Namiki
PRECISION JEWEL CO., LTD.

DC Brushless Driver

SHSD24-01A

＜ Hardware part ＞

Instruction Manual

Ver. 1.07

NAMIKI GROUP

SHSD24-01A is dedicated driver that make it operate for our standard products (brushless type). You could choose either sensorless drive or sensored drive.

Features

- **Applicable for all the of Namiki standard motor (Brushless)**
- **Maximum rotation speed 150000rpm (When operating for SBL015)**
- **Driving direction, enable input**
- **Adjustable maximum output current of the motor (0～1000mA)**
- **Speed control is possible by either external command voltage or built-in potentiometer**
- **Adjustable of PWM duty ratio when the motor starts up**
- **Adjustable control gain**
- **FG (Monitor output of rotation speed)**
- **Status displayed by STATUS output and LED display**
- **Connection terminal of the motor is applicable for all the Namiki standard motor (Brushless)**
- **Motor control by RS232C communication is available**
- **Speed can be monitored through LCD speed monitor (Option)**

Table of contents

1. Safety Instructions

Skilled personnel

Only skilled or experienced personnel should install and prepare SHSD24-01A and the motor.

Statutory regulations

Follow the law and regulations in each area regarding the setting up and connection of SHSD24-01A.

Additional safety equipment

Any electrical equipment is, in principle, not fail-safe. Therefore, devices should be hooked up and used with independent monitoring and safety system.
If the device breaks down or goes out of control,

Repairs

Leave the reair to us. It is very dangerous fo user to break down or repair the device.

Danger

Ensure that apparatus is not connected to the power supply during installation of SHSD24-01A. After switching on, do not touch any live parts.

Wiring work

Ensure that the power to SHSD24-01A is off during all the cable connecting Work. Make sure the wiring done correctly.

Connection of power supply

Make sure that supply voltage is between 7.5～26.4VDC. Inappropriate voltage or wrong polarity will destroy the unit.

Short circuit and earth fault

The amplifire is not protected against winding short circuits against ground safety earth and /or Gnd.

Caution when the motor starts up

In case of sensorless drive, motor may not start up in high friction and high inertial moment application due to its property.

Electrostatic sensitive device (ESD)

Connection with motor

This driver should be used with specified motor combination.

Usage environment

Make sure not to use it at the place where it might get wet, in corrosive atomosphere, in flammable gas atomosphere, and near the burnable materials.

Ambient temperature

Do not touch the SHSD24-01A and the motor during power-on or some time after shut down as the temperature of them may get high.

Acceptance of delivery and checkup

If you find the product that you receive is different from what you ordered (model No., output rating, etc.), or if you find excess or deficiency, do not use them and contact our sales office immediately.

Storage

Do not storage where the rain or water drop falls, where mephitic gas and where the direct sunlight come in. Keep the products in a specified temperature and humidity range.

Transportation

Handle SHSD24-01A with care during carrying it in order not to drop and break down.

Installation

- Do not put heavy stuff on SHSD24-01A.
- Do not make an impact to SHSD24-01A.
- Avoide the enterance of foreign object into SHSD24-01A.
- Conduct proper attachment suitable for output or weight of main unit.

Potentiometer adjustment

Do not adjust potentiometer other than specified VR. It may cause a malfunction of SHSD24-01A.

2. Technical data

2.1 Accommodate motor

SBL015 series, SBL02 series ,SBL04 series, SBL07series, SBL12series, SBL22-3727

2.2 Electrical data

Supply voltage +Vcc ····· 7.5～26.4VDC
Absolute minimum input voltage +Vcc min ··· 7.0VDC
Absolute maximum input voltage ＋Vcc max ··· 28.5VDC
Maximum output voltage ····· Vcc
Maximum continuous current ····· 1A
Maximum output current ····· 2A
PWM carrier frequency ····· 32kHz...110kHz
Maximum speed ····· 150000rpm
Circuit consumption current ····· 30mA

2.3 Input

Speed setting ····· analog voltage（0～5VDC）
Enable ····· GND or connect to＋5VDC
Switch driving direction ····· GND or connect to＋5VDC

2.4 Output

Speed monitor<<FG>> ····· Digital output signal +5VDC
Status indicator<<STATUS>> · Digital output signal +5VDC

2.5 Motor connections

Motor coil U, Motor coil V, Motor coil W

2.6 LED indicator

Operating condition ····· Green LED
Fault condition ····· Red LED

2.7 Ambient temperature / humidity range

Operation ····· －10℃...＋50℃
Storage ····· －20℃...＋85℃
No condensation ····· 20%...80%

2.8 Protective functions

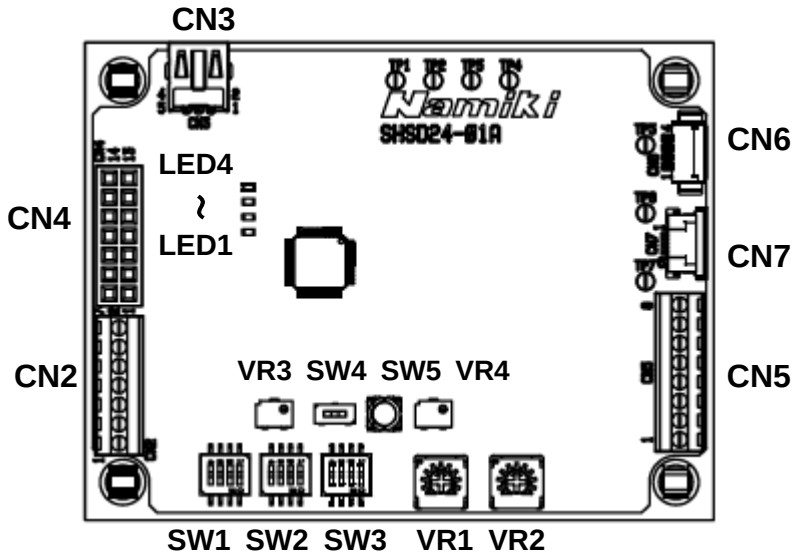
Motor start ····· If failed forced communication
During motor driving ····· If failed position detection（Lock protection）
Current restriction ····· 0～1A
Under voltage protect
··· Vcc ＜ Impossible to drive at 7.0VDC
Excess voltage protect
··· Vcc ＞ Impossible to drive at 28.5VDC

2.9 Mechanical data

Weight ····· 36.5g
Dimensions（L×W×H） ····· 83 × 63 × 21mm
Mounting ····· M4 × 4
Mounting hole separation ····· 73 × 53mm

3. Parts and pin assignment

3.1 Parts and pin assignment

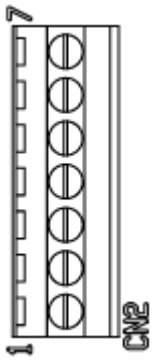


Part No.	Function
CN2	Power supply and each I/O connector
CN3	RS232C communication connector
CN4	LCD connector ※1
CN5	Motor connection connector (SBL12)
CN6	Motor connection connector (SBL22)
CN7	Motor connection connector (SBL015, SBL02, SBL04, SBL07)
SW1	Model setting SW
SW2	Driving mode and Control method SW
SW3	PI gain and driving direction SW
SW4	Motor voltage SW
SW5	Reset SW
VR1	Adjust PWM duty rate when motor start-up
VR2	Control target motor speed (In VR mode)
VR3	※Do not change VR value.
VR4	Control Max. output current of motor
LED1	Driver setting error display
LED2	Motor driving error display
LED3	Driver status display
LED4	Power status display

※1

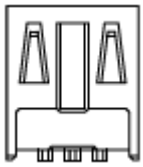
LCD does not come with the product. It is to check driving status. When you need it, contact our sales representative.

3.1.1 CN2 Pin assignment (For power supply and each I/O connector)



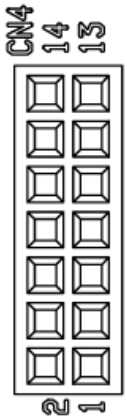
Pin No.	Name	Details
7	Power GND	Power supply GND
6	+Vcc	Power supply 7.5 … 26.4VDC
5	SPEED	Speed setting input
4	CW/CCW	Direction input
3	ENABLE	Enable input
2	STATUS	Status display
1	FG	Speed monitor

3.1.2 CN3 (RS232C communication)

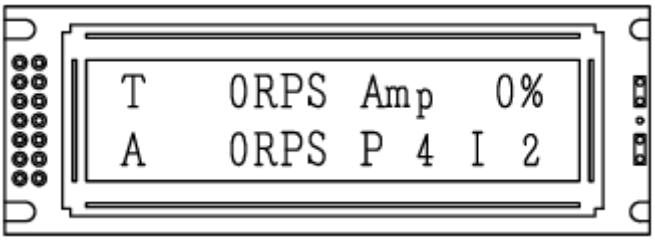


Motor can be driven in PC mode.
Refer to software instruction manual for details.

3.1.3 CN4 (LCD connector)

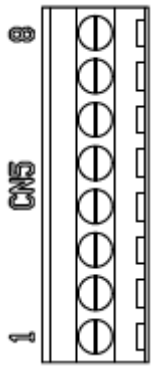


It is possible to check target speed, current speed, PI gain value and error status if you attach LCD.



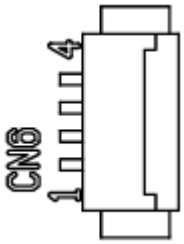
※ Contact our sales representative if you need to check driving status by using LCD display.

3.1.4 CN5 Pin assignment



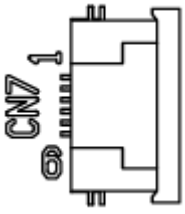
Pin No.	Name	Details
8	Hall Vcc	Voltage for Hall IC
7	Hall GND	GND for Hall IC
6	Hall W	Hall IC input signal W
5	Hall V	Hall IC input signal V
4	Hall U	Hall IC input signal U
3	Motor W	Motor winding W
2	Motor V	Motor winding V
1	Motor U	Motor winding U

3.1.5 CN6 Pin assignment



Pin No.	Name	Details
4	NC	Not used
3	Motor W	Motor winding W
2	Motor V	Motor winding V
1	Motor U	Motor winding U

3.1.6 CN7 Pin assignment



Pin No.	Name	Details
1	Motor U	Motor winding U
2	Motor U	Motor winding U
3	Motor V	Motor winding V
4	NC	Not used
5	Motor W	Motor winding W
6	Motor W	Motor winding W

4. Preparation of power supply

Use the power supply in accordance with below.

Power voltage range, Motor stall current, Motor max. continuous output current by model

Model	Power voltage range	Motor stall current	Motor max. output current
SBL015	7.5V ... 26.8V	About 50mA (When motor voltage 3V)	1000mA
SBL02	7.5V ... 26.8V	About 30mA (When motor voltage 3V)	1000mA
SBL04	7.5V ... 26.8V	About 100mA (When motor voltage 3V)	1000mA
SBL07	7.5V ... 26.8V	About 170mA (When motor voltage 3V)	1000mA
SBL12	7.5V ... 26.8V (Use 12V)	About 3000mA (When motor voltage 12V)	1000mA
SBL22	7.5V ... 26.8V (Use 24V)	About 900mA (When Motor voltage 24V)	1000mA

Note 1: Motor current above does not include circuit consumption current of SHSD24-01A.
Therefore, choose power supply in consideration of consumption current of circuit.

Circuit consumption current of SHSD24-01A : About 30mA

※Circuit consumption current varies depending on driver switch, LED and status of potentiometer VR. Besides, in case of attaching LCD, circuit consumption current goes up about 20mA.

Note 2: Use the power supply which is protected from back electromotive force that occurs when turning off the motor or changing rotating direction.

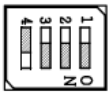
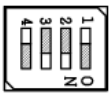
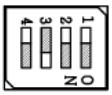
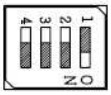
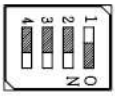
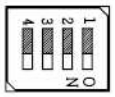
Note 3: If power voltage Vcc gose out of the range stated above, voltage detection error of driver will occur and driver will be in shutdown condition. Therefore, when you use it in a low voltage, consider voltage descent of power supply cable.

5. Switch setting

5.1 Set up motor model (SW1)

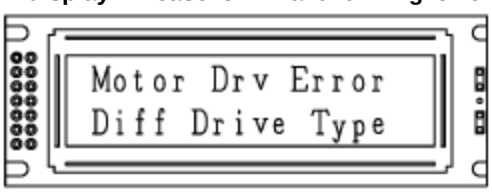
SW1 is used to selected the model of the motor.
Set up as below depending on the motor that you use.

Motor model setting (SW 1, 1 – 4 bit)

SW1 setting	Equivalent mode
	**SBL015-06 series**
	**SBL02-06H1 series**
	**SBL04-0829 series**
	**SBL07-1218 series**
	**SBL12-2204 series**
	**SBL22-3727**
	**SOBL23-1207**
	**ALL-TYPE(slow)**
	**ALL-TYPE(fast)**

※In case of setting other than above, invalid error (driver setting error) will occur.

LCD display in case of invalid driving error



STATUS and LED display in case of invalid error

LED1 (ERROR2)	**Flash twice in a high speed**
LED2 (ERROR1)	**Off**
LED3 (STATUS)	**Off**
CN2-6	**Hi**

※In case of error, check the setting of SW1 (1-4 bit) and SW2 (1-2 bit).

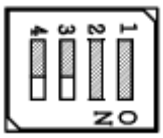
5.2 Set up control method (SW2)

SW2 is used to select control method and driving method of the motor.

5.2.1 Selection of control method (SW2)

Select the motor control method and set up as below.

Selection of motor control method (SW 2 3,4bit)

SW2 (3,4 bit) setting	Control method
	**EXT/IO mode** **EXT/IO mode is to control motor speed and rotating direction by using I/O connector of CN2 and external analog voltage.**
	**VR mode** **VR mode is to control motor speed and rotating direction by using built-in potentiometer and SW.**
	**PC mode** **PC mode is to control motor speed and rotating Direction by using RS232C communication.** **Refer to software instruction manual for details.**
	**Not used.** **In case of setting this, invalid control error will occur.**

LCD display in case of invalid control error

STATUS and LED display in case of invalid control error

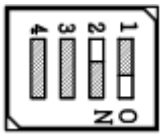
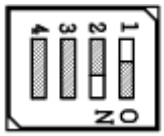
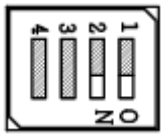
LED1 (ERROR2)	**Flash 3 times in a high speed**
LED2 (ERROR1)	**Off**
LED3 (STATUS)	**Off**
CN2-6	**Hi**

※In case of error, check the setting of 3rd bit and 4th bit of SW2.

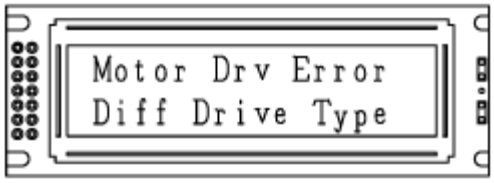
5.2.2 Selection of driving method (SW2)

Select the motor driving method and set up as below.

Selection of motor driving method (SW2 1, 2 bit)

SW2 (1,2 bit) setting	Driving method
	**Sensorless driving mode** Sensorless driving mode is to drive the motor without the sensor signal of the motor.
	**Hall sensor driving mode** Hall sensor mode is to drive the motor by using hall sensor signal of the motor. For the motor with sensor (SBL12-2204EPG series), this setting enables to drive it.
	**Not used** In case of setting this, invalid driving error will occur.
	**Not used** In case of setting this, invalid driving error will occur.

LCD display in case of invalid driving error



STATUS and LED display in case of invalid driving error

LED1 (ERROR2)	**Flash twice in a high speed**
LED2 (ERROR1)	**Off**
LED3 (STATUS)	**Off**
CN2-6	**Hi**

※In case of error, check the setting of SW 1 (1-4 bit) and SW 2(1-2 bit).
If you set up SBL015 series, SBL02 series, SBL04series, SBL07 series and SBL22-3727 on hall sensor driving mode, invalid control error will occur.

5.3 Set up gain (SW3)

SW 3 is used to select PI gain value at the time of motor driving and the motor driving direction.
※PI gain value is switched by 2- 4 bit of SW3 in all mode.

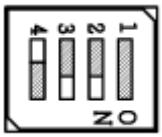
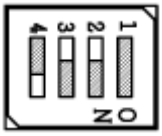
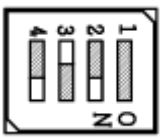
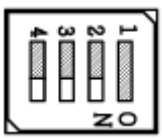
5.3.1 Explanation of PI gain

PI gain is a constant number to calculate PWM duty ratio of output motor voltage when controlling motor speed. The bigger PI gain value is, the sooner current motor speed gets to close to the target speed. However, if the PI gain value is big, motor may vibrate. Besides, PI gain value is small, motor speed goes close to traget speed slowly.

5.3.2 SW setting of PI gain

PI gain setting at the time of motor driving is as below.

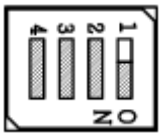
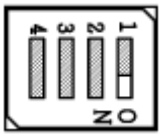
Selection of PI gain at the time of motor driving (2–4 bit)

SW3 (2-4 bit) setting	PI gain value	Recommended value for model
	P=1, I=1	
	P=2, I=1	SBL22
	P=2, I=2	SBL015 SBL02 SBL04 SBL12
	P=3, I=2	
	P=4, I=2	SBL07
	P=6, I=3	
	P=8, I=4	
	P=12, I=6	

5.3.3 Selection of rotating direction

1st bit of SW3 is used to select rotating direction in VR mode.

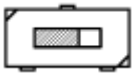
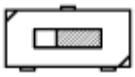
Selection of motor driving direction (1st bit of SW3)

SW3 setting	Motor rotating direction
	**CCW**
	**CW**

5.4 Set up motor driving voltage (SW 4)

SW 4 is used to select motor driving voltage.

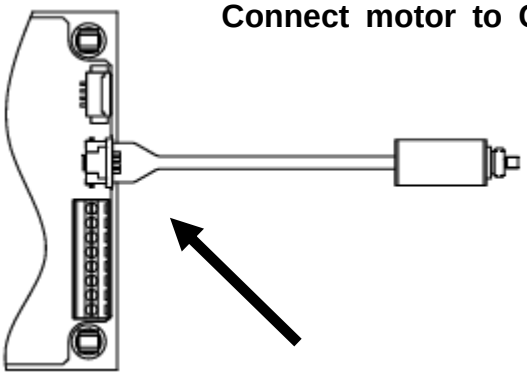
Selection of motor driving voltage

SW 4 setting	Motor driving voltage
	**Motor voltage is set in 3V.** **Set up with the above when you drive SBL015 series, SBL02 series, SBL04 series and SBL07 series.**
	**Motor voltage is set in power supply voltage.** **Set up with the above when you drive SBL12-2204EPG series and SBL22-3727.**

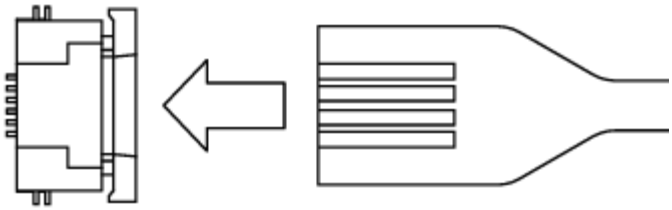
6. Connecting Instruction (By type of motors)

6.1 SBL015 series, SBL02 series, SBL04 series, SBL07 series

Connect motor to CN7.

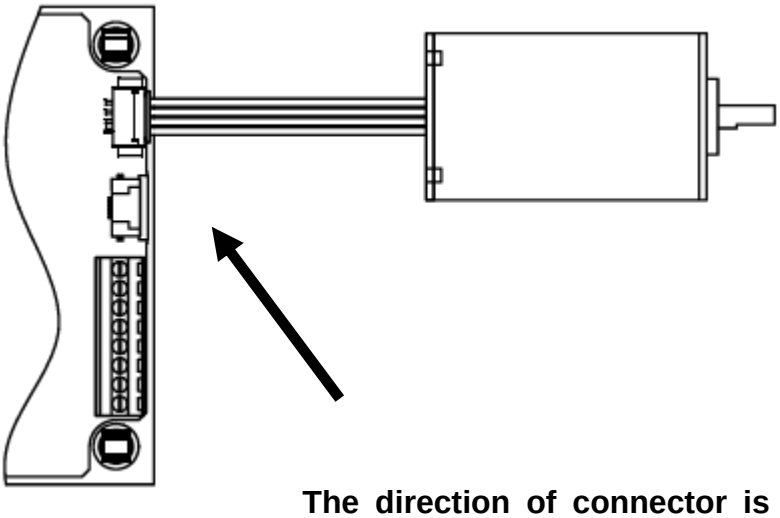


Put it into the connector with terminal side of FPC side up (Each model in common)

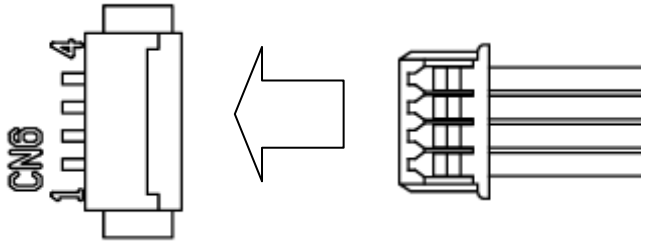


6.2 SBL22-3727

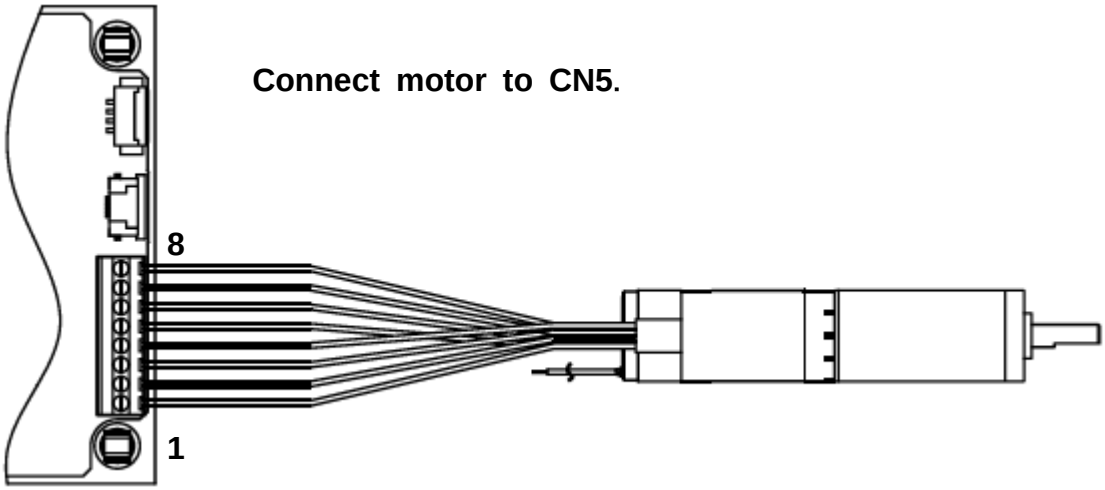
Connect motor to CN6.



The direction of connector is as below.



6.3 SBL12-2204EPG series



When driving it in hall sensor driving, connect the motor as below.
(When driving it in sensorless driving, it could drive only with connection of pin No. 1 to 3.)

Pin No.	Name	Lead wire of the motor
8	Hall Vcc	Red (AWG32)
7	Hall GND	Black (AWG32)
6	Hall W	Purple (AWG32)
5	Hall V	Gray (AWG32)
4	Hall U	White (AWG32)
3	Motor W	Yellow (AWG28)
2	Motor V	Blue (AWG28)
1	Motor U	White (AWG28)

In case of wrong connection between the driver and the motor, over current will apply to the motor when driving.
Since it causes the malfunction of the driver or the motor, make sure to connect in the right way.

7. Operating Instruction (By type of models)

7.1 control method in EXT mode / IO mode

This is the mode that controls motor driving by CN2 input.
Control method is as follows;

7.1.1 ENABLE

Enable/disable (ON/OFF) will be selected by controlling input voltage of 3rd pin (ENABLE) of CN2.
Actual enable condition is as below.

Input voltage < 1.00V ⟶ Enable
Connect to GND

Input voltage > 4.00V ⟶ Disable
No connection (Open)

※Do not change enable setting when motor is driving.
It causes failure of the driver.

7.1.2 SPEED (Target speed adjestment)

Motor target speed will be adjusted by controlling analog input voltage of 5th pin (SPEED) of CN2.
Motor speed for analog command voltage is as below.

Analog voltage = 0V ⟶ Analog voltage = 5V
Motor speed = 0 rpm ⟶ Motor speed = Max. Value by model

※As for analog voltage, do not put over 5V. It causes failure of the driver.

7.1.3 CW/CCW (Rotating direction switchover)

Motor rotating direction will be changed by controlling analog input voltage of 4th pin (CW／CCW) of CN2.
Motor rotating direction for analog voltage will be as below.

Input voltage < 1.00V ⟶ Direction CCW
Connect to GND

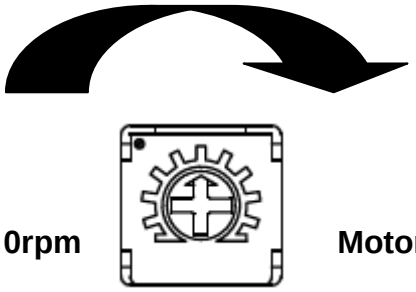
Input voltage > 4.00V ⟶ Direction CW
No connection (Open)

7.2 Control method in VR mode

This is the mode which control motor driving by potentiometer(VR2) and SW3. Control method is as follows;

7.2.1 How to adjust the speed

You could adjust the target speed by potentiometer(VR2).
Adjust the target speed as follows;



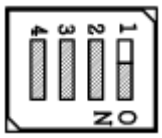
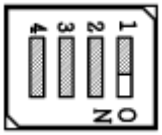
Motor speed ＝0rpm **Motor max. speed by model**

VR2

7.2.2 Switchover of rotating direction

You could change motor rotating direction by switching over 1st bit of SW3. Rotating direction will be as follows;

How to select rotating direction (1st bit of SW3)

SW3 setting	Motor rotating direction
	**CCW**
	**CW**

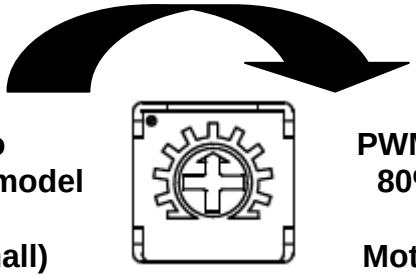
7.3 Control method in PC mode

This is the mode which controls motor driving in PC mode.
Refer to software instruction manual for details.

8. Start-up Characteristics & gain value (Applicable for all the mode)

8.1 Characteristics of when the motor starts up

PWM duty ratio of output waveform on start-up phase will be adjusted by VR1. When the motor starts up, the motor will be drove by duty ratio which is adjusted by VR1. Adjust VR1 depending on loading status of the motor.



※In case of inappropriate VR1 value, the motor may not drive due to occurrence of forced commutation error.

8.2. Setting of PI gain value

Setting of PI gain value will be adjusted by 2-4 bit of SW3.
Refer to 5.3.2 select of setting for PI gain value for SW3.

Note1: In case that time out error occurs when the motor starts up,change the gain value.
Note2: In case that the motor vibrates or dose not rotate smoothly,change the gain value to lower value.
Note3: Change of gain value should be done during motor stopping. If you change 2-4 bit of SW3 during motor driving, gain will not be changed.

Recommended value of gain value by model is as 8.2.1.

8.2.1 Recommended value of PI gain by model

※Refer to page.9 for setting of SW3

Model of motor	P	I
SBL015	2	2
SBL02	2	2
SBL04	2	2
SBL07	4	2
SBL12	2	2
SBL22	2	1

Note 1: Since appropriate PI gain value changes depending on presence or absence of gear,number of stages of gear, or load status of the motor, if the motor cannot start up with the value above, change PI gain value or adjust the PWM duty ratio of when motor starts up by VR1.
Note 2: If the load of the motor is too big, the motor may not start up even though you adjust PI gain value.

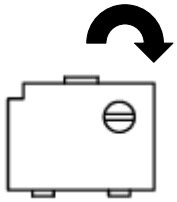
9. Current restriction function (Applicable for all the mode)

9.1 You could adjust limit value of motor current by VR4.

You could adjust maximum output current of motor driving by VR4 of potentiometer.

Full turn to the left
Max. output current 0A

Current does not apply to motor.



Full turn to the right
Max. output current 1A

9.2 Limit value of motor current by model

Limit value of motor current is set by model as below in order to protect the motor. If the motor current exceeds the value below, current limit error will occur and motor will be forced to stop.

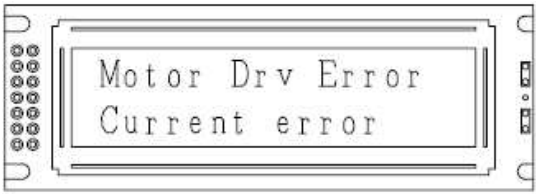
Limit value of motor current by model

Model of motor	Current limit value
SBL015	1000mA
SBL02	1000mA
SBL04	1000mA
SBL07	1000mA
SBL12	1000mA
SBL22	1000mA

If current limit error occurs, set the speed command value as zero to reduce the motor load.

9.2.1 LCD display, STATUS and LED display when current limit error occurs

LCD display when current limit error occurs



STATUS and LED display when current limit error occurs

LED1 (ERROR2)	Off
LED2 (ERROR1)	On
LED3 (STATUS)	Off
CN2-6	Hi

10 Output signal (Applicable for all the mode)

10.1 FG (1st pin of CN2)

Motor speed can be monitored by <<FG>> output. Motor speed is digital signal (high/Low) and pulse of duty ratio about 83% per one rotation of motor will be output.

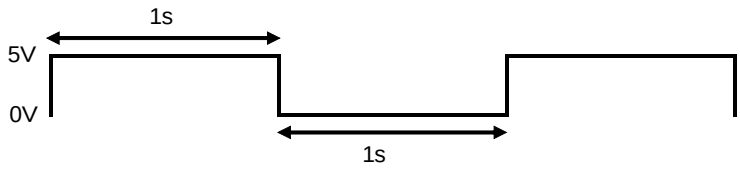
Motor speed formula is as follows;

f_{FG} = Output frequency of FG [Hz]

n = f_{FG} × 60 [rpm] (case of non SOBL23-1207)
n = f_{FG} × 60 / 8 [rpm] (case of SOBL23-1207)

10.2 STATUS (2nd pin of CN2)

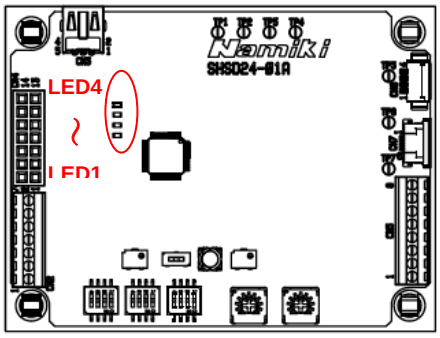
<<STATUS>> outputs driving status of the driver. Digital signal (High/Low) will be output depending the status. The signal patern by STATUS is as follows;

STATUS output pattern	Driving status
	(Driving disable) On error status
	(Driving disable) EXT/IO mode disable status
	(Driving disable) EXT/IO mode enable status or VR, PC mode
	(Driving enable)

11. LED display (Applicable for all the mode)

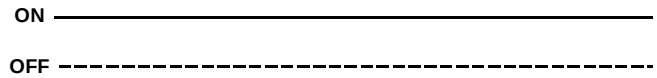
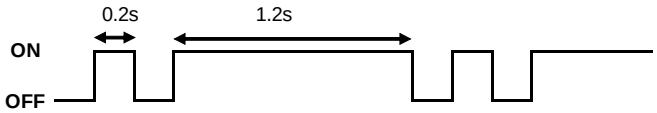
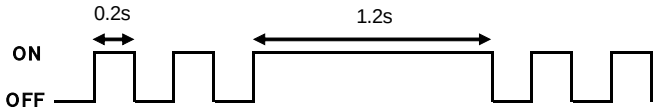
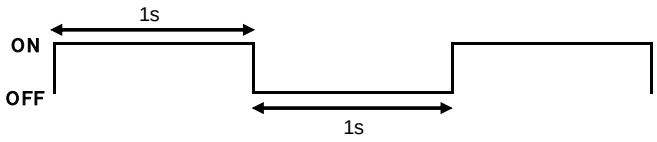
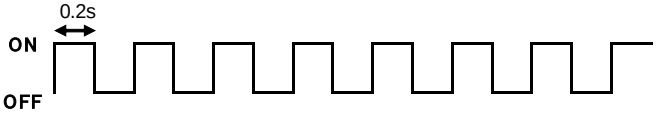
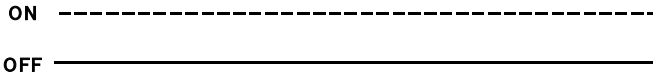
You could check the driving status of the driver by LED.

LED4 (green) <<POWER>>
LED3 (green) <<STATUS>>
LED2 (red) <<ERROR1>>
LED1 (red) <<ERROR2>>



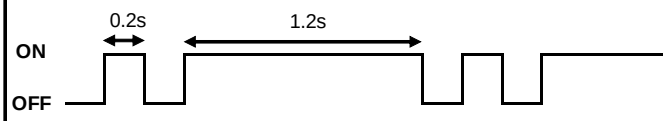
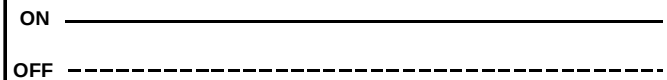
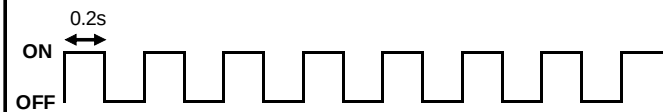
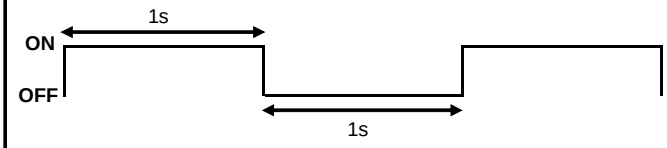
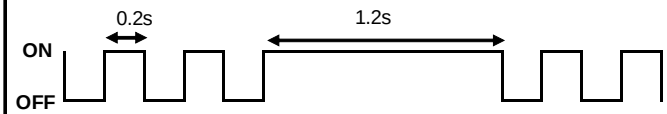
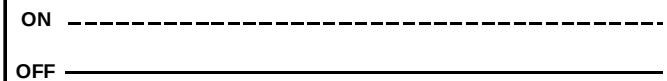
11.1 LED1 (red)<<ERROR2>>

You could check the setting error status of the driver by LED1.

	ON	Power voltage detection error
	Blink two times at high speed	Invalid driving error
	Blink three times at high speed	Invalid control error
	Blink at low speed	Sensor non-connected error
	Blink at high speed	Motor voltage detection error
	OFF	No error

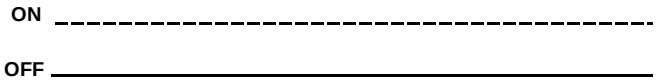
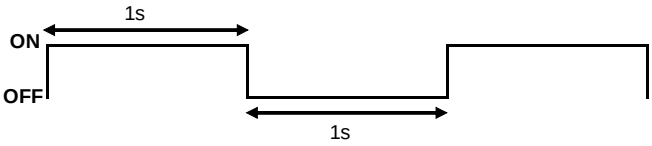
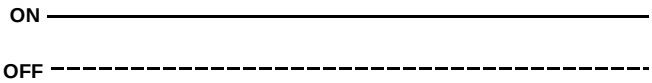
11.2 LED2 (red) <<ERROR1>>

You could check motor driving error status by LED2.

LED2 lighting status	LED status	Driving error
	Blink two times at high speed	EMG error
	ON	Motor current detection error
	Blink at high speed	Forced commutation error
	Blink at low speed	Time out error
	Blink three times at high speed	RS232C communication error
	OFF	No error

11.3 LED3 (green) <<STATUS>>

You could check the STATUS of driver by LED3.

LED3 lighting status	LED status	Driving status
	OFF	(Driving disable) On error status
	Blink at low speed	(Driving disable) EXT/IO mode disable status
	ON	(Driving disable) EXT/IO mode enable status or VR, PC mode
	Blink at high speed	(Driving enable)

11.4 LED4 (green) <<POWER>>

You could check the status of power activation status of the driver by LED4.

Power non-activated status ⟶ LED4 : OFF

Power activated status ⟶ LED4 : ON

12. How to recover from error condition

12.1 Driver setting error

Error description	LED lighting patern	LCD display content	How to recover from error condition
Power detection error	LED1:ON LED2:OFF LED3:OFF	MotorDrv Error Out Of voltage	Check the power voltage.
Invalid driving error	LED1:Blink 2 times (High speed) LED2:OFF LED3:OFF	MotorDrv Error Diff Drive Type	Check the setting of model (SW1) and driviging (SW2-1…2 bit).
Invalid control error	LED1:Blink 3 times (High speed) LED2:OFF LED3:OFF	MotorDrv Error Invalid Cnt Type	Check the control method (SW2-3…4bit). Set the mode either EXT/IO, VR or PC.
Sensor non-connected error	LED1:Blink (Low speed) LED2:OFF LED3:OFF	MotorDrv Error UnCnct Hall Sens	Check the connection of hall sensor.
Motor voltage detection error	LED1:Blink (High speed) LED2:OFF LED3:OFF	MotorDrv Error MTR Drv Vol Err	Chose motor voltage is not appropriate. Check the status of motor voltage SW4.

※After fixing the setting, cycle the power or press SW5 (RESET) button.

12.2 Motor driving error

Error description	LED lighting patern	LCD display content	How to recover from error condition
EMG error	LED1:OFF LED2:Blink 2 times (High speed) LED3:OFF	MotorDrv Error EMG error	Overcurrent applied to the motor. Set the speed command value to zero once and eliminate the cause of overcurrent.
Motor current detection error	LED1:OFF LED2:ON LED3:OFF	MotorDrv Error Current error	Overcurrent applied to the motor. Set the speed command value to zero once and eliminate the cause of overcurrent.
Forced Commutation error	LED1:OFF LED2:Blink (High speed) LED3:OFF	MotorDrv Error Forced error	Motor was unable to drive. Set the speed command value to zero once, check the loading status of motor and adjust the duty ratio of when VR1 start up. Besides, there is possibility of disconnect of motor coil.
Time out error	LED1:OFF LED2:Blink (Low speed) LED3:OFF	MotorDrv Error Timeout Position	Position was unable to detected during motor's driving. Check the loading status of the motor and change the gain value. Besides, there is possibility of disconnect of motor coil.
RS232C Communication error	LED1:OFF LED2:Blink 3 times (High speed) LED3:OFF	MotorDrv Error RS232C error	Communication error occurred. Refer to the communication software instruction manual for details.

13. Adjustable range of rotation speed

13.1 Here is the chart of adjustable range of target speed by motor model.

Motor model	Target speed of motor (Minimum)	Target speed of motor (Maximum)
SBL015 (SSL driving)	44400rpm	150000rpm
SBL02 (SSL driving)	30000rpm	108000rpm
SBL04 (SSL driving)	7980rpm	39000rpm
SBL07 (SSL driving)	2580rpm	13200rpm
SBL12 (SSL driving)	2400rpm	32280rpm
SBL12 (SSL driving)	1500rpm	32280rpm
SBL22 (SSL driving)	840rpm	5220rpm
SOBL23-1207	1020rpm	18000rpm
ALL TYPE(slow)	1980rpm	7980rpm
ALL TYPE(fast)	7980rpm	120000rpm

The target speed for analog command voltage in EXT/IO mode is caliculated by following formula;

V_{SPEED} : Analog command voltage of 5th pin of CN2 [V]

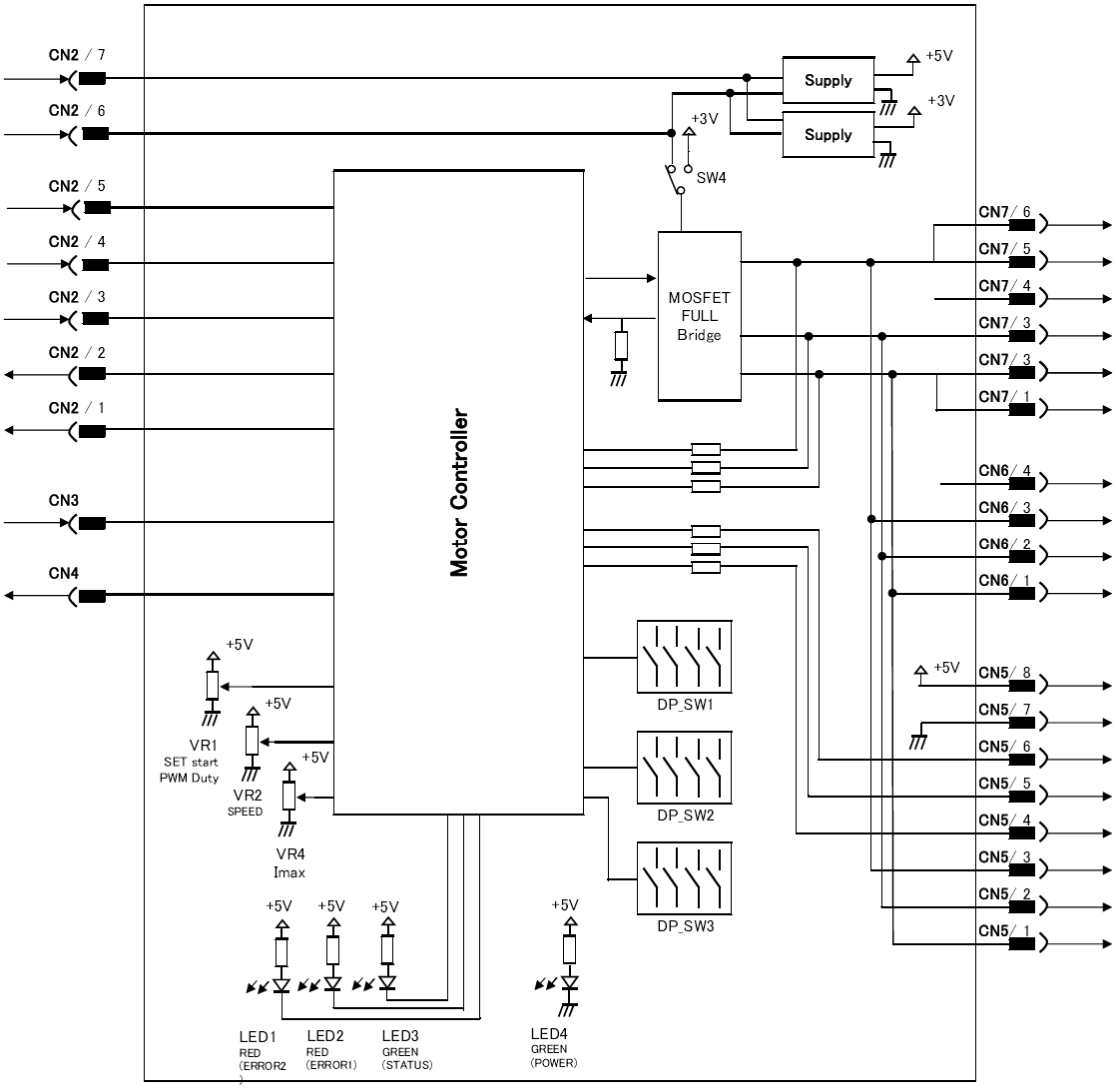
$$N_{SBL015} = 30598 \times V_{SPEED} - 1496 \quad [rpm]$$
$$N_{SBL02} = 22031 \times V_{SPEED} - 1077 \quad [rpm]$$
$$N_{SBL04} = 7956 \times V_{SPEED} - 389 \quad [rpm]$$
$$N_{SBL07} = 2693 \times V_{SPEED} - 132 \quad [rpm]$$
$$N_{SBL12} = 6585 \times V_{SPEED} - 322 \quad [rpm]$$
$$N_{SBL22} = 1065 \times V_{SPEED} - 52 \quad [rpm]$$

Note 1 : In case that the above target speed is lower than minimum value of target speed by motor model, the motor will be stopped because target speed become 0 rpm. Besides, in case that the target speed is higher than maximum value of target speed by motor model, target speed will be maximum value of target speed.

Note 2 : The maximum value of target speed is set as above, but actual maximum motor speed will be as follows;
- **SBL015 - 150000rpm (±25%)**
- **SBL02 - 95000rpm (±25%)**
- **SBL04 - 38000rpm (±15%)**
- **SBL07 - 13000rpm (±15%)**
- **SBL12 - 32000rpm (±15%)**
- **SBL22 - 5000rpm (±15%)**

Note 3 : The actual adjustable range of speed will be narrower than the above range of traget speed depending on loading status of the motor.

14. Block diagram



15. Outline dimentional drawing

Unit [mm]