

The accessories of the driver are as follows.

Name	Model	Quantity	Remarks
Housing for CN1	VHR-3N（JST）	1	
Connect for CN1	BVH-21T-P1.1（JST）	3	Applicable Wire Diameter: AWG 22-18
Housing for CN3	ZHR-8（JST）	1	
Connect for CN3	SZH-002T-P0.5（JST）	12	Applicable Wire Diameter: AWG 28-26 Status of the 12 reels (including 4 backup reels)

Note: Please utilize the appropriate tools when crimping.

4-13 Driver Labels and Descriptions

The product label and adjustment label are attached to the driver. Please refer to “Dimensions” (4-3) for positioning of the labels.
The descriptions are as follows.

Label Title	Entry	Descriptions
Product Label (*1)	SER.	Product serial number of the driver.
	PT.	Management number of the product specifications.
Adjustment Label	ADJ.	Model of the combined adjustment LSA
	SER.	Serial number of the combined adjustment LSA
	LOAD	Identification symbol of the combined adjustment load (*2)

*1 The driver model is not listed on the product label.
Please identify the model from the silk print on the board.

*2 The descriptions of the LOAD are our adjustment specification management numbers.
Example: 101000, etc.
It is possible to use the contents specified by the customer within the limitations below. Please contact us for the details.

- Within 6 single bit, alphanumeric characters (without symbols)
  Example: mirror / X / Y / SYS, etc.
- The products of the same adjustment specifications will have the same descriptions. (There is no support for serial numbers.)
- The descriptions are limited to the contents that have been agreed upon when the adjustment specifications documents are submitted.

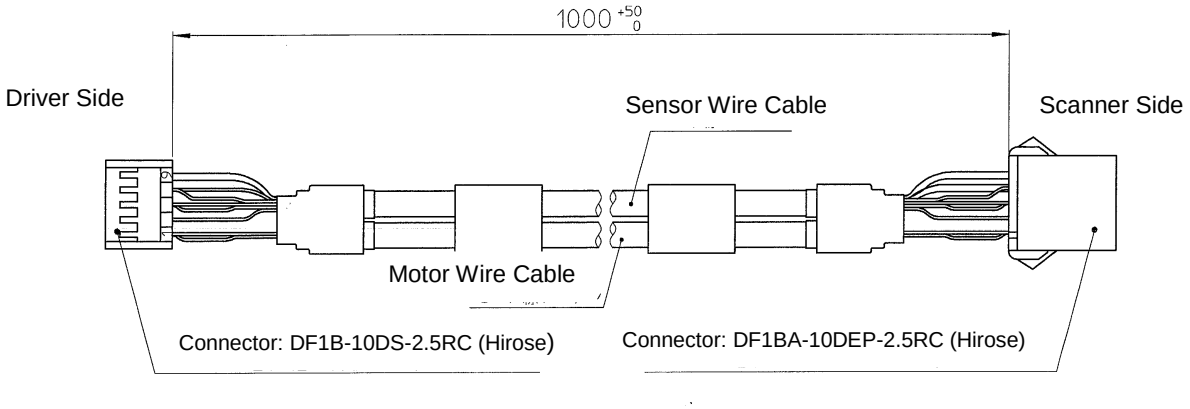
Chapter 5 Options

The options of the LSA-10A-30-D-130 scanner system are as follows.

5-1 Extension cable

The Extension cable that extends the distance between the LSA-10A-30 (scanner) and PSM-130 (driver).

Product Name	Model	Cable Length
Extension cable	EWA-EM01-HR10-HR10	1m



Caution

As the connector is a simple lock type, ensure that there is sufficient length to the cable and no tension on the cable. In addition, please refer to 2-4-1 [14] and 3-7-2 for handling the cable.

Chapter 6 Packaging

The combined adjustment components (scanner, driver, accessories) are packaged in identical and exclusive boxed packaging.
After opening, please confirm the details of the scanner and driver adjustment labels (refer to 4-13).
Any specially arranged supplied products, etc. are not included in the same package.
The customer's load device (supplied product) will be shipped separately.
As the supplied product may take a different transport route, it may not be delivered at the same time as the product. Your understanding is appreciated.

Chapter 7 Warranty

The warranty period and scope of the LSA-10A-30 and PSM-130 products as listed in this specification document are as follows.

7-1 Warranty Period

The warranty period is for one year after delivery, under the condition that the device is utilized in the normal installed state, as listed in this specification document.

7-2 Warranty Terms

If the device malfunctions due to defects in workmanship during the abovementioned warranty period, we will take responsibility for repairing or exchanging the aforementioned product.
However, situations that correspond to the following shall be excluded from the scope of this warranty.

(1) Inappropriate handling or misuse by the customer
(2) Modifications or repairs by personnel other than our staff.
(3) Malfunctions caused by events unrelated to this product.
(4) Other events, such as natural disasters, etc.

Furthermore, the warranty applies only to the product itself as described in this manual.
We are not liable for consequential damages or cost and man-hours dedicated to remove or install the product from or in the equipment

Note: When returning the product for readjustment, please send all of the combined adjustment components (scanner, driver, load device).