

# 5CH Power Driver for CD-ROM, DVD-ROM

## BD7903FS

BD7903FS is a 5-channel driver IC that integrates all drivers necessary for CD-ROM, and DVD-ROM systems into a single chip. Low noise, and low vibration can be achieved by applying the 180° PWM driving system for spindle motor drivers. Current lag phase occurred by the load of the inductance can be reduced by using the current feedback linear BTL system to driver the actuator.

### ●Applications

CD-ROM, DVD-ROM

### ●Features

- 1) 4channel BTL driver and 3phase motor driver.
  - ALL of the motor and actuator for CD-ROM, DVD-ROM etc.
- 2) These mode is able to be selected by the two control terminals.
  - ON/OFF of loading, and other 4channels, brake mode of spindle driver and standby mode.
- 3) Built-in triangular-wave generator.
- 4) Package SSOP-A54 has large power dissipation.
- 5) Built in thermal-shut-down circuit.

#### < Spindle driver >

- Efficient drive by current feedback PWM drive.
- Built in current limit, hall bias, short brake, FG 3-phase mixed signal output and reverse protection circuit.
- Low ON-Resistor. (RON=0.85Ω)

#### < Sled motor driver, Loading driver >

- Voltage feedback Linear BTL drive system.

#### < Actuator driver >

- Current feedback Linear BTL drive system.
- Current phase lag influenced load inductance is little, because this type is current feedback.

## Optical disc ICs

## ●Absolute maximum ratings (Ta=25°C)

Parameter	Symbol	Limits	Unit
POWER MOS power supply voltage	SPVM1,2	15	V
Preblock/BTL powerblock power supply voltage	PreVcc, VMACT	15	V
Spindle control block power supply voltage	SPVcc	7	V
Power dissipation	Pd	2.6*1	W
Operating temperature range	Topr	-35 to +85	°C
Storage temperature	Tstg	-55 to +150	°C

\*1 PCB (70mm×70mm×1.6mm glass epoxy) mounting.  
Reduced by 20.8mW for each increase in Ta of 1°C over 25°C.

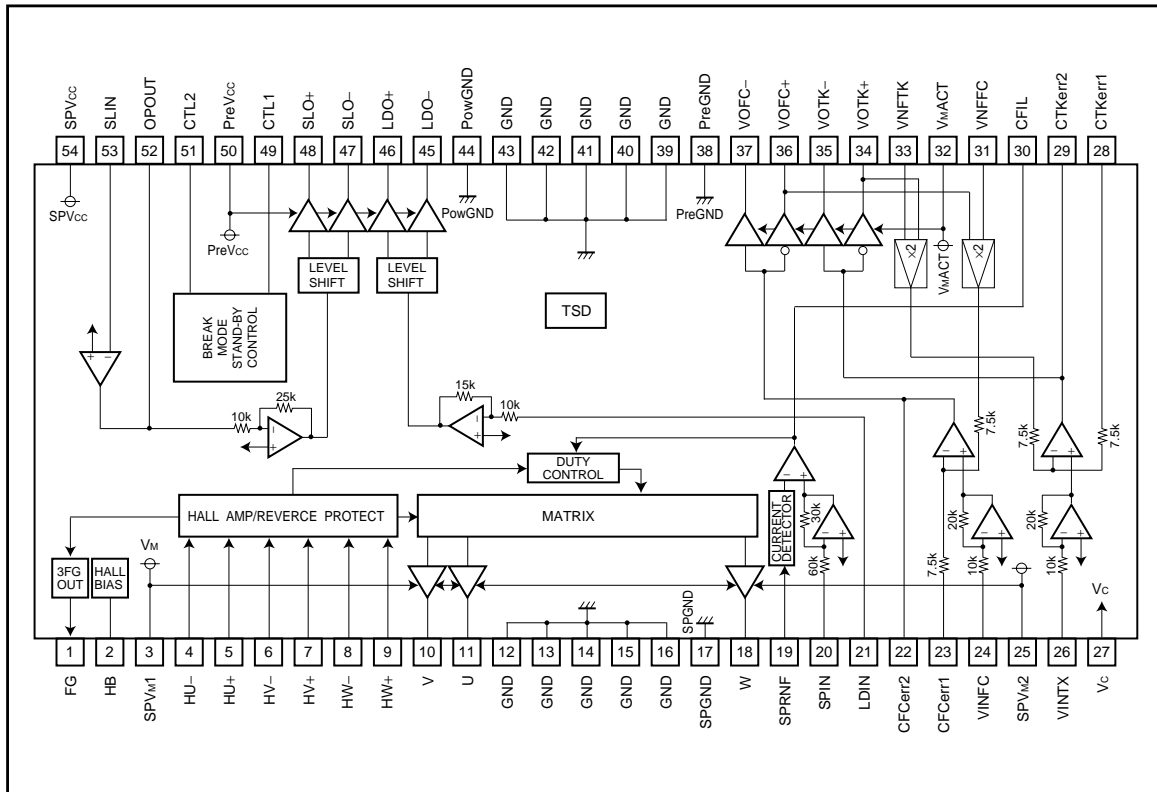
## ●Recommended operating conditions (Ta=25°C)

(Set the power supply voltage taking allowable dissipation into considering)

Parameter	Symbol	Min.	Typ.	Max.	Unit
POWER MOS Power supply voltage1	SPVM1, 2	SPVcc	12	14	V
Preblock Power supply voltage	PreVcc	VMACT	12	14	V
Power block Power supply voltage	VMACT	4.5	5.0	PreVcc	V
Spindle control block Power supply voltage	SPVcc	4.5	5.0	6.0	V

Optical disc ICs

●Block diagram



## Optical disc ICs

## ●Pin descriptions

Pin No.	Pin name	Function	Pin No.	Pin name	Function
1	FG	Frequency generator output	28	CTKerr1	Connection with capacitor for error amplifier
2	HB	Hall bias	29	CTKerr2	Connection with capacitor for error amplifier
3	SPVM1	Spindle driver power supply 1	30	CFIL	Connection with capacitor for spindle loop
4	HU-	Hall amp.U negative input	31	VNFFC	Feedback for focus driver
5	HU+	Hall amp.U positive input	32	VMACT	Actuator driver block power supply
6	HV-	Hall amp.V negative input	33	VNFTK	Feedback for tracking driver
7	HV+	Hall amp.V positive input	34	VOTK+	Tracking driver positive output
8	HW-	Hall amp.W negative input	35	VOTK-	Tracking driver negative output
9	HW+	Hall amp.W positive input	36	VOFC+	Focus driver positive output
10	V	Spindle driver output V	37	VOFC-	Focus driver negative output
11	U	Spindle driver output U	38	PreGND	Pre-ground
12	GND	GND	39	GND	GND
13	GND	GND	40	GND	GND
14	GND	GND	41	GND	GND
15	GND	GND	42	GND	GND
16	GND	GND	43	GND	GND
17	SPGND	Spindle driver power ground	44	PowGND	BTL block power ground
18	W	Spindle driver output W	45	LDO-	Loading driver negative output
19	SPRNF	Spindle driver current sense	46	LDO+	Loading driver positive output
20	SPIN	Spindle driver input	47	SLO1-	Slide drive negative output
21	LDIN	Loading driver input	48	SLO1+	Slide drive positive output
22	CFCerr2	Connection with capacitor for error amplifier	49	CTL1	Driver logic control input 1
23	CFCerr1	Connection with capacitor for error amplifier	50	PreVcc	Loading block power supply
24	VINFC	Focus driver input	51	CTL2	Driver logic control input 2
25	SPVM2	Spindle driver power supply 2	52	OPOUT	OP amp output
26	VINTK	Tracking driver input	53	SLIN	Slide driver input
27	Vc	Reference voltage input	54	SPVcc	Spindle block control power supply

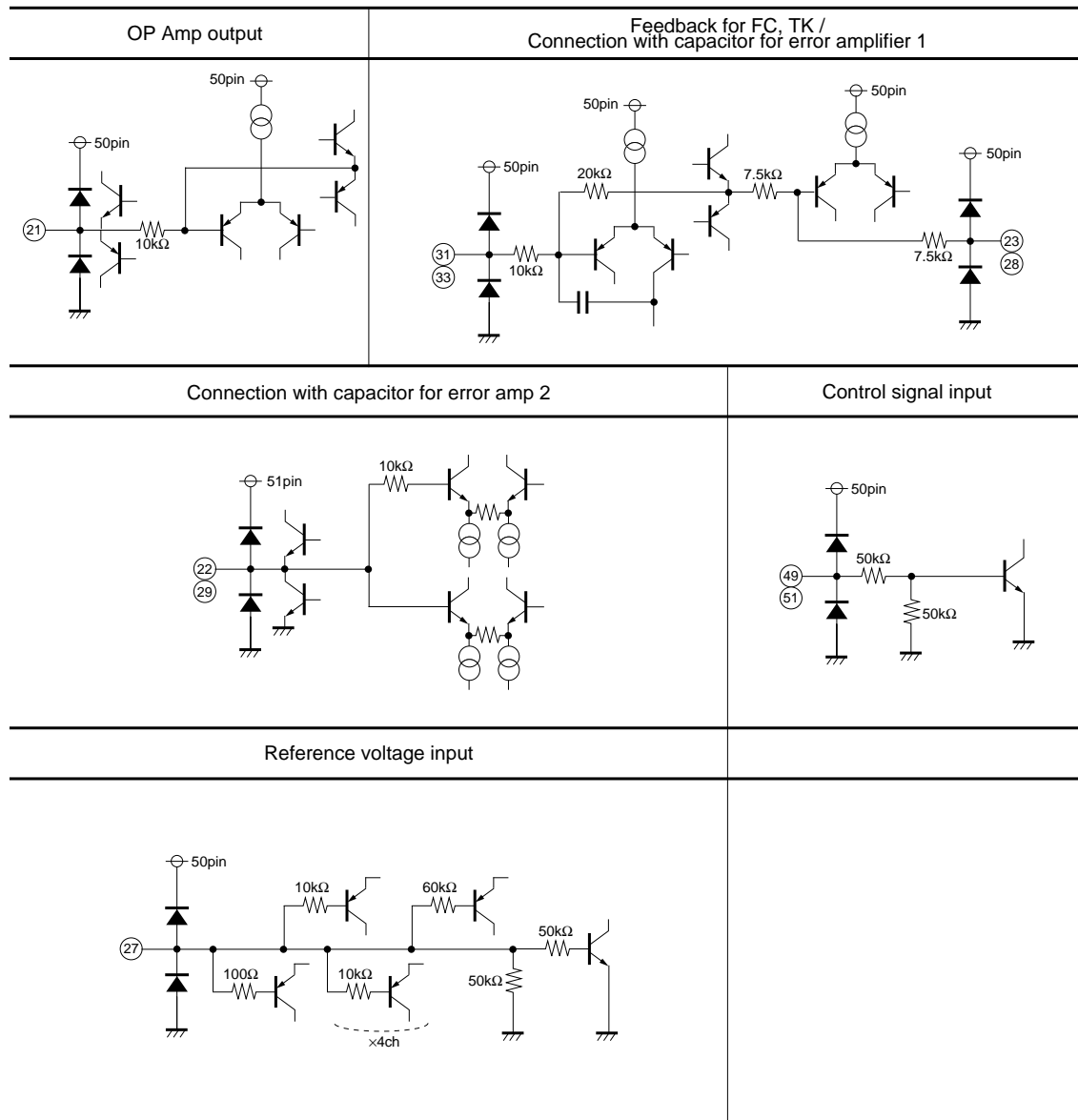
\* Positive/negative of the output terminals are determined in reference to those of the input terminals.

Optical disc ICs

●Input output circuit

Three-phase motor driver output	Spindle driver current detection input	Hall bias
Hall signal input	Spindle driver feedback filter pin	FG signal output
current feedback BTL driver output FO, TK	BTL driver output SL, LD	PWM driver input Spindle
current feedback BTL driver input FO, TK	BTL driver input LD	BTL driver input SL

Optical disc ICs



## Optical disc ICs

## ●Electrical characteristics

(unless otherwise noted, Ta=25°C, PreV<sub>CC</sub>=SPVM1/2=12V, SPV<sub>CC</sub>=V<sub>MACT</sub>=5V, V<sub>C</sub>=1.65V, R<sub>NF</sub>=0.33Ω, P<sub>d</sub>=0.5Ω)

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Circuit
Circuit current							
Quiescent current 1	I <sub>Q1</sub>	–	26	40	mA	V <sub>CC</sub> (Loading OFF)	Fig.1, 2
Quiescent current 2	I <sub>Q2</sub>	–	20	32	mA	V <sub>CC</sub> (Loading ON)	Fig.1, 2
Quiescent current 3	I <sub>Q3</sub>	–	2.9	4.5	mA	SPV <sub>CC</sub>	Fig.1, 2
Standby-on current 1	I <sub>ST1</sub>	–	–	1	mA	V <sub>CC</sub>	Fig.1, 2
Standby-on current 2	I <sub>ST2</sub>	–	–	1	mA	SPV <sub>CC</sub>	Fig.1, 2
Spindle driver block ( Hall bias )							
Hall bias voltage	V <sub>HB</sub>	0.5	1.0	1.5	V	I <sub>HB</sub> =10mA	Fig.1, 2
Spindle driver block ( Hall amplifier )							
Input bias current	I <sub>HIB</sub>	–	1	5	μA		Fig.1, 2
Input level	V <sub>HIM</sub>	50	200	–	mV		Fig.1, 2
Common mode input range	V <sub>HICM</sub>	1	~	4	V		Fig.1, 2
Spindle driver block ( Torque control )							
Input dead zone (one side)	V <sub>DZSP</sub>	20	50	100	mV		Fig.1, 2
Input output gain	gm <sub>SP</sub>	1.2	1.5	1.8	Arms/V	R <sub>NF</sub> =0.33Ω	Fig.1, 2
Output ON resistor (Upper)	V <sub>OHS</sub>	–	0.6	1.0	Ω	I <sub>o</sub> =500mA	Fig.1, 2
Output ON resistor (lower)	V <sub>OMS</sub>	–	0.25	0.5	Ω	I <sub>L</sub> =–500mA	Fig.1, 2
Output limit current	I <sub>LIMS</sub>	1.5	1.8	2.0	A	R <sub>NF</sub> =0.33Ω	Fig.1, 2
PWM frequency	f <sub>OSC</sub>	–	100	–	kHz		Fig.1, 2
Spindle driver block ( FG output )							
High voltage	V <sub>FGH</sub>	4.7	4.9	–	V	Connect 100kΩ between FG and 5V	Fig.1, 2
Low voltage	V <sub>FGL</sub>	–	0.1	0.2	V		Fig.1, 2
Slide driver block ( Pre OP AMP )							
Input range	V <sub>ICMOP</sub>	0.3	~	11	V		Fig.1, 2
Input bias current	I <sub>BOP</sub>	–	80	300	nA		Fig.1, 2
Low level output voltage	V <sub>OLOP</sub>	–	0.1	0.5	V		Fig.1, 2
Max output source current	I <sub>SOOP</sub>	–	–	0.3	mA		Fig.1, 2
Max output sink current	I <sub>SIOP</sub>	–	–	1	mA		Fig.1, 2
Slide driver block							
Output offset voltage	V <sub>OOFSL</sub>	–100	0	100	mV		Fig.1, 2
Output saturation voltage "H"	V <sub>OMSL</sub>	–	1.3	1.6	V	I <sub>o</sub> =500mA	Fig.1, 2
Output saturation voltage "L"	V <sub>OLSL</sub>	–	0.5	0.85	V	I <sub>o</sub> =500mA	Fig.1, 2
Voltage gain	G <sub>VSL</sub>	18.0	20.0	22.0	dB	The gain of pre-OP AMP is 0dB	Fig.1, 2
Actuator driver block							
Output offset current	I <sub>OO</sub>	–8	0	8	mA	R <sub>L</sub> =8Ω	Fig.1, 2
Max output voltage amplitude	V <sub>OM</sub>	3.6	4.0	–	V	R <sub>L</sub> =8Ω	Fig.1, 2
Trans conductance	G <sub>m</sub>	1.4	1.7	2.0	A/V	V <sub>IN</sub> =BIAS±0.2V	Fig.1, 2

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## Optical disc ICs

Parameter	Symbol	Min.	Typ.	Max.	Unit	Conditions	Circuit
Loading driver block							
Output offset voltage	VOFLD	-70	0	70	mV		Fig.1, 2
Output saturation voltage "H"	VOHLD	-	1.3	1.6	V	Io=500mA	Fig.1, 2
Output saturation voltage "L"	VOLL	-	0.5	0.85	V	Io=500mA	Fig.1, 2
Voltage gain	GVLD	13.5	15.5	17.5	dB		Fig.1, 2
CTL1, CTL2							
Input high voltage	VIH	2.0	-	-	V		Fig.1, 2
Input low voltage	VIL	-	-	0.5	V		Fig.1, 2
Others							
Vc drop-muting	VMVC	0.5	0.7	1.0	V		Fig.1, 2
Vcc drop-muting ON voltage	VMVcc ON	3.85	4.00	-	V		Fig.1, 2
Vcc drop-muting OFF voltage	VMVcc OFF	-	4.25	4.40	V		Fig.1, 2
Vcc drop-muting hysteresis width	VHYVcc	100	-	-	mV		Fig.1, 2

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Optical disc ICs

●Measurement circuits

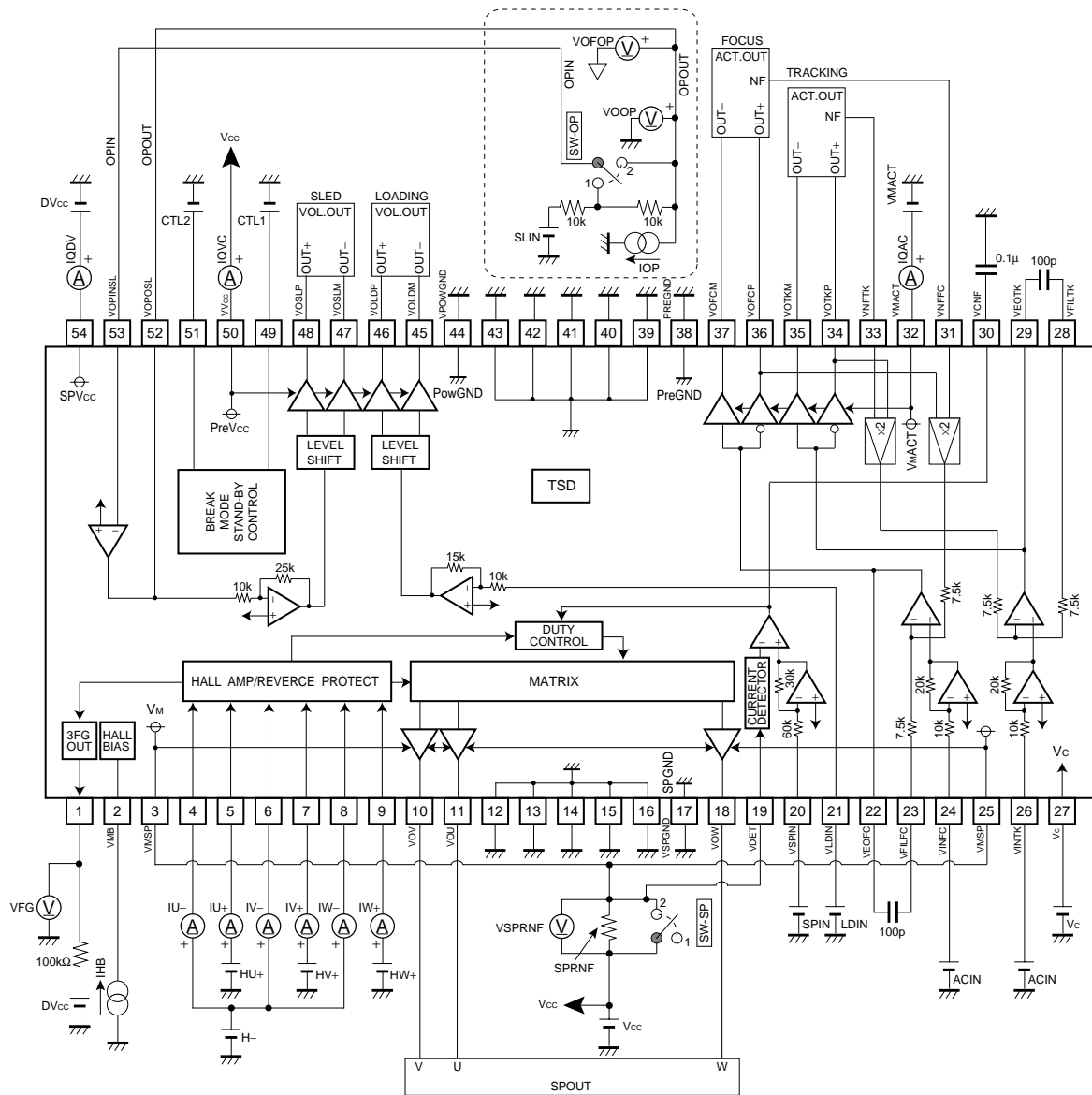


Fig.1

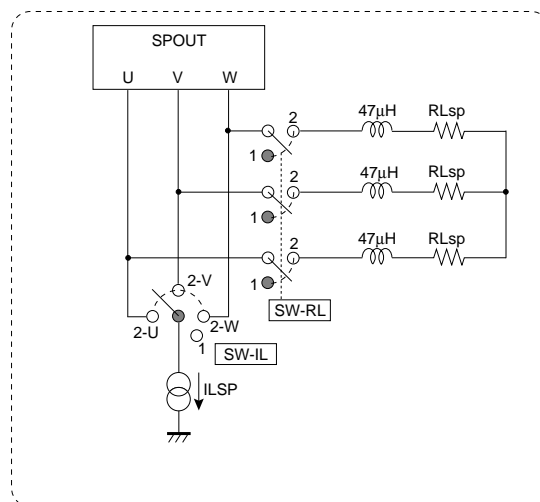
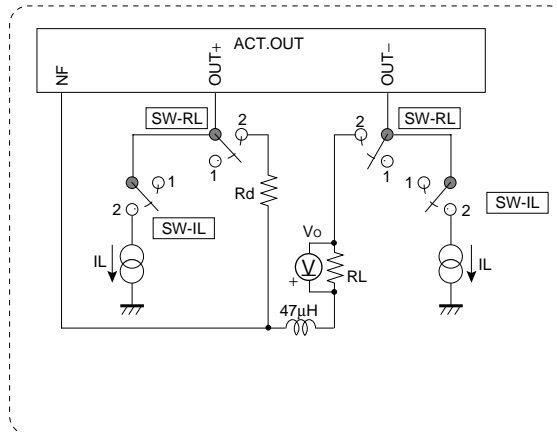
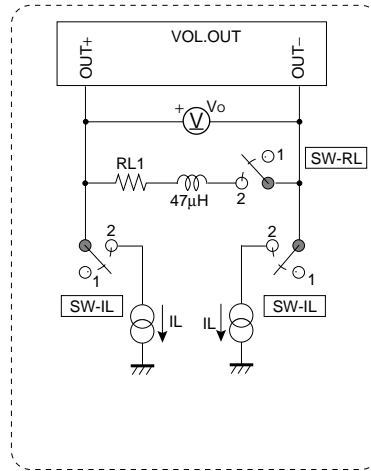


Fig.2

## Optical disc ICs

## ●Table of measure circuit switches position 1

( $V_{CC}=SPVM=12V$ ,  $DV_{CC}=VMACT=5V$ ,  $V_C=1.65V$ ,  $R_L(\text{act})=8\Omega$ ,  $R_L(\text{SL})=8\Omega+47\mu\text{H}$ ,  $R_L(\text{SP})=2\Omega+47\mu\text{H}$ ,  
 $P_d=0.5\Omega$ ,  $SPRNF=0.33\Omega$ ,  $H=-2.5V$ ,  $HU+=2.6V$ ,  $HV+=HW+=2.4V$ )

Designation	INPUT	CTL		SWITCH					Conditions	Measure point
	VIN	1	2	RL	SP	SL	IL	OP		
Circuit current										
IQ1	-	L	H	1	1	1	1	1		IQVC
IQ2	-	H	L	1	1	1	1	1		IQVC
IQ3	-	L	H	1	1	1	1	1		IQDV
IST1	-	L	L	1	1	1	1	1		IQVC
IST2	-	L	L	1	1	1	1	1		IQDV
Spindle driver block										
< Hall bias >										
VHB	1.65V	H	H	1	1	1	1	1	IHB=10mA	Pin 2
< Hall amplifier >										
IHB	1.65V	H	H	1	1	1	1	1	Current flowing in each terminal at H=-2.5V, H+=2.7V (2.3V)	IU+ (-), IV+ (-), IW+ (-)
< Torque command >										
VDZSP	*1	L	H	2	1	1	1	1	*1 Check VRNF with no output at $V_{IN}=V_C\pm 20\text{mV}$ Check VRNF with output at $V_{IN}=V_C\pm 100\text{mV}$	VSPRNF
gmSP	*2	L	H	2	1	1	1	1		VSPRNF
RONUSP	0V	H	H	1	2	1	2	1	ILSP=500mA $R_{ON} = \frac{12V - V_{OSP}}{0.5A}$	OUTU, V, W
RONLSP	0V	H	H	1	2	1	2	1	ILSP=-500mA $R_{ON} = \frac{V_{OSP}}{0.5A}$	OUTU, V, W
ILIMSP	0V	H	H	2	1	1	1	1		VSPRNF
fosc	0.65	H	H	2	1	1	1	1		VOSPU
< FG >										
VFGH	1.65V	H	H	1	1	1	1	1	HW+=2.6V, HV+=2.4V, HW+=2.4V	VFG
VFGL	1.65V	H	H	1	1	1	1	1	HW+=2.6V, HV+=2.6V, HW+=2.4V	VFG

\*2 Spindle driver

$V_{IN}=-400\text{mV}$ ,  $V_{IN}=-900\text{mV}$

$$gm (+) = \left( \frac{V_{SPRNF1} - V_{SPRNF2}}{900\text{mV} - 400\text{mV}} \right) / 0.33\Omega$$

## Optical disc ICs

## ●Table of measure circuit switches position 2

( $V_{CC}=SPVM=12V$ ,  $DV_{CC}=V_{MACT}=5V$ ,  $V_C=1.65V$ ,  $R_L(\text{act})=8\Omega$ ,  $R_L(\text{SL})=8\Omega+47\mu H$ ,  $R_L(\text{SP})=2\Omega+47\mu H$ ,  
 $P_d=0.5\Omega$ ,  $SPRNF=0.33\Omega$ ,  $H=2.5V$ ,  $HU+=2.6V$ ,  $HV+=HW+=2.4V$ )

Designation	INPUT	CTL		SWITCH					Conditions	Measure point
	VIN	1	2	RL	SP	SL	IL	OP		
Actuator driver block										
IOOAC	1.65V	H	H	2	1	1	1	1	IOOAC= $V_o/8$	VO
VOMAC	3.3V (0V)	H	H	2	1	1	1	1		VO
GMAC	$\pm 0.20V$	H	H	2	1	1	1	1	$(VO - IOOAC \times 8) / 0.2 \times 8$	VO
Slide driver block										
VOFSL	1.65V	L	H	2	1	1	1	1		VO
VOHSL	3.3V (0V)	L	H	1	1	1	2	1	IL=500mA	12-OUT+ (-)
VOLSL	0V (3.3V)	L	H	1	1	1	2	1	IL=-500mA	OUT+ (-)
GVSL	$\pm 0.25V$	L	H	2	1	1	1	1	$20\log (VO - VOFSL) / \pm 0.25 $	VO
Loading driver block										
VOFLD	1.65V	H	L	2	1	1	1	1		VO
VOHLD	3.3V (0V)	H	L	1	1	1	2	1	IL=500mA	12-OUT+ (-)
VOLL D	0V (3.3V)	H	L	1	1	1	2	1	IL=-500mA	OUT+ (-)
GVLD	$\pm 0.25V$	H	L	2	1	1	1	1	$20\log (VO - VOFLD) / \pm 0.25 $	VO
Pre-operational amplifier block										
IBOP	1.65V	H	H	1	1	1	1	2		IOPB
IOSOOP	-	H	H	1	1	1	1	2	IOP=500 $\mu$ A	VOF
IOSIOP	-	H	H	1	1	1	1	2	IOP=-1mA	VOF
VOLOP	5V	H	H	1	1	1	1	1		VOOP
CTL1, CTL2										
VIH	1.65V	L	L	2	1	1	1	1	Check active at "H"=2.0	IQVC
VIL	1.65V	H	H	2	1	1	1	1	Check stand-by at "L"=0.5	IQVC
Others										
VMVC	1.65V	H	H	1	1	1	1	1	Check all output at $V_C=0.5V$	OUTPUT
VMV <sub>CC</sub> ON	1.65V	H	H	1	1	1	1	1	Check all output at $V_{CC}=4.0V$	OUTPUT
VMV <sub>CC</sub> OFF	1.65V	H	H	1	1	1	1	1	Check all output at $V_{CC}=4.4V$	OUTPUT

## Optical disc ICs

## ●Circuit operations

## 1. Driver control terminal 1 and 2 (pin49 and pin51)

All the drivers and spindle-drive braking mode can be switched on/off by inputting combinations of H-level signal (higher than 2V) and L-level signal (lower than 0.5V) to these terminals.

CTL1 (Pin22)	CTL2 (Pin23)	Spindle	Slide	Focus	Tracking	Loading	
L	L	×	×	×	×	×	1)
H	L	×	×	×	×	○	2)
-	H	○	○	○	○	×	○ ... ON    × ... OFF

CTL1 (Pin22)	CTL2 (Pin23)	SPIN < V <sub>c</sub>	SPIN > V <sub>c</sub>	
L	H	Forward-rotation mode	Reverse-rotation braking mode	3)
H	H	Forward-rotation mode	Short-circuit braking mode	4)

## 1) Standby mode

The IC is brought into standby state, and its power dissipation can be limited. The outputs of all the channels are turned high-impedance.

## 2) Drivers muting

All the output channels except the loading are muted and their outputs are turned high-impedance.

## 3) Reverse-rotation braking mode (spindle)

A reverse-rotation torque is applied when SPIN > V<sub>c</sub>.

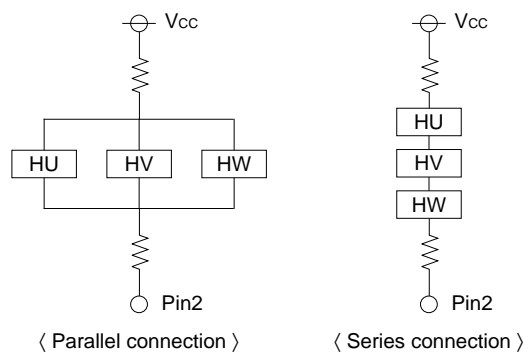
Reverse-rotation is detected with SPIN input and Hall input. If the spindle detects reverse rotation when SPIN > V<sub>c</sub>, all the outputs are shorted out to GND.

## 4) Short-circuit braking mode (spindle)

All the spindle driver outputs are shorted out to GND when SPIN > V<sub>c</sub>.

## 2. Hall inputs (pin 4 to 9) and Hall bias (pin 2) (Spindle)

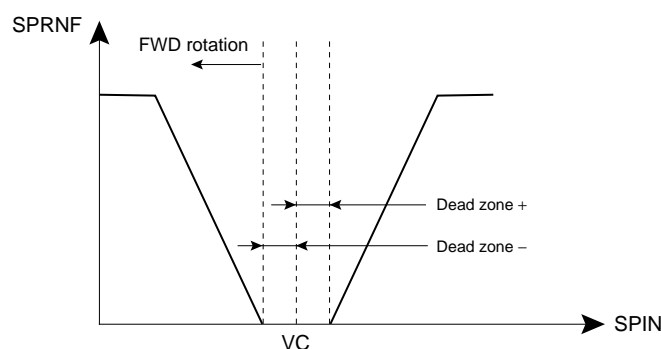
Hall elements can be connected either in series or in parallel. Set the Hall input voltage to 1.0 to 4.0V.



## Optical disc ICs

### 3. Torque command (pin 20) / output current detection terminals (pin 19)

The relation between the torque command input SPIN and the output current detection terminals input SPRNF is expressed as shown below:



The input-output gain ( $g_m$ ) and the output-limit current ( $I_{LIM}$ ) depend on the resistance of RNF (output current detection resistor). Please refer to the following expression.

The gain to drive the spindle motor can be decreased by connecting a resistor in series to each input terminal.

#### ● Gain expression (typ.)

	Spindle
Input-output gain	$0.5/RNF$ (Arms/V)
Output-limit current	$0.6/RNF$ (A/V)
Gain with the added resistor	$29.7k/\{RNF \times (Rin + 60k)\}$ (Arms/V)

Rin : added series resistor

### 4. PWM oscillation frequency

The PWM oscillation for driving the spindle is free running. The oscillating frequency is 100kHz (typ.).

### 5. Muting functions

#### a) V<sub>c</sub>-drop muting

When the voltage at V<sub>c</sub> terminal (pin 27) drops to a value lower than 0.7V (typ.), the outputs of all the channels are turned high-impedance. Set the V<sub>c</sub> terminal voltage to larger than 1.0V.

#### b) V<sub>CC</sub>-drop muting

When the voltages at DV<sub>CC</sub> terminal (pin 54) or V<sub>CC</sub> terminal (pin 50) drop to lower than 4.0V (typ.), the outputs of all the channels are turned high-impedance. When the voltages rise to more than 4.25V (Typ.), the IC start operating again.

### 6. Thermal-shutdown

A thermal-shutdown circuit (over-temperature protection circuit) is built in to prevent the IC from thermal breakdown. Use the IC under the thermal loss allowed to the package. In case the IC is left running over the allowable loss, the junction temperature rises, and the thermal-shutdown circuit works at the junction temperature of 175°C (typ.) (the outputs of all the channels are turned off). When the junction temperature drops to 150°C (typ.), the IC start operating again.

Optical disc ICs

●Application example

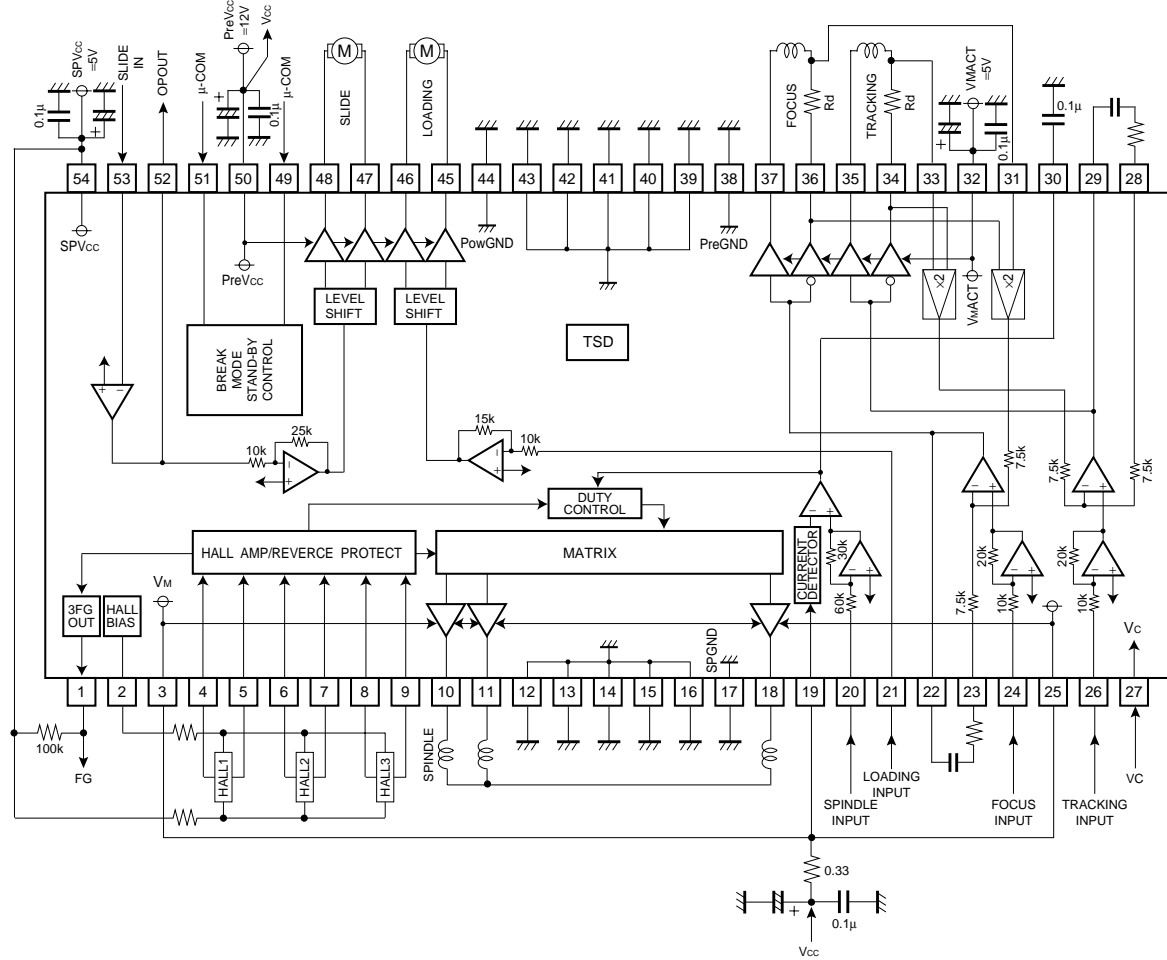
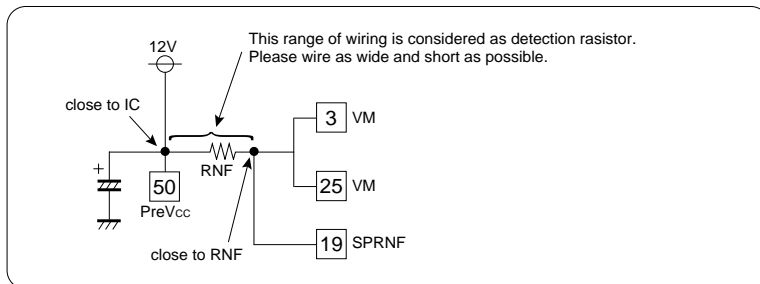


Fig.3

●Operation notes

(1) Wiring for SPRNF

Considering the wiring resistance, connect each detecting resistor as close as possible to the current detection terminals for the spindle drive SPRNF (pin 19) of the IC.



Optical disc ICs

(2) Filtering capacitor

It is recommended to connect 0.1μF filtering capacitor to CFIL terminals. This capacitor filters PWM output carrier frequency. Dispersion of the cut off frequency due to circuit board wiring layout is taken into consideration.

If it is difficult to filter at the recommended value due to circuit board wiring led round, the capacity can be increased. In this case, note that the output transmission delay time may be longer.

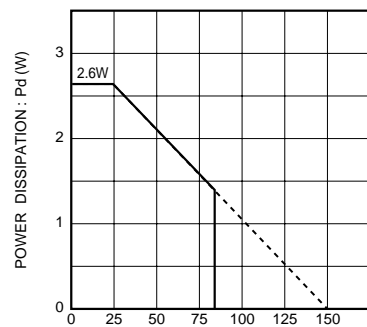
(3) Bypass capacitor

Please connect a bypass capacitor (0.1μF) across the supply voltage lines close to the IC pins and please connect large capacity and small ESR capacitor (10μF~) close to the power supply voltage lines.

(4) Supply fault, ground fault, and short-circuit between output terminals

Do not short-circuit between any output pin and supply pin (supply fault) or ground (ground fault), or between any output pins (load short-circuit). When mounting the IC on the circuit board, be extremely cautions about the orientation of the IC. If the orientation is mistaken, the IC may break down, and produce smoke in some cases.

●Electrical characteristic curves



AMBIENT TEMPERATURE : Ta (°C)  
 \* On less than 25.7% (percentage occupied by copper foil),  
 70x70mm<sup>2</sup>, t=1.6mm glass epoxy mounting.

Fig.4 Power dissipation

●External dimensions (Units : mm)

