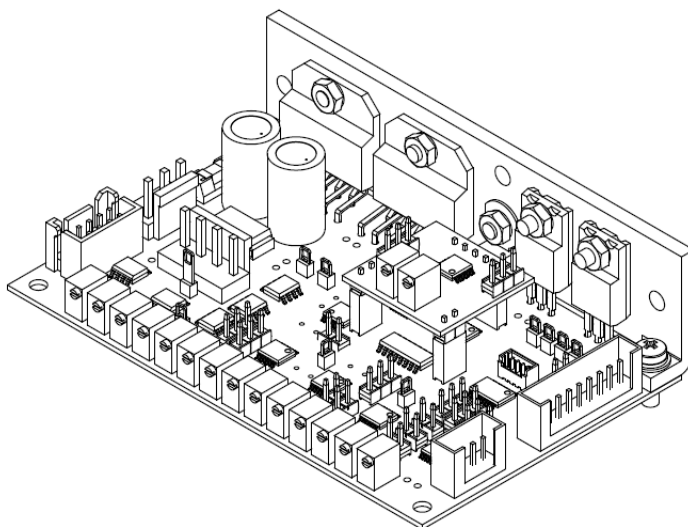


# **Galvanometer Scanner Servo Driver GVD1 Series Instruction Manual**



**CITIZEN CHIBA PRECISION CO., LTD.**

## Contents


1. Product Overview .....	4
1-1. Standard Accessories .....	4
1-2. Main Features .....	4
1-3. Details of Model Type and Serial Numbers .....	5
1-4. Name Plate .....	5
1-5. Specifications .....	6
1-6. Optional Cable .....	7
2-1. Outline and Name of Each Part .....	8
2. Settings .....	
2-2. Setting Jumpers for Main Board .....	8
2-3. Setting Jumpers for Optional Boards for PI Control .....	10
3. Installation and Wiring .....	11
3-1. Installation .....	11
3-2. Example of Connection .....	11
3-3. Connectors .....	12
3-4. Input / Output Interfaces .....	13
4. Operation .....	16
4-1. Start-Up Procedure .....	16
4-2. Mirror Mounting Mode .....	16
5. Adjustments .....	17
5-1. Volumes for Adjustments .....	17
5-2. Check Terminals .....	18
6. Product Warranty .....	19
7. Contact Information .....	19

# Preface

Thank you very much for purchasing our GVD1 Series Galvanometer Scanner Driver.

This Instruction Manual explains the specifications, input/output interfaces and important notes concerning GVD1 Series Galvanometer Scanner Driver. Please read this manual carefully to use this product properly.

Failure to follow the instructions may make our product not to perform fully but also may cause damages and accidents. For your safety, please keep this manual accessible even after read it all.

The definitions of signal words next to this symbol  in this Instruction Manual are as follows. Please be sure to follow them to avoid any danger.



This is the symbol used for notification of any general cautions, warnings, and dangers.

## **DANGER:**

This signal word indicates direct hazards. Failure to follow this caution may result in death, serious injury or critical damage to property such as total loss of equipment or fire.

## **WARNING:**

This signal word indicates indirect hazards. Failure to follow this caution may result in death, serious injury or critical damage to property such as total loss of equipment or fire.

## **CAUTION:**

This signal word indicates potential hazards. Failure to follow this caution may result in minor or moderate injury, or partial damage to equipment.

## **NOTE:**

**All rights reserved. This Instruction Manual may not be photocopied or reproduced without our prior written permission.**

**The contents of this Instruction Manual are subject to change without prior notice.**

## 1. Product Overview

Our GVD1 Series is a set of servo drivers for one-axis mirror position control system that is exclusively designed for Citizen Chiba Precision's galvanometer scanner. The series has achieved high precision and high controllability, and its powerful protective functions ensure the safe operation of galvanometer scanners and the drivers.



CAUTION

**This product is the driver exclusively for Citizen Chiba Precision's galvanometer scanners. It cannot control any galvanometer scanners made by other manufacturers.**



CAUTION

**Do not use this product without the bracket.  
Failure to follow this caution may result in a damage.**

### 1-1. Standard Accessories

GVD1 package contains the following items besides the main unit. Please make sure that all items are contained in the package before use. If any item is missing or damaged, please contact our Sales representatives by "Section 7: Contact Information".

No.	Accessories	Model	Manufacturer	Qty.
1	Connector Housing for CN1	VHR-4N	J.S.T Mfg.	4
2	Contact Pin for CN1	BVH-21T-P1.1	J.S.T Mfg.	3
3	Connector Housing for CN3	DF1B-4S-2.5R	HIROSE ELECTRIC CO., LTD.	1
4	Contact Housing for CN5	DF1B-9S-2.5R	HIROSE ELECTRIC CO., LTD.	1
5	Contact Pin for CN3 / CN5	DF1B-2428SCA	HIROSE ELECTRIC CO., LTD.	13

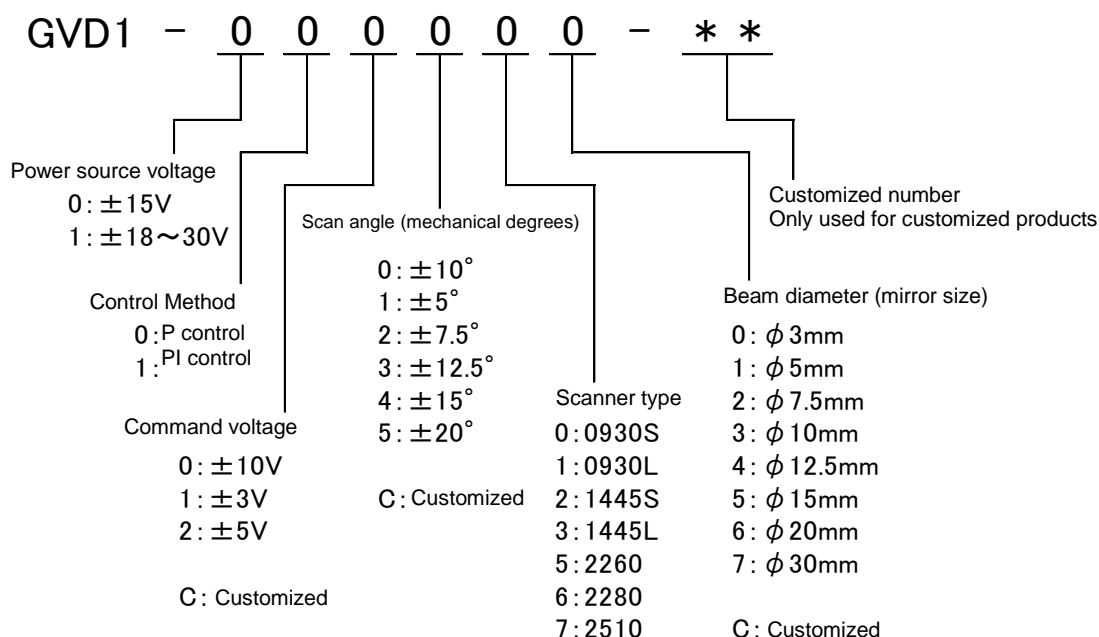
### 1-2. Main Features

Our GVM Series Galvanometer Scanners are developed based on the small servomotor technology that we have developed and improved over a long time, and our newly developed small high-precision optical position sensor. The following are the features of the system combining GVM Series Galvanometer Scanners and the driver:

- Fast response / Low inertia / High torque
- High linearity and positional accuracy
- Excellent temperature characteristics

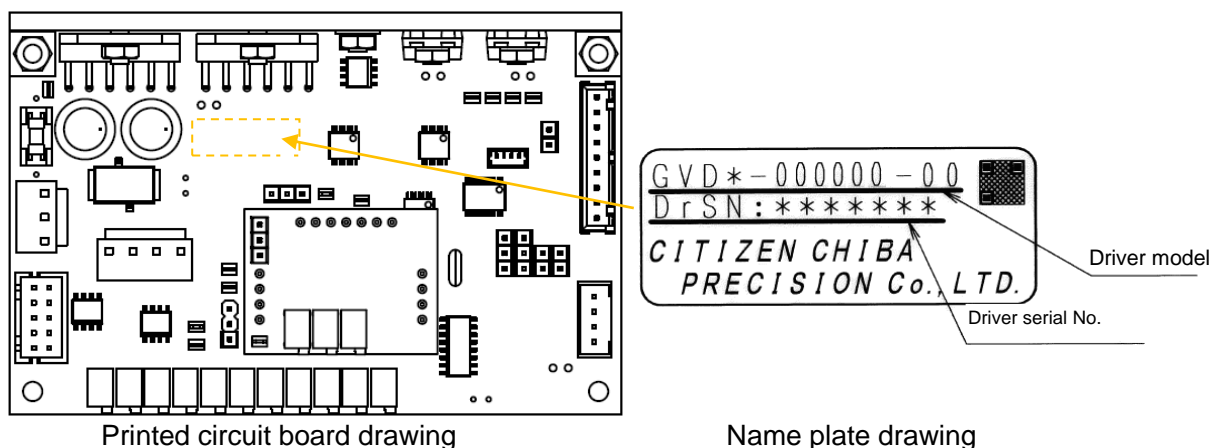
### 1-3. Details of Model Type and Serial Numbers

The model types of GVD1 Series drivers vary according to the specifications.  
The relationship between driver model number and each specification are as follows:



### 1-4. Name Plate

A name plate, as shown in the "Name plate drawing" below right, is attached to the area indicated by the yellow dotted lines on the printed circuit board drawing below left.



### Details of Serial Numbers:

18                      X                      0001  
**Shipping Year    Shipping Month    Sequence Number**

\*The shipping year indicates last two digits of the year

\*Following months are indicated as follows: October: X, November: Y, December: Z

**This product is adjusted and inspected in a system by pairing GVM Series galvanometer scanner and the optical mirror. The name plate of scanner indicates serial numbers of compatible driver. Please be sure to use this product with the scanner witch has same serial numbers.**

## 1-5. Specifications

### 1-5-1. Main Specifications for Drivers

Power Source Voltage	: DC $\pm 15$ V or DC $\pm 18$ V to DC $\pm 30$ V (5A or more is recommended)
Driving System	: Linear Drive
Power Source Current	: Approx. (+) 266 mA / Approx. (-) 199 mA (at DC $\pm 24$ V and servo lock)
Output Current	: 5A rms / Peak current: 11.5 A

### 1-5-2. Input Signals

Position Command Input : Voltage range:  $\pm 3.0$  V<sub>p-p</sub> or  $\pm 5.0$  V<sub>p-p</sub> or  $\pm 10.0$  V<sub>p-p</sub> (Differential)\*<sup>3</sup>  
(Single-ended inputs referred to ground are available.)

Control Input : Servo-OFF input (Active-LOW)

### 1-5-3. Output Signals

#### (1) Analog signal output

Position Signal Output : Voltage range  $\pm 1.5$  V<sub>p-p</sub> or  $\pm 2.5$  V<sub>p-p</sub> or  $\pm 5.0$  V<sub>p-p</sub>\*<sup>3</sup>  
(Single-ended inputs referred to ground)

\*<sup>3</sup> Please select the voltage range at time of purchase.

The position signal output is half of the position command input.

Speed Signal Output : Voltage range  $\pm 10$  V<sub>p-p</sub>  
(Single-ended inputs referred to ground)

Current Signal Output : Voltage range  $\pm 10$  V<sub>p-p</sub>  
(Single-ended inputs referred to ground)

Position Deviation Signal Output: Voltage range  $\pm 10$  V<sub>p-p</sub>  
(Single-ended inputs referred to ground)

#### (2) Digital signal output

90% Load Warning Output	: Open collector output
Alarm Output	: Open collector output
Alarm Detection Pulse Output	: Open collector output

\*ON voltage of output transistor is (-)15V. It is possible to change to 0V by using jumper JP11.

### 1-5-4. Protective Function

Sensor Error / Overload / Driver Overheating / Initial Over Position / Over Position /  
Power Source Voltage Drop Error / 90% Load Warning

### 1-5-5. Storage and Operating Environment

Storage Environment:

Ambient temperature range	: 0°C to (+) 50°C
Humidity range	: 10% to 85% RH (No condensation)
Operating location	: Indoor under clean atmosphere

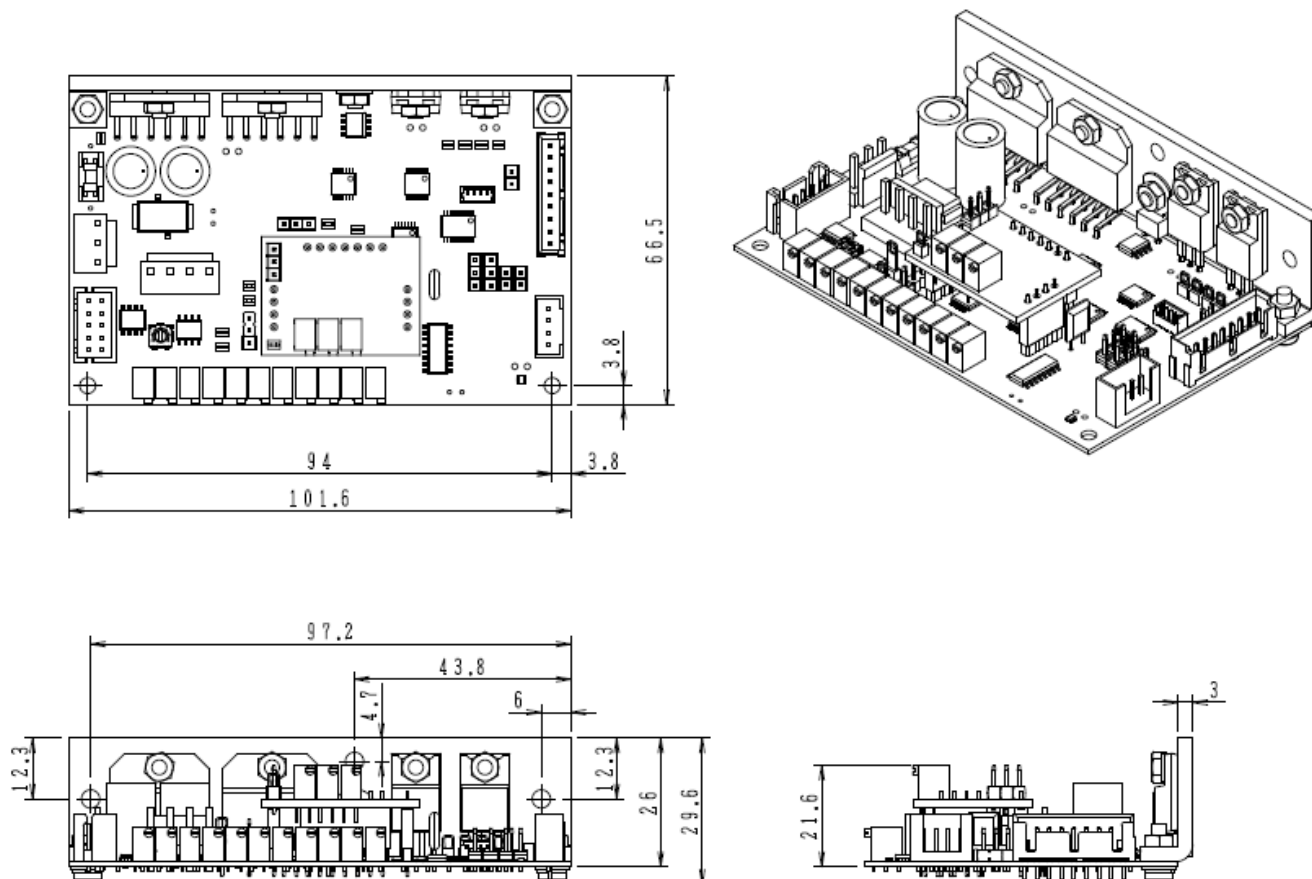
Operating Environment:

Ambient temperature range	: 0°C to (+) 50°C
Humidity range	: 10% to 85% RH (No condensation)
Operating location	: Indoor under clean atmosphere

## 1-5-6. Dimensions and Weight

Structure	: Open frame
External Dimensions	: 101.6mm × 66.5mm × 30.8mm (including bracket)
Weight	: 93g (including Bracket / PI Control / Optional board)
	: 86g (including Bracket / P Control)

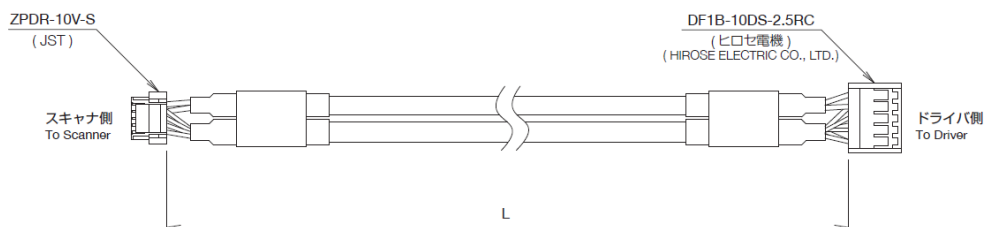
### External Layout Drawing (When mounted on the Optional Board for PI Control specification)



## 1-6. Optional Cable

GVM-0930 Series and GVM-1445 Series scanners need the cable shown below to connect with driver. Please specify the cable length when ordering the product. The cable lengths and the models are as follows:

\*Since GVM-2260, 2280, and 2510 Series scanners have cables connected to their main unit as initial setting, no need to purchase a cable.

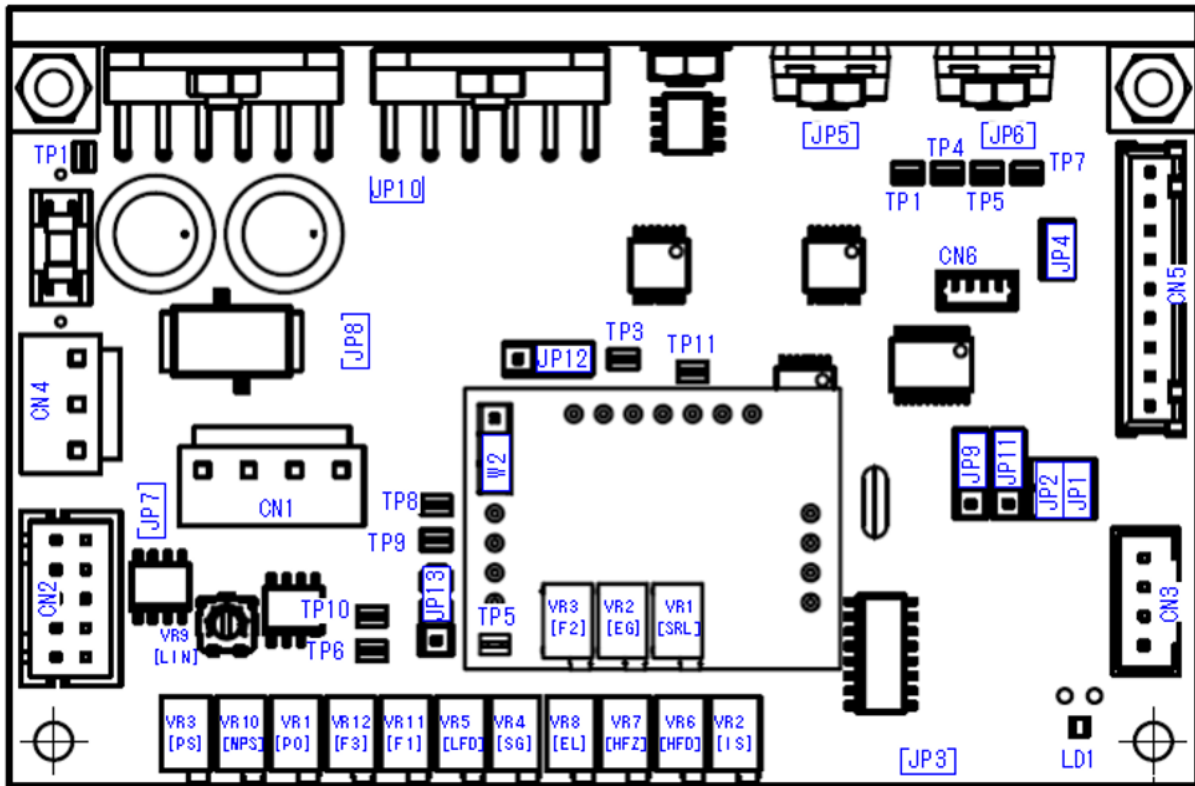


Model	Cable length (mm)
GC00	250
GC10	300
GC20	500
GC30	1000
GC40	3000

## 2. Settings

### 2-1. Outline and Name of Each Part

Connectors, volumes for adjustment, jumpers for various settings, and check terminals for monitoring are placed as shown below. This drawing is for PI Control specification which is mounted on the optional board.



- CN1 to CN6 : Connectors
- VR1 to VR12 : Volumes for Adjustment / The functions are indicated by abbreviation in [ ]
- JP1 to JP13 : Jumpers for Various Settings
- W2 : Jumper for Setting Notch Filter of Optional Board
- TP1 to TP10 : Terminals for Monitoring Signals
- LD1 : LED Display

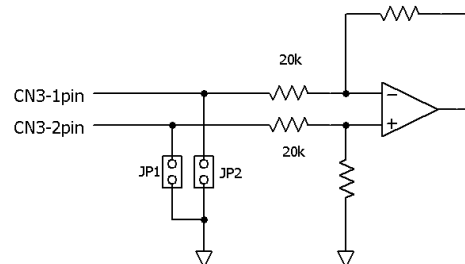
### 2-2. Setting Jumpers for Main Board

The functions of the jumpers and settings are as follows. **Please set them up by all power OFF.**

#### 2-2-1. Setting for Position Command Input JP1 and JP2

Please set the jumpers according to the position command input setting for CN3 you chose. The command input circuit is shown below:

Input Method	JP1	JP2
Differential Input	OPEN	OPEN
Single-ended (+)	OPEN	SHORT
Single-ended (-)	SHORT	OPEN



When positive input is in positive voltage and negative input is in negative voltage, the scanner would drive CW which is seen from the output axis side.



### 2-2-2. Error Limiter Circuits JP3

If using scanner by P Control (without Option Board), you can use Error Limiter Circuits instead of Slew Rate Limiter. It works almost the same as Slew Rate Limiter. It is effective to scan large angle by high speed.

Error Limiter Circuit	JP3	
Disabled	OPEN	
Enabled	SHORT	Please use it under P Control

### 2-2-3. Mirror Mounting Mode JP4

This mode lowers the servo loop gain to mount the mirror to the shaft and fix the shaft slightly at the origin position. LED will light up in red when the mode is enabled. It is disabled in Servo Off Mode.

Mirror Mounting Mode	JP4
Disabled	OPEN
Enabled	SHORT

### 2-2-4. Setting for Power Source Voltage JP5 and JP6

Please set the jumpers according to the power source voltage you chose. Those are the jumpers which allow Input Power Source to be Control Power Source directly without using  $\pm 15$  V three-terminal regulator.

Power Source Voltage	JP5 and JP6
$\pm 18$ V to 30 V	OPEN
$\pm 15$ V	SHORT

\*Because the jumpers are already set according to the model number specified at purchase as initial setting, it is normally unnecessary for customers to set the voltage.

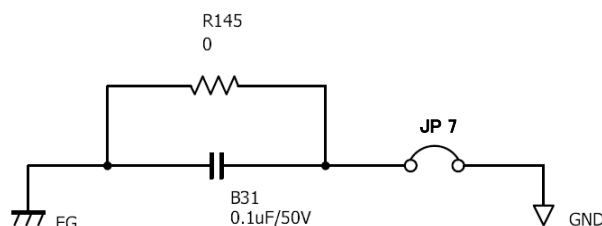
### 2-2-5. Setting for the Connection of Frame Ground JP7

Please select the connection setting between the frame ground (FG) and ground (GND) which is input from CN1. The following diagram shows the jumper's peripheral circuits.

Please use solder for setting. Normally, JP7 is set to SHORT.

For the circuit configuration, please refer to the following circuit diagram.

GND-FG	JP7
Connected	SHORT
Disconnected	OPEN



### 2-2-6. Setting the Configuration of Power Operational Amplifiers JP8, JP9, and JP10

These are the jumpers to select configuration of the power operational amplifiers at the output stage of the drivers. Normally, it is in two-amplifiers configuration.

One-amplifier configuration can reduce the heat of drivers. However, using X and Y in pairs would cause large ground current and therefore it may result in crosstalk between two axes.

Please use solder to set JP8 and JP10.



**Changing the setting of these jumpers requires the servo parameters to be re-adjusted subsequently. Customers are not recommended to make any change.**

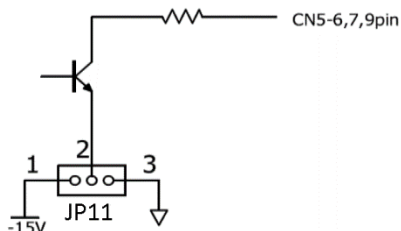
Configuration	JP8	JP9	JP10
Two-amplifiers configuration	OPEN	1 – 2	SHORT
One-amplifier configuration	SHORT	2 – 3	OPEN

### 2-2-7. Setting Voltage Level for ON Output Signals JP11

This is the jumper to select a voltage level of the open collector output signal sent from CN5 when the output transistor is ON. The output circuit of the transistor is shown below.

Normally, it is set in (-)15 V as initial setting.

Emitter Voltage Level	JP11
(-)15V	1 – 2
0V	2 – 3



### 2-2-8. Setting Jumpers for Enable/Disable of First Notch Filter JP12

This is the jumper to select Enable or Disable of the notch filter that damps the primary resonance of galvanometer scanners.

First Notch Filter	JP12
Enabled	2 – 3
Disabled	1 – 2



**Do not change the initial manufacturer setting. Resonance may make the servo system unstable which would result in a failure.**

### 2-2-9. Setting Jumpers for Enable/Disable of the Third (Second) Notch Filter JP13

This is the jumper to select Enable or Disable of the notch filter that damps the third resonance of scanners. (It is secondary resonance if under P Control Mode without optional board.)

Third (Second) Notch Filter	JP13
Enabled	2 – 3
Disabled	1 – 2



**Do not change the initial manufacturer setting. Resonance may make the servo system unstable which would result in a failure.**

## 2-3. Setting Jumpers for Optional Boards for PI Control

### 2-3-1. Setting Jumpers for Enable / Disable Second Notch Filter W2

This is the jumper to select Enable or Disable notch filter that damps the secondary resonance of the scanner.

Second Notch Filter	W2
Enabled	1 – 2
Disabled	2 - 3



**Do not change the initial manufacturer setting. Resonance may make the servo system unstable which would result in a failure.**

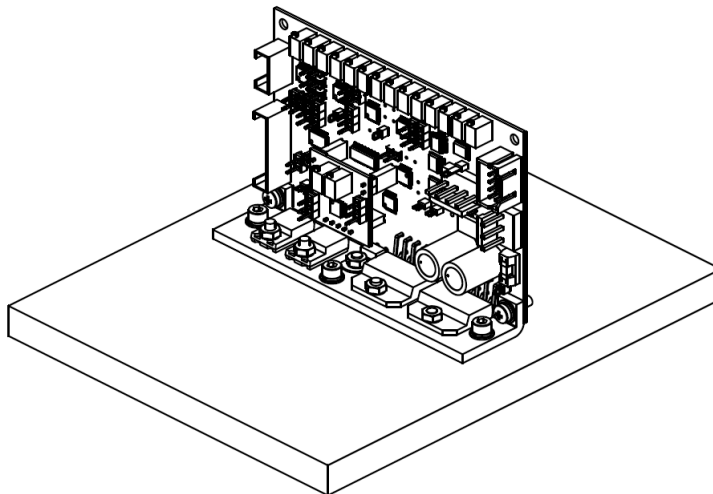
### 3. Installation and Wiring

#### 3-1. Installation

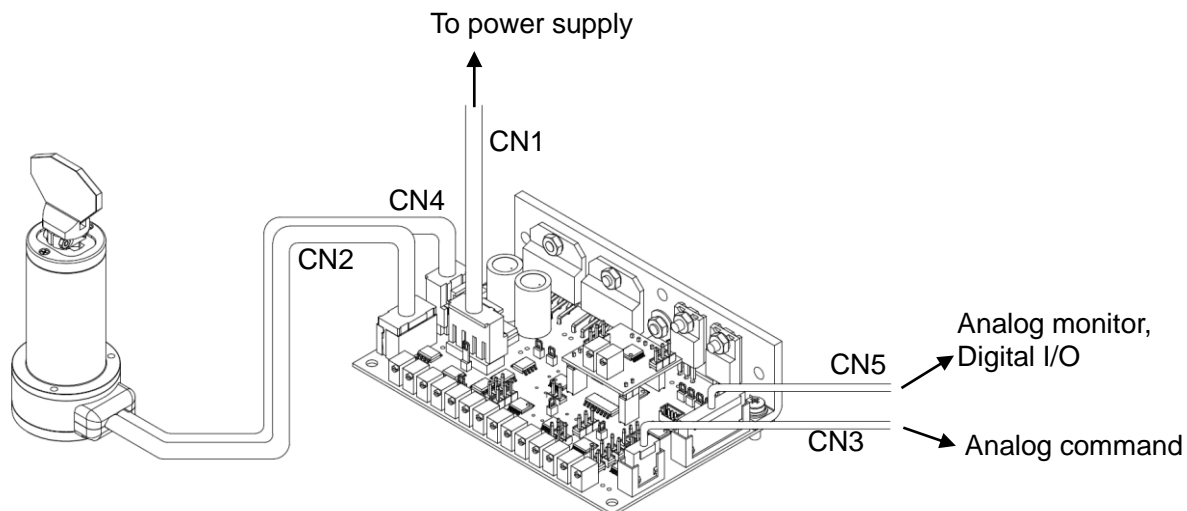
It is necessary to cool driver according to the drive condition of scanner.

Since driver bracket alone cannot provide sufficient heat radiation, please be sure to cool driver when driving scanner.

To mount the driver on a heat sink, please fix it by using three mounting holes as shown in the drawing below. Also, to ensure sufficient heat radiation, please apply silicon grease with high thermal conductance to the mounting surface.



#### 3-2. Example of Connection



### 3-3. Connectors

The specifications for connectors of the driver are as follows:

#### 3-3-1. Connector for Input Power Source CN1

Manufactured by J.S.T Mfg. Co., Ltd.

Driver Connector : B4P-VH

Pairing Connector : VHR-4N

Contact : BVH-21T-P1.1 (Applicable wires: AWG22 to 18)

Terminal No.	Signal Name / Function
1	DC (-)
2	GND
3	GND
4	DC (+)

#### 3-3-2. Connector for Galvanometer Scanner CN2

Manufactured by HIROSE ELECTRIC CO., LTD.

Driver Connector : DF1BZ-10DP-2.5DSA (01)

Pairing Connector : DF1B-10S-2.5R

Contact : DF1B-2428SCA (Applicable wires: AWG28 to 24)

Terminal No.	Signal Name / Function	Terminal No.	Signal Name / Function
1	Positional Signal Output 1	2	Positional Signal Output 2
3	GND	4	GND
5	AGC	6	GND
7	GND	8	GND (Motor Cable Shield)
9	Motor Winding (-)	10	Motor Winding (+)

\*Connectors are assembled into galvanometer scanner cables or exclusive cables as initial setting.  
GVM-2260, GVM-2280, and GVM-2510 do not use either Terminal 9 or 10.

#### 3-3-3. Connector for Position Command Signal Input CN3

Manufactured by HIROSE ELECTRIC CO., LTD.

Driver Connector : DF1BZ-4P-2.5DSA (01)

Pairing Connector : DF1B-4S-2.5R

Contact : DF1B-2428SCA (Applicable wires: AWG28 to 24)

Terminal No.	Signal Name / Function
1	(-) Position Command Input
2	GND
3	(+) Position Command Input
4	GND

#### 3-3-4. Connector for Galvanometer Scanner Driving Output CN4

Manufactured by J.S.T Mfg. Co., Ltd.

Driver connector : B3P-VH

Pairing connector : VHR-3N

Contact : BVH-21T-P1.1 (Applicable wires: AWG22 to 18)

Terminal No.	Signal Name / Function
1	Frame Ground
2	Motor Winding (-)
3	Motor Winding (+)

GVM-0930 and GVM-1445 do not use this connector.

### 3-3-5. Connector for Input / Output Signal CN5

Manufactured by HIROSE ELECTRIC CO., LTD.

Driver connector : DF1BZ-9P-2.5DSA (01)

Mating connector : DF1B-9S-2.5R

Contact : DF1B-2428SCA (Applicable wires: AWG28 to 24)

Terminal No.	Signal Name/Function
1	Speed Monitoring
2	Position Monitoring
3	GND
4	Position Error Monitoring
5	Current Monitoring
6	90% Load Warning Output
7	Alarm Output
8	Servo-OFF
9	Alarm Detection Pulse Output

### 3-3-6. Connector for Manufacturer Setting CN6

This is the connector for shipping inspection at manufacturer. This is not available to customers.

### 3-3-7. Jumpers to Connect Optional Board J2, J3 and J4

It is not necessary to set by customer normally.

For PI Control, the optional board is conneted by using J2, J3 and J4.

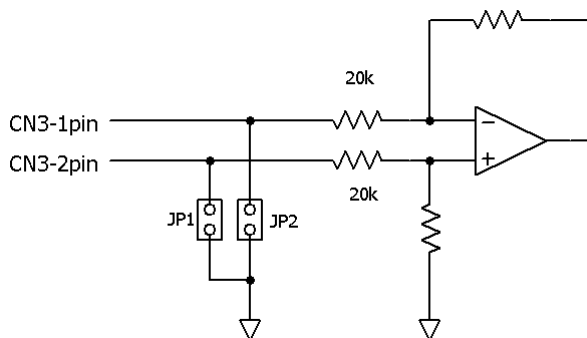
For P Control, J2, J3, and J4 are set as OPEN in appropriate position by jumpers.

(The product settings vary according to the specifications that customer ordered at the time of purchase)

## 3-4. Input / Output Interfaces

The circuit specifications are as follows:

### 3-4-1. Position Command Signal Input CN3

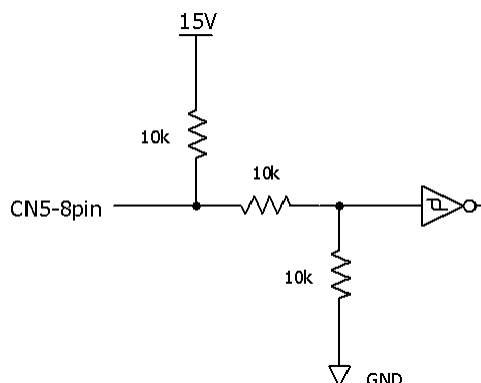


The input impedance is 20 k $\Omega$ .

Setting JP1 and JP2 allow an operator to select the input method (differential input or single-ended input).

When CN3-2 pin is in positive voltage and CN3-1 pin is in negative voltage, the scanner drives CW which is seen from the output axis side.

### 3-4-2. Digital Input (Servo-OFF) CN5

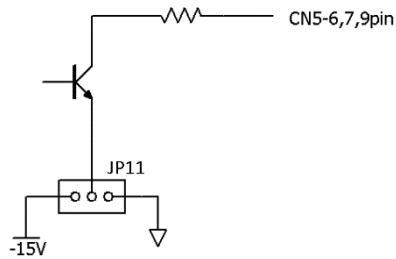


It is pulled up to 15V by 10 k $\Omega$  resistor.

Setting the voltage LOW makes the driver set to Servo-OFF. When Servo-OFF is enabled, the LED lights up in orange.

When Servo-OFF is disabled, the pin is set to the normal control mode by rising sequence.

### 3-4-3. Digital Output (90% Load Warning, Alarm Output, Alarm Detection Pulse) CN5



#### 90% Load Warning

It will output warning when the power supplied to the scanner, which is calculated from the current value detected inside of the driver, exceeded 90% of the maximum allowable power. When it output warning, the transistor would turn ON and output a voltage selected by JP5 and JP6. Normally, the transistor is OFF.

#### Alarm Output

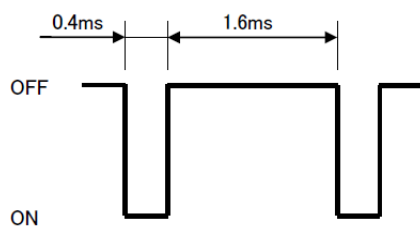
It will output alarm when detected an error inside of the driver. When detected an error, the transistor would turn ON and output a voltage selected by JP5 and JP6. Normally, the transistor is OFF. It is possible to distinguish the details of error by checking Alarm Detection Pulses.

#### Alarm Detection Pulses

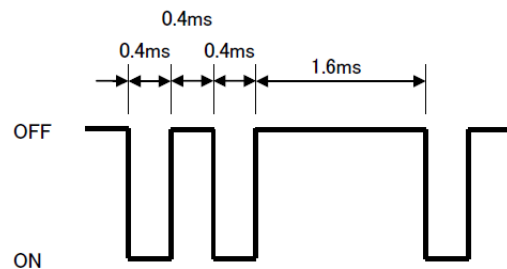
When an alarm is generated, pulses are output. One to six sequence pulses are output and the number of the pulses indicates the detail of error.

Normally, the transistor is OFF. No pulse output while detecting 90% load, but transistor would turn ON and output a voltage selected by JP5 and JP6. Please refer to the drawings below for the number of pulses and the causes of alarm.

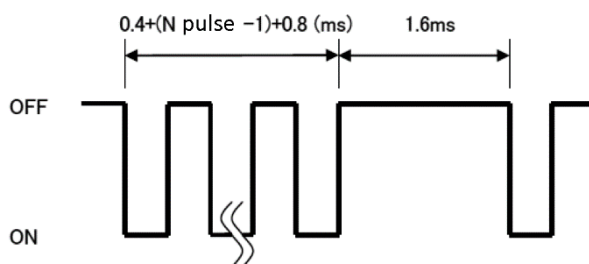
#### Timing chart for one pulse



#### Timing chart for two pulses



#### Timing chart for three or more pulses



#### One Pulse: Sensor Error

One pulse is output when connector is misconnected, cable is broke, or position sensor is damaged. The driver is set to servo-OFF. Please restart the power source after clear the error to restore.

#### Two Pulses: Overload

Two pulses are output when the power, which is calculated from the current value detected inside the drivers, exceeded 90% of the maximum allowable power. The driving condition is exceeded the scanner's capability including the load moment of the mirror.

In this case, it needs to reconsider the speed and amplitude. If the scanner is used for a long time, it might be reached to the life.

The driver is set to the servo-OFF. Please restart the power source after clear the error to restore.

### Three Pulses: Overheating of Drivers

Three pulses are output when a driver power element exceeded the allowable temperature.

Cooling may be insufficient against the driving conditions. In this case, please make the size of the heatsink larger or reconsider the cooling method. Also, unstable control would cause the scanner to produce heat.

The driver is set to the servo-OFF. Please restart the power source after clear the error to restore.

### Four Pulses: Initial Out-Position

Four pulses are output when the galvanometer scanner exceeded the configured angle range by turn the power ON. In this case, the driver would make the mirror's position back to the origin. If the mirror did not go back to origin position, six pulses are output as Out-Position.

### Five Pulses: Power Source Voltage Drop

Five pulses are output when a power source voltage drop is detected. This includes the voltage drop of the power source IC in inside of the driver.

In this case, the capacity of the power source may be insufficient against the driving conditions, or incorrect wiring can be considered.

The driver is set to the servo-OFF. Please restart the power source after clear the error to restore.

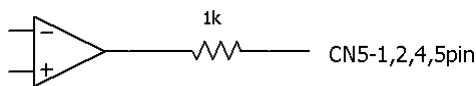
### Six Pulses: Out-Position

Six pulses are output when the galvanometer scanner exceeded the configured angle range during an operation other than "initial out-position".

In this case, positional command input may be exceeded the configured angle range, or large overshoot is generated by unstable control.

The driver is set to the servo-OFF. Please restart the power source after clear the error to restore.

## 3-4-4. Analog Monitoring Signals



The analog monitoring signals from CN5 are output through 1 k $\Omega$  protective resistor.

### CN5-1 pin: Speed Monitoring

It outputs a voltage proportional to the scanner speed.

The scale is arbitrary.

### CN5-2 pin: Position Monitoring

It outputs a voltage proportional to the angle of scanner shaft.

The scale is the setting value of positional command input scale [V/°] times (\*) 0.5 V.

### CN5-4 pin: Position Error Monitoring

It outputs a voltage proportional to the error between position command input and position sensor output.

The scale is the setting value of the position command input scale [V/°] times (\*) 0.5 V.

### CN5-5 pin: Current Monitoring

It outputs a voltage proportional to the current flowing into the scanner.

The scale of the scanner is 0.5/A.

## 4. Operation

### 4-1. Start-Up Procedure

GVD1 shifts to the scanner servo state by following the steps below after turn the power ON.

**Step 1:**

No current flows into the scanner right after GVD1 is powered ON because the amplifier output is disabled. At this time, the servo gain is zero and the command input is also disabled.

**Step 2:**

The servo gain slightly increases for about one second.  
Meanwhile, the alarm output of CN5 is enabled and the LED lights up in red.

**Step 3:**

The amplifier output is enabled.

**Step 4:**

The servo gain increases to the normal operation value. At the same time, the scanner moves slowly toward the center. This state lasts for about two seconds.

**Step 5:**

The command input is enabled.  
LED Display changes from red to green.  
The scanner starts its operation according to the command input.

### 4-2. Mirror Mounting Mode

By short-circuiting JP4 enables the Mirror Mounting Mode.

This mode lowers the servo loop gain and fixes the shaft lightly at the origin to adjust mirror position against the shaft, or attach to or remove the mirror from the shaft.

At this time, the servo driver is set to the state described in Step 4 of Start-Up Procedure. LED Display lights up in red.



**Do not attach, remove, or adjust the mirror position in the normal servo state.  
Failure to follow this caution may make the servo system unstable and  
cause a damage.**

Opening the short-circuited JP10 enables the command input two seconds later.



## 5. Adjustments

### 5-1. Volumes for Adjustments

The functions of the volumes are as follows:

#### 5-1-1. Main Board

Part No.	Name	Description of Adjustment
VR1	PO	<b><u>Adjustment for Position Command Input Offset</u></b> This allows to add offsets to position command input. This also allows to adjust the origin of mirror after scanner is mounted. Origin of mirror drives CW when it is seen from the mirror side.
VR2	IS	<b><u>Adjustment for Position Command Input Scale</u></b> This allows to adjust the voltage scale of position command input. It changes unit voltage of deflection angles of the mirror. The voltage scale decreases by driving CCW (reduces the maximum scan angle).
VR3	PS	<b><u>Adjustment for Position Signal Scale</u></b> This allows to adjust the feedback amount of scanner's angle sensor. Same as VR2, it changes unit voltage of deflection angles of the mirror.  However, this also changes the loop gain at the same time and therefore please do not use this for adjustment on angles.
VR4	SG	<b><u>Adjustment for Proportional Gain on Position Signal</u></b> This allows to adjust the first overshoot under positioning control. It is available for PI Control only.
VR5	LFD	<b><u>Adjustment for Position Signal Derivative Gain</u></b> This allows to adjust overshoots and undershoots small under position control. It works effectively for low frequency components.
VR6	HFD	<b><u>Adjustment for Current Integral Gain</u></b> This allows to adjust overshoots and undershoots to be small under positioning control. It works effectively for high frequency components.
VR7	HFZ	<b><u>Minor Tuning for Frequency Band of Current Integration Feedback Signals</u></b> This allows minor tuning for the center frequency of VR6. It eliminates the overshoots remaining after the adjustment of VR6. The effect is very small; if all the overshoots cannot be eliminated, please readjust it by combination of VR5 and VR6.
VR8	EL	<b><u>Adjustment for Error Limiter</u></b> This allows to adjust response speed of large step. The response speed increases by driving CCW. It is only enabled for P control. It cannot be used with the slew rate limiter of positional command input VR1 (SRL) on optional board at the same time.
VR9	LIN	<b><u>Correction of Linearity</u></b> Non-Linearity has been adjusted to the rated value according to the pairing scanner before delivery.
VR10	MPS	<b><u>Adjustment for Output Scale of Position Monitoring Signals</u></b> This allows to adjust the output scale of position monitoring signals. This has been adjusted according to the scale of the position command input before delivery.
VR11	NF1	<b><u>Adjustment for Removing Primary Resonance</u></b> This allows to adjust the center frequency of notch filter that damps the primary resonance of galvanometer scanners. The center frequency decreases by driving CW.
VR12	F3	<b><u>Adjustment for Removing Tertiary (or Secondary) Resonance</u></b> This allows to adjust the center frequency of notch filter that damps the tertiary resonance (or secondary resonance if P Control without optional board is selected) of galvanometer scanners. The center frequency decreases by driving CW.

## 5-1-2. Optional Board

Part No.	Name	
VR1	SRL	<b><u>Adjustment for Slew Rate Limiter of Position Command Input</u></b> This allows to adjust the response speed of large step by limiting the maximum speed. The maximum speed increases by driving CCW. Appropriate adjustment reduces wobble and jitter.
VR2	EG	<b><u>Adjustment for Position Error Amplifier Gain</u></b> This allows to adjust acceleration while scanner is driving. The response of the scanner increases by driving CW and makes overshoots larger.
VR3	F2	<b><u>Adjustment for Removing Secondary Resonance</u></b> This allows to adjust the center frequency of notch filter that damps the secondary resonance of galvanometer scanners. The center frequency decreases by driving CW.

## 5-2. Check Terminals

The details of the check terminals are as follows:

Part No.	Name	
TP1	Position Monitoring	This allows to output a voltage proportional to the angle of scanner shaft. The scale is the setting value of positional command input scale [V/°] times (*) 0.5.
TP2	Power Amplifier Output	This allows to output the voltage equivalent to half (1/2) of the scanner voltage.
TP3	Current Monitoring	This allows to output the voltage proportional to the current flowing into the scanner. The scale is 0.5/A according to the scanner.
TP4	Speed Monitoring	This allows to output the voltage proportional to the scanner speed. The scale is arbitrary.
TP5	Error Monitoring	This allows to output the voltage proportional to the error between position command input and position sensor output. The scale is the setting value of position command input scale [V/°] times (*) 0.5.
TP6	AGC Output	This is AGC (Automatic Gain Control) Output. This output is intended for use as power source for the position sensor in scanners.
TP7	Servo-OFF	This allows to Servo-OFF the the system by connecting to GND.
TP8	Adjustment for Notch Filter	This is the adjustment for notch filter.
TP9	Torque Command	This is the torque command voltage which is operated inside of the servo driver. This also can be used as adjustment for notch filter.
TP10	GND	This is GND for signal measurement.

## **6. Product Warranty**

1. Duration of this warranty is one year from the date of delivery. If the customer discovered a defect in material and workmanship within this period, we will repair the product for free only if the customer carry it in or return it to our company address by customer's expense. Please note that it would take several days to repair.
2. For the defect caused by "misuse" or "mishandling" by any party, or the defect caused later than one year from the date of delivery, the customer is responsible for repairing charges. We will repair the product only if the customer carry it in to our company address or the customer is responsible to all shipping charges.
3. We are not liable to the damages caused during transit. Please pack the product with sufficient cushioning materials to prevent external vibration.

## **7. Contact Information**

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