

# AN8293SA, AN8293SC

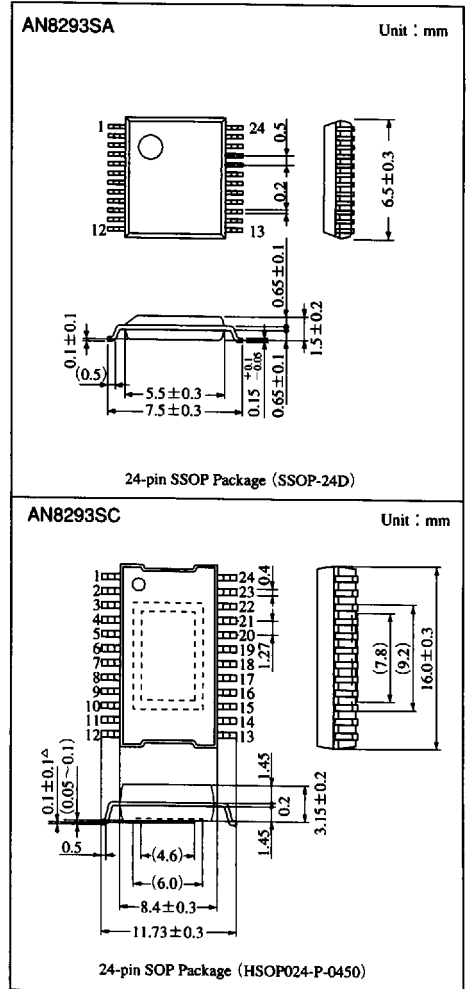
## Optical Disc Brush-less Spindle Motor Drive IC

### Overview

The AN8293SA and AN8293SC are ICs for driving the Optical Disc spindle motor. They employ three-phase full-wave soft switch driving system, and do not require the capacitor between motor windings (snubber-less). They are suitable for miniaturized brush-less motor drive.

### Features

- Operating supply voltage :  $V_{CC}=4.25$  to  $5.5V$   $V_M=3.0$  to  $14V$  (AN8293SA) ,  $V_M=4.5$  to  $14V$  (AN8293SC)
- Soft switch, snubber-less
- Current detection resistor connected to the power supply ( $V_M$  side) to reduce the voltage loss
- Short brake built-in
- Forward/reverse rotation switching function provided
- Current limitation function and thermal protective circuit built-in



ICs for Motor

### Pin Name

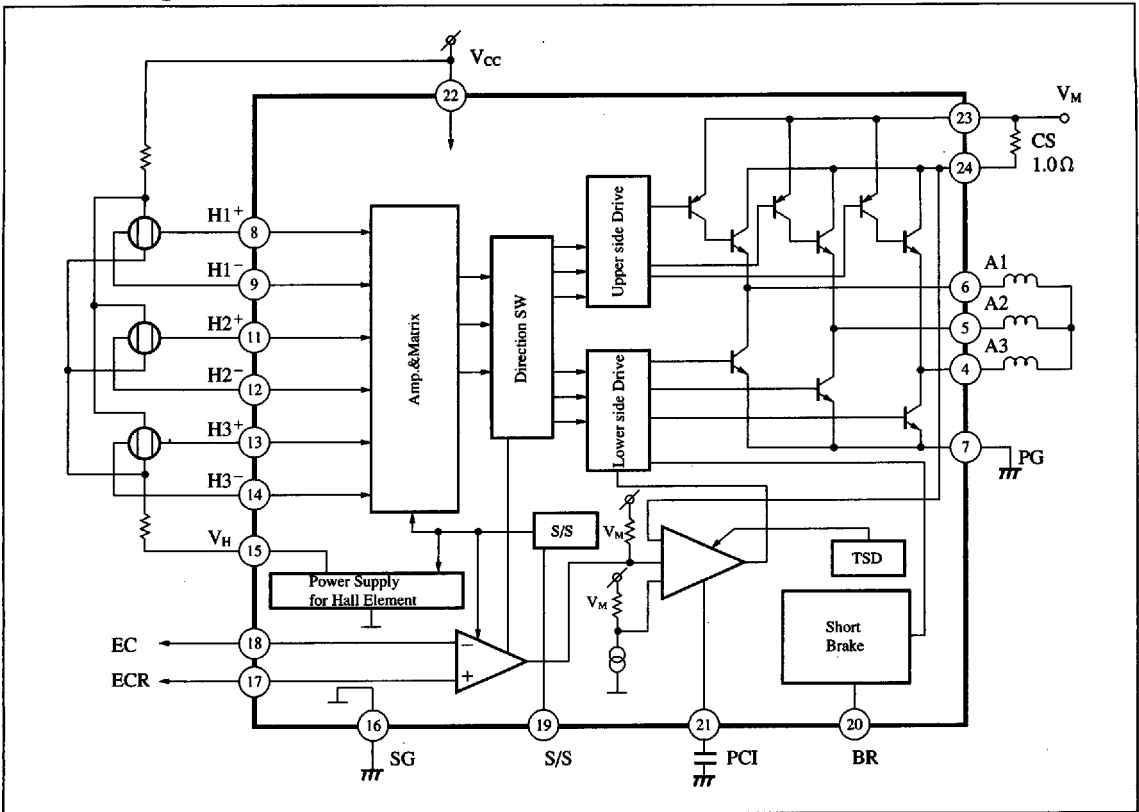
Pin No.	Symbol	Pin name	Pin No.	Symbol	Pin name
1	NC	—	13	$H_3^+$	Hall element input
2	NC	—	14	$H_3^-$	Hall element input
3	NC	—	15	VH	Hall bias terminal
4	$A_3$	Drive output 3	16	SG	Signal GND terminal
5	$A_2$	Drive output 2	17	ECR	Torque command reference input terminal
6	$A_1$	Drive output 1	18	EC	Torque command input terminal
7	PG	Power GND	19	S/S	Start/Stop control terminal
8	$H_1^+$	Hall element input	20	BR	Brake terminal
9	$H_1^-$	Hall element input	21	PCI	Current feedback system phase compensation terminal
10	NC	—	22	$V_{CC}$	Power supply terminal
11	$H_2^+$	Hall element input	23	$V_M$	Motor power supply terminal
12	$H_2^-$	Hall element input	24	CS	Current detection terminal

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## Block Diagram



## Absolute Maximum Rating (T<sub>a</sub>=25°C)

Parameter	Symbol	Rating	Unit
Supply voltage	V <sub>CC</sub>	7	V
Supply current	I <sub>CC</sub>	30	mA
Motor drive terminal voltage	V <sub>M</sub>	14.4	V
Output current <sup>Note 1)</sup>	I <sub>n,OUT</sub>	±1000	mA
Hall bias current	I <sub>15</sub>	50	mA
Control signal input voltage <sup>Note 2)</sup>	V <sub>n,cont</sub>	0 to V <sub>CC</sub>	V
Power dissipation	AN8293SA	925	mW
	AN8293SC	1033	mW
Operating ambient temperature	T <sub>opr</sub>	-20 to +70	°C
Storage temperature	T <sub>stg</sub>	-55 to +150	°C

Note 1) n=4, 5, 6 (n is a pin number)

Note 2) n=17, 18, 19, 20 (n is a pin number)

## Recommended Operating Range (T<sub>a</sub>=25°C)

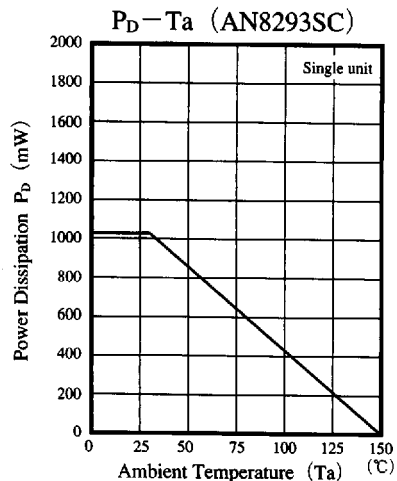
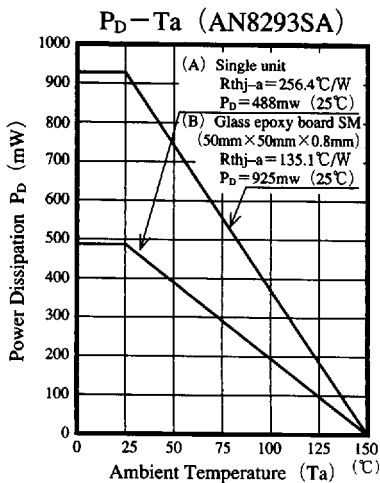
Parameter	Symbol	Range
Operating supply voltage	V <sub>CC</sub>	4.25V to 5.5V
	AN8293SA V <sub>M</sub>	3.0V to 14V
	AN8293SC V <sub>M</sub>	4.5V to 14V

Electrical Characteristics (V<sub>CC</sub>=5V, T<sub>a</sub>=25°C)

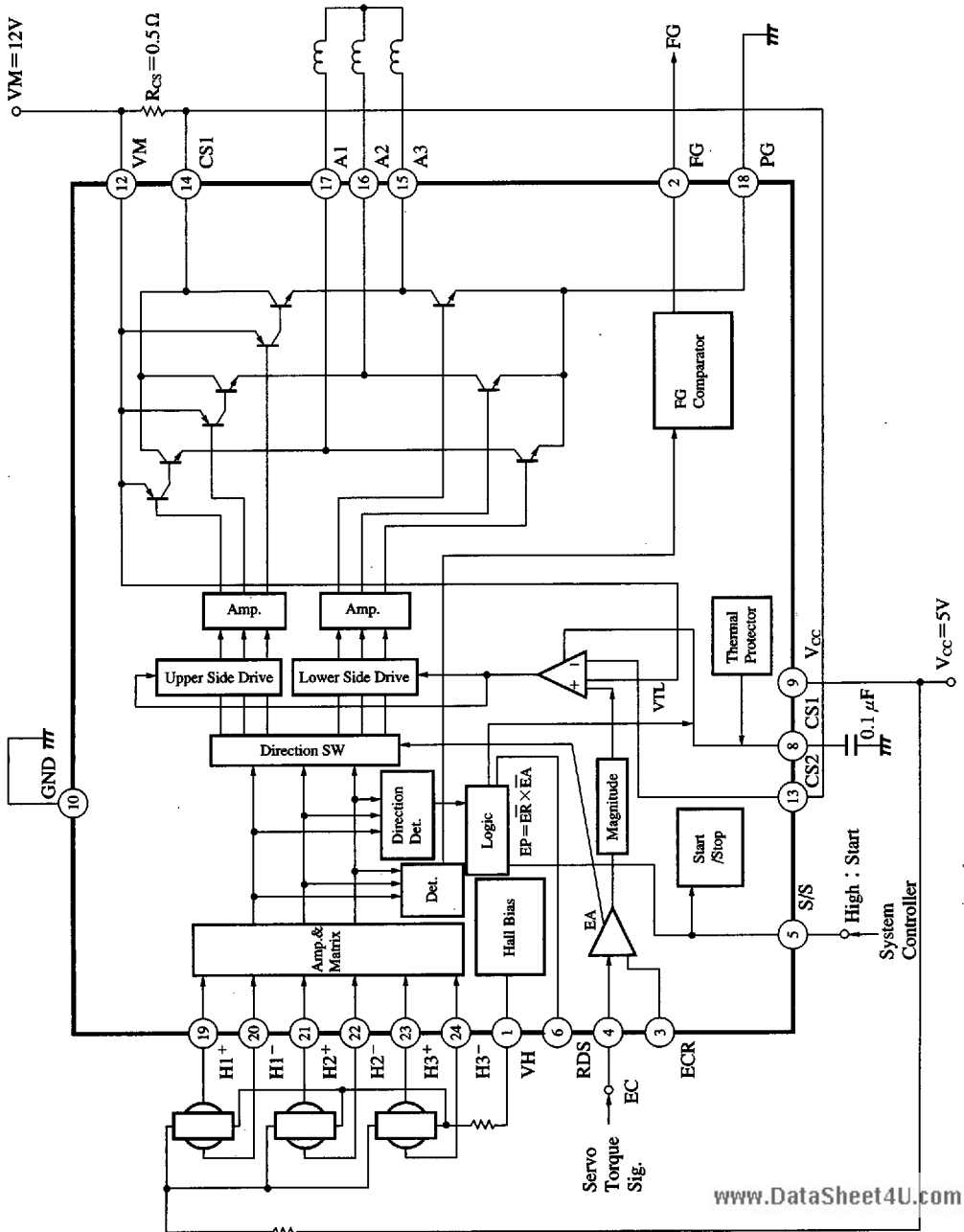
Parameter	Symbol	Condition	min	typ	max	Unit
<b>Total</b>						
Circuit current 1	I <sub>CC1</sub>	V <sub>I9</sub> =0V	—	0	0.1	mA
Circuit current 2	I <sub>CC2</sub>	V <sub>I9</sub> =5V, I <sub>O</sub> =0mA	—	4	8	mA
<b>Power Save</b>						
Circuit start voltage	I <sub>start</sub>		3.5	—	—	V
Circuit stop voltage	I <sub>stop</sub>		—	—	1	V
<b>Hall Bias</b>						
Hall bias voltage	V <sub>HB</sub>	I <sub>HB</sub> =25mA	1.0	1.6	2.3	V
<b>Hall Amp.</b>						
Input bias current	I <sub>BH</sub>		—	1	5	μA
Common-mode input voltage range	V <sub>HBR</sub>		1.5	—	4.0	V
Minimum input level	V <sub>INH</sub>		60	—	—	mV <sub>P-P</sub>
<b>Torque Command</b>						
Input voltage range (AN8293SA)	E <sub>C</sub>		1	—	4	V
Input voltage range (AN8293SC)	E <sub>C</sub>		1	—	3.9	V
Offset voltage	E <sub>COF</sub>		-150	—	150	mV
Dead zone	E <sub>CDZ</sub>		50	—	150	mV
Input current	E <sub>CIN</sub>	E <sub>C</sub> =E <sub>CR</sub> =2.5V	-5	-1	—	μA
Input/Output gain	A <sub>CS</sub>	R <sub>CS</sub> =1.0Ω	0.20	0.25	0.30	A/V
<b>Output</b>						
Output saturation voltage H	V <sub>OH</sub>	I <sub>O</sub> =-300mA	—	0.9	1.4	V
Output saturation voltage L	V <sub>OL</sub>	I <sub>O</sub> =300mA	—	0.2	0.45	V
Torque limit current	I <sub>TL</sub>	R <sub>CS</sub> =1.0Ω	280	350	420	mA
<b>Brake</b>						
Brake operation voltage	V <sub>BrON</sub>		3.5	—	—	V
Brake release voltage	V <sub>BrOFF</sub>		—	—	1	V
Brake current	I <sub>Br</sub>		5	15	—	mA
<b>Thermal Protection</b>						
Thermal protection operation <sup>Note 1)</sup>	T <sub>SDON</sub>	ΔE <sub>C</sub> =100mV	—	180	—	°C
Thermal protection hysteresis width <sup>Note 1)</sup>	ΔT <sub>SD</sub>	ΔE <sub>C</sub> =100mV	—	50	—	°C

Note 1) These are design reference values, but not guaranteed ones.


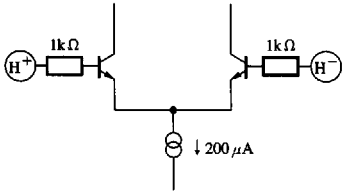

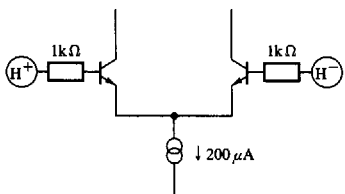

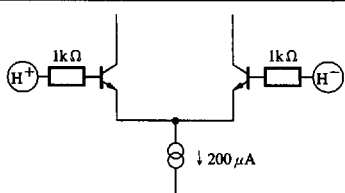

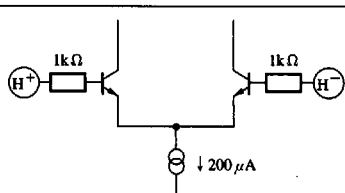

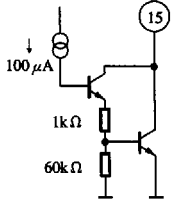



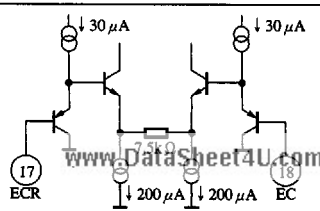
Package Power Dissipation



Block Diagram



Pin Descriptions (cont.)

Pin No.	Pin name	Standard waveform	Description	Equivalent circuit
11	H <sub>2</sub> <sup>+</sup> : Hall element input		Same as for H <sub>1</sub> <sup>+</sup> * Signal deviated by 180° from that for H <sub>2</sub> <sup>+</sup> is applied.	
12	H <sub>2</sub> <sup>-</sup> : Hall element input		Same as the above * Signal deviated by 180° from that for H <sub>2</sub> <sup>+</sup> is applied.	
13	H <sub>3</sub> <sup>+</sup> : Hall element input		Same as the above * Signal deviated by 180° from that for H <sub>3</sub> <sup>-</sup> is applied.	
14	H <sub>3</sub> <sup>-</sup> : Hall element input		Same as the above * Signal deviated by 180° from that for H <sub>3</sub> <sup>+</sup> is applied.	
15	V <sub>H</sub> : Hall bias		Terminal supplying the current to Hall element	
16	SG : Signal ground			
17	ECR : Torque command reference input		Terminal to which the reference voltage, giving the command about what amount of current is flowed in the motor, is applied.	

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## Pin Descriptions (cont.)

Pin No.	Pin name	Standard waveform	Description	Equivalent circuit
18	EC : Torque command input	_____	Terminal to which the command, about what amount of current is flowed in the motor, is applied.	
19	S/S : Start/Stop control	_____	Terminal turning ON/OFF the IC. High : motor rotate Low or Open : motor stop	
20	BR : Brake	_____	Terminal used to work the short brake. High : Short brake Low or Open : Normal rotation	
21	PCI : Current feedback system phase compensation	_____	Terminal adding the capacitance for phase compensation of current feedback loop	
22	V <sub>CC</sub> : Power supply	_____	IC power supply terminal	_____
23	VM : Motor power supply	_____	Power supply terminal supplying the power for driving the motor	_____
24	CS : Current detection	_____	Terminal connecting the resistor to VM and detecting the motor current amount	_____

## Function Operation Description for AN8293SA

### 1. Overview

The AN8293SA is a silicon monolithic bipolar IC for optical disk brush-less spindle motor drive.

The AN8293SA is an IC for optical disk spindle motor drive consisting of the brush-less motor. It employs, snubber-less, three-phase full-wave soft switch system and the motor coil block can be constructed with the external capacitor-less type.

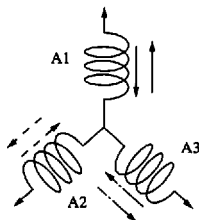
In addition, also available is the AN8293SC, which is molded in VHSOP-24 package, with 1033mW of power dissipation (under 25°C, single unit). The AN8293SA has 488mW of power dissipation (under 25°C, single unit).

### 2. Features

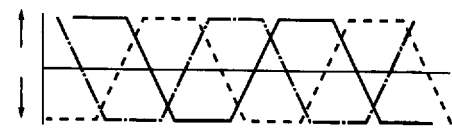
- Three-phase full-wave soft switch drive system, and can be used by snubber-less.
- Start/Stop terminal provided. Power saved in stop mode.
- The TSD detects the junction temperature and turns off all circuit under high temperature. (It is same as under power saved condition in stop mode)
- The voltage setting of EC/ECR allows Normal/Reverse rotation to be changed over.
- Hall bias built-in
- Short brake built-in

### 3. Function Description

#### 1) Three-phase full-wave soft switch system (snubber-less system)



Pulled out



Sunk into

Output current

The AN8293SA employs highly effective three-phase full-wave system, by which current is pulled out or sunk from/into each phase, A1, A2 and A3.

Current switching for each phase is done with the trapezoidal-wave-shaped linear switching current. The AN8293SA provides snubber-less system, which does not require the external capacitor at coil ends.

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Motor

#### 2) Start/Stop terminal provided and power save in stop mode

The circuit operation starts by "H" signal. In stop mode, the entire circuit is turned off and the bias circuit current is not flown either, thus very very small power consumption is realized. Thus consumption power becomes very small.

#### 3) TSD (Thermal Shunt Down)

The TSD detects the junction temperature, and when it exceeds the detection temperature (180°C, typ.), it turns off the entire circuit. Under this condition, the power consumption becomes very small, almost the same as the case when the start/stop terminal is set to the stop condition.

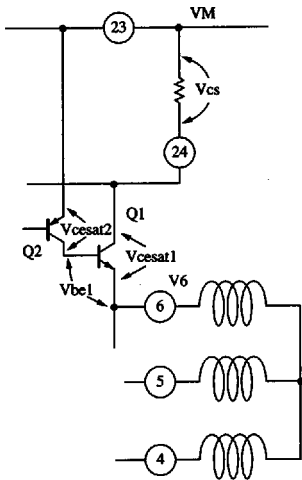
The TSD has hysteresis, the width of which is set to 50°C (typ.) and is automatically reset when the temperature decreases.

4) Current limitation

The current limitation is achieved through detection of the voltage fall of the resistor (detection resistor) which is connected between Pins 23 and 24. The detection voltage is set to 0.35V (typ.). When 1Ω is connected between Pins 23 and 24, the limitation current is :

$$\frac{0.35V}{1\Omega} = 0.35A$$

The fall of voltage between Pins 23 and 24 can not affect the rise of saturation voltage.



The V6 voltage of upper transistor block is given as follows :

$$V_6 = V_M - V_{be1} - V_{cesat2} \text{ Or } V_6 = V_M - V_{cesat1} - V_{cs}$$

Therefore,

$$V_{be} + V_{cesat2} = V_{cesat1} + V_{cs}$$

$$V_{cesat1} - V_{cesat2} = V_{be1} - V_{cs}$$

If the voltage drop  $V_{cs}$  does not exceed  $V_{be}$  (the voltage between base and emitter of Q1), assuming that Q1 and Q2 have the same saturation voltage, the saturation voltage of upper side transistor block is not affected.

The above calculation can be also applied to the other phases.

The current limitation voltage is set to 0.35V. This voltage is lower than the voltage between base and emitter, and therefore the voltage fall due to detection resistance does not have a certain relationship with the saturation voltage, which affects the motor current. Thus, the AN8293SA has the superior current detection system.

5) Reverse rotation brake is available by EC/ECR voltage setting

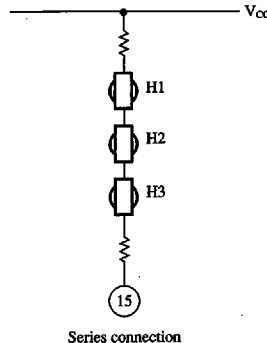
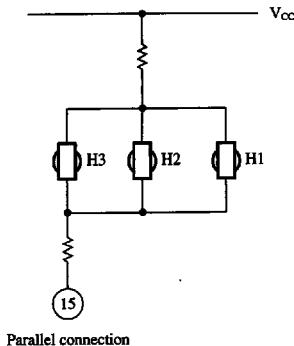
The motor rotation direction can be changed by changing the sequence of current flowing in each output phase through voltage setting with EC/ECR. Voltage difference between EC and ECR is proportional to the motor torque (motor current) (V characteristics).

6) Hall Bias Built-in

The AN8293SA incorporates the power supply for Hall element, a position sensor.

Hall bias voltage is 1.6V, typ. ( $V_{CC}=5V$ , Hall current is 25mA). It is almost stable, even when the supply voltage fluctuates.

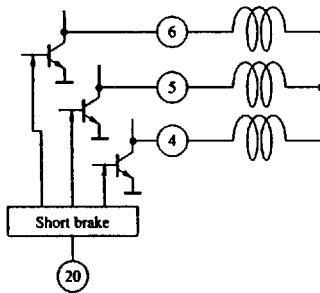
In addition, Hall element may be connected either in series or in parallel.





## 7) Short Brake Built-in

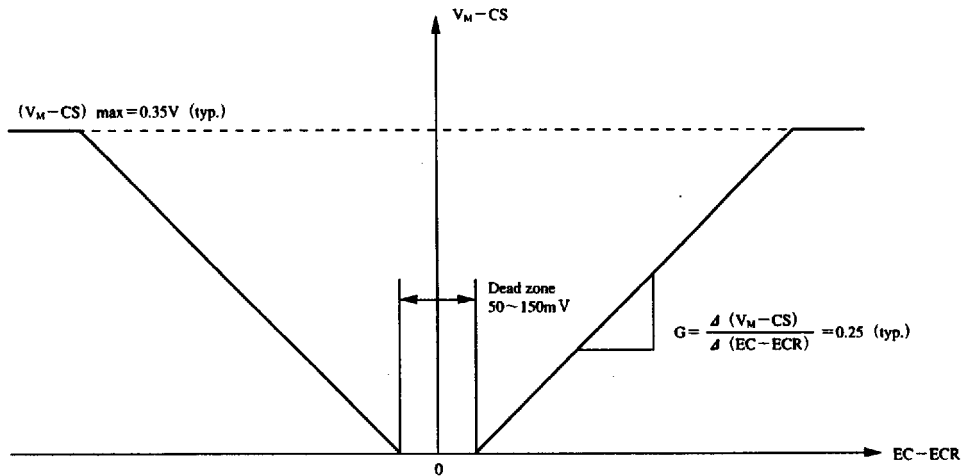
The AN8293SA incorporates the short brake and the motor can be stopped in a short time.



As shown in the left figure, when high signal is applied to the brake terminal ⑳, the lower side transistors are turned on to set the motor coil to the short condition and the brake operation is executed.

## 8) Torque Command and Output Current

The voltage difference between EC terminal and ECR terminal controls the output current. (Refer to the following figure.)



The  $G$  shown in the above figure and  $(V_M - CS)_{max}$  are almost stable, independent of current detection resistance (resistance between  $V_M$  and  $CS$  terminals),  $R_{CS}$ . For example, if  $R_{CS} = 1 \Omega$ ,

• Transmission gain  $A_{CS}$  from EC terminal voltage to output current is :

$$A_{CS} = \frac{G}{R_{CS}} = \frac{0.25}{1 \Omega} = 0.25 \text{ (A/V) (typ.)}$$

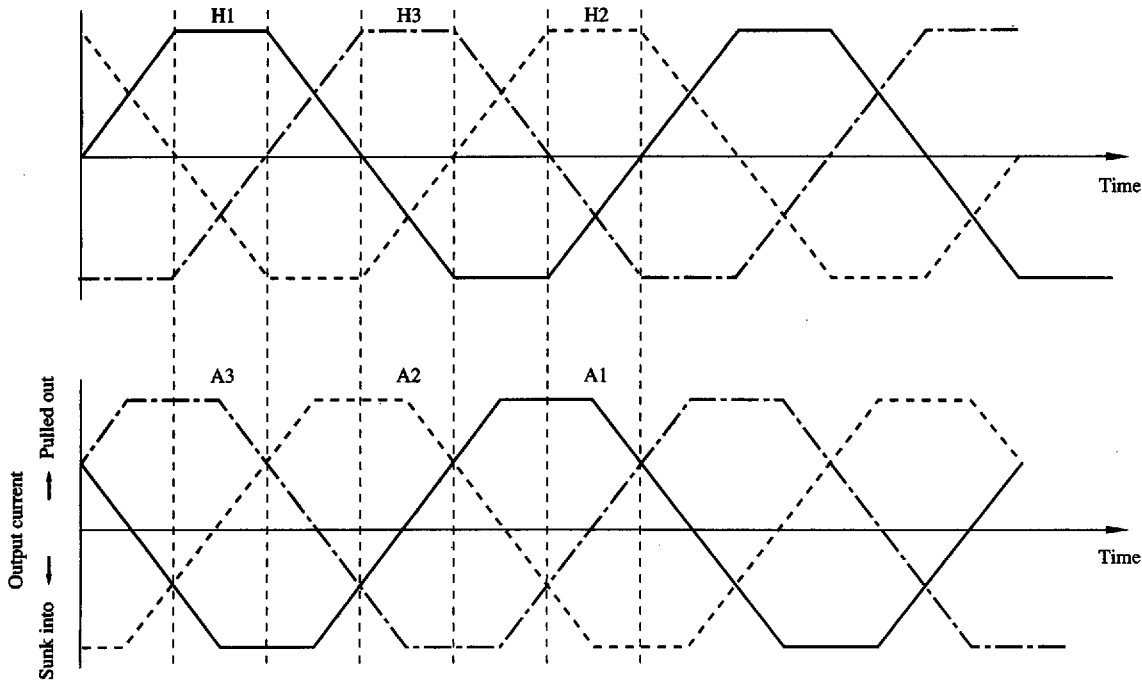
• Output maximum current  $I_{TL}$  is :

$$I_{TL} = \frac{0.35 \text{ V}}{1.0 \Omega} = 0.35 \text{ A (typ.)}$$

The  $R_{CS}$  should be set at the value of approximately 0.5 to 2.0  $\Omega$ .

## 9) Phase Relationship between Hall Input and Output Current

The phase relationship between Hall input and output current when  $EC < ECR$  is shown in the following figure :



When  $EC > ECR$ , the pulling-out and sinking-into of the output current is just reversed from those shown in the above figure, and the motor rotation direction is reversed.

For Hall input, DC level should be set at 1.5 to 4.0V and the amplitude of each phase ( $H_n^+ - H_n^-$ ) should be set at  $60\text{mV}_{p-p}$  or more.