



**SANYO Semiconductors**

# DATA SHEET

## LA6505 — Monolithic Linear IC For CD-ROM, DVD-ROM and MD players Six-Channel Driver

### Overview

The LA6505 is a six-channel driver for CD and MD players and recorders.

It adopts direct PWM drive output in the spindle motor drive to minimize heat generation at high spindle speeds. It also features a soft switching function that minimizes spindle motor drive noise by making the current changes at each phase switch more gradual.

The sled motor driver implements two-phase stepping drive and supports direct PWM inputs. The LA6505 uses a BTL amplifier design for the focus and tracking driver blocks, and a similar design for the loading driver as well.

### Functions

#### (1) Spindle motor driver block

- Three-phase brushless motor driver
- Adopts a current feedback direct PWM drive design
- Supports analog inputs and features a V-type control amplifier
- Built-in oscillator circuit (The oscillator frequency can be set with an external capacitor.)
- Soft-switching drive
- FG output for one phase (the U phase)
- Built-in reverse rotation prevention circuit
- Built-in Hall sensor power supply (npn transistor, open collector output)
- Current limiter setting function (The limit is set by the resistor RF.)
- Standby mode (SS) function that operates for the spindle driver and BTL amplifiers.

#### (2) Sled motor driver block

- Adopts a current feedback direct PWM drive design
- Supports stepping motors
- Muting function (MUTE-SLD; only applies to the sled driver)

#### (3) Sled motor driver block

- BTL amplifier based design
- Built-in input operational amplifiers
- Built-in level shifting circuits
- Standby mode (SS) function

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- (4) Loading block
- BTL amplifier based design
  - Muting function (MUTE-LOAD; only applies to the loading driver)
- (5) Other circuits
- Built-in thermal shutdown circuit (design guarantee)

## Specifications

### Absolute Maximum Ratings at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage - $V_{CC}$	$V_{CCS}$	Signal system supply voltage, $V_{CC} \geq VS^*$	14	V
Supply voltage - P-SPD	VS-SPD	Spindle block power stage supply voltage	14	V
Supply voltage - P-SLD	VS-SLD	Sled block power stage supply voltage	14	V
Supply voltage - P-BTL	VS-BTL	BTL amplifier block power stage supply voltage	14	V
Allowable power dissipation	$P_d \text{ max1}$	Independent IC	0.85	W
	$P_d \text{ max2}$	When mounted on the specified circuit	1.72	W
Maximum input voltage	$V_{IN} \text{ max}$		6	V
Maximum output current 1	$I_O \text{ max1}$	Spindle block	1.25	A
Maximum output current 2	$I_O \text{ max2}$	Sled block output	0.5	A
Maximum output current 3	$I_O \text{ max3}$	Outputs for the focus, tracking, and loading blocks	0.5	A
Operating temperature	$T_{opr}$		-30 to +85	$^\circ\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^\circ\text{C}$

\* Specified board size : 76.1mm×114.3mm×1.6mm, glass epoxy board.

### Recommended Operating Conditions at $T_a = 25^\circ\text{C}$

Parameter	Symbol	Conditions	Ratings	Unit
Supply voltage S	$V_{CC-S}$	$V_{CC-S} \geq VS^*$	6 to 13	V
Supply voltage P	$V_{CC-P}^*$	$V_{CC-S} \geq VS^*$	6 to 13	V

\* : The term "VS-\*" refers to VS-SPD, VS-BTL, and VS-SLD.

### Electrical Characteristics at $T_a = 25^\circ\text{C}$ , $V_{CC} = VS\text{-SPD} = VS\text{-SLD} = VS\text{-BTL} = 8\text{V}$ , $V_{REF} = 1.65\text{V}$ , $R_{F\text{-SPD}} = 0.5\Omega$ , unless especially specified.

Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Overall</b>						
No-load current drain	$I_{CC\text{-ON1}}$	SS : H, MUTE SLED/LOAD : H		50	58	mA
	$I_{CC\text{-OFF}}$	SS/MUTE SLED/MUTE LOAD : L		12	20	mA
Thermal shutdown operating temperature	TSD	Junction temperature, design guarantee	150	180	210	$^\circ\text{C}$
Thermal shutdown hysteresis	$\Delta TSD$	Junction temperature, design guarantee		40		$^\circ\text{C}$
<b>VREF-AMP</b>						
VREF-AMP offset voltage	$V_{OFF-VREF}$	The potential difference between VREF and VREF-OUT	-7		7	mV
VREF pin input current	$I_{VCREF}$	$V_C = V_{REF} = 1.65\text{V}$			1	$\mu\text{A}$
<b>Output on/off function (S/S : Spindle driver)</b>						
Low-level input voltage	$V_{SSL}$				0.5	V
High-level input voltage	$V_{SSH}$		2.0			V
Input current	$I_{SSH}$				60	$\mu\text{A}$
<b>MUTE-SLD/LOAD : Sled driver and loading driver</b>						
Low-level input voltage	$V_{MUTEL}$				0.5	V
High-level input voltage	$V_{MUTEH}$		2.0			V
Input current	$I_{MUTEH}$				60	$\mu\text{A}$

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Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Spindle Motor Driver Block (Output Block)</b>						
Output saturation voltage	V <sub>O</sub> SATL	I <sub>O</sub> = 0.5A, V <sub>O</sub> (SINK)		0.4	0.45	V
	V <sub>O</sub> SATH	I <sub>O</sub> = 0.5A, V <sub>O</sub> (SOURCE)		1.2	1.5	V
Output leakage current	I <sub>O</sub> -LEAK (L)	Sink side			100	μA
	I <sub>O</sub> -LEAK (H)	Source side			100	μA
<b>Hall Amplifier Block</b>						
Input offset voltage	V <sub>OFF</sub> -HALL		-6		6	mV
Input bias current	I <sub>HB</sub>			1	3	μA
Input voltage range	V <sub>ICM</sub>		1.3		4	V
Minimum Hall sensor input level	V <sub>HIN</sub>		60			mV
<b>PWM Oscillator</b>						
PWM oscillator frequency	FOSC	Between OSC and ground : 330 pF	65	86	105	kHz
<b>Input Amplifier</b>						
VC pin input current	IVCTL	VC = VREF = 1.65V, spindle motor driver input			1	μA
Forward gain	GDF+		0.4	0.46	0.52	V/V
Reverse gain	GDF-		0.4	0.46	0.52	V/V
Forward limiter voltage	VRF1		0.42	0.5	0.58	V
Reverse limiter voltage	VRF2		0.42	0.5	0.58	V
Startup voltage	V <sub>IN</sub>		1.5		1.8	V
Input dead zone width	VDZ-SPDL		150	200	250	mV
<b>FG Pin : Speed pulse output</b>						
Low-level output voltage	V <sub>FGL</sub>	IFG = 2mA			0.4	V
Hall comparator hysteresis	V <sub>FGHYS</sub>		4	8	15	mV
<b>Hall Sensor Power Supply</b>						
Hall sensor power supply voltage	V <sub>H</sub>	I <sub>H</sub> = 5 mA, with respect to the ground potential.		0.8	1.2	V
Allowable current	I <sub>H</sub>				20	mA
<b>Sled Driver Block (Output Block)</b>						
Maximum output voltage	V <sub>O</sub> -SLD	I <sub>O</sub> = 0.2A	6.35	6.8		V
Output leakage current	I <sub>O</sub> LEAK (L)	Sink side			100	μA
	I <sub>O</sub> LEAK (H)	Source side			100	μA
<b>Input Amplifier</b>						
V <sub>IN</sub> pin input current	IVCTL	VC = VREF = 1.65V, sled driver input			1	μA
I/O gain	VG-SLD		0.2	0.23	0.26	V/V
Output limit voltage	LIMIT-SLD		0.21	0.25	0.29	V
Startup voltage	V <sub>IN</sub>		1.5		1.8	V
Input dead zone width	VDZ-SLD		100	150	200	mV
Input voltage range	V <sub>IN</sub> -OP (SLD)	Design guarantee, input buffer amplifier	0		V <sub>CC</sub> -1.5	V
Output on delay time	TON			2	10	μs
Output off delay time	TOFF			2	10	μs
Switching time	TSW			2	10	μs
<b>Focus and Tracking (BTL-AMP)</b>						
Output offset voltage	V <sub>OFF</sub> -BTL	Input operational amplifier buffer	-50		50	mV
Maximum output voltage	V <sub>O</sub> -BTL	I <sub>O</sub> = 0.3A	5.7	6		V
I/O gain	VG-BTL		3.6	4	4.4	times
Slew rate	SR	Across the BTL amplifier output		1		V/μs
Input voltage range	V <sub>IN</sub> -OP (BTL)	Design guarantee, input buffer amplifier	0		V <sub>CC</sub> -1.5	V

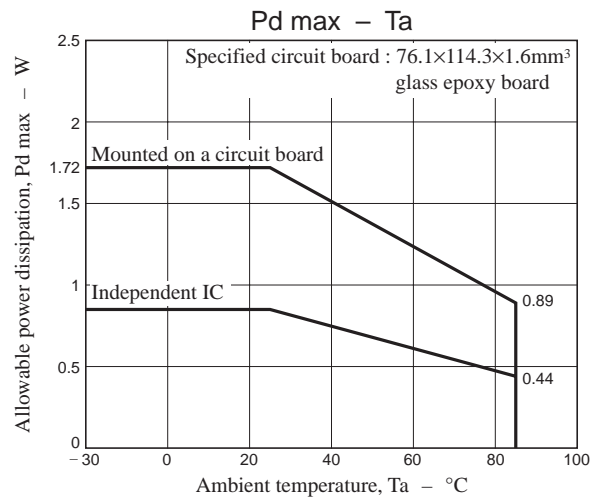
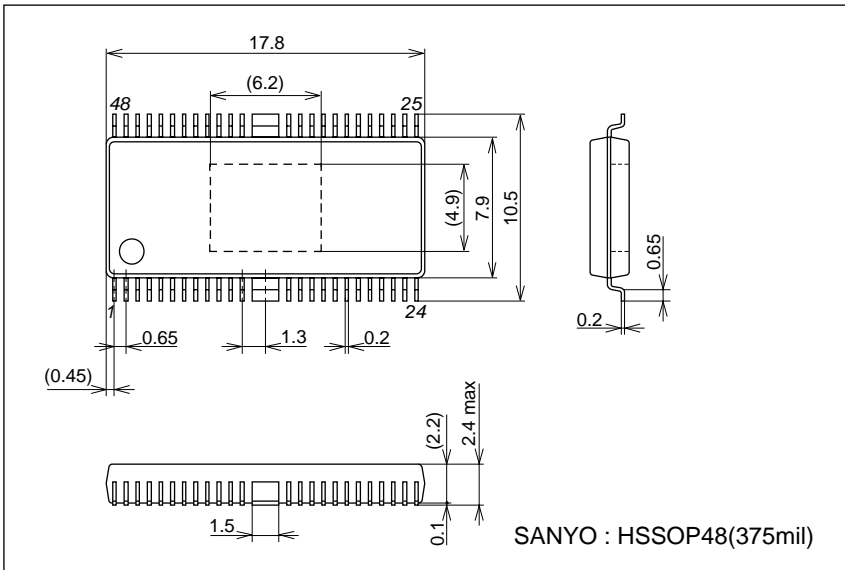
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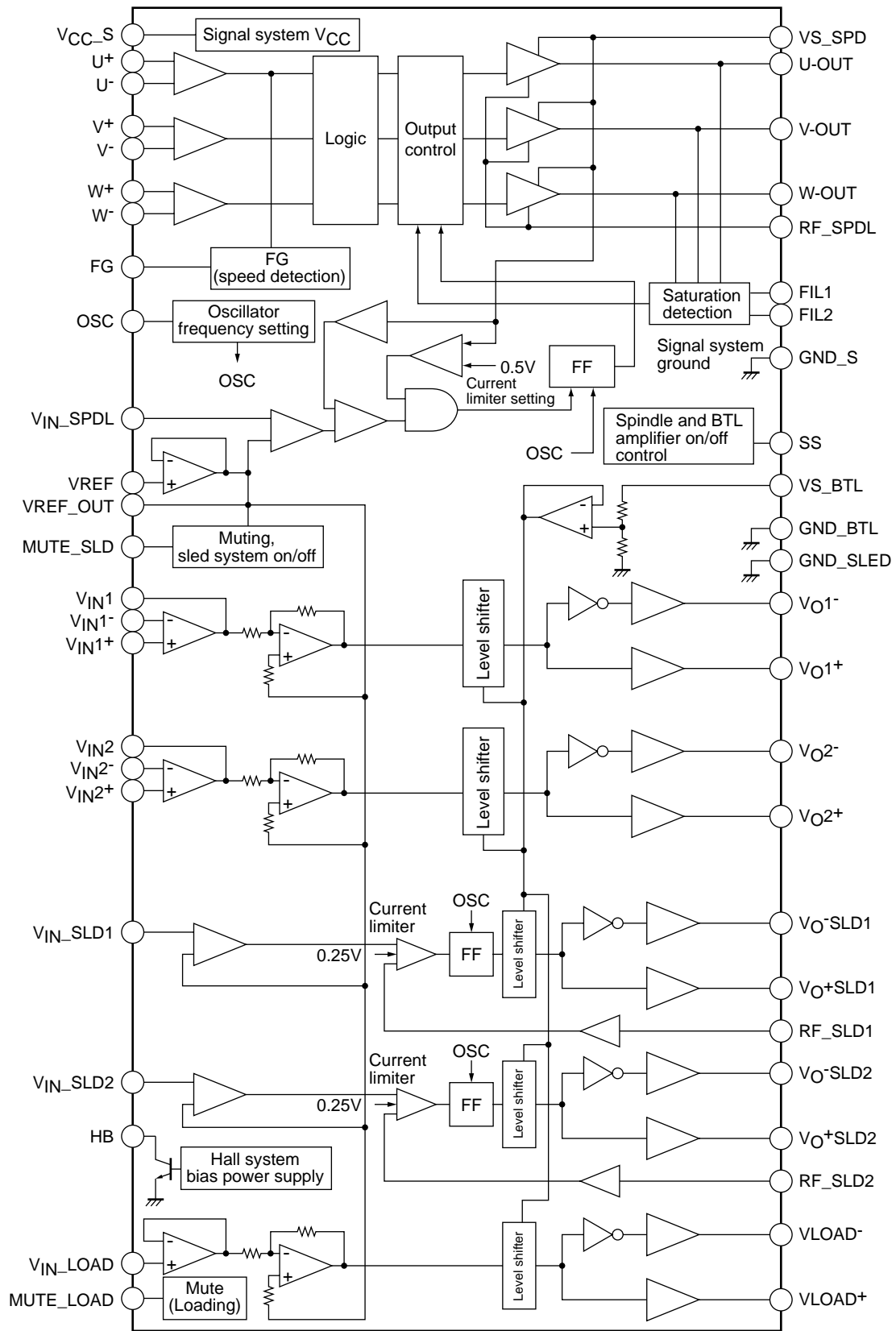
Parameter	Symbol	Conditions	Ratings			Unit
			min	typ	max	
<b>Input Operational Amplifier</b>						
Output offset voltage	$V_{OFF-OP}$		-7		7	mV
Output sink current	SINK-OP		2			mA
Output source current	SOURCE-OP		300	500		$\mu$ A
Input voltage range	$V_{IN-OP}$			1		V/ $\mu$ s
Input voltage range	$V_{IN-OP}$ (BTL)		0		$V_{CC}-1.5$	V
<b>Loading Block (BTL-AMP)</b>						
Output offset voltage	$V_{OFF-LOAD}$		-50		50	mV
Maximum output voltage	$V_{O-LOAD}$	$I_O = 0.5A$	6	6.6		V
I/O gain	$V_G-LOAD$		3.6	4	4.4	times
Slew rate	SR			1		V/ $\mu$ s
Input voltage range	$V_{IN-LOAD}$	Design guarantee, input buffer amplifier	0		$V_{CC}-1.5$	V

**Package Dimensions**

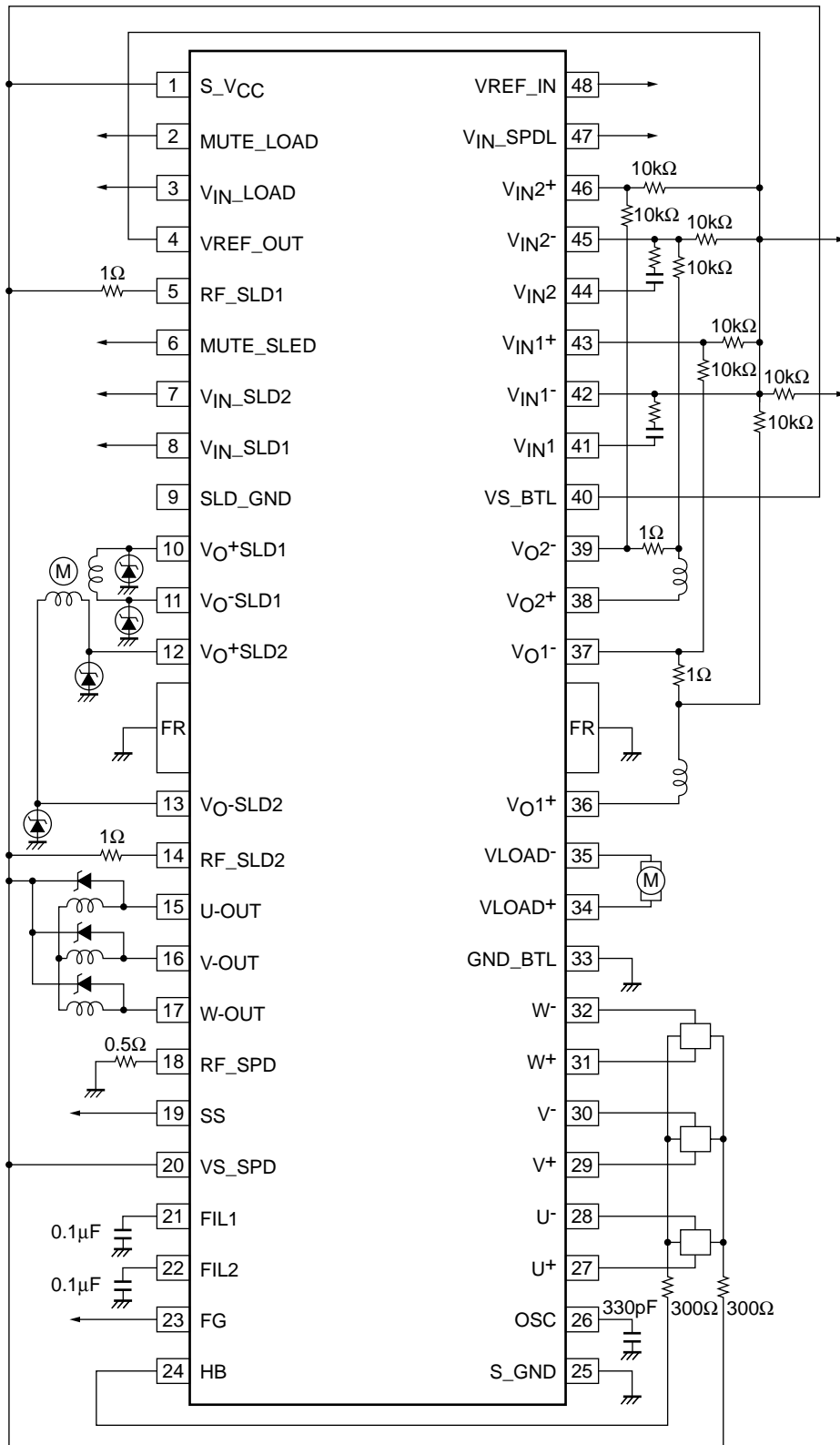
unit : mm (typ)  
3278



**Block Diagram**



Pin Assignment and Application Circuit Example



For the diodes between the spindle outputs (pins 15, 16, and 17), use Schottky barrier diodes with current capacities of over 1A, small temperature coefficients, and low reverse currents.

## Pin Functions

Pin No.	Pin	Descriptions
1	V <sub>CC-S</sub>	Signal system power supply and BTL amplifier output stage power supply
2	MUTE_LOAD	Loading output on/off control
3	V <sub>IN_LOAD</sub>	Loading input
4	VREF-OUT	VREG amplifier (buffer) output
5	RF_SLD1	SLED1 output current detection
6	MUTE_SLED	Sled output on/off control
7	V <sub>IN_SLD2</sub>	SLED2 input
8	V <sub>IN_SLD1</sub>	SLED1 input
9	GND_SLD	Power system ground, Sled
10	V <sub>O</sub> <sup>+</sup> SLD1	SLED1 <sup>+</sup> output
11	V <sub>O</sub> <sup>-</sup> SLD1	SLED1 <sup>-</sup> output
12	V <sub>O</sub> <sup>+</sup> SLD2	SLED2 <sup>+</sup> output
13	V <sub>O</sub> <sup>-</sup> SLD2	SLED2 <sup>-</sup> output
14	RF_SLD2	SLED2 output current detection
15	U-OUT	U phase output
16	V-OUT	V phase output
17	W-OUT	W phase output
18	RF_SPDL	Output current detection (SPINDLE)
19	SS	BTL amplifier (channels 1 and 2) and spindle driver on/off control
20	VS_SPDL	Spindle output stage power supply
21	FIL1	Source side output oscillation prevention
22	FIL2	Sink side output oscillation prevention
23	FG	FG output. This is an open collector output that outputs one of the Hall phases (the U phase).
24	HB	Hall sensor bias power supply (open collector output)
25	GND_S	Signal system ground
26	OSC	PWM oscillator frequency setting (A capacitor is connected between this pin and ground.)
27	U <sup>+</sup>	Hall sensor bias input (U <sup>+</sup> )
28	U <sup>-</sup>	Hall sensor bias input (U <sup>-</sup> )
29	V <sup>+</sup>	Hall sensor bias input (V <sup>+</sup> )
30	V <sup>-</sup>	Hall sensor bias input (V <sup>-</sup> )
31	W <sup>+</sup>	Hall sensor bias input (W <sup>+</sup> )
32	W <sup>-</sup>	Hall sensor bias input (W <sup>-</sup> )
33	GND_BTL	Power system ground and BTL amplifier (including loading driver)
34	VLOAD <sup>+</sup>	Loading driver output (+)
35	VLOAD <sup>-</sup>	Loading driver output (-)
36	V <sub>O</sub> 1 <sup>+</sup>	Channel 1 output (+)
37	V <sub>O</sub> 1 <sup>-</sup>	Channel 1 output (-)
38	V <sub>O</sub> 2 <sup>+</sup>	Channel 2 output (+)
39	V <sub>O</sub> 2 <sup>-</sup>	Channel 2 output (-)
40	VS_BTL	Power system ground and BTL amplifier (including loading driver)
41	V <sub>IN</sub> 1	Channel 1 input, channel 1 operational amplifier output
42	V <sub>IN</sub> 1 <sup>-</sup>	Channel 1 input, input operational amplifier inverting input
43	V <sub>IN</sub> 1 <sup>+</sup>	Channel 1 input, input operational amplifier noninverting input
44	V <sub>IN</sub> 2	Channel 2 input, channel 1 operational amplifier output
45	V <sub>IN</sub> 2 <sup>-</sup>	Channel 2 input, input operational amplifier inverting input
46	V <sub>IN</sub> 2 <sup>+</sup>	Channel 2 input, input operational amplifier noninverting input
47	V <sub>IN_SPDL</sub>	Spindle input
48	VREF_IN	Reference voltage input

**Pin Description**

Pin No.	Pin	Function	Equivalent circuit
43 42 41 46 45 44	$V_{IN1}^+$ $V_{IN1}^-$ $V_{IN1}$ $V_{IN2}^+$ $V_{IN2}^-$ $V_{IN2}$	Channel 1 and channel 2 (BTL amplifier) input. operational amplifier inputs and outputs.	
3	$V_{IN\_LOAD}$	Loading driver input.	
8 7 47	$V_{IN\_SLD1}$ $V_{IN\_SLD2}$ $V_{IN\_SLD3}$	Sled and spindle driver inputs.	
48	VREF_IN	VREF-IN input (VREF amplifier input).	
36 37 38 39 34 35	$V_{O1}^+$ $V_{O1}^-$ $V_{O2}^+$ $V_{O2}^-$ VLOAD+ VLOAD-	Outputs for channel 1, channel 2, and the loading driver.	<p>○ Devices market with a broken circle are diodes added for structural reasons.</p>

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Pin No.	Pin	Function	Equivalent circuit
20 18 15 16 17	VS_SPD RF_SPDL U-OUT V-OUT W-OUT	Spindle and other output pins.	<p>○ Devices market with a broken circle are diodes added for structural reasons.</p>
5 14 9 10 11 12 13	RF_SLD1 RF_SLD2 SLD_GND V <sub>O</sub> <sup>+</sup> SLD1 V <sub>O</sub> <sup>-</sup> SLD1 V <sub>O</sub> <sup>+</sup> SLD2 V <sub>O</sub> <sup>-</sup> SLD2	Sled system output pins.	<p>○ Devices market with a broken circle are diodes added for structural reasons.</p>
27 28 29 30 31 32	U <sup>+</sup> U <sup>-</sup> V <sup>+</sup> V <sup>-</sup> W <sup>+</sup> W <sup>-</sup>	Hall sensor bias inputs.	
26	OSC	Oscillator frequency setting. This pin sets the PWM oscillator frequency.	
23	FG	FG output. This pin outputs a signal synchronized with the U phase. (Single Hall sensor output)	

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Pin No.	Pin	Function	Equivalent circuit
24	HB	Hall bias output.	
6 2 19	MUTE_SLED MUTE_LOAD SS	SS and muting control inputs. These inputs control the on/off states of the corresponding outputs.	

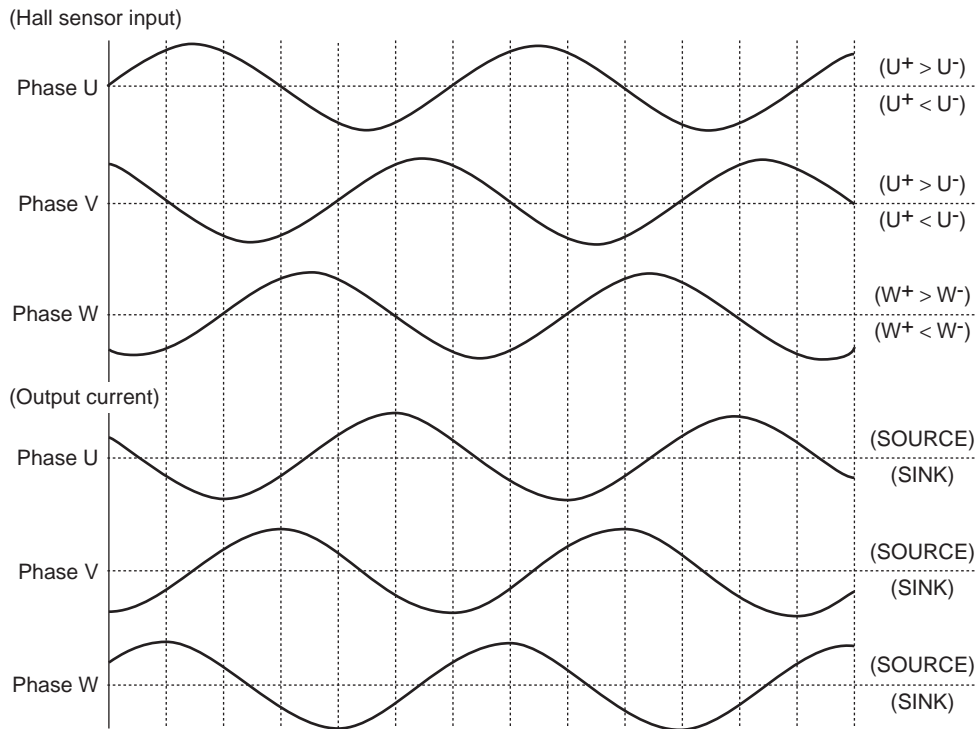
**Spindle Truth Table**

(For forward rotation,  $V_{IN\ SPDL} > V_{REF}$ )

	Input	Hall sensor input						Output status			FG output
		U		V		W		SOURCE	→	SINK	
		U <sup>+</sup>	U <sup>-</sup>	V <sup>+</sup>	V <sup>-</sup>	W <sup>+</sup>	W <sup>-</sup>				
(1)	H	H	L	H	L	L	H	W	→	V	H
(2)		H	L	L	H	L	H	W	→	U	H
(3)		H	L	L	H	H	L	V	→	U	H
(4)		L	H	L	H	H	L	V	→	W	L
(5)		L	H	H	L	H	L	U	→	W	L
(6)		L	H	H	L	L	H	U	→	V	L

(For reverse rotation,  $V_{IN\ SPDL} < V_{REF}$ )

	Input	Hall sensor input						Output status			FG output
		U		V		W		SOURCE	→	SINK	
		U <sup>+</sup>	U <sup>-</sup>	V <sup>+</sup>	V <sup>-</sup>	W <sup>+</sup>	W <sup>-</sup>				
(1)	H	H	L	H	L	L	H	V	→	W	H
(2)		H	L	L	H	L	H	U	→	W	H
(3)		H	L	L	H	H	L	U	→	V	H
(4)		L	H	L	H	H	L	W	→	V	L
(5)		L	H	H	L	H	L	W	→	U	L
(6)		L	H	H	L	L	H	V	→	U	L



## Output On/Off Control Functions

### 1. Relationships Between Muting Inputs and Output States

MUTE SLED	Sled output
H	ON
L	OFF

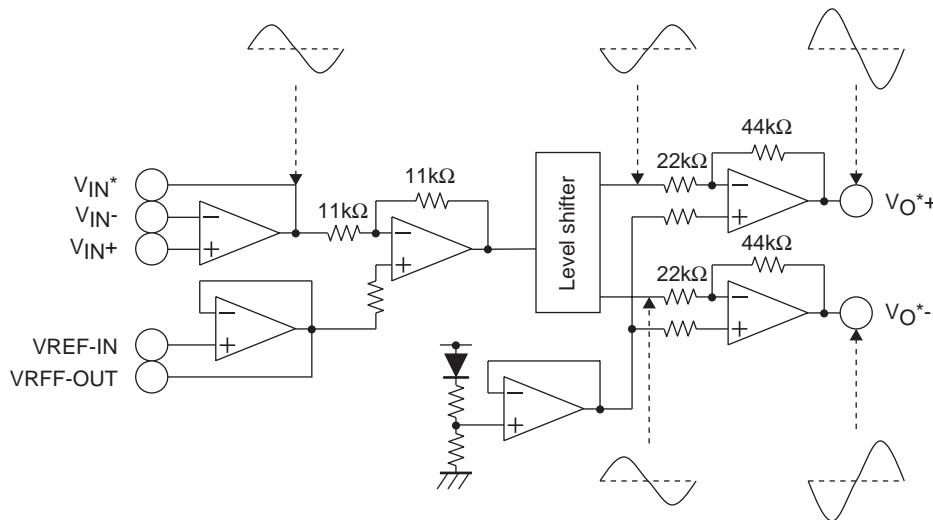
MUTE SLED	Loading driver output
H	ON
L	OFF

### 2. Relationship Between S/S and the Corresponding Output

MUTE SLED	Spindle BTL-AMP
H	ON
L	OFF

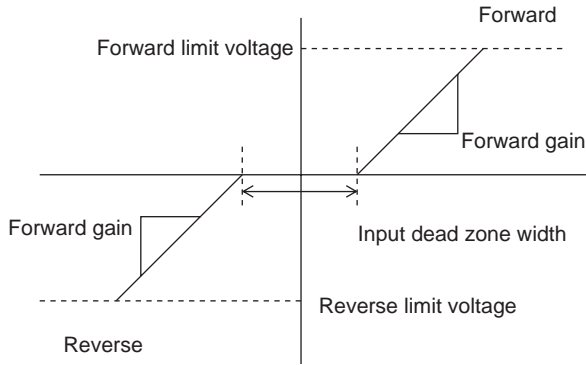
- \* : The BTL amplifier and the loading driver input amplifier operate regardless of the MUTE inputs. The output on/off states are controlled only by muting the output amplifiers.
- \* : When both the MUTE and S/S pins are low, the outputs go to the high-impedance state. However, note that the output amplifier gain setting feedback resistor is connected.

## BTL Amplifier I/O Relationship



- \* : The loading driver input operational amplifier is a voltage-follower circuit ( $V_{IN}$  and  $V_{IN-}$  are shorted together).
- \* : To make the I/O relationship easier to see in figure 7, Block Diagram, the diagram is written as though gain is applied in the input amplifier. In the actual circuit, however, the gain occurs in the output amplifier.

**Spindle and Sled Gain and Limiter**



**(SPINDLE)**

RF resistor (Ω)	Forward/reverse limiter current (A)	I/O gain	
		(A/V)	(V/V)
0.5	1.0	1.0	0.5
1.0	0.5	0.5	0.5

**(SLED)**

RF resistor (Ω)	Forward/reverse limiter current (A)	I/O gain	
		(A/V)	(V/V)
0.5	0.50	0.50	0.25
1.0	0.25	0.25	0.25

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