



**THE DATASHEET OF  
MAX9381ESA**



System LSIs for Blu-ray Drive

# System Motor Driver IC for Half Height Drive(Sensor less)

BD7763EFV

**General Description**

BD7763EFV are 9ch system motor driver ICs, developed for the spindle motor, actuator coil, stepping motor, SA stepping motor and the loading motor drive of the Blu-ray drive. Since spindle driver adopts sensor less drive system and the hall sensor (3 pieces) of the motor position detection is not needed, it is suitable for making of flexible cable conserve wiring and the reductions of external parts. The actuator, loading driver, the spindle, stepping, and SA stepping use power MOSFET to reduce power consumption.

**Package(s)**

HTSSOP-B54      18.5mm x 9.5mm x 1.0mm



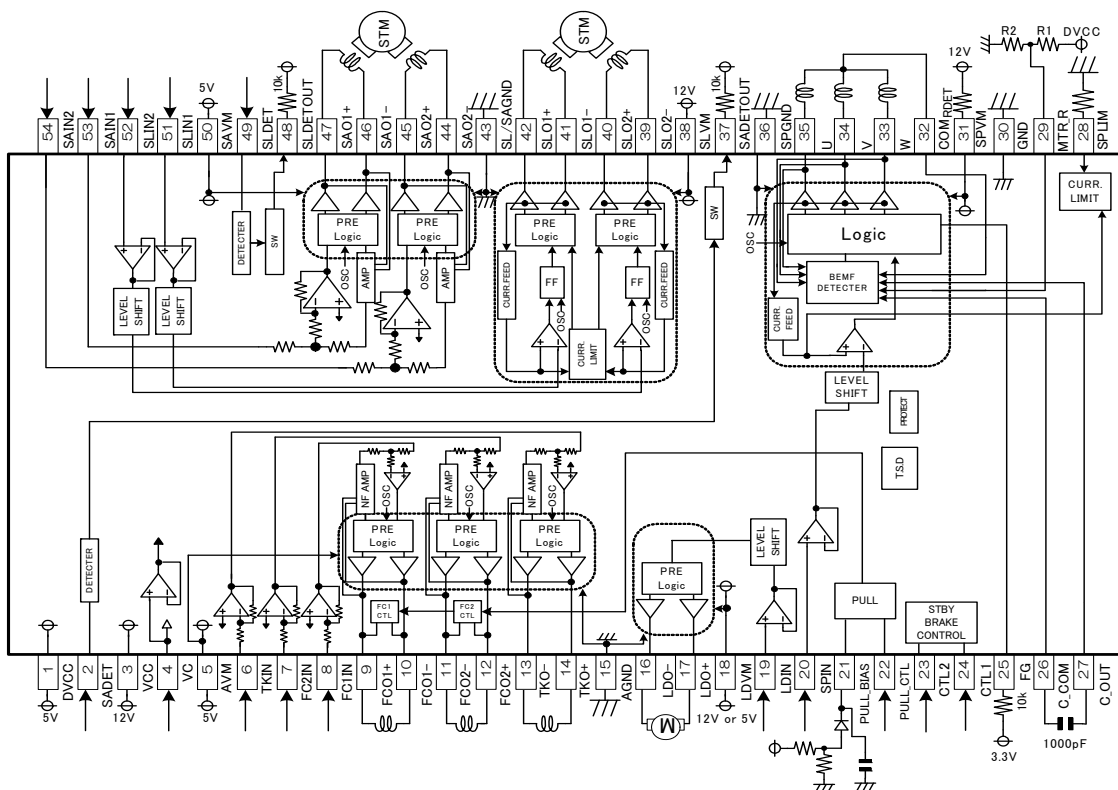
**Applications**

- For Blu-ray drive

**Features**

- The hall sensor is not needed by 3-phase sensor less drive system.
- The spindle motor driver achieves stability high speed start by ROHM's own energizing method.
- Spindle, stepping and SA stepping achieve high efficiency drive by PWM control driver. The actuator is able to reduce power consumption by using PWM drive system.
- The loading adopts forward/reverse-rotation drive system.
- ON/OFF of loading and other channels, brake mode of spindle driver, and stand-by mode are selectable by the two control terminals.
- Built-in thermal-shut down circuit.
- Improved heat radiation efficiency utilizing Im-type HTSSOP package with good thermal conductivity.

**Typical Application Circuit(s)**



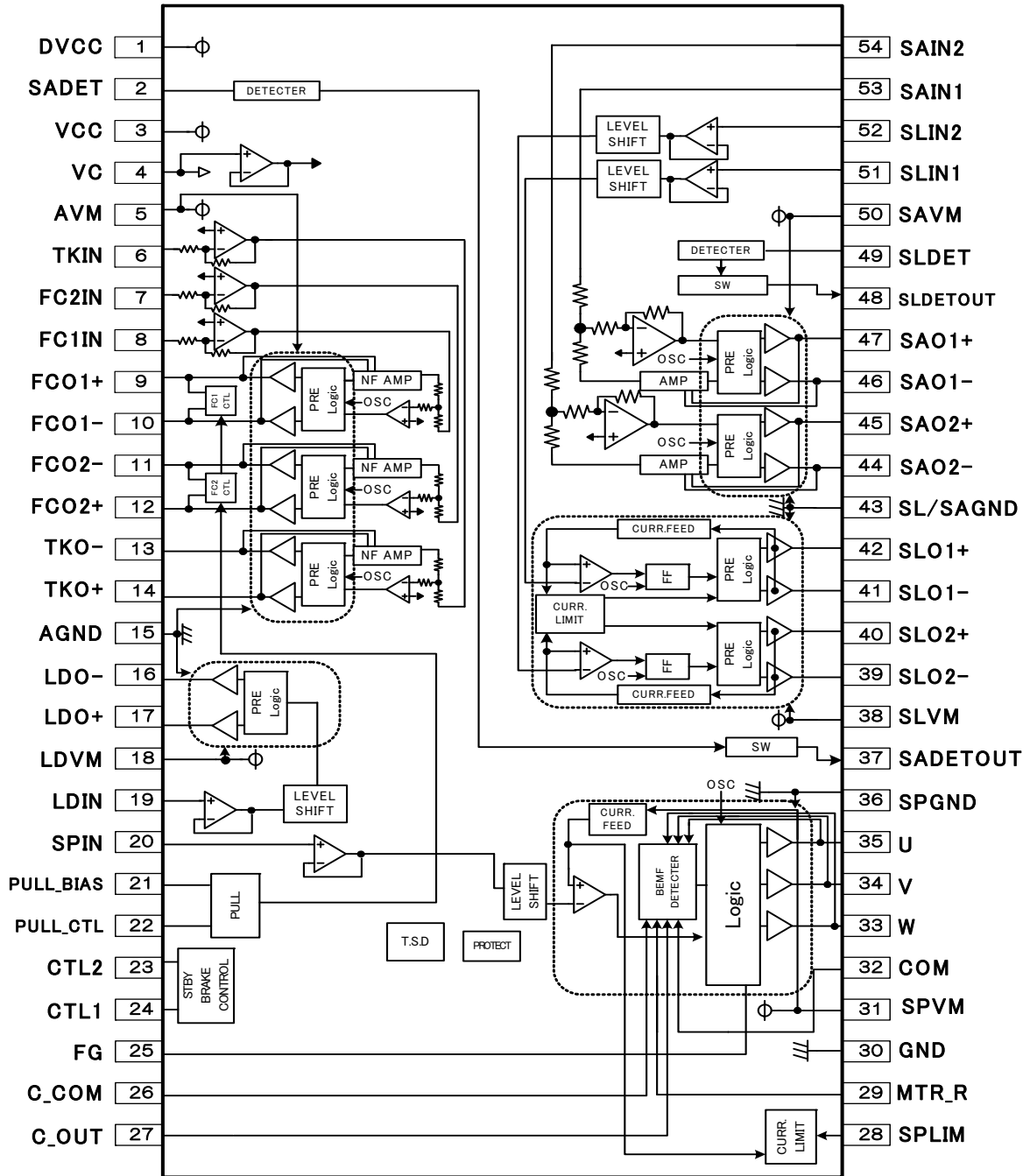
○Product structure : Silicon monolithic integrated circuit ○This product is not designed protection against radioactive rays.

## Pin Description(s)

No.	Symbol	Description	No.	Symbol	Description
1	DVcc	PWM block control power supply	28	SPLIM	Adjustable resistor connection for spindle driver current limit
2	SADET	SA motor detection signal control input	29	MTR_R	motor start pattern adjustment terminal
3	Vcc	Pre block power supply	30	GND	Pre block ground
4	VC	Reference voltage input	31	SPVM	Spindle driver power supply
5	AVM	Actuator driver block power supply	32	COM	Motor coil center point input
6	TKIN	Tracking driver input	33	W	Spindle driver output W
7	FC2IN	Focus 2 driver input	34	V	Spindle driver output V
8	FC1IN	Focus 1 driver input	35	U	Spindle driver output U
9	FCO1+	Focus 1 driver positive output	36	SPGND	Spindle driver power ground
10	FCO1-	Focus 1 driver negative output	37	SADETOUT	SA motor detection signal output
11	FCO2-	Focus 2 driver negative output	38	SLVM	Sled motor driver power supply
12	FCO2+	Focus 2 driver positive output	39	SLO2-	Sled driver 2 negative output
13	TKO-	Tracking driver negative output	40	SLO2+	Sled driver 2 positive output
14	TKO+	Tracking driver positive output	41	SLO1-	Sled driver 1 negative output
15	AGND	Actuator/Loading driver power ground	42	SLO1+	Sled driver 1 positive output
16	LDO-	Loading driver negative output	43	SL/SAGND	Sled/SA driver block pre and power ground
17	LDO+	Loading driver positive output	44	SAO2-	SA driver 2 negative output
18	LDVM	Loading driver block power supply	45	SAO2+	SA driver 2 positive output
19	LDIN	Loading driver input	46	SAO1-	SA driver 1 negative output
20	SPIN	Spindle driver input	47	SAO1+	SA driver 1 positive output
21	PULL_BIAS	Pick-up pull current control terminal	48	SLDETOUT	Sled motor detection signal output
22	PULL_CTL	Pick-up pull control terminal	49	SLDET	Sled motor detection signal control input
23	CTL2	Driver logic control 2 input	50	SAVM	SA driver power block power supply
24	CTL1	Driver logic control 1 input	51	SLIN1	Sled driver 1 input
25	FG	Frequency generator output	52	SLIN2	Sled driver 2 input
26	C_COM	Smooth capacitor connection terminal (com side)	53	SAIN1	SA driver 1 input
27	C_OUT	Smooth capacitor connection terminal (output side)	54	SAIN2	SA driver 2 input

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

Block Diagram(s)



## Absolute Maximum Ratings

Parameter	Symbol	Limits	Unit
POWER MOS power supply voltage 1	SPVM、SLVM、LDVM	15 #1	V
POWER MOS power supply voltage 2	SAVM、AVM	7 #2	V
Pre block power supply voltage	Vcc	15	V
PWM control block power supply voltage	DVcc	7	V
Power dissipation	Pd	2.00 #3	W
Operating temperature range	Topr	-20~75	°C
Storage temperature	Tstg	-55~150	°C
Junction temperature	Tjmax	150	°C

#1 POWER MOS output terminals (16~17pin, 39~42pin, 33~35pin) are contained.

#2 POWER MOS output terminals (9~14pin,44~47pin) are contained.

#3 PCB mounting (70mmX70mmX1.6mm, occupied copper foil is less than 3%, glass epoxy standard board).  
Reduce by 16mW/□ over 25□

## Recommended Operating Rating(s)

Parameter	Symbol	Min.	Typ.	Max.	Unit
Spindle / Sled motor driver power block power supply voltage	SPVM、SLVM	—	Vcc#4	—	V
Pre block power supply voltage	Vcc	10.8	12	13.2	V
Loading driver Pre block / power block supply voltage	LDVM	4.3	5.0	Vcc	V
SA, Actuator driver power block power supply voltage	SAVM、AVM	4.3	5.0	5.5	V
PWM control block power supply voltage	DVcc	4.3	5.0	5.5	V
Spindle driver output current	Iosp	—	1.0	2.5#5	A
Actuator, SA, sled, loading motor driver output current	Ioo	—	0.5	0.8	A

#4 Set the same supply voltage to SPVM, SLVM and Vcc.

#5 The current is guaranteed 3.5A in case of the Short-circuit braking mode and the current which is turned on/off in a duty-ratio of less than 1/10 with a maximum on-time of 5msec.

## Electrical Characteristic(s)

(Unless otherwise noted, Ta=25°C, Vcc=SPVM=SLVM=12V, DVcc=AVM=SAVM=LDVM=5V, Vc=1.65V, RL=8Ω, RLSP=2Ω, RDET=0.33Ω)

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Condition
<b>Circuit current</b>						
Quiescent current 1	IQ1	—	4.3	13	mA	Vcc (at loading OFF)
Quiescent current 2	IQ2	—	4.4	13	mA	Vcc (at loading ON)
Quiescent current 3	IQ3	—	14	42	mA	DVcc
Standby-on current 1	IST1	—	2.2	5	mA	Vcc
Standby-on current 2	IST2	—	1.5	4	mA	DVcc
<b>Sled driver block</b>						
Input dead zone (one side)	VDZSL	0	30	80	mV	
Input output gain	gmSL	0.86	1.15	1.44	A/V	
Output On resistor (top and bottom)	RONSL	—	2.2	3.3	Ω	IL=500mA
Output limit current	ILIMSL	0.8	1.1	1.4	A	
PWM frequency	foscSL	—	100	—	kHz	
<b>Spindle driver block &lt;Torque instruction input / output&gt;</b>						
Input dead zone (one side)	VDZSP	20	55	90	mV	
Input output gain	gmSP	0.86	1.15	1.44	A/V	
Output On resistor (top and bottom)	RONSP	—	1.0	1.7	Ω	IL=500mA
Output limit current	ILIMSP	0.88	1.04	1.20	A	RSPLIM=5.6kΩ
PWM frequency	foscSP	—	167	—	kHz	
<b>FG output, SLDETOUT output SADETOUT output</b>						
High voltage	VOH	2.3	3.2	—	V	10kΩ pull up to 3.3V
Low voltage	VOL	—	0.15	0.3	V	
<b>Focus 1 / Focus 2 / Tracking driver block</b>						
Output offset voltage	VOFACT	-50	0	50	mV	
Output On resistor (top and bottom)	RONACT	—	1.5	2.5	Ω	IL=500mA
Voltage gain	GVACT	15.7	17.5	19.3	dB	
Relative gain difference (FC1,FC2)	ΔGVFC	-1.0	0	1.0	dB	between positive outputs and between negative outputs
PWM frequency	foscACT	200	280	360	KHz	
<b>SA stepping driver block</b>						
Input dead zone (one side)	VDZSA	10	40	80	mV	
Input output gain	GVSA	15.5	17.5	19.5	dB	
Output On resistor (top and bottom)	RONSA	—	1.3	2.5	Ω	IL=200mA
PWM frequency	foscSA	200	300	400	kHz	
<b>Loading driver block</b>						
Input threshold voltage (IN>Vc)	VOFLD+	2.16	2.475	2.79	V	
Input threshold voltage (IN<Vc)	VOFLD-	0.51	0.825	1.14	V	
Output On resistor (top and bottom)	RONLD	—	1.5	2.5	Ω	IL=500mA
<b>CTL1, CTL2</b>						
Input high voltage	VIH	2.7	—	3.7	V	
Input middle voltage	VIM	1.4	—	2.0	V	
Input low voltage	VIL	GND	—	0.5	V	
<b>PULL_CTL</b>						
Input high voltage	VPH	2.0	—	3.7	V	
Input low voltage	VPL	GND	—	0.5	V	
<b>Others</b>						
VC input current	IVC	5	20	90	uA	
VC drop-muting	VMLVC	0.4	0.7	1.0	V	
VC over voltage muting	VMUVC	2.0	2.5	3.0	V	
Vcc drop-muting	VMVcc	3.45	3.85	4.25	V	

Functional description

1-1. Driver logic control terminal 1 and 2 (CTL1,2)

All drivers and spindle-drive braking modes can be switched on/off by inputting combinations of H-level signal (higher than 2.7V and lower than 3.7V), L-level(open) signal (lower than 0.5V) and M-level signal (higher than 1.4V and lower than 2.0V).

Driver ON/OFF logic table

mode	CTL1	CTL2	SP	SL(2ch)	ACT(3ch)	SA(2ch)	LOADIN G	
①	L	L	x	x	x	x	x	
②	H	L	x	x	x	x	o	
③	M	L	x	Inner detection	x	Inner detection	o	
④	L、H	H	o	o	o	o	x	o:ON
⑤	M	H	o	o	o	Inner detection	x	x:OFF
⑥	L、H	M	o	o	o	x	x	
⑦	M	M	o	Inner detection	o	x	x	

① Stand-by mode

The IC is brought into stand-by mode, and its power dissipation can be limited.

② Drivers muting

All output channels, except the loading, are muted and their outputs are turned off.

③ SL/SA inner detection mode

④ Loading OFF mode

⑤ SA inner detection mode

⑥ SA mute mode

⑦ SL inner detection mode

Spindle braking mode table

mode	CTL1	CTL2	SPIN > VC	SPIN < VC
⑧	M	M、H	Forward-rotation mode	Reverse-rotation braking mode
⑨	L	M、H		Short-circuit braking mode
⑩	H	M、H		Reverse-rotation braking mode

⑧⑩ Reverse-rotation braking mode (spindle)

When SPIN < VC, all outputs are shorted to SPVM in 4500rpm (Typ.) or more. In less than 4500rpm (Typ.), the outputs become reverse-rotation braking mode.

Rotation speed is less than 140rpm when SPIN < VC, all outputs are shorted to SPVM.

(However, the above-mentioned rotational speed is expressed in the case of 12pole motor.)

⑨ Short-circuit braking mode (spindle)

All spindle driver outputs are shorted to SPVM when SPIN < VC.

1-2. Spindle output mode

The spindle output changes as follows by the setting of SPIN.

Rotation speed	0rpm	400rpm	4500rpm
SPIN > VC	120° energizing	150° energizing	
SPIN < VC	120° energizing	150° energizing	Short brake

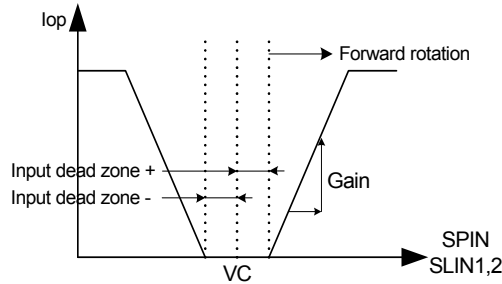
2. Output limit for spindle (SPLIM)

A=3844

$$I_{LIMSP} = \frac{A}{(R_{SPLIM}[\Omega] + 5600) \times (R_{DET}[\Omega])} \quad [A]$$

3. Torque command (SPIN) (SLIN1,2)

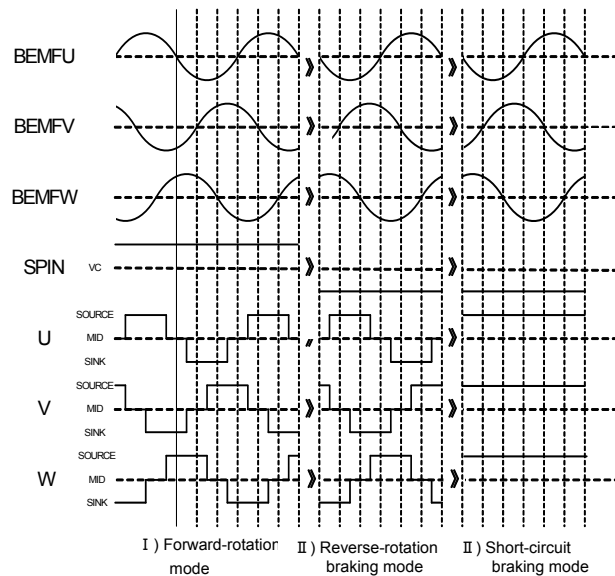
Torque command inputs vs. peak current value  $I_{op}$  or  $I_{oo}$  is expressed in the figure below:  
 The gain is defined by the inclination between two points.  
 (Please exclude the dead zone from the input voltage when calculating  $I_{op}$ .)



4. FG output (FG))

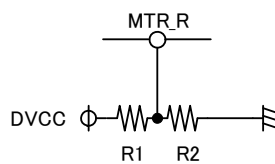
3FG output begins after 90° degrees in electric angle, after the start mode ends and the BEMF detection starts. When the rotational speed becomes 24rpm (Max.) or less in case of brake, the FG output is fixed to high.  
 The above-mentioned rotation speed applies to the 12 pole motor.

5. Input/Output timing chart



6. Motor start pattern adjustment terminal (MTR\_R)

There are eight pattern setting of MTR\_R. The voltage change can be canceled by connecting the power supply of external resistance R1 and R2 with DVCC. It is as follows of energizing time and a set voltage of MTR\_R. Please decide a set pattern by the adjustment with the spindle motor.



Pattern	Energizing time [us]	MTR_R setting voltage[V]	R1	R2
1	14	4.24	10kΩ	56kΩ
2	17	5	10kΩ	open
3	24	3.75	10kΩ	30kΩ
4	34	3.24	12kΩ	22kΩ
5	48	2.75	18kΩ	22kΩ
6	68	0	open	10kΩ
7	92	2.22	15kΩ	12kΩ
8	126	1.76	22kΩ	12kΩ

The MTR\_R setting voltage is a value in DVCC=5V.

7. Pick-up lens pull function

PULL_CTL	Function
L	ON
H	Normal (function:OFF)

FOCUS 1 and the FOCUS2 load are driven by the charge of the electrolytic capacitor connected with VCC (3pin). The load drive current flows as follows.

- FCO1-(10pin)→FCO1+(9pin)
- FCO2-(11pin)→FCO2+(12pin)

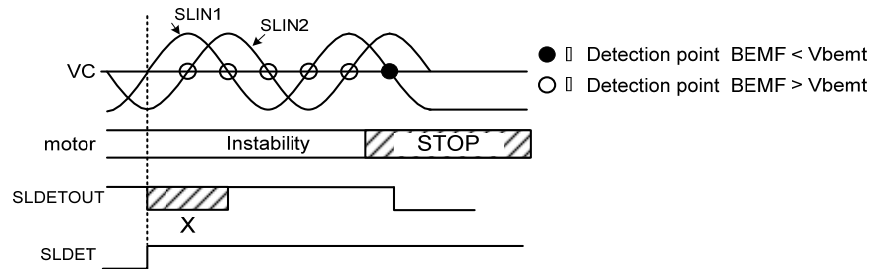
The load drive current and time can be adjusted according to the voltage of VCC(3pin) and PULL\_BIAS(21pin). After 30 ms(Typ.) when PULL\_CTL is made L, the FET Gate voltage is clamped to 1.67V(Typ.). The above-mentioned clamping function does not work when the DVcc drop-muting operates. Please turn off this function by PULL\_CTL=H when you use the driver usually.

8. Inner detection function

OSled

BEMF of the motor is monitored according to timing for the sled input signal of micro step drive to pass VC, and Sled is detected reaching the inner. The judgment voltage of BEMF can be set according to the voltage input to the SLDET. If BEMF below the judgment voltage is detected twice continuously, it becomes SLDETOUT=L. When the motor starts, the SLDETOUT might become L because BEMF is unstable. Please take measures such as installing the time of the mask when it starts for the detection prevention.

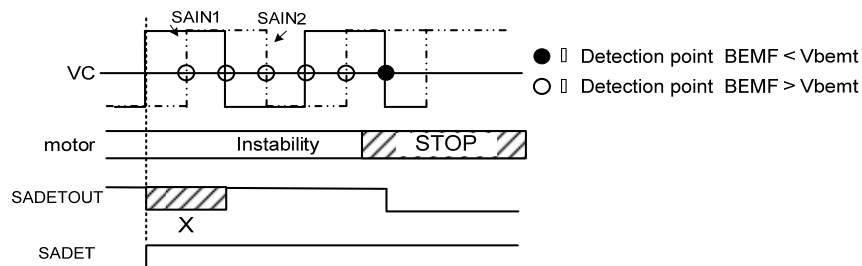
$$\text{Judgment voltage } V_{bemf}[V] = 0.62 \times (\text{SLDET}[V] - VC[V]) + 0.66$$



OSA

BEMF of the motor is monitored according to timing for SA input signal of two aspect excitation drive to pass VC, and SA is detected reaching the inner. The judgment voltage of BEMF can be set according to the voltage input to the SADET. If BEMF below the judgment voltage is detected once, it becomes SADETOUT=L. When the motor starts, the SADETOUT might become L because BEMF is unstable. Please take measures such as installing the time of the mask when it starts for the detection prevention.

$$\text{Judgment voltage } V_{bemf}[mV] = 31.6 \times \text{SADET}[V] + 3.4$$



9. PWM oscillation frequency

The PWM oscillation for driving the spindle and sled is free running.  
 The sled oscillating frequency is 100kHz (Typ.)  
 The spindle oscillating frequency is 167kHz (Typ.)

10. Muting functions

a) VC-drop muting

When the VC voltage drops to a value lower than 0.7V (Typ.) or higher than 2.5V(Typ.), the outputs of all the channels are turned off.

Please set the voltage of the VC from 1.0 to 2.0V.

b) Vcc-drop muting

When the voltage at DVcc terminal and Vcc terminal drop to lower than 3.85V (Typ.), the outputs of all the channels are turned off.

c) Over voltage protection circuit

When the voltage at SPVM terminal exceed 14.1V (Typ.), only the spindle block output is turned off.

**11. Protect system 1 (Load protection function)**

If full drive continues 130ms(Typ.) to protect focus, tracking, and tilt coil, this function protects IC by turning off actuator output.

※The protection function can be reset by CTL1,2=L(stand-by mode), when the protection function operates and the output is turned off.

**12. Protect system 2 (Connecting to VCC or GND)**

This function is to protect output POWER TR when the driver output connects to Vcc or GND.  
Spindle,SLED,Actuator,SA

When SINK side POWER TR has been turned on, if the output voltage

(SPVM/2&SLVM/2&AVM/2&SAVM/2<TYP> or more) is detected, the channel concerned will be turned off.

When SOURCE side POWER transistor has been turned on, if the output voltage

(SPVM/2&SLVM/2&AVM/2&SAVM/2<TYP> or less) is detected, the channel concerned will be turned off

**13. Protection system 3 (Over voltage input protection function)**

When detecting LDIN and SLIN1 input voltage more than  $DVCC \times 0.9$ <TYP>, this function protects motor by turning off the output.

※If protection function operates and output is turned off, protection function can be reset by CTL1, 2 =L(stand by mode)

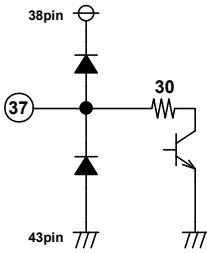
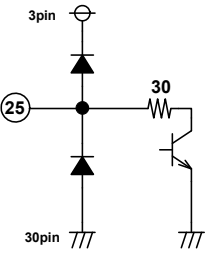
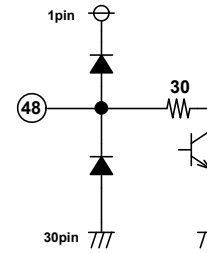
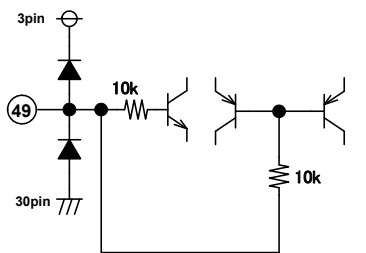
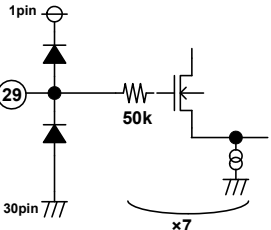
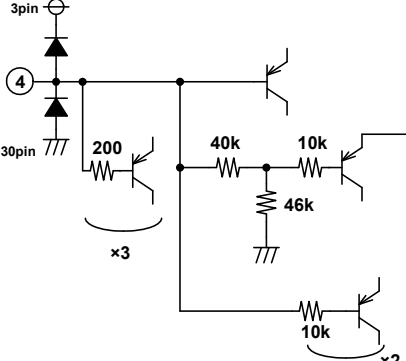
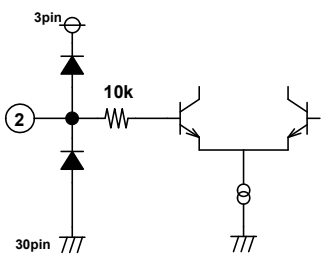
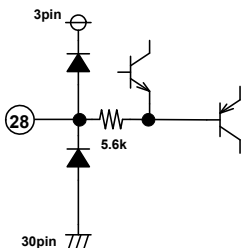
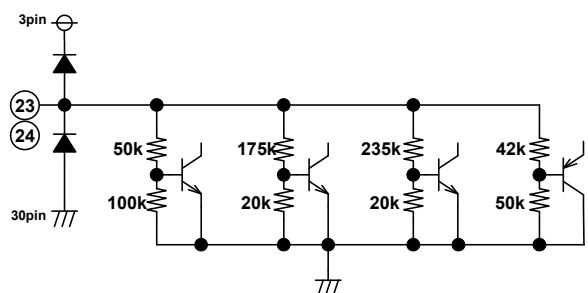
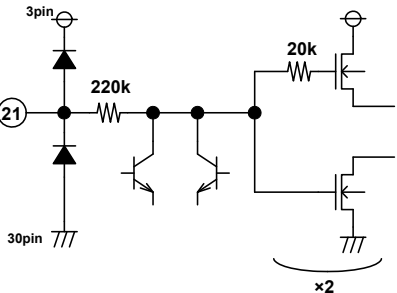
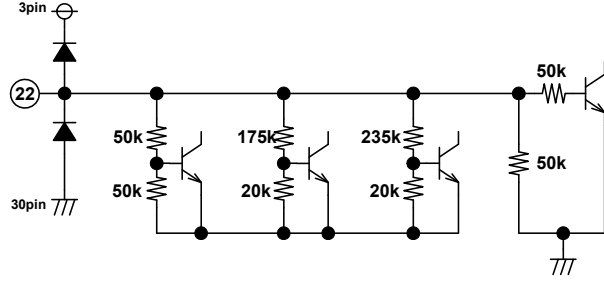
**14. Thermal-shut down**

Thermal-shutdown circuit (over-temperature protection circuit) is built in to prevent the IC from thermal breakdown. Use the IC according to the thermal loss allowed in the package. In case the IC is left running over the allowed loss, the junction temperature rises, and the thermal-shutdown circuit works at a 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 resumes operation.

I/O equivalence circuit

<p><b>Three-phase motor driver output</b></p>	<p><b>BEMF voltage detection input</b></p>	
<p><b>PWM driver output (SLED1,2)</b></p>	<p><b>PWM driver output (SA1,2)</b></p>	<p><b>PWM driver output (FC,TK,TL)</b></p>
<p><b>PWM driver output (LD)</b></p>	<p><b>PWM driver input (FC,TK,TL)</b></p>	<p><b>PWM driver input (SLED1,2)</b></p>
<p><b>PWM driver input (SA1,2)</b></p>	<p><b>PWM driver input (SP)</b></p>	<p><b>PWM driver input (LD)</b></p>

<p><b>SADETOUT signal output</b></p> 	<p><b>FG signal output</b></p> 	<p><b>SLDETOUT signal output</b></p> 	<p><b>SLED inner detection input(SLDET)</b></p> 
<p><b>Motor start pattern adjustment terminal(MTR-R)</b></p>	<p><b>Reference voltage input (VC)</b></p>	<p><b>SA inner detection input(SADET)</b></p>	
			
<p><b>Spindle driver current limit (SPLIM)</b></p>	<p><b>Driver logic control 2 input (CTL1,CTL2)</b></p>		
			
<p><b>Pick-up pull current control terminal(PULL_BIAS)</b></p>	<p><b>Pick-up pull control terminal(PULL_CTL)</b></p>		
			

## Operational Notes

### 1. Absolute maximum ratings

We are careful enough for quality control about this IC. So, there is no problem under normal operation, excluding that it exceeds the absolute maximum ratings. However, this IC might be destroyed when the absolute maximum ratings, such as impressed voltages ( $V_{cc}$ ,  $V_M$ ) or the operating temperature range( $T_{opr}$ ), is exceeded, and whether the destruction is short circuit mode or open circuit mode cannot be specified. Please take into consideration the physical countermeasures for safety, such as fusing, if a particular mode that exceeds the absolute maximum rating is assumed.

### 2. Power supply line

Due to switching and EMI noise generated by magnetic components (inductors and motors), using electrolytic and ceramic suppress filter capacitors(0.1 $\mu$ F) close to the IC power input terminals ( $V_{cc}$  and GND) is recommended. Please note: the electrolytic capacitor value decreases at lower temperatures.

Current rush might flow momentarily by the order of turning on the power supply and the delay in IC with two or more power supplies. Note the capacity of the power supply coupling, width and drawing the power supply and the GND pattern wiring.

Please make the power supply lines (where large current flow) wide enough to reduce the resistance of the power supply patterns, because the resistance of power supply pattern might influence the usual operation (output dynamic range etc...).

### 3. GND line

The ground line is where the lowest potential and transient voltages are connected to the IC.

### 4. Thermal design

Do not exceed the power dissipation ( $P_d$ ) of the package specification rating under actual operation, and please design enough temperature margins.

### 5. Short circuit mode between terminals and wrong mounting

Do not mount the IC in the wrong direction and be careful about the reverse-connection of the power connector. Moreover, this IC might be destroyed when the dust short the terminals between them or GND

### 6. Radiation

Strong electromagnetic radiation can cause operation failures.

### 7. ASO(Area of Safety Operation.)

Do not exceed the maximum ASO and the absolute maximum ratings of the output driver.

### 8. TSD(Thermal shut-down)

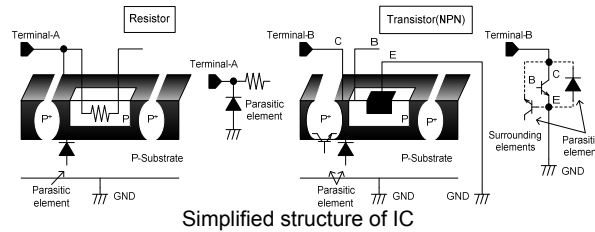
The TSD is activated when the junction temperature ( $T_j$ ) reaches 175°C(with 25°C hysteresis), and the output terminal is switched to Hi-z. The TSD circuit aims to intercept IC from high temperature. The guarantee and protection of IC are not purpose. Therefore, please do not use this IC after TSD circuit operates, nor use it for assumption that operates the TSD circuit.

### 9. Inspection by the set circuit board

The stress might hang to IC by connecting the capacitor to the terminal with low impedance. Then, please discharge electricity in each and all process. Moreover, in the inspection process, please turn off the power before mounting the IC, and turn on after mounting the IC. In addition, please take into consideration the countermeasures for electrostatic damage, such as giving the earth in assembly process, transportation or preservation.

10. Earth wiring pattern

This IC is a monolithic IC, and has P<sup>+</sup> isolation and P substrate for the element separation. Therefore, a parasitic PN junction is formed in this P-layer and N-layer of each element. For instance, the resistor or the transistor is connected to the terminal as shown in the figure below. When the GND voltage potential is greater than the voltage potential at Terminals A or B, the PN junction operates as a parasitic diode. In addition, the parasitic NPN transistor is formed in said parasitic diode and the N layer of surrounding elements close to said parasitic diode. These parasitic elements are formed in the IC because of the voltage relation. The parasitic element operating causes the wrong operation and destruction. Therefore, please be careful so as not to operate the parasitic elements by impressing to input terminals lower voltage than GND(P substrate). Please do not apply the voltage to the input terminal when the power-supply voltage is not impressed. Moreover, please impress each input terminal lower than the power-supply voltage or equal to the specified range in the guaranteed voltage when the power-supply voltage is impressing.



11. Earth wiring pattern

Use separate ground lines for control signals and high current power driver outputs. Because these high current outputs that flows to the wire impedance changes the GND voltage for control signal. Therefore, each ground terminal of IC must be connected at the one point on the set circuit board. As for GND of external parts, it is similar to the above-mentioned.

12. Reverse-rotation braking

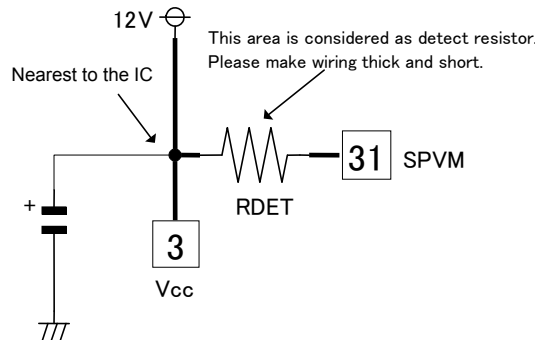
In the case of reverse-rotation braking from high speed rotation, pay good attention to reverse electromotive force. Furthermore, fully check the voltage to be applied to the output terminal and consider the revolutions applied to the reverse-rotation brake.

13. About the capacitor between SPVM and SPGND

The capacitor between SPVM and SPGND absorbs the change in a steep voltage and the current because of the PWM drive, as a result, there is a role to suppress the disorder of the SPVM voltage. However, the effect falls by the influence of the wiring impedance etc, if the capacitor becomes far from IC. Please examine the capacitor between SPVM and SPGND to arrange it near IC.

14. About wiring between SPVM and RNF

Please be careful about the wiring resistor for power supply terminal (current detect terminal) of spindle. Detect resistor should be connected by being shorted to the IC as near as possible.

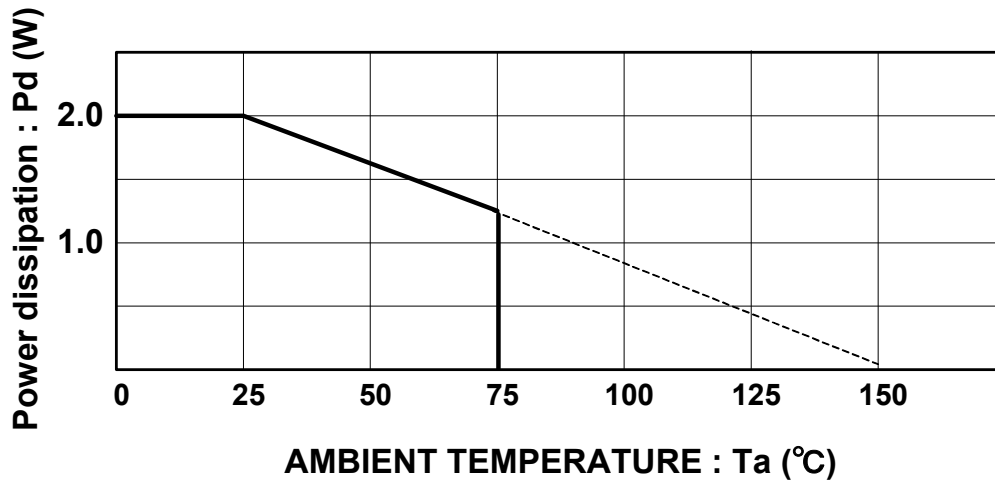


Status of this document

The Japanese version of this document is formal specification. A customer may use this translation version only for a reference to help reading the formal version.

If there are any differences in translation version of this document formal version takes priority

Power Dissipation



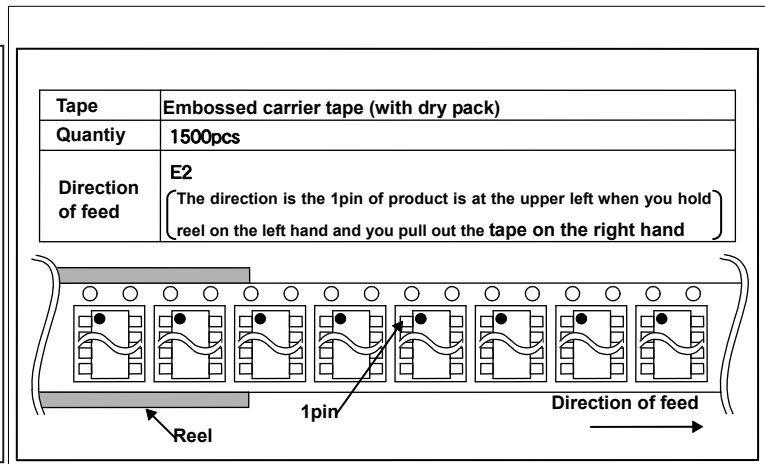
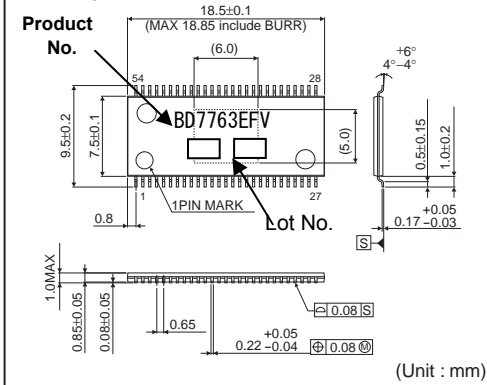
Ordering Information

B D 7 7 6 3 E F V	E 2
Part Number	Packaging and forming specification E2: Embossed tape and reel
Package EFV: HTSSOP-B54	

Physical Dimension Tape and Reel Information

HTSSOP-B54

<Package outlines>



# Notice

## Precaution on using ROHM Products

- Our Products are designed and manufactured for application in ordinary electronic equipments (such as AV equipment, OA equipment, telecommunication equipment, home electronic appliances, amusement equipment, etc.). If you intend to use our Products in devices requiring extremely high reliability (such as medical equipment <sup>(Note 1)</sup>, transport equipment, traffic equipment, aircraft/spacecraft, nuclear power controllers, fuel controllers, car equipment including car accessories, safety devices, etc.) and whose malfunction or failure may cause loss of human life, bodily injury or serious damage to property ("Specific Applications"), please consult with the ROHM sales representative in advance. Unless otherwise agreed in writing by ROHM in advance, ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of any ROHM's Products for Specific Applications.

(Note1) Medical Equipment Classification of the Specific Applications

JAPAN	USA	EU	CHINA
CLASS III	CLASS III	CLASS II b	CLASS III
CLASS IV		CLASS III	

- ROHM designs and manufactures its Products subject to strict quality control system. However, semiconductor products can fail or malfunction at a certain rate. Please be sure to implement, at your own responsibilities, adequate safety measures including but not limited to fail-safe design against the physical injury, damage to any property, which a failure or malfunction of our Products may cause. The following are examples of safety measures:
  - Installation of protection circuits or other protective devices to improve system safety
  - Installation of redundant circuits to reduce the impact of single or multiple circuit failure
- Our Products are designed and manufactured for use under standard conditions and not under any special or extraordinary environments or conditions, as exemplified below. Accordingly, ROHM shall not be in any way responsible or liable for any damages, expenses or losses arising from the use of any ROHM's Products under any special or extraordinary environments or conditions. If you intend to use our Products under any special or extraordinary environments or conditions (as exemplified below), your independent verification and confirmation of product performance, reliability, etc. prior to use, must be necessary:
  - Use of our Products in any types of liquid, including water, oils, chemicals, and organic solvents
  - Use of our Products outdoors or in places where the Products are exposed to direct sunlight or dust
  - Use of our Products in places where the Products are exposed to sea wind or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - Use of our Products in places where the Products are exposed to static electricity or electromagnetic waves
  - Use of our Products in proximity to heat-producing components, plastic cords, or other flammable items
  - Sealing or coating our Products with resin or other coating materials
  - Use of our Products without cleaning residue of flux (even if you use no-clean type fluxes, cleaning residue of flux is recommended); or Washing our Products by using water or water-soluble cleaning agents for cleaning residue after soldering
  - Use of the Products in places subject to dew condensation
- The Products are not subject to radiation-proof design.
- Please verify and confirm characteristics of the final or mounted products in using the Products.
- In particular, if a transient load (a large amount of load applied in a short period of time, such as pulse. is applied, confirmation of performance characteristics after on-board mounting is strongly recommended. Avoid applying power exceeding normal rated power; exceeding the power rating under steady-state loading condition may negatively affect product performance and reliability.
- De-rate Power Dissipation (Pd) depending on Ambient temperature (Ta). When used in sealed area, confirm the actual ambient temperature.
- Confirm that operation temperature is within the specified range described in the product specification.
- ROHM shall not be in any way responsible or liable for failure induced under deviant condition from what is defined in this document.

## Precaution for Mounting / Circuit board design

- When a highly active halogenous (chlorine, bromine, etc.) flux is used, the residue of flux may negatively affect product performance and reliability.
- In principle, the reflow soldering method must be used on a surface-mount products, the flow soldering method must be used on a through hole mount products. If the flow soldering method is preferred on a surface-mount products, please consult with the ROHM representative in advance.

For details, please refer to ROHM Mounting specification

**Precautions Regarding Application Examples and External Circuits**

1. If change is made to the constant of an external circuit, please allow a sufficient margin considering variations of the characteristics of the Products and external components, including transient characteristics, as well as static characteristics.
2. You agree that application notes, reference designs, and associated data and information contained in this document are presented only as guidance for Products use. Therefore, in case you use such information, you are solely responsible for it and you must exercise your own independent verification and judgment in the use of such information contained in this document. ROHM shall not be in any way responsible or liable for any damages, expenses or losses incurred by you or third parties arising from the use of such information.

**Precaution for Electrostatic**

This Product is electrostatic sensitive product, which may be damaged due to electrostatic discharge. Please take proper caution in your manufacturing process and storage so that voltage exceeding the Products maximum rating will not be applied to Products. Please take special care under dry condition (e.g. Grounding of human body / equipment / solder iron, isolation from charged objects, setting of Ionizer, friction prevention and temperature / humidity control).

**Precaution for Storage / Transportation**

1. Product performance and soldered connections may deteriorate if the Products are stored in the places where:
  - [a] the Products are exposed to sea winds or corrosive gases, including Cl<sub>2</sub>, H<sub>2</sub>S, NH<sub>3</sub>, SO<sub>2</sub>, and NO<sub>2</sub>
  - [b] the temperature or humidity exceeds those recommended by ROHM
  - [c] the Products are exposed to direct sunshine or condensation
  - [d] the Products are exposed to high Electrostatic
2. Even under ROHM recommended storage condition, solderability of products out of recommended storage time period may be degraded. It is strongly recommended to confirm solderability before using Products of which storage time is exceeding the recommended storage time period.
3. Store / transport cartons in the correct direction, which is indicated on a carton with a symbol. Otherwise bent leads may occur due to excessive stress applied when dropping of a carton.
4. Use Products within the specified time after opening a humidity barrier bag. Baking is required before using Products of which storage time is exceeding the recommended storage time period.

**Precaution for Product Label**

QR code printed on ROHM Products label is for ROHM's internal use only.

**Precaution for Disposition**

When disposing Products please dispose them properly using an authorized industry waste company.

**Precaution for Foreign Exchange and Foreign Trade act**

Since concerned goods might be fallen under listed items of export control prescribed by Foreign exchange and Foreign trade act, please consult with ROHM in case of export.

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