Reversible Motor Driver IC Series for Brush Motors

Reversible Motor Drivers for Output 0.8A or less 1 Motor

(with variable speed function)

BA6950FS,BA6951FS

●Description

The BA6950FS and BA6951FS are reversible motor drivers that can directly drive brush type motors which require normal and reverse rotations. Four modes of output setting are available by the use of input logic (2 inputs); namely, normal, reverse, stop (idling), and braking. In addition, since voltage applied to motors varies in accord with the control terminal, motor rotating speed can be optionally set and by the built-in current feedback amplifier, the motor can be driven at a constant speed.

●Features

1) Four-mode outputs of normal rotation, reverse rotation, stop (idling), and braking are enabled in compliance with input logic (2 inputs) of Control Logic.
2) Motor speed can be varied by Vcontrol signal.
3) Motors can be driven at a constant speed by a current feedback amplifier.
4) Control gain can be freely set by external resistors.
5) Built-in thermal shutdown circuit (TSD)
6) Built-in current limiting function (BD6951FS).

●Applications

VTR, audio equipment in general, OA equipment in general

●Absolute maximum ratings (Ta=25℃)

Parameter	Symbol	Limits		Unit
		BA6950FS	BA6951FS	
Supply voltage	VCC	8	8	V
Supply voltage	VB	18	18	V
Power dissipation	Pd	*800	*800	mW
Operating temperature	Topr	-20～+75	-20～+75	℃
Storage temperature	Tstg	-55～+150	-55～+150	℃
Output current	Iout	**400	**800	mA
Junction temperature	Tjmax	150		℃

* *with 90 mm x 50 mm x 1.6 mm glass epoxy substrate mounted.

* When used at Ta=25°C or higher, derated at 6.4 mW/°C.

** However, do not allow current to exceed Pd and ASO.

●Recommended operating range（common）(Ta＝25℃)

Parameter	Symbol	Range	Unit
Supply voltage	VCC	3～6	V
Supply voltage	VB	3～16	V
VCTL voltage	VCTL	0～(VCC-1.8V)	V

●Electrical characteristics

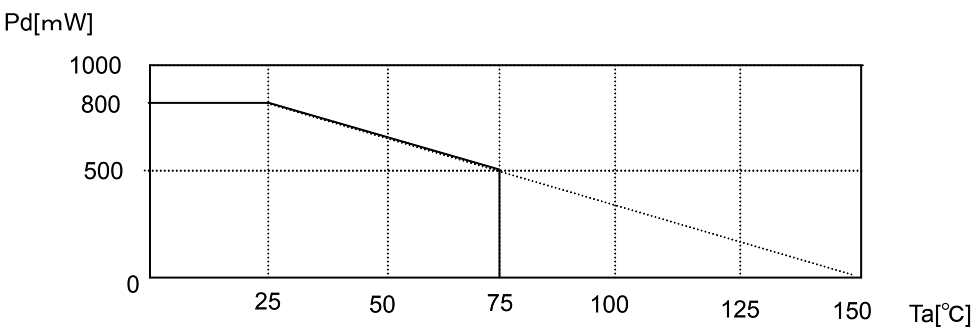
BA6950FS(Unless otherwise specified,　Ta＝25℃, VCC=4.8V,VB=4.8V)

Parameter	Symbol	Limits			Unit	Conditions
		Min.	Typ.	Max.		
Supply current 1	ICC1	-	4.0	6.0	mA	(RIN,FIN)=(L,H)or(H,L), VCTL=0V
Supply current 2	ICC2	-	0.7	1.5	mA	(RIN,FIN)=(L,L), VCTL=0V
Supply current 3	IBoff	-	0	1.0	μA	@Vcc=0V
Input threshold voltage ”H”	VR/F H	2.0	-	-	V	
Input threshold voltage ”L”	VR/F L	-	-	0.8	V	
Input bias current	IR/F H	-	80	135	μA	RIN=2V, FIN=2V
CTL AMP offset	VCTL ofs	-5.0	-	+5.0	mV	(VCTL-RC) @VCTL=0V, 1V
CTL AMP gain	VCTL Ga	40	46	52	μA/V	△IRT1/1@VCTL=2V, 1V
CTL output ratio 1	ICTLR1	0.85	1	1.15	ratio	IRT1/IRC@IRC=20μA
CTL output ratio 2	ICTLR2	0.90	1	1.10	ratio	IRT1/IRC@IRC=200μA
CSAMP offset	CS ofs	-5.0	-	+5.0	mV	CS1-CS2) @CS1=0V, 0.1V
CS output ratio 1	ICSR1	0.85	1	1.15	ratio	IRT2/ICS2@ICS=20μA
CS output ratio 2	ICSR2	0.90	1	1.10	ratio	IRT2/ICS2@ICS=200μA
Output H voltage	VH	2.0	4.6	-	V	VM1,VM2 @VCTL=0.2V
Output saturation voltage L	VOL	-	0.07	0.2	V	RT1=VCC@ I_O=50mA
Output saturation voltage H	VOH	-	0.09	0.3	V	RT1=VCC@I_O=50mA

BA6951FS(Unless otherwise specified,　Ta＝25℃, VCC=4.8V,VB=4.8V)

Parameter	Symbol	Limits			Unit	Condition
		Min.	Typ.	Max.		
Supply current 1	ICC1	-	4.0	6.0	mA	(RIN,FIN)=(L,H)or(H,L), VCTL=0V
Supply current 2	ICC2	-	0.7	1.5	mA	(RIN,FIN)=(L,L), VCTL=0V
Supply current 3	IBoff	-	0	1.0	μA	VCC=0V の時の IB
Input threshold voltage ”H”	VR/F H	2.0	-	-	V	
Input threshold voltage ”L”	VR/F L	-	-	0.8	V	
Input bias current	IR/F H	-	80	135	μA	RIN=2V, FIN=2V
CTL AMP offset	VCTL ofs	-5.0	-	+5.0	mV	(VCTL-RC)@ VCTL=0V, 1V
CTL AMP gain	VCTL Ga	40	46	52	μA/V	△IRT1/1@ VCTL=2V, 1V
CTL output ratio 1	ICTLR1	0.85	1	1.15	ratio	IRT1/IRC@ IRC=20μA
CTL output ratio 2	ICTLR2	0.90	1	1.10	ratio	IRT1/IRC@ IRC=200μA
CSAMP offset	CS ofs	-5.0	-	+5.0	mV	(ATC-CS)@ ATC=0V, 0.1V
CS output ratio 1	ICSR1	0.85	1	1.15	ratio	IRT2/ICS@ ICS=20μA
CS output ratio 2	ICSR2	0.90	1	1.10	ratio	IRT2/ICS@ ICS=200μA
TL-R_{ATC} offset	TL-$R_A$ofs	6	18	30	mV	TL=0.3V, R_{ATC}=1.0Ω
Output H voltage	VH	1.85	2.2	2.55	V	VCTL=1.0V
Output saturation voltage L	VOL	-	0.28	0.56	V	RT1=VCC@ I_O=300mA
Output saturation voltage H	VOH	-	0.32	0.64	V	RT1=VCC@ I_O=300mA

●Thermal derating curves



* with 90 mm x 50 mm x 1.6 mm glass epoxy substrate mounted.

*When used at Ta=25℃ or higher, derated at 6.4mW/℃.

Fig.1

●Reference data

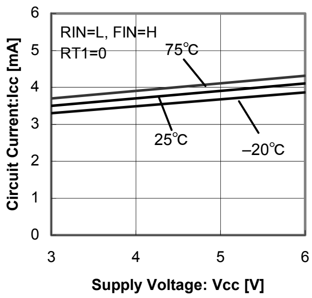


Fig.2 Supply voltage 1(FWD)
(BA6950FS)

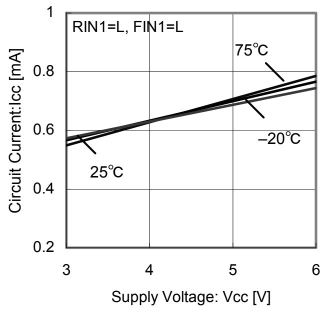


Fig.3 Supply voltage 2(IDLE)
(BA6950FS)

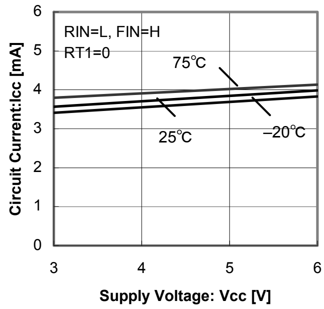


Fig.4 Supply current 1(FWD)
(BA6951FS)

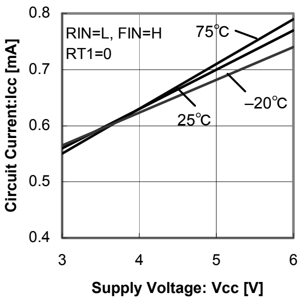


Fig.5 Supply current 2(IDLE)
(BA6951FS)

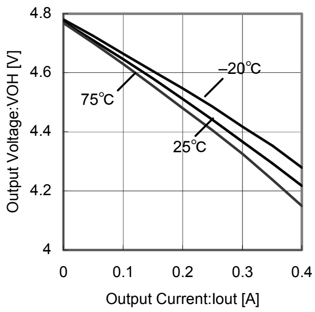


Fig.6 Output saturation voltage H
(BA6950FS)

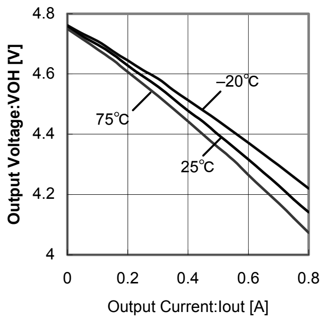


Fig.7 Output saturation voltage H
(BA6951FS)

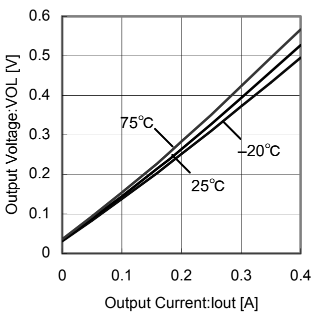


Fig.8 Output saturation voltage L
(BA6950FS)

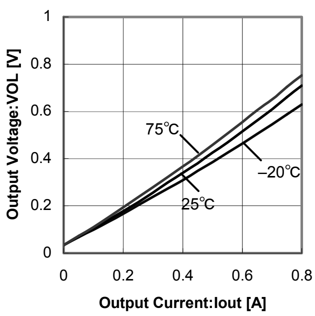


Fig.9 Output saturation voltage L
(BA6951FS)

●Truth table

FIN	RIN	M1	M2	Mode
H	L	L	H	Forward
L	H	H	L	Reverse
H	H	L	L	Brake
L	L	OPEN		Standby

●Block diagram, application circuit

BA6950FS

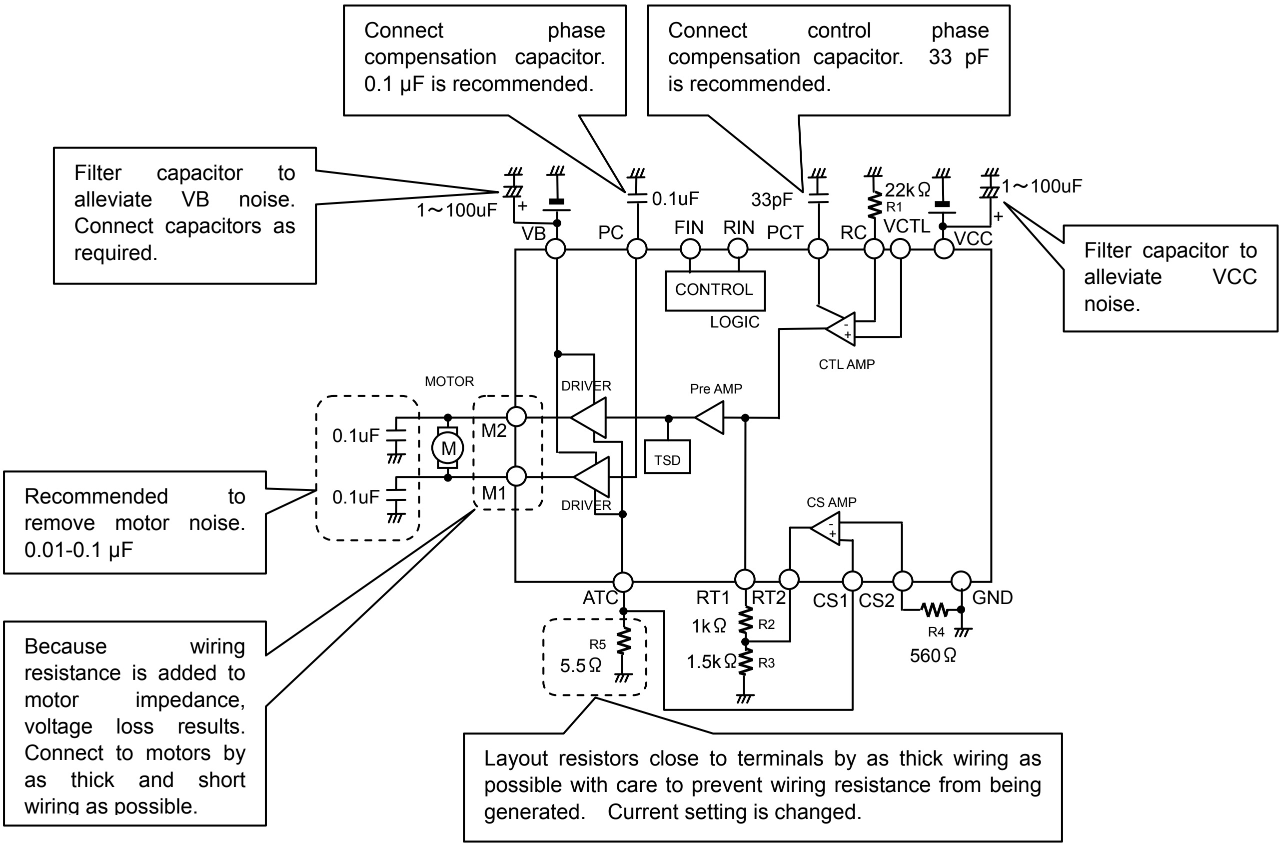


Fig.10

PIN No.	Pin name	Function
1	GND	Ground
2	VCTL	Control voltage input pin
3	RC	Control gain setting pin
4	PCT	Phase compensation for CTL amp
5	RIN	Control logic input
6	VB	Power supply for driver
7	M1	Driver output
8	ATC	Power ground
9	M2	Driver output
10	FIN	Control logic input
11	PC	Phase compensation for small signal
12	VCC	Power supply for small signal
13	CS1	CS amp gain setting pin
14	CS2	CS amp gain setting pin
15	RT2	Control gain setting pin
16	RT1	Control gain setting pin

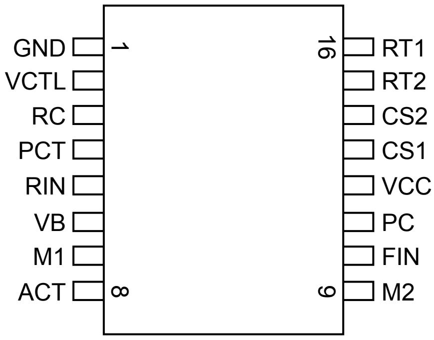


Fig.11

BA6951FS

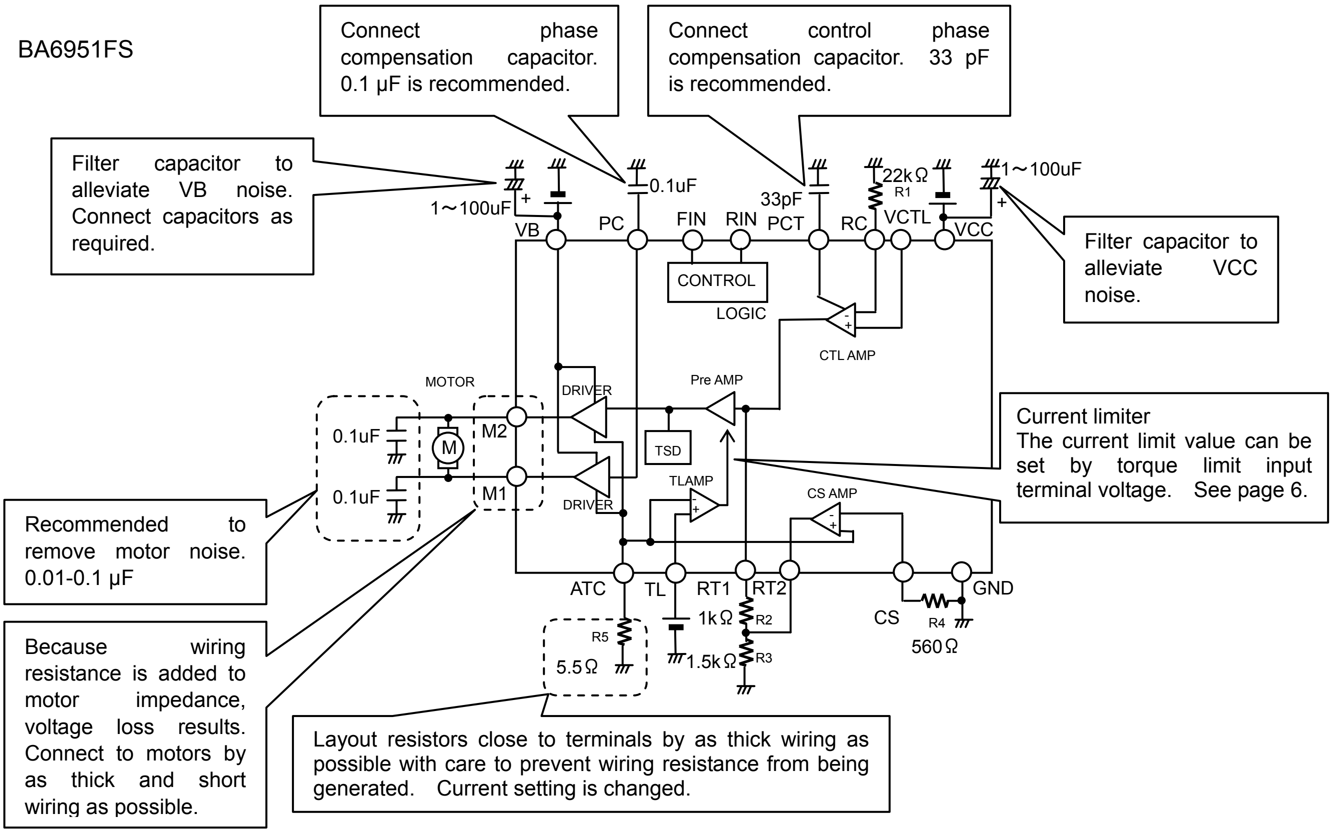


Fig.12

Pin No.	Pin Name	Function
1	GND	Ground
2	VCTL	Control voltage input pin
3	RC	Control gain setting pin
4	PCT	Phase compensation for CTL amp
5	RIN	Control logic input
6	VB	Power supply for driver
7	M1	Driver output
8	ATC	Power ground
9	M2	Driver output
10	FIN	Control logic input
11	PC	Phase compensation for small signal
12	VCC	Power supply for small signal
13	TL	Torque limiter setting pin
14	CS	CS amp gain setting pin
15	RT2	Control gain setting pin
16	RT1	Control gain setting pin

●Interfaces BA6950FS、BA6951FS

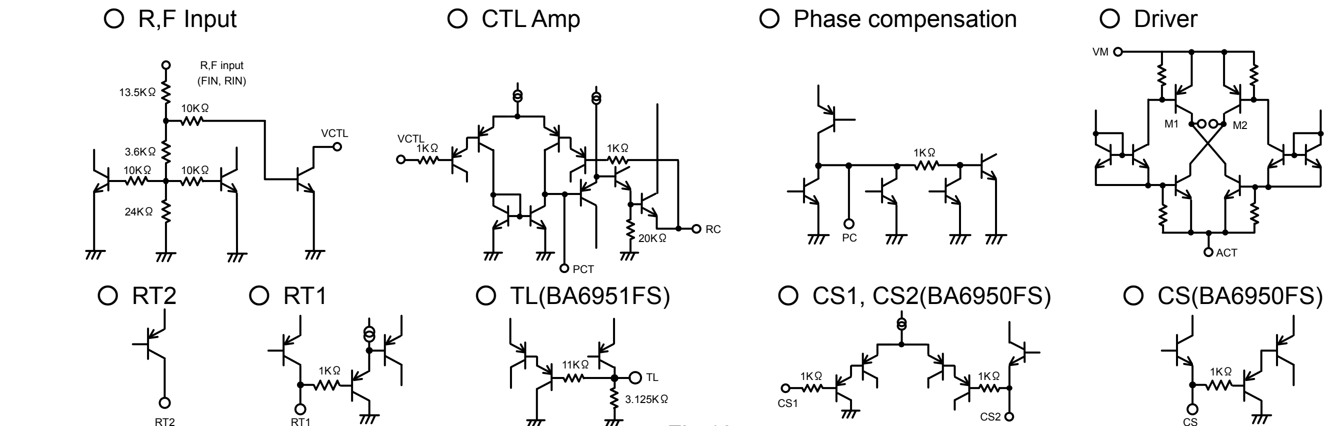


Fig.13

●Operations

(1) Description on input sections (FIN, RIN) and I/O mode

Terminal to enter control signals. Operation of each mode is described as follows.

When FIN is "H" and RIN is "L," the normal rotating mode is achieved and current flows from M2 to M1. When FIN is "L" and RIN is "H," the reverse rotating mode is achieved, and current flows from M1 to M2. When both FIN and RIN are "H", the brake mode is achieved. Operation in such event takes place as follows: the upper-side output transistor turns OFF to stop supplying motor driving current and the lower-side output transistor turns ON to absorb back electromotive force and apply brake to the motor. When both FIN and RIN are "L," M1 and M2 reach open potential (all output transistors OFF) and the motor stops.

(2) Motor speed control servo function

It is possible to vary output H voltage by controlling input voltage of control AMP (CTRL) and optionally set the motor rotating speed.

In addition, it is also possible to drive motors with constant speed servo applied by feeding back motor current to the output with a built-in current feedback amplifier.

It is possible to set output H voltage control gain and current feedback amplifier gain in conformity to Eq. [1] through [4] from resistance values of R1 through R4.

Output H voltage control gain: $\Delta VOH / \Delta VCTRL = (R2+R3) \times 4 / R1$

Current feedback AMP gain: $\Delta VH / \Delta I8pin(ATC) = R5 \times R3 \times 4 / R4$

(3) CTL AMP(control amplifier)

This is an amplifier to set motor output High voltage. By adjusting the motor output High voltage, it is possible to control the motor rotating speed. The current which flows out from 16pin(RT1) is created from 2pin(VCTL) voltage and R1 resistance value in compliance with Eq. [1].

I16pin(IRT1)=V2pin/R1 V2pin(VCTL)/R1 ・・・[1]

(4) CS AMP(current sense amplifier)

CS AMP is an amplifier which has a function to multiply the current flowing to motors (current that flows out from ATC) by R5/R4 and allow the current to flow out from the RT2 terminal. CS AMP detects current that flows to motors by resistor R5 connected to 8pin(ATC) and enters it to the CSAMP+ side. The CSAMP output is outputted as constant current from 15pin(RT2). This current is expressed by Eq. [2] from the current that flows out from 8pin(ATC) and resistance values of R4 and R5.

I15pin(IRT2)=I8pin(ACT)×R5/R4 ・・・[2]

CS AMP gain can be adjusted by resistance values of R4 and R5.

(5) Pre AMP(preamplifier)

CTR AMP output and CSAMP output are added and entered into PreAMP. PreAMP outputs voltage four times as much as the input voltage" to 9pin(HI side) in compliance with Eq. [4]. This voltage is created from currents I16pin and I15pin created by CTR AMP and CS AMP and resistance values of R2 and R3 in compliance with Eq. [3].

V16pin=R3×(I16pin+I15pin)+R2×I16pin ・・・[3]

V7,9pin=4×V16pin(Typ.) ・・・[4]

Now, by adjusting R2 and R3, the radio of CS AMP output added to CTRL AMP output added can be varied.

(6) Setting of motor rotating speed

The motor rotating speed is determined by the motor output High voltage. The motor output High voltage is determined by Eq. [1] through [4]. That is, it is not determined by the VCTL input voltage only but R1 through R5 resistance values are involved, too. It is recommended to first set R1 through R5 resistance values to the recommended values and adjust the motor output High voltage by the VCTL voltage.

(7) DRIVER

This is an I/O section circuit that supplies voltage to the motor output in compliance with signals from PreAMP.

(8) TLAMP (current limit AMP) (BA6951FS)

In the event that motor current flows to R5 and the generated voltage exceeds the torque limit terminal input voltage VTL, control is activated to lower output H voltage and limit the motor current. The current limit I_{limit} can be expressed by Eq. [5].

$I_{limit} = VTL / R5$ ・・・[5]

●Constant setting method

Resistors R1 through R5 which set output H voltage control gain and current feedback AMP gain can be set by Eq. [1] through Eq. [4]. In such event, it is recommended to set resistors within the range of recommended conditions of the table below.

Constant	Parameter	Conditions	Method
R1	I16pin(RT1)	I16pin＜1 mA	Equation [1]
R5	V8pin(ATC)	V8pin＜1 V	V8pin = R5 × IOUT
R4	I15pin(RT2)	I15pin＜1 mA	Equation [2]
R2+R3	V16pin(RT1)	V16pin＜VCC/4	Equation [3]
R2／R3	Ratio		Check the stability at constant velocity drive.

●Cautions on use

1) Absolute Maximum Ratings
For the present product, thoroughgoing quality control is carried out, but in the event that applied voltage, working temperature range, and other absolute maximum rating are exceeded, the present product may be destroyed. Because it is unable to identify the short mode, open mode, etc., if any special mode is assumed, which exceeds the absolute maximum rating, physical safety measures are requested to be taken, such as fuses, etc.

2) Reverse connection of power supply connector
Reverse connection of power supply connector may destroy the IC. Take necessary measures to protect the IC from reverse connection breakage such as externally inserting diodes across power supply and IC power supply terminal as well as across power supply and motor coil.

3) Power supply line
Because return of current regenerated by Back-EMF of a motor occurs, take necessary measures such as inserting capacitors across the power supply and GND as a path for regenerated current, and determine the capacity value after thoroughly confirming that there would be no problems in various characteristics such as capacitance drop at low temperature which may occur with electrolytic capacitors. By the way, in the event that the power supply connected does not have sufficient current absorbing capability, voltage of the power supply line rises due to regenerative current and there is a fear in that the present product including the peripheral circuits exceeds the absolute maximum rating. It is therefore requested to provide physical safety measures, such as inserting a diode for voltage clamp across power supply and GND, etc.

4) Electrical potential at GND
Keep the GND terminal potential to the minimum potential under any operating condition. In addition, check if there is actually any terminal, which provides voltage below GND including transient phenomena.

5) Thermal design
Consider the power dissipation (Pd) under actual working condition and carry out thermal design with sufficient margin provided.

6) Short-circuiting between terminals, and mismounting
When mounting to PCB, care must be taken to avoid mistake in its orientation and alignment. Failure to do so may result in IC breakdown. Short-circuiting due to foreign matters entered between output terminals, or between output and power supply or GND may also cause breakdown.

7) Operation in strong electromagnetic field
The use in the strong electromagnetic field may sometimes cause malfunction, to which care must be taken.

8) ASO
When IC is used, design in such a manner that the output transistor does not exceed absolute maximum ratings and ASO.

9) Built-in thermal shutdown circuit
When junction temperature (Tj) becomes thermal shutdown ON temperature 175°C, the thermal shutdown circuit (TSD circuit) is activated and turns OFF all the coil outputs to motors. In addition, there is 20°C temperature hysteresis. The thermal shutdown protection circuit is first and foremost intended for interrupt IC from thermal runaway, and is not intended to protect and warrant the IC. Consequently, never attempt to continuously use the IC after this circuit is activated or to use the circuit with the activation of the circuit premised.

10) Capacitor across output and GND
In the event a large capacitor is connected across output and GND, when VCC and VIN are short-circuited with 0V or GND for some kind of reasons, current charged in the capacitor flows into the output and may destroy the IC. Use a capacitor smaller than 1 μF between output and GND.

11) Inspection by set substrate
In the event a capacitor is connected to a pin with low impedance at the time of inspection with a set substrate, there is a fear of applying stress to the IC. Therefore, be sure to discharge electricity for every process. Furthermore, when the set substrate is connected to a jig in the inspection process, be sure to turn OFF power supply to connect the jig and be sure to turn OFF power supply to remove the jig. As electrostatic measures, provide grounding in the assembly process, and take utmost care in transportation and storage.

12) IC terminal input
The present IC is a monolithic IC and has P^+ isolation and a P substrate between elements to separate elements. With this P layer and N layer of each element, PN junction is formed, and various parasitic elements are formed. For example, when resistors and transistors are connected to terminals as is the case of Fig. 14, where in the case of resistor, the potential difference satisfies the relation of ground (GND)>(terminal A), and in the case of transistor (NPN), the potential difference satisfies the relation of ground (GND)>(terminal B), PN junction works as a diode. Furthermore, in the case of transistor (NPN), a parasitic NPN transistor operates by the N-layer of other elements adjacent to the parasitic diode. The parasitic element is inevitably formed because of the IC construction. The operation of the parasitic element gives rise to mutual interference between circuits and results in malfunction, and eventually, breakdown. Consequently, take utmost care not to use the IC to operate the parasitic element such as applying voltage lower than GND (P substrate) to the input terminal. In addition, when the power supply voltage is not applied to IC, do not apply voltage to the input terminal, either. Similarly, when the power supply voltage is applied, each input terminals shall be the voltage below the power supply voltage or within the guaranteed values of electrical properties.

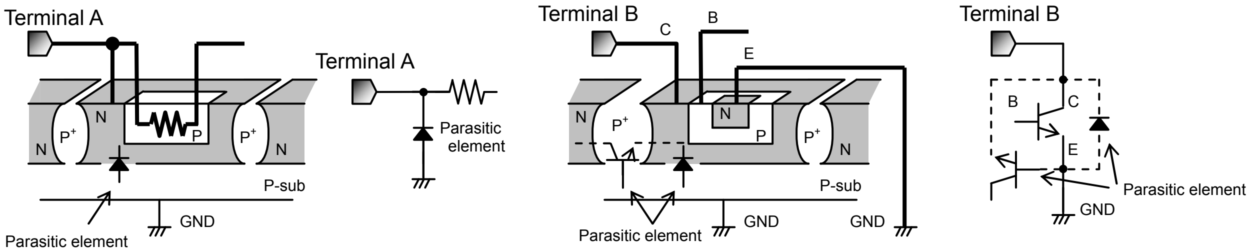


Fig.14 Example of the basic structure of a bipolar IC

13) GND wiring pattern

If there are a small signal GND and a high current GND, it is recommended to separate the patterns for the high current GND and the small signal GND and provide a proper grounding to the reference point of the set not to affect the voltage at the small signal GND with the change in voltage due to resistance component of pattern wiring and high current. Also for GND wiring pattern of the component externally connected, pay special attention not to cause undesirable change to it.

●Ordering part number

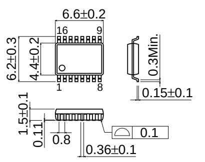
B	A		6	9	5	0		F	S	–	E	2

ROHM part number — Type — Package — Package specification

E2 = Embossed taping

SSOP-A16

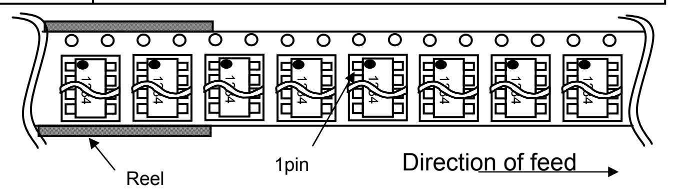
<Dimension>



(Unit:mm)

<Tape and Reel information>

Tape	Embossed carrier tape
Quantity	2500pcs
Direction of feed	E2 (The direction is the 1pin of product is at the upper left when you hold reel on the left hand and you pull out the tape on the right hand)



※When you order , please order in times the amount of package quantity.

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France	TEL: +33-1-5697-3060	FAX: +33-1-5697-3080	Xiamen	TEL: +86-592-238-5705	FAX: +86-592-239-8380
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