TOSHIBA Bipolar Linear Integrated Circuit Silicon Monolithic

TA7259P,TA7259P(LB),TA7259F

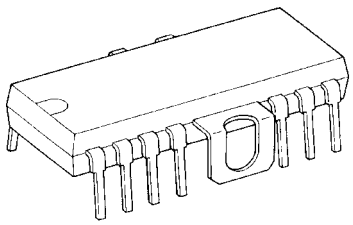
3-Phase Full-Wave Brushless DC Motor Driver IC

The TA7259P is a 3−phase Bi−directional motor driver IC.
It designed for use VCR tape deck, floppy disk and record player motor drivers.
It contains output power drivers, position sensing circuits, control amplifier and CW/CCW control circuit.
We recommend that a Hall-effect sensor be used as a position detector with this motor driver IC.

Features

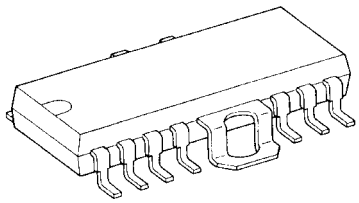
- Wide operating supply voltage range: V_{CC} (opr.) min. = 7 V
- Forward and reverse rotation is controlled simply by means of a CW/CCW control signal fed into FRS
- High sensitivity of position sensing amplifier (V_H = 10 mV (typ.)
- Output current up to ±1.2 A
- Few external parts required
- Surge protect diode connected for all input terminals
- Recommend to use TOSHIBA Ga−As hall sensor “THS” series

TA7259P



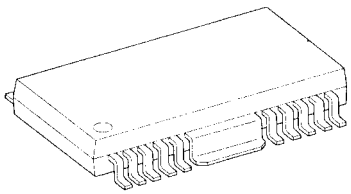
HDIP14-P-500-2.54A

TA7259P (LB)



HSOP14-P-2.54

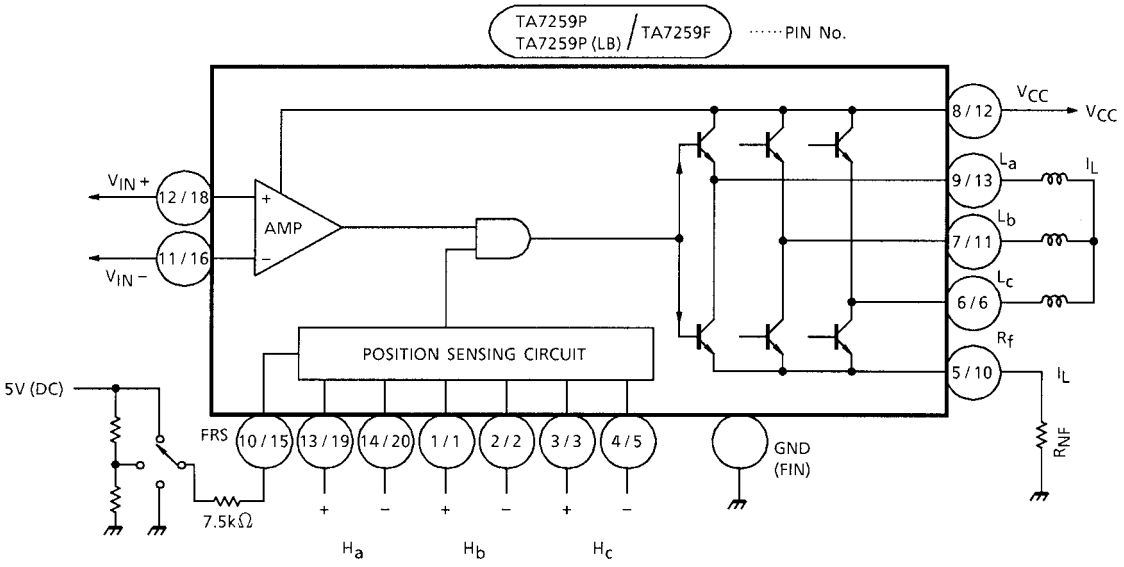
TA7259F



HSOP20-P-450-1.00

Weight
HDIP14−P−500−2.54A: 3.00 g (typ.)
HSOP14−P−2.54: 3.00 g (typ.)
HSOP20−P−450−1.00: 0.79 g (typ.)

Block Diagram

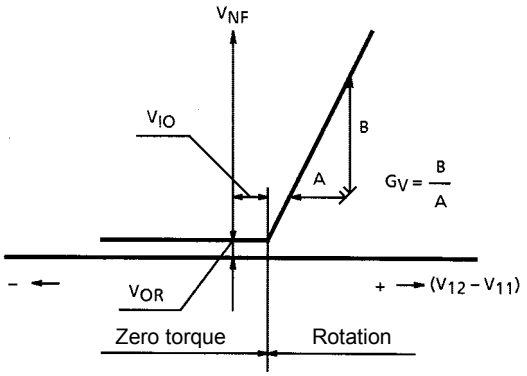


Pin Function

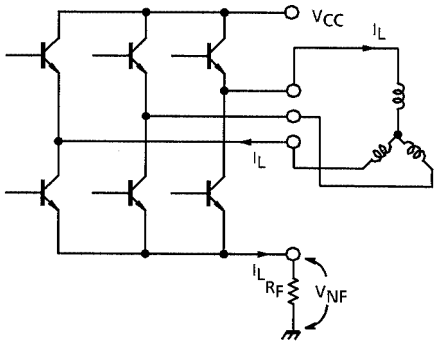
Pin No.		Symbol	Function Description
P Type	F Type		
1	1	H_b +	b−phase Hall Amp. positive input terminal
2	2	H_b −	b−phase Hall Amp. negative input terminal
3	3	H_c +	c−phase Hall Amp. positive input terminal
4	5	H −	c−phase Hall Amp. negative input terminal
5	10	R_F	Output current detection terminal
6	6	L_c	c−phase drive output terminal
7	11	L_b	b−phase drive output terminal
8	12	V_{CC}	Power supply input terminal
9	13	L_a	a−phase drive output terminal
10	15	FRS	Forward/Reverse/Stop switch terminal
11	16	V_{IN} −	Control Amp, negative input terminal
12	18	V_{IN} +	Control Amp, positive input terminal
13	19	H_a +	a−phase Hall Amp. positive input terminal
14	20	H_a −	a−phase Hall Amp. negative input terminal
Fin	Fin	GND	GND terminal

*: 4-, 7-, 8-, 9-, 14-and 17-pin for F type are NC.

Input/Output Characteristics



V_{NF} is a voltage drop across the R_F.
To be specific, let I_L be a coil current in a star connection. $V_{NF} = R_F \cdot I_L$.
See the following schematic diagram.



Connecting the inputs (V_{IN}+ and V_{IN}- pins) directly to each other or satisfying "V at pin 11 ≥ V at pin 12" makes the rotation torque zero. This state can be attained also by applying a specified voltage to the FRS input (FRS pin) or opening this input. This method is advantageous because it only requires less current than the former.

Function

FRS	Position Sensing input			Coil Output		
	H_a	H_b	H_c	L_a	L_b	L_c
L	1	0	1	H	L	M
	1	0	0	H	M	L
	1	1	0	M	H	L
	0	1	0	L	H	M
	0	1	1	L	M	H
	0	0	1	M	L	H
H	1	0	1	L	H	M
	1	0	0	L	M	H
	1	1	0	M	L	H
	0	1	0	H	L	M
	0	1	1	H	M	L
	0	0	1	M	H	L
M	1	0	1	High impedance		
	1	0	0			
	1	1	0			
	0	1	0			
	0	1	1			
	0	0	1			

Note: In the above table, “1” for the Hall-effect device inputs means that the positive-side input of each Hall-effect device is supplied with a voltage at least +10 mV higher than that for the negative-side input. “0” means that the negative-side input is supplied with a voltage at least +10 mV higher than that for the positive-side input. Certainly in this case, the DC voltage potential must be within the in-phase voltage range of the Hall-effect device inputs.

“H”, “M”, and “L” for the outputs mean, respectively, V_{CC} − VSAT1, ≃ V_{CC}/2, and VSAT2. “L”, “H”, and “M” for the FRS inputs mean that voltages within, respectively, the V_F, V_R, and V_S ratings are applied.

Make these measurements when the circuit is made operating by applying necessary voltages to the control inputs (V_{IN}+ and V_{IN}−).

Inputting Control Signals

Usually, control voltages in proportion or (in reverse proportion) to rotation speeds, such as F/V converter outputs, are applied to the stage preceding the TA7259P separately or in a differential manner.

The TA7259P's gain from its control to its output (RF pin) is 15 as stated in the rating table. Reducing the gain through negative feedback (NF) can improve the W/F and other characteristics.

Following is an example of applying NF.

The DC voltages (V_{IN}+ and V_{IN}–) of the control inputs (V_{IN}+ and V_{IN}- pins) must be within their ratings (2.0 to V_{CC} − 2.5 V) when NF is applied (and also when NF is not applied). If the input DC level or F/V conversion output (control output) does not match the inputs of the IC, insert a DC level shifter and attenuator before the inputs of the IC.

Figure 1-c is an example of inserting these components.

a) Positive input

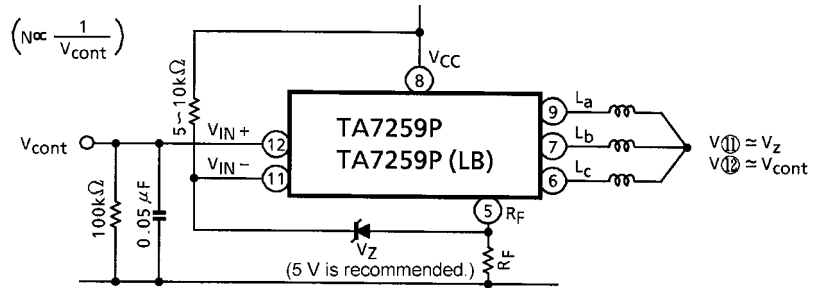


Figure 1-a

b) Negative input

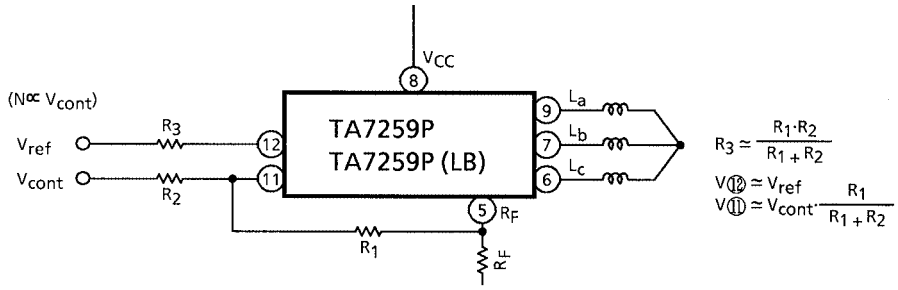


Figure 1-b

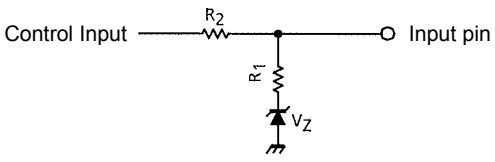


Figure 1-c

The control signal component is attenuated at R_1 and R_2 by shifting the DC component level with a Zener diode.

Driving a Hall-Effect Device

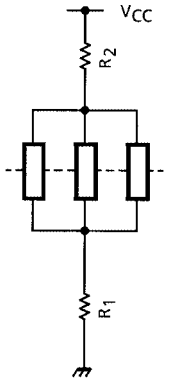
The TA7259P has a wide in-phase voltage range (rated at 2 to V_{CC} − 2.5 V) for the input of a position detector (typically Hall-effect sensor), thus making it possible to drive the Hall-effect sensor with either a constant current or a constant voltage.

We recommend Toshiba's Ga-As Hall-effect sensor THS series.

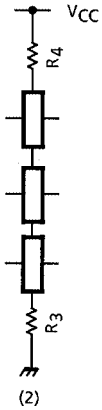
The Ga-As Hall-effect sensor features high mechanical strengths and a high temperature characteristic, compared with the In-Sb Hall-effect sensor. In addition, it is less likely to saturate with respect to magnetism and current, compared to the In-Sb Hall-effect sensor.

Generally, however, the Ga-As Hall-effect sensor might have been difficult to use because of its sensitivity being lower than that of the In-Sb Hall-effect sensor.

In the TA7259P, the sensitivity of the position detector input amplifier has been increased to make it possible to use the Ga-As Hall-effect sensor, which has merits in almost every aspect except for sensitivity. Also, its offset has been lowered. If the W/F characteristic is low, increasing the Hall-effect device input may have effect. (Do not exceed the maximum permissible input, however.)



Method 1 for driving a Hall-effect device



(2)

(Refer to the technical data sheet for the Toshiba Ga-As Hall-effect sensor THS series for details.)

Maximum Ratings (Ta = 25°C)

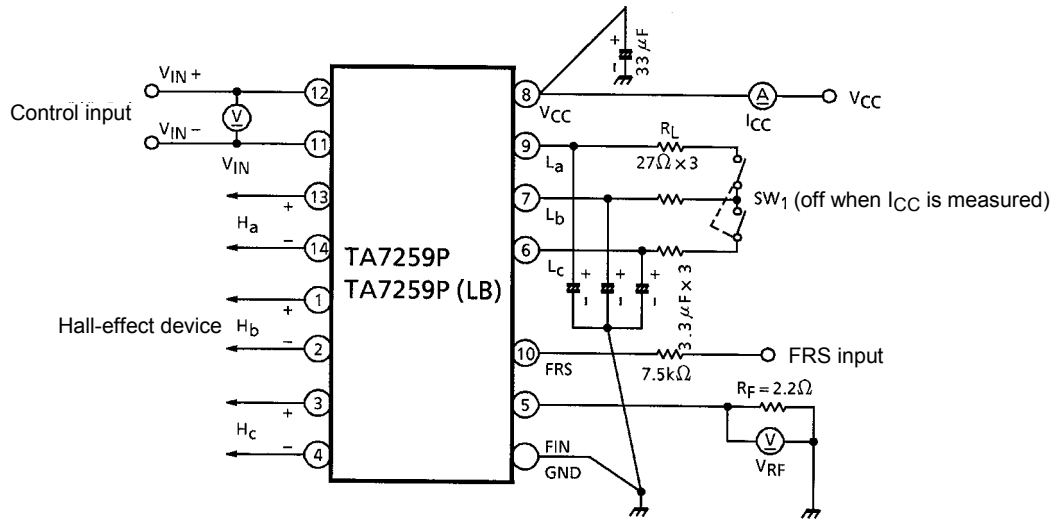
Characteristics		Symbol	Rating	Unit
Supply voltage		V_{CC}	26	V
Output current		I_O	1.2	A
Power dissipation (Note)	TA7259P	P_D	2.3	W
	TA7259P (LB)		2.3	
	TA7259F		1.0	
Operating temperature		Topr	−30 to 75	°C
Storage temperature		T_{stg}	−55 to 150	°C

Note: No heat sink.

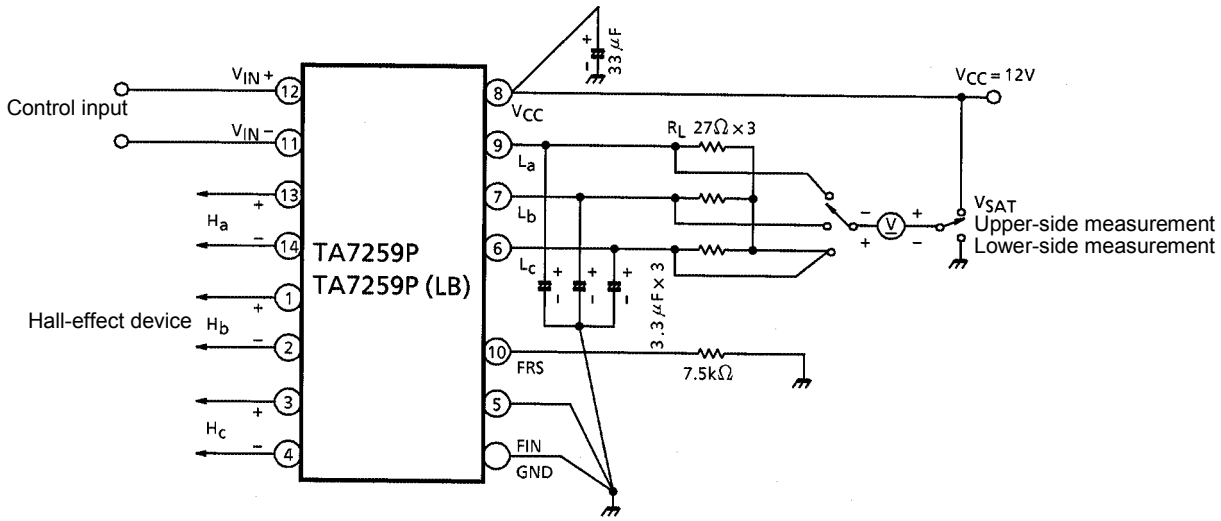
Electrical Characteristics (unless otherwise specified, V_{CC} = 12 V, Ta = 25°C)

Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Quiescent current		I_{CC1}	1	FRS open	2	4	7	mA
		I_{CC2}		FRS = 5 V	2	5	9	
		I_{CC3}		V_{CC} = 22 V, FRS = GND	2	5	9	
Input offset voltage		V_{IO}	1	—	—	40	—	mV
Residual output voltage		V_{OR}	1	V_{IN} − = V_{IN} + = 7 V	—	0	10	mV
Voltage gain		G_V	1	R_{NF} = 2.2 Ω	—	15.0	—	—
Saturation voltage	Upper	V_{SAT1}	2	I_L = 400 mA	—	1.0	1.5	V
	Lower	V_{SAT2}	2		—	0.4	1.0	
Cut−off current	Upper	I_{OC1}	—	V_C = 20 V	—	—	20	μA
	Lower	I_{OC2}	—		—	—	20	
Position sensing input sensitivity		V_H	1	—	—	10	—	mA
Maximum position sensing input voltage		V_H MAX.	1	—	—	—	400	mV_{p-p}
Input operating voltage	Position	CMR_H	1	—	2.0	—	V_{CC} − 2.5	V
	Control	CMR_C	1	—	2.0	—	V_{CC} − 2.5	
Rotation control input voltage	CW	V_F	1		—	0	0.4	V
	STOP	V_S	1	—	2.5	3.0	3.5	
	CCW	V_R	1	—	4.5	5.0	5.8	

Test Circuit 1



Test Circuit 2



Cautions for Using the ICs

Because a motor driving IC has many high-impedance input pins, such as Hall-effect device input and control signal input pins, carries a high current, and is switched, it is susceptible to adverse effect from unwanted feedback.

Because the load of the motor driving IC is inductive, you must be careful to protect it from breakdown due to impulses that can occur when it is turned on and off. In addition, when it is used especially with a high supply voltage (V_{CC} = 18 V or higher), you must be careful that the output transistor will not be subjected to a voltage or current higher than their ratings.

We recommend that the device be used with a supply voltage of 18 V or lower. If you use it with a higher supply voltage, be sure to observe the cautions stated above.

(1) Points to keep in mind with respect to reliability designs

i) Do not put the output transistors in the IC into a high-voltage or high-current range (especially when the motor is locked, V_{CC} is turned on or off, or the outputs are short-circuited).

ii) It is desirable to keep the output ringing killer capacitor as low as possible (because the charging or discharging current of this capacitor may break an output transistor). If a problem arises, try to adjust not only the capacitor value but also the connection point and connection method (delta or star) as well as taking an oscillation prevent measure described later and inserting a resistor (several ohms to several tens of ohms) in series with the capacitor.

iii) When mounting the IC on a PC board, be careful to keep its heat sink from stress. Also, finish its soldering within several seconds (at 260℃).

iv) Providing as large a grounding pad as possible for the IC on the PC board to help release heat through the heat sink of the soldered IC is an effective method to maintain its reliability.

(2) Points to keep in mind with respect to wiring

Observe the following in designing printed circuit patterns in order to prevent parasitic oscillation.

i) For an output coil current path, use a ground line separate from other circuits, because a high current resulting from switching flows through this path.
Prevent the line of R_F pin → R_F resistor → ground from working as a common impedance for other circuits (this is very important).
If this is impossible, or oscillation cannot be completely eliminated, connect a capacitor of 0.01 to 0.1 μF in parallel to the RF.

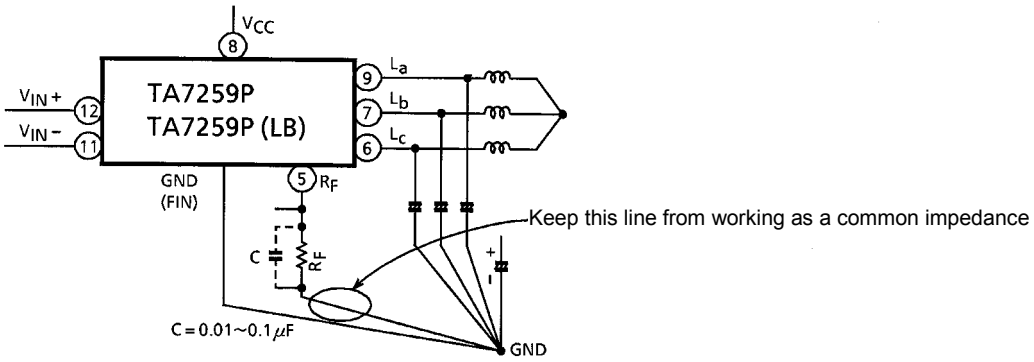


Figure 2

ii) We recommend that a grounding point for the drive current path of the Hall-effect device be separated as much as possible from other paths (especially the output current path).
If external noise comes into the position detection device, insert a capacitor of 0.05 to 1 μF between the positive and negative input pins of each position detection input section.
If external noise comes into the control input pin, connect a capacitor of 0.001 to 0.1 μF between the pin and a ground.

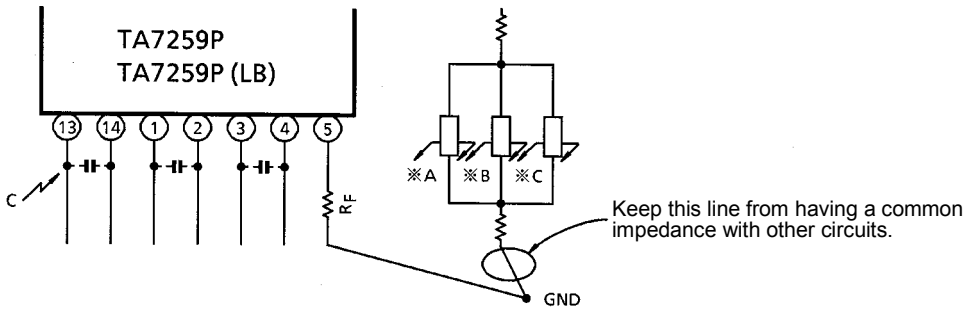


Figure 3

iii) If oscillation at 5 MHz or higher occurs, connect the capacitors from the coil outputs to a common point, and connect a capacitor of 0.01 to 0.1 μF between the common connection point and the R_F pin. (Figure 4-a)
Alternatively, connect a capacitor between each coil output and the R_F pin in addition to the ringing killer capacitor as required. (Figure 4-b)

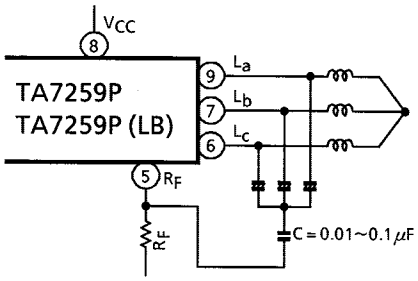


Figure 4-a

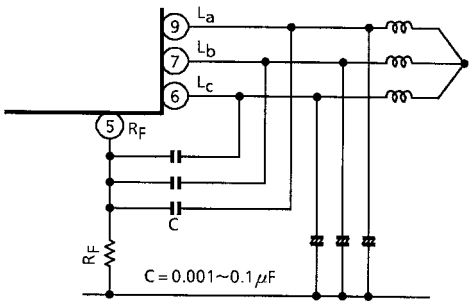


Figure 4-b

iv) Be sure to connect a supply voltage bypass capacitor directly to the V_{CC} pin (pin 8).
Also do not use a common impedance in connecting the bypass capacitor to a ground.
In addition, capacitor C2 (0.01 to 0.1 μF) may take effect.

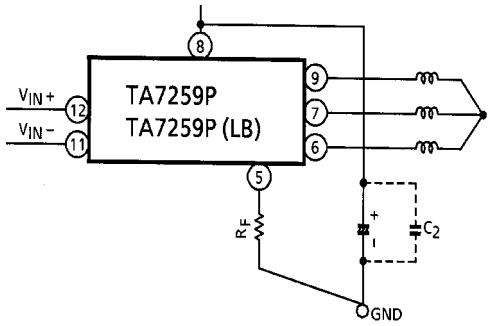


Figure 5

(3) Connecting an output ringing killer capacitor

We recommend that an output ringing killer capacitor be connected from each coil pin directly to a ground. To prevent oscillation and breakdown more securely, you may use the following additional methods.

i) Change the value of the capacitor.
ii) Use a delta connection (Figure 6-a).
iii) Connect the capacitor to V_{CC} rather than to a ground (Figure 6-b). In this case, however, be careful about breakdown.
If the voltage or current trajectory goes out of the ASO, it is necessary to insert a resistor in series with the capacitor.
iv) Connect the capacitor to the RF pin.
v) Insert a resistor in series with the capacitor. (Figure 6-c)
vi) Combine items i), ii), iii), and iv).

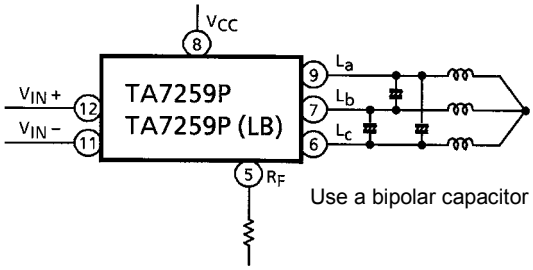


Figure 6-a

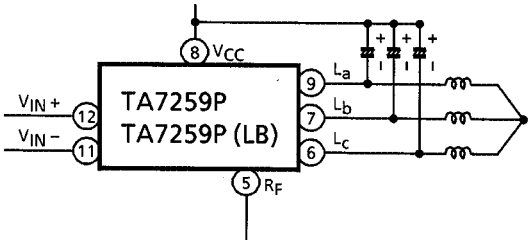


Figure 6-b

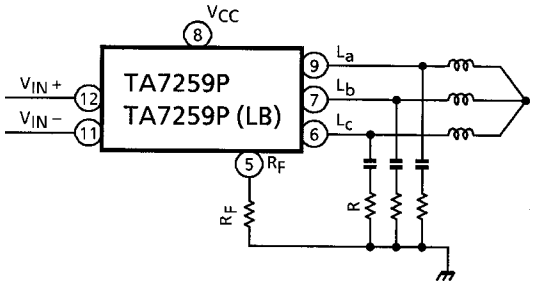


Figure 6-c

Cautions and Other Information

The output transistor in the IC may break down depending on the value of the output capacitor and the way it is connected. To prevent breakdown, find the trajectories of the voltage and current of the output transistor, using the test circuit shown below, and make sure that the trajectories are within the ASO. (It is important to measure them in a transition of forward rotation → reverse rotation → forward rotation especially when the transistor is switched on and off).

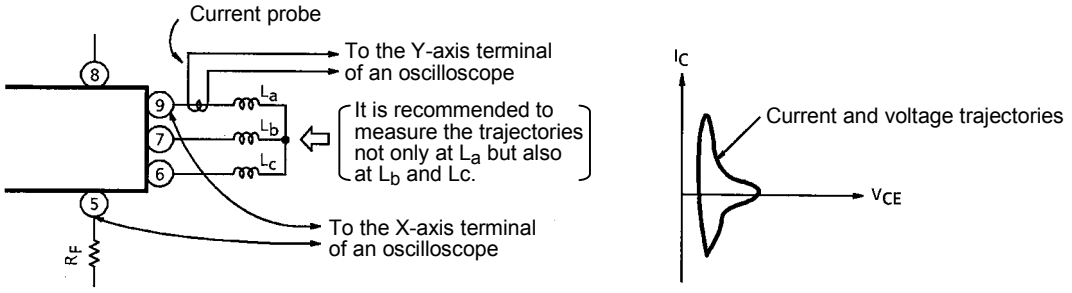
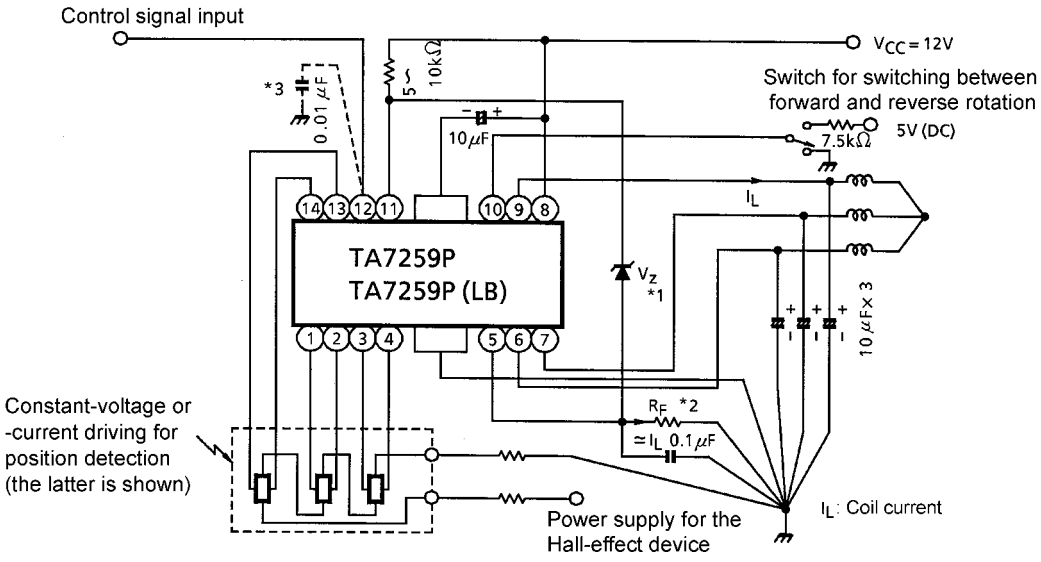


Figure 7

Application Circuit Example 1

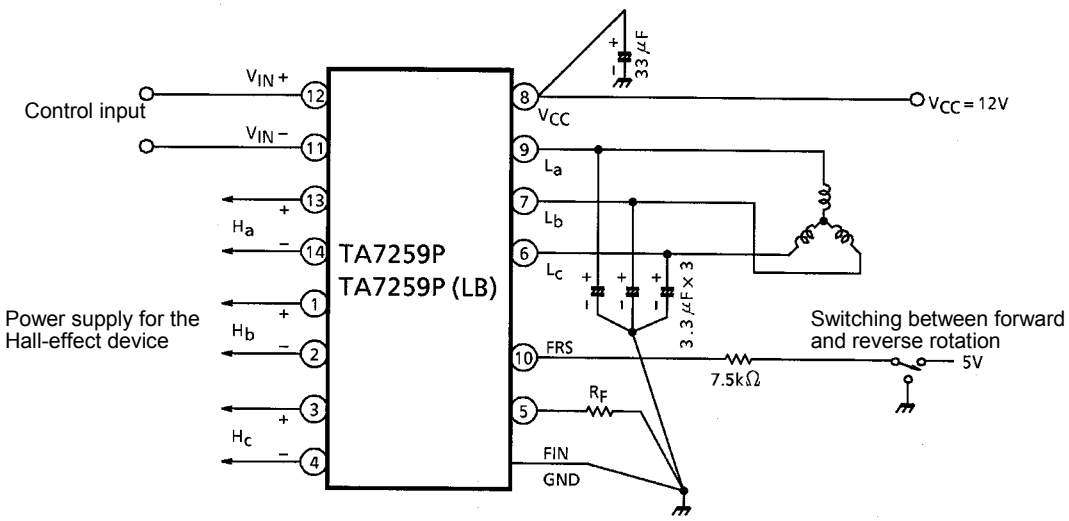


*1: Make Zener diode V_Z match the DC level of the control signal input.
(V_Z = 2.5 to 9 V or so. 5 V is recommended if you take the temperature characteristic into account.
The DC level of the negative control input (V_{IN}- pin) is $V_Z + R_V \times IL$.)

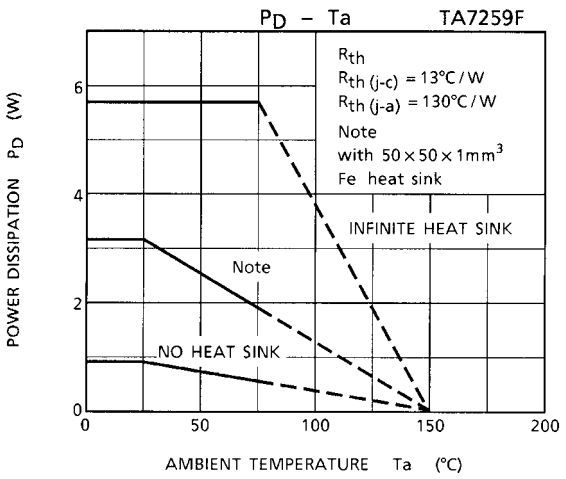
*2: The R_F value should be determined according to the coil impedance, F/V conversion voltage (control input), and the required starting torque. It should be 0.3 to 5 Ω or so.

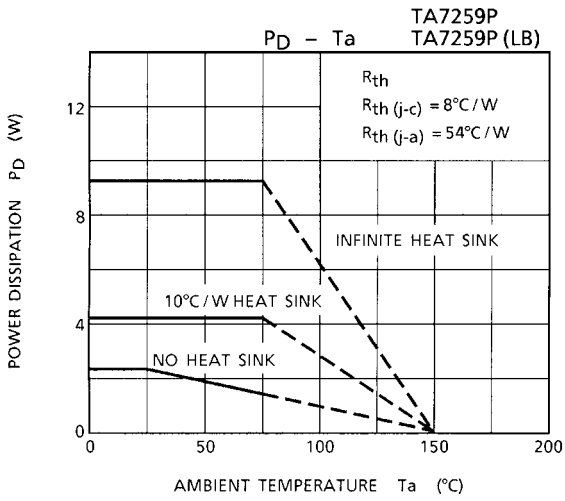
*3: If external noise comes into the control input pin, connect this capacitor.

Application Circuit Example 2



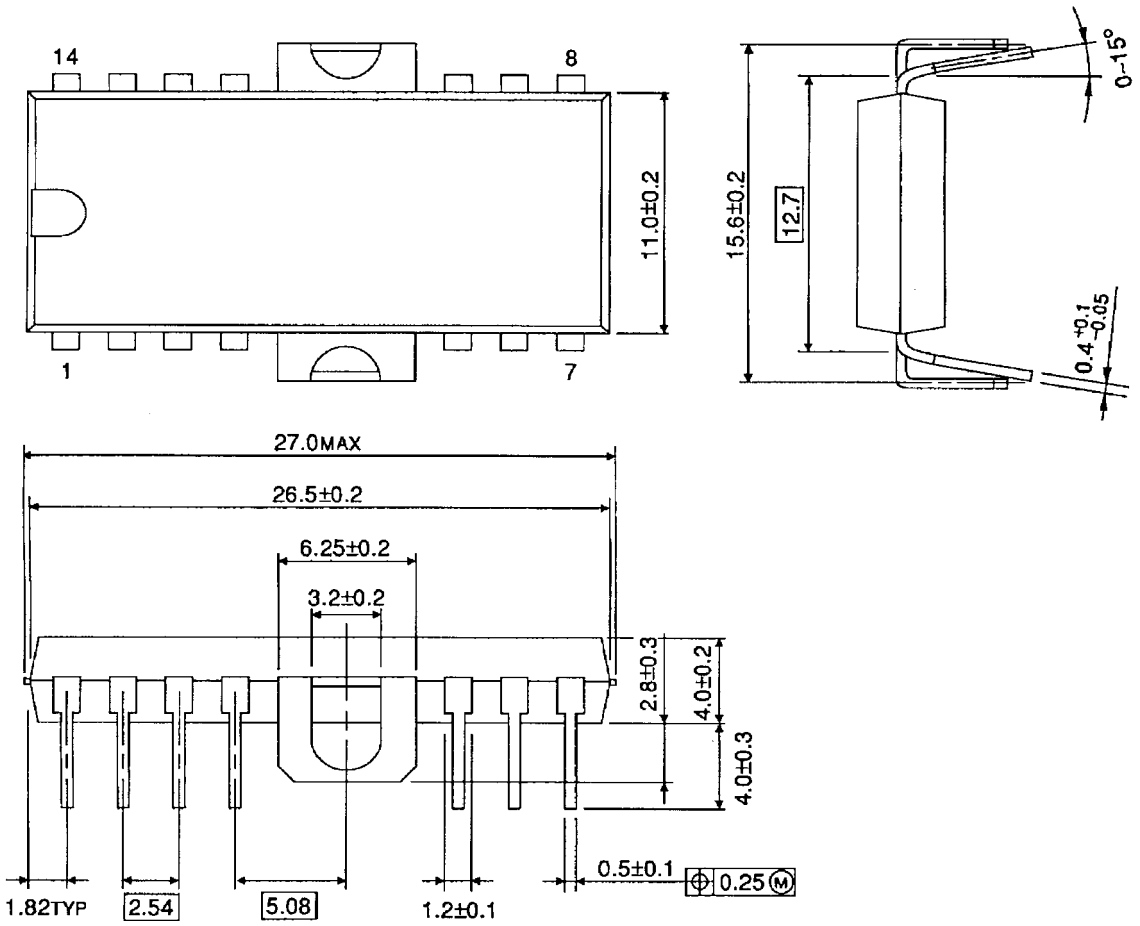
Note: Utmost care is necessary in the design of the output line, V_{CC} (V_M, V_S, V_{EE}) and GND line since IC may be destroyed due to short-circuit between outputs, to supply, or to ground.


P_D – Ta TA7259F
R_{th}
$R_{th\ (j-c)}$ = 13°C / W
$R_{th\ (j-a)}$ = 130°C / W
Note
with 50 × 50 × 1mm³
Fe heat sink
INFINITE HEAT SINK
Note
NO HEAT SINK
POWER DISSIPATION P_D (W)
0
2
4
6
0
50
100
150
200
AMBIENT TEMPERATURE Ta (°C)


TA7259P
TA7259P (LB)
P_D – Ta
R_{th}
$R_{th\ (j-c)}$ = 8°C / W
$R_{th\ (j-a)}$ = 54°C / W
INFINITE HEAT SINK
10°C / W HEAT SINK
NO HEAT SINK
POWER DISSIPATION P_D (W)
0
4
8
12
0
50
100
150
200
AMBIENT TEMPERATURE Ta (°C)

Package Dimensions

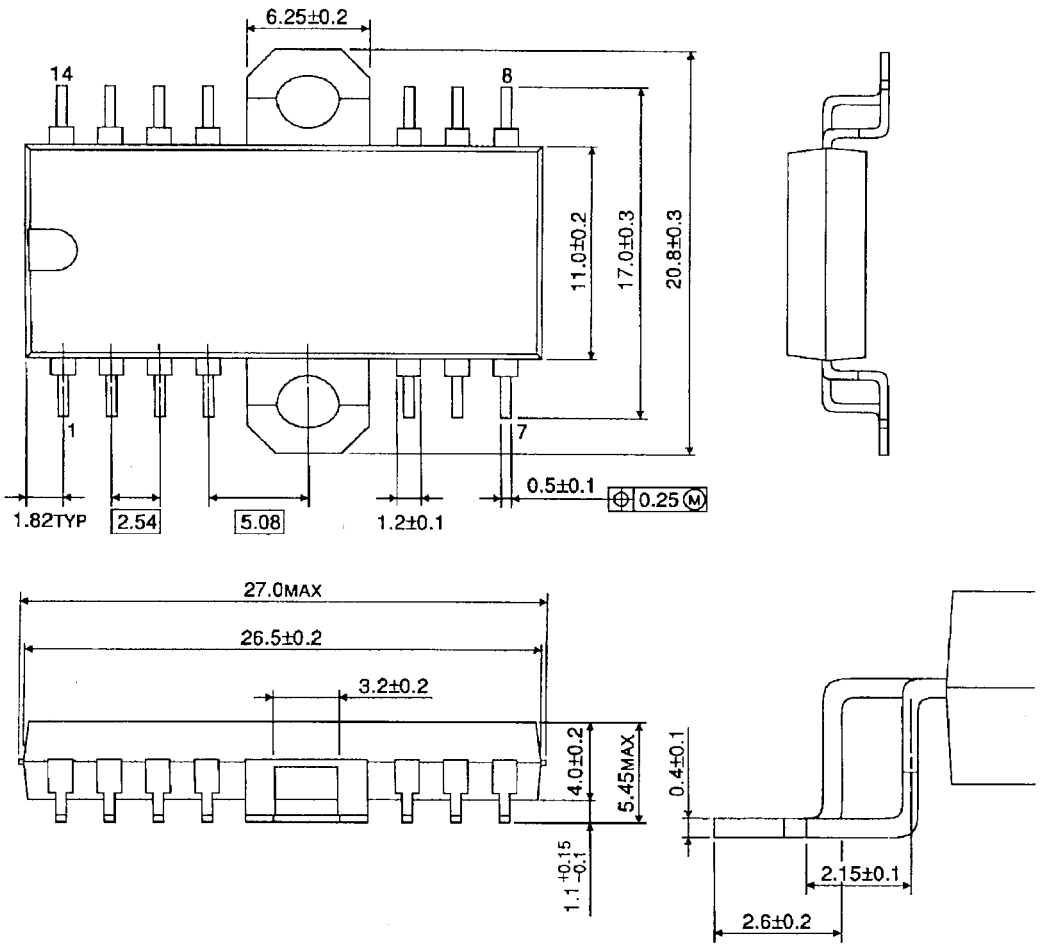
HDIP14-P-500-2.54A Unit : mm



Weight: 3.00 g (typ.)

Package Dimensions

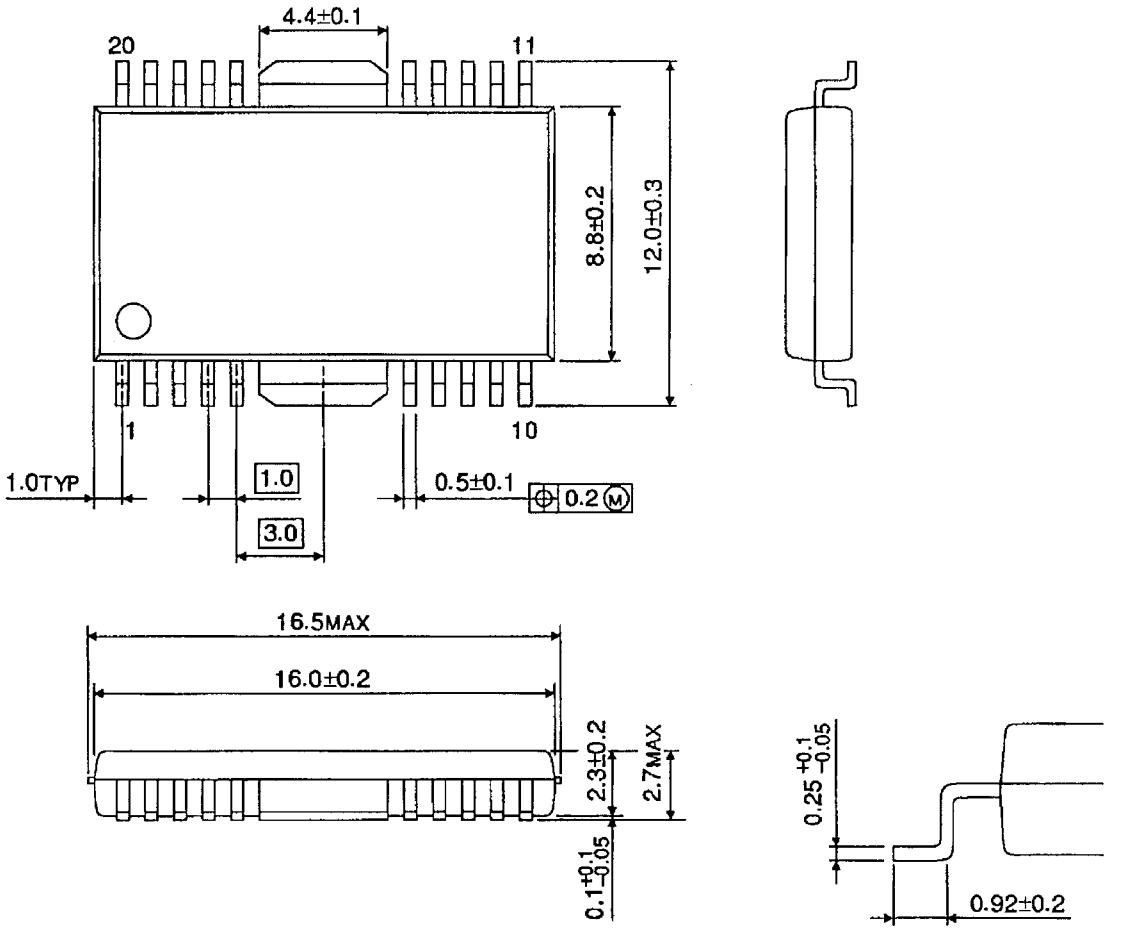
HSOP14-P-2.54 Unit : mm



Weight: 3.00 g (typ.)

Package Dimensions

HSOP20-P-450-1.00 Unit : mm



Weight: 0.79 g (typ.)

RESTRICTIONS ON PRODUCT USE

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