

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

# TA7259P, TA7259F/FG

## 3-PHASE BRUSHLESS DC MOTOR DRIVER IC

The TA7259P/F/FG is a 3-phase Bi-directional motor driver IC. It designed as an output driver for motors in VTR (capstan, cylinder, and reel), tape deck, floppy disk, and record player applications.

To detect position, use of a position sensing device is recommended.

### FEATURES

- Wide operating supply voltage range:  $V_{CC}(\text{opr.})_{\text{MIN.}} = 7 \text{ V}$
- Forward and reverse rotation is controlled simply by means of a CW / CCW control signal fed into FRS.
- High sensitivity of position sensing amplifier.  
( $V_H = 10 \text{ mV (Typ.)}$ ), TOSHIBA Ga-As Hall sensor "THS" series is recommended.
- 3-phase Bi-directional driver and output current up to  $\pm 1.2 \text{ A}$ .
- Few external parts required.
- Surge-protect diode connected for all input terminals (position sensing, control, CW / CCW control inputs).

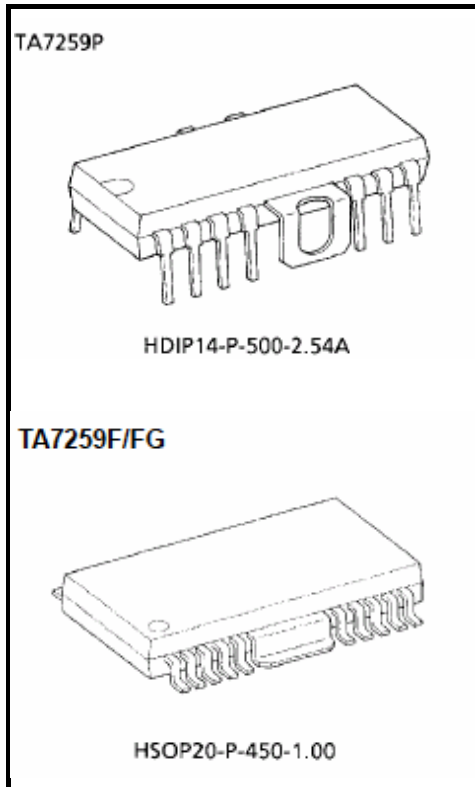
The TA7259FG is a Pb free product.

The TA7259P is an Sn-plated product including Pb.

The following conditions apply to solderability:

\*Solderability

1. Use of Sn-37Pb solder bath
  - \*solder bath temperature =  $230^\circ\text{C}$
  - \*dipping time = 5 seconds
  - \*number of times = once
  - \*use of R-type flux
2. Use of Sn-3.0Ag-0.5Cu solder bath
  - \*solder bath temperature =  $245^\circ\text{C}$
  - \*dipping time = 5 seconds
  - \*the number of times = once
  - \*use of R-type flux

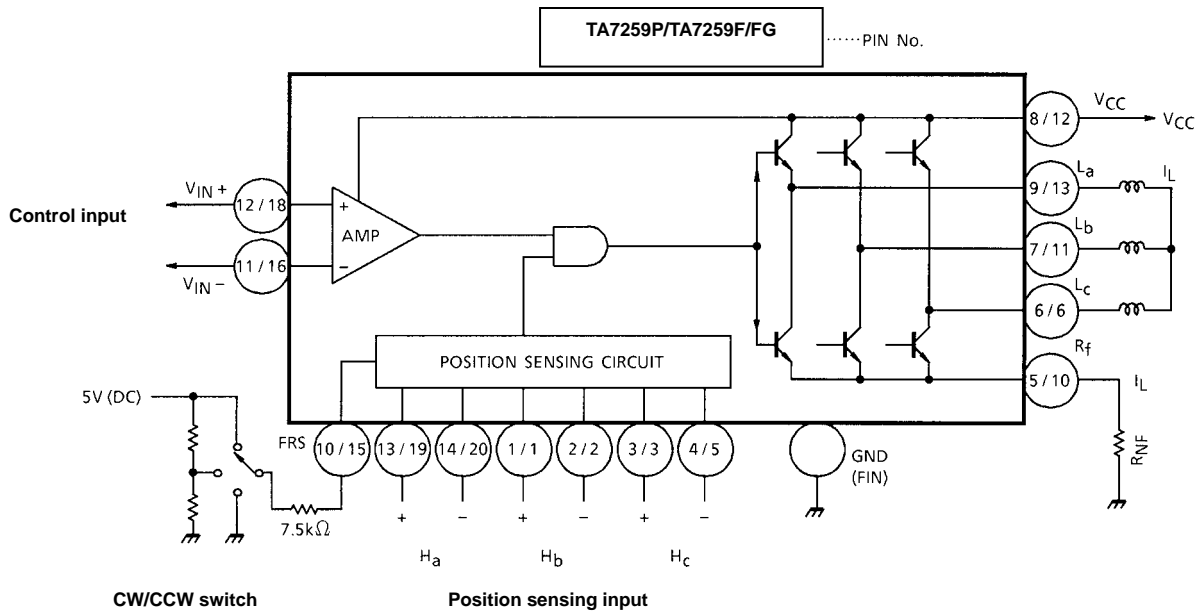


Weight

HDIP14-P-500-2.54A : 3.00 g (Typ.)

HSOP20-P-450-1.00 : 0.79 g (Typ.)

## BLOCK DIAGRAM

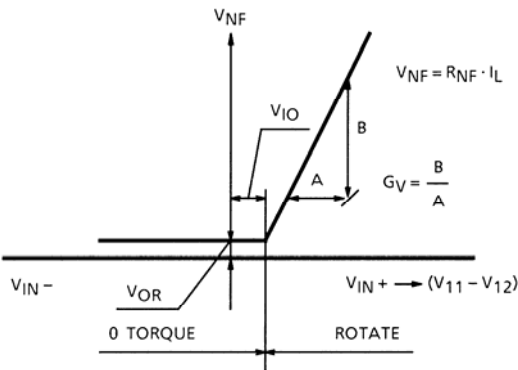


## PIN FUNCTION

PIN No.		SYMBOL	FUNCTION DESCRIPTION
P TYPE	F/FG TYPE		
1	1	H <sub>b</sub> +	b-phase Hall Amp. positive input terminal
2	2	H <sub>b</sub> -	b-phase Hall Amp. negative input terminal
3	3	H <sub>c</sub> +	c-phase Hall Amp. positive input terminal
4	5	H -	c-phase Hall Amp. negative input terminal
5	10	R <sub>F</sub>	Output current detection terminal
6	6	L <sub>C</sub>	c-phase drive output terminal
7	11	L <sub>b</sub>	b-phase drive output terminal
8	12	V <sub>CC</sub>	Power supply input terminal
9	13	L <sub>a</sub>	a-phase drive output terminal
10	15	FRS	Forward / Reverse / Stop switch terminal
11	16	V <sub>IN</sub> -	Control Amp, negative input terminal
12	18	V <sub>IN</sub> +	Control Amp, positive input terminal
13	19	H <sub>a</sub> +	a-phase Hall Amp. positive input terminal
14	20	H <sub>a</sub> -	a-phase Hall Amp. negative input terminal
Fin	Fin	GND	GND Terminal

F/FG type: NO. 4, 7, 8, 9, 14, 17 pins are no connection.

**INPUT vs. OUTPUT**

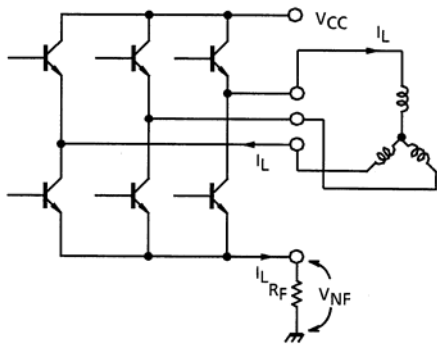


$V_{NF}$  declares  $R_F$  voltage drop.

In star-connection;

$$V_{NF} = R_F \times I_L \quad (I_L: \text{Coil current})$$

Refer to the diagram below.



When  $V_{IN+}$  and  $V_{IN-}$  pins short-circuit or when  $V_{11}$  is equal to or greater than  $V_{12}$ , rotating becomes zero torque. However, zero torque status is also achieved by setting the FRS input pin to the specified voltage or open status. In this case, power consumption is reduced.

## FUNCTION

FRS (10 PIN)	POSITION SENSING INPUT			COIL OUTPUT		
	H <sub>a</sub>	H <sub>b</sub>	H <sub>c</sub>	L <sub>a</sub>	L <sub>b</sub>	L <sub>c</sub>
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			

### Notes)

- Position sensing input;
  - “1”: Energizing +10mV or more to the positive side of each position sensing input.
  - “0”: Energizing - 10mV or less to the negative side of each position sensing input.
 In this case, DC voltage must be within the same-phase voltage range of the position sensing input.
- Coil output;
  - “H”:  $V_{CC} - \frac{1}{2} V_{SAT1}$
  - “M”:  $V_{CC}$
  - “L”:  $V_{SAT2}$
- FRS input;
  - “L”: Applied voltage within the specified range of  $V_F$ .
  - “H”: Applied voltage within the specified range of  $V_R$ .
  - “M”: Applied voltage within the specified range of  $V_S$ .

During testing, necessary voltage must be applied to the control input ( $V_{IN+}$ ,  $V_{IN-}$ ) and the circuit must be driven status.

**Control signal input**

In the initial state of the TA7259P/F/FG, the control voltage is usually input either by an F/V inverter or such like, where the voltage is in proportion or inverse proportion to the number of rotations, or independently.

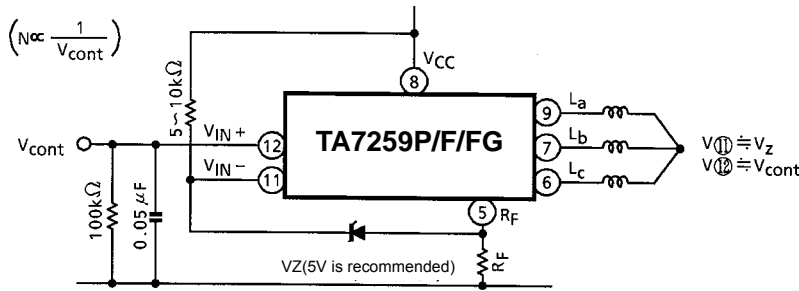
Though output ( $R_F$  pin) gain from the TA7259 control is specified in the table as 15 times, it can be reduced to improve the characteristics of W/F etc. by applying NF.

An example of the application is shown below.

Whether NF is applied or not, the DC voltage ( $V_{IN+}$  and  $V_{IN-}$ ) of the control input ( $V_{IN+}$  pin and  $V_{IN-}$  pin) must be within the specified range (2.0 to  $V_{CC}-2.5V$ ). When the input DC level and F/V conversion output (control output) cannot interface with the IC input, input DC level shift and attenuator before IC input.

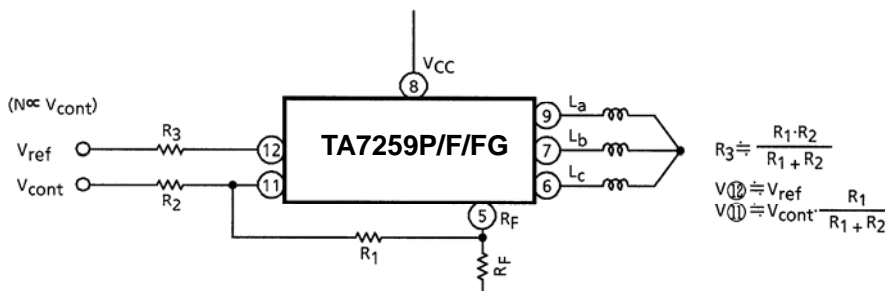
One example is shown in Figure 1-c.

**a) Positive input**

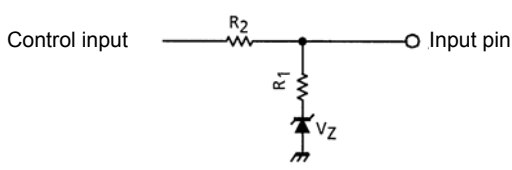


**Figure 1-a**

**b) Negative input**



**Figure 1-b**



**Figure 1-c**

Control output is level shifted with DC content by zener diode and attenuator, with control signal content by  $R_1$  and  $R_2$ .

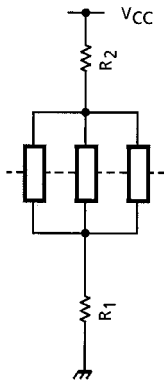
**Position sensing drive**

Both constant current drive and constant voltage drive are available because the same-phase voltage range of the position sensing device is wide. (Spec.:  $2 \sim V_{CC}-2.5V$ . When  $V_{CC}$  is 12V, the range is 2 to 9.5V).

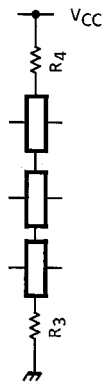
We recommend use of the TOSHIBA THS series of Ga-As position sensing devices.

In comparison with an In-Sb position sensor, the Ga-As sensor is mechanically stronger, has better temperature characteristics, and is less prone to saturation by magnetism or current. However, its application has been limited by its lower sensitivity when compared with the In-Sb type.

As for the TA7259, a Ga-As position sensor can be applied by improving the sensitivity of its input amp and reducing the offset. When W/F characteristics are poor, increasing the position sensing input may be effective. However, take care not to exceed the maximum permissible input.



Position sensing drive (1)



(2)

(For details, refer to the technical documents of the Toshiba THS series of Ga-As position sensing devices.)

## ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

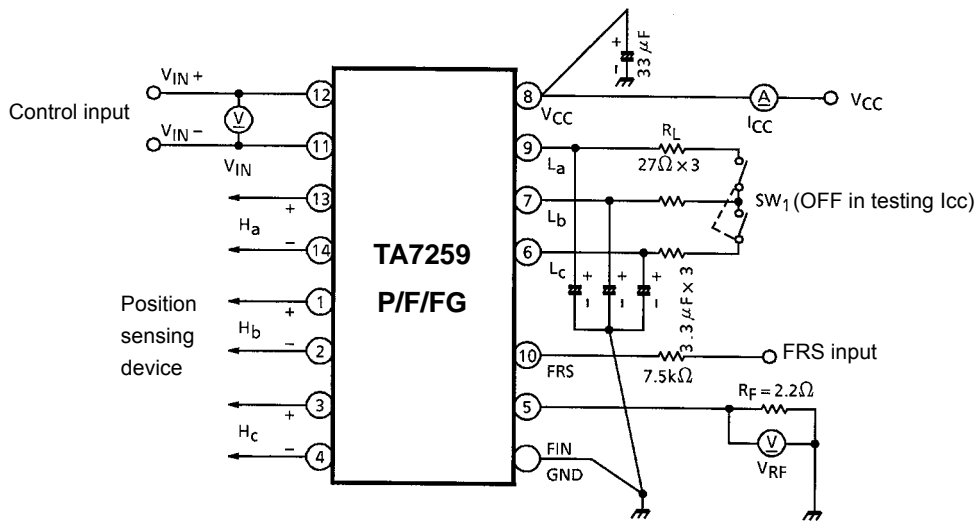
CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V <sub>CC</sub>	26	V
Output Current		I <sub>O</sub>	1.2	A
Power Dissipation	TA7259P	P <sub>D</sub> (Note)	2.3	W
	TA7259F/FG		1.0	
Operating Temperature		T <sub>opr</sub>	-30~75	°C
Storage Temperature		T <sub>stg</sub>	-55~150	°C

Note: IC only.

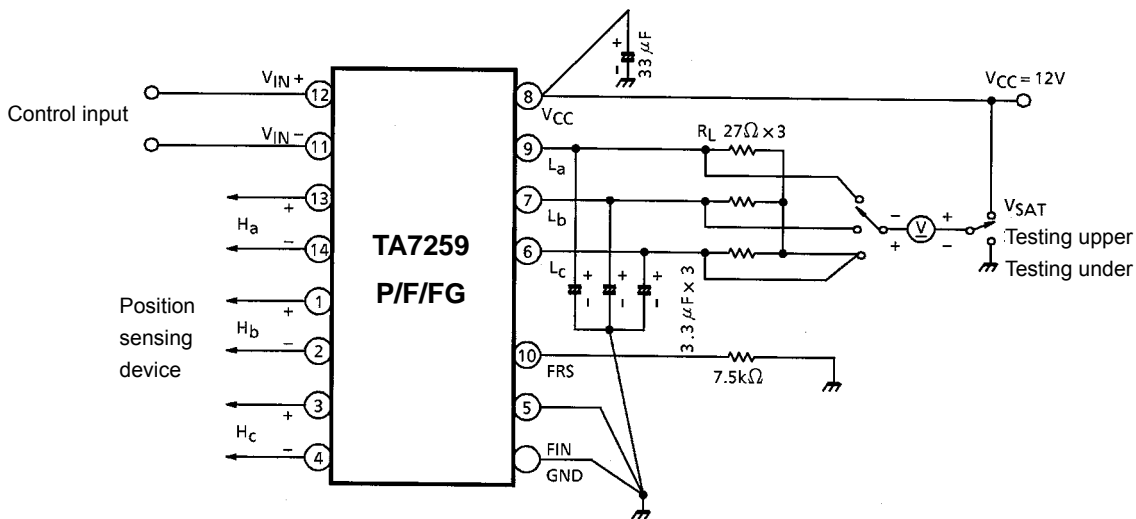
## ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V<sub>CC</sub> = 12 V, Ta = 25°C)

CHARACTERISTIC		SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT
Quiescent Current		I <sub>CC1</sub>	1	FRS open	2	4	7	mA
		I <sub>CC2</sub>		FRS = 5 V	2	5	9	
		I <sub>CC3</sub>		V <sub>CC</sub> = 22 V, FRS = GND	2	5	9	
Input Offset Voltage		V <sub>IO</sub>	1	—	—	40	—	mV
Residual Output Voltage		V <sub>OR</sub>	1	V <sub>IN-</sub> = V <sub>IN+</sub> = 7 V	—	0	10	mV
Voltage Gain		G <sub>V</sub>	1	—	—	15.0	—	—
Saturation Voltage	Upper	V <sub>SAT1</sub>	2	I <sub>L</sub> = 400 mA	—	1.0	1.5	V
	Lower	V <sub>SAT2</sub>	2		—	0.4	1.0	
Cut-off Current	Upper	I <sub>OC1</sub>	—	V <sub>C</sub> = 20 V	—	—	20	μA
	Lower	I <sub>OC2</sub>	—		—	—	20	
Position Sensing Input Sensitivity		V <sub>H</sub>	1	—	—	10	—	mA
Maximum Position Sensing Input Voltage		V <sub>H</sub> MAX.	1	—	—	—	400	mV <sub>p-p</sub>
Input Operating Voltage	Position	CMR <sub>H</sub>	1	—	2.0	—	V <sub>CC</sub> - 2.5	V
	Control	CMR <sub>C</sub>	1	—	2.0	—	V <sub>CC</sub> - 2.5	
Rotation Control Input Voltage (FRS input)	CW	V <sub>F</sub>	1	—	—	0	0.4	V
	STOP	V <sub>S</sub>	1	—	2.5	3.0	3.5	
	CCW	V <sub>R</sub>	1	—	4.5	5.0	5.8	

## Test circuit 1



## Test circuit 2





## Notes on handling the IC

Motor drive ICs are easily affected by parasitic vibration and unnecessary feedback. This is because the number of high impedance pins, such as position sensing inputs and control signal inputs, is large, and the output current value is high and switched.

Moreover, because it is coil loading, care must be taken not to allow the impulse to destroy the IC during ON/OFF switching. Especially when using a high voltage supply ( $V_{CC}$  is 18V or more), care must be taken not to apply voltage and current to the output transistor which exceed the specification. Use of a supply voltage of 18V or less is recommended. Pay particular attention to the notes above when using a supply voltage over 18V.

### (1) Notes in designing reliability

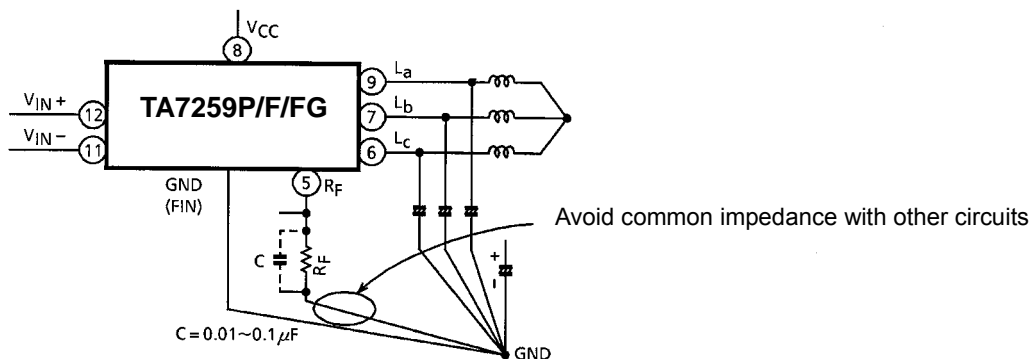
- ) Do not expose the output transistor of the internal IC to high voltage and current, especially, in motor lock status, ON/OFF switching of  $V_{CC}$ , output short-circuiting, etc.)
- ) The output condenser for ringing absorption should be as small as possible because the output transistor can be destroyed by the charge-discharge current of this condenser. When there is a problem, adjusting the capacity of the condenser, the connecting position and the connecting method (delta or star), and inserting a series resistor (of a few  $\Omega$  to dozens of  $\Omega$ ) to the condenser and series should provide the oscillating protection explained later.
- ) In mounting to the print-board, do not stress the FIN, and solder for only a few seconds at 260 .
- ) Using the large earth area of the print-board to release heat from the FIN is effective in ensuring reliability.

### (2) Notes in wiring

To protect from parasitic vibration, design the print-pattern following the method below.

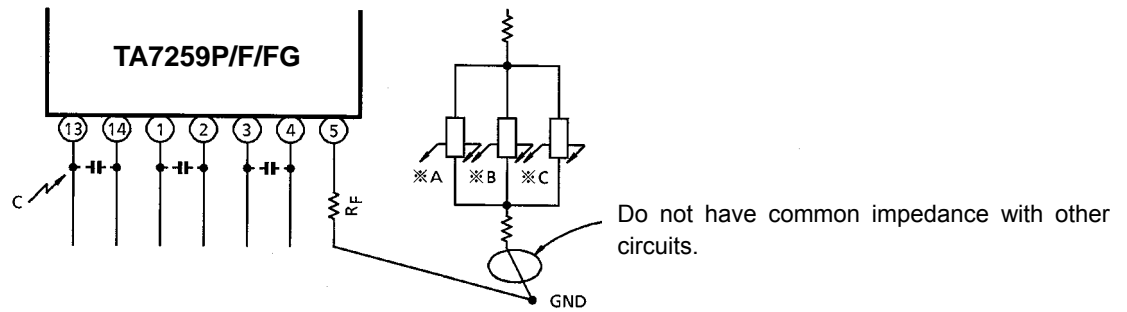
- ) The output coil current path must be separated from other GND lines because a switched high current flows in this path. It is very important that the line ( $R_F$  pin  $R_F$  resistor GND) should not be of a common impedance with other circuits.

If the above is impossible or the oscillation cannot be removed completely, connect the condenser ( $0.01 \sim 0.1\mu F$ ) and  $R_F$  in parallel.



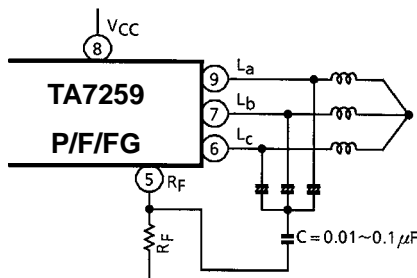
**Fig. 2**

- ) The drive current path of the position sensing device should be connected to the GND independently. It should be separated especially from the output current path. If there is a plunge in position sensing device, insert the condenser (0.05~1 $\mu$ F) between + pin and - pin of each position sensing device. If there is a plunge in control input, insert the condenser (0.001 ~ 0.1 $\mu$ F) between this pin and the GND.

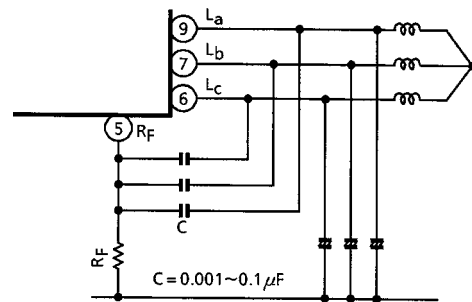


**Fig. 3**

- ) If upper oscillation (5MHz or more) is found, connect the condensers commonly from each coil output and then insert the condenser ( $C = 0.01 \sim 0.1\mu\text{F}$ ) between this connecting point and RF pin. (Fig.4-a) Aside from using a ringing absorbing condenser, consider a different method to connect the condenser between each coil output and RF pin. (Fig 4-b)

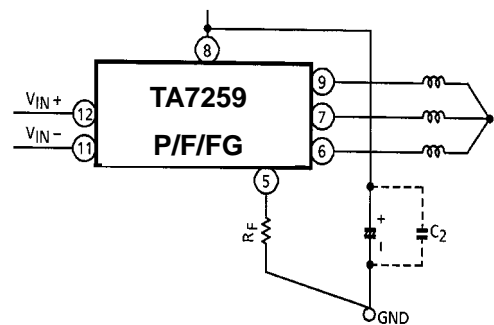


**Fig. 4-a**



**Fig. 4-b**

- ) Make sure to take the power supply from VCC pin ("8" pin) directly. Design the circuit not to have the common impedance toward GND. Use of  $C_2$  (0.01 ~ 0.1 $\mu$ F) is also effective.



**Fig. 5**

**(3) Connecting condenser for output ringing absorption**

We recommend connecting a condenser between each coil and the GND for output ringing absorption. However, other methods below can be also applied to prevent oscillation and destruction.

- ) Changing capacity.
- ) Delta connection (Fig.6-a)
- ) Connect to VCC, not to the GND. (Fig. 6-b) In this case; take care not to let the IC be destroyed. If voltage-current locus is beyond the ASO, series resistance or equivalent must be inserted.
- ) Connect to R<sub>F</sub> pin.
- ) Insert a resistance between condenser and series. (Fig. 6-c)
- ) Combination of ), ), ), and ).

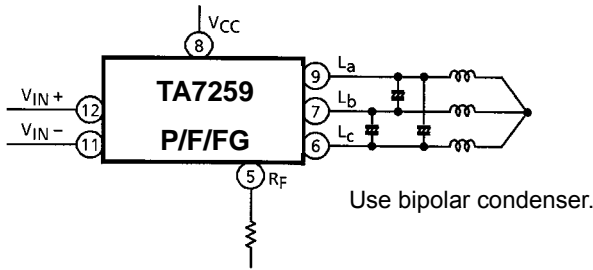


Fig. 6-a

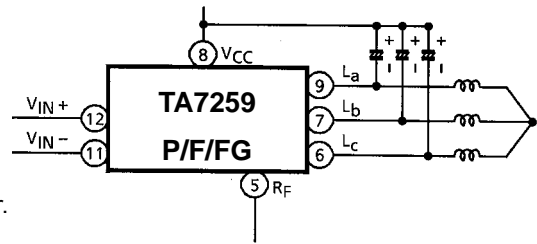


Fig. 6-b

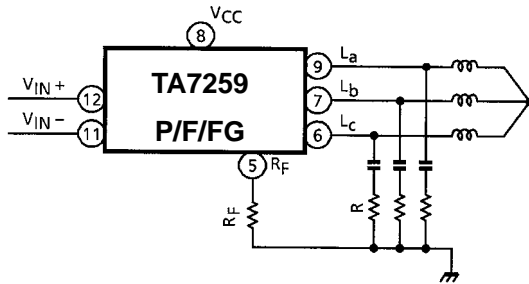


Fig. 6-c

**Others**

The output transistor of the IC can be destroyed when the capacity of the output condenser or its connection is not appropriate. To prevent destruction, confirm the voltage-current locus of the output transistor gained from the test (see the figure below) is within the ASO. It is especially important to measure the output transistor in SW's ON/OFF timing and the sequence of normal rotation, reverse rotation, and normal rotation.

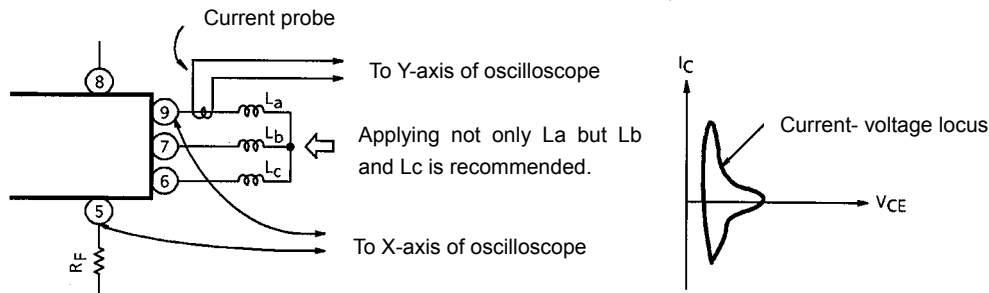
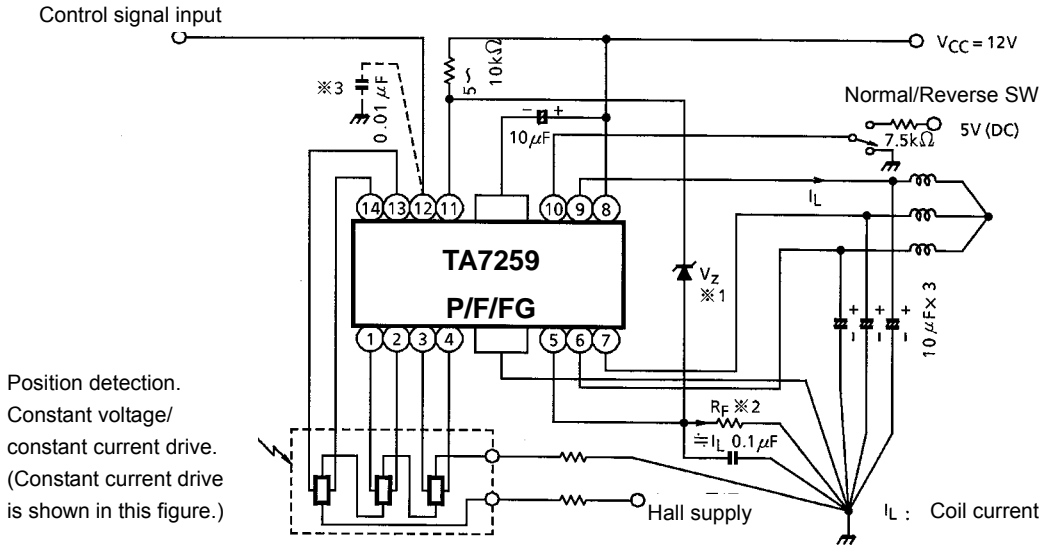


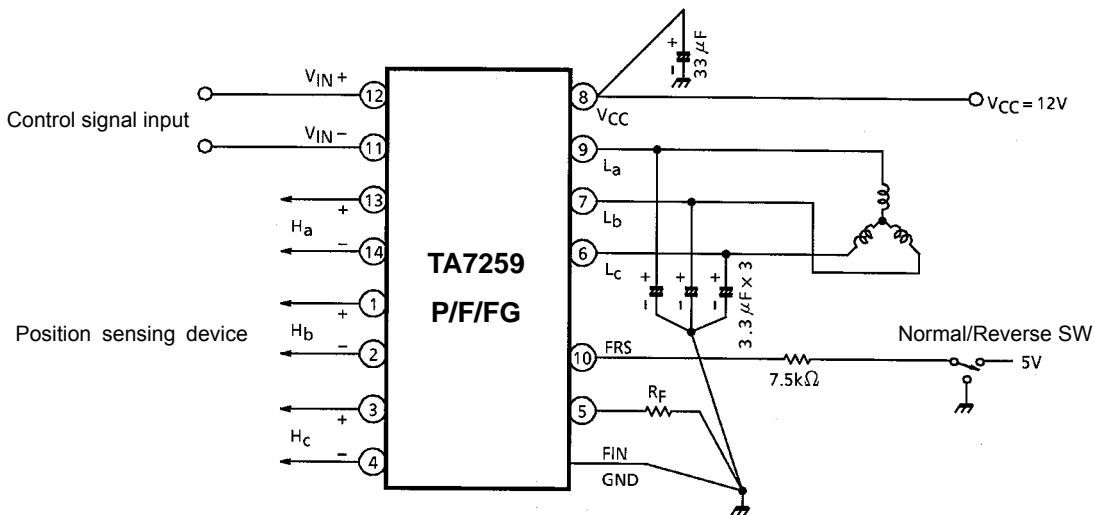
Fig. 7

Application circuit 1



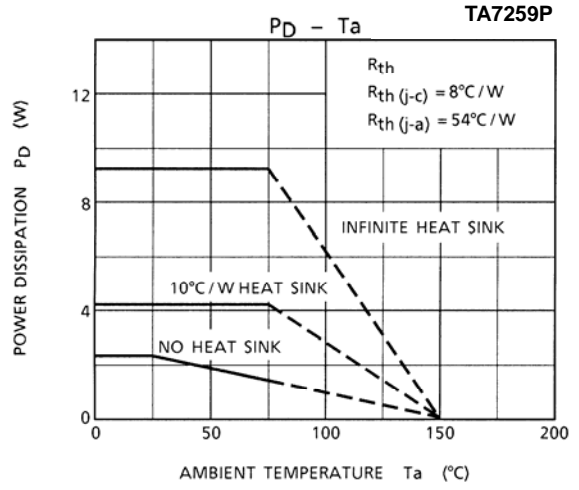
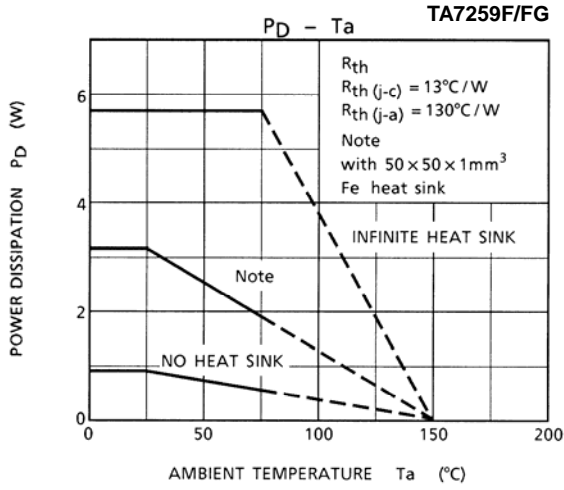
- 1:  $V_Z$  of zener diode should correspond to DC level of control signal input. ( $V_Z = 2.5 \sim 9V$ . In considering temperature characteristics, applying 5V is recommended. DC voltage of negative control input ( $V_{IN-pin}$ ) equals  $V_Z + R_F \cdot I_L$ .)
- 2:  $R_F$  is determined by the coil impedance, F/V converter voltage (control input), and necessary starting torque. However, please apply within the range of 0.3 to 5Ω.
- 3: Connect this condenser when there is a pulse in control input.

Application circuit 2



Note:

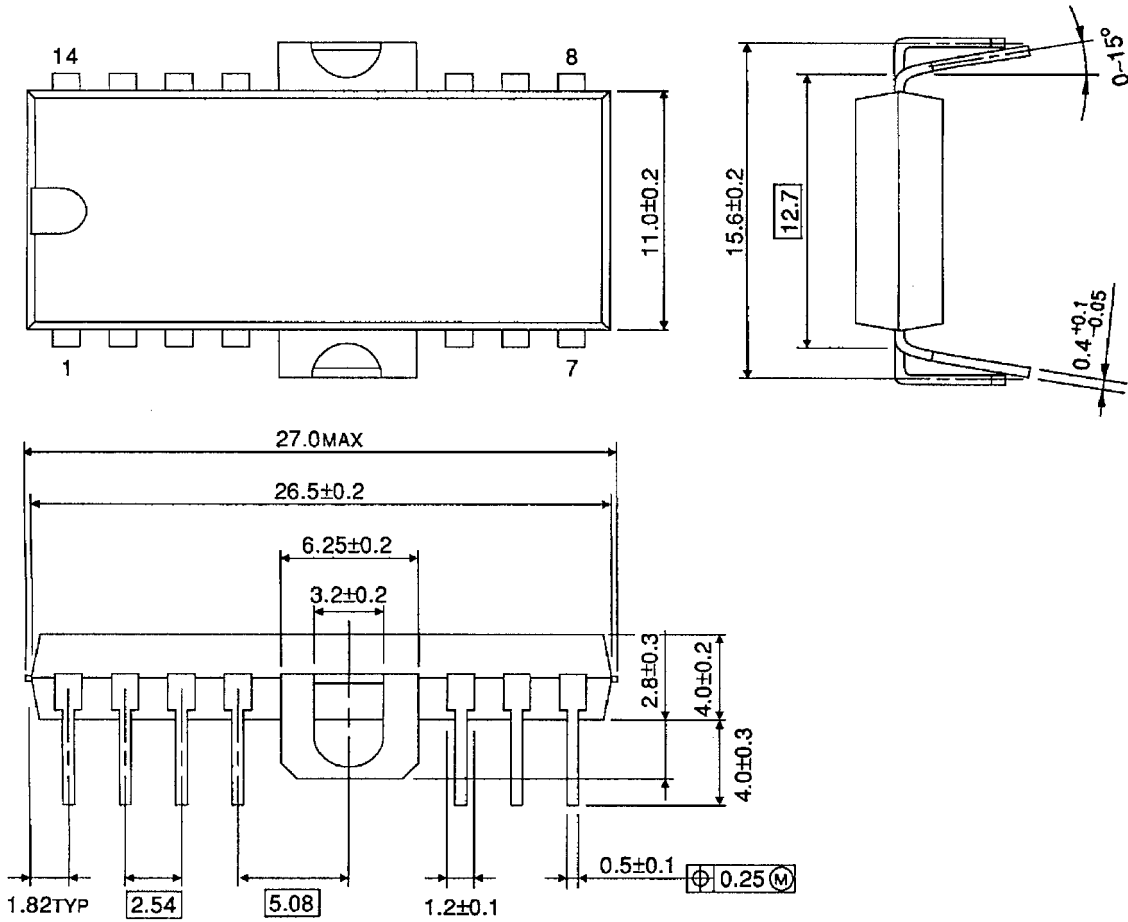
Utmost care is necessary in the design of the output,  $V_{CC}$ ,  $V_M$ , and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.



**PACKAGE DIMENSIONS**

HDIP14-P-500-2.54A

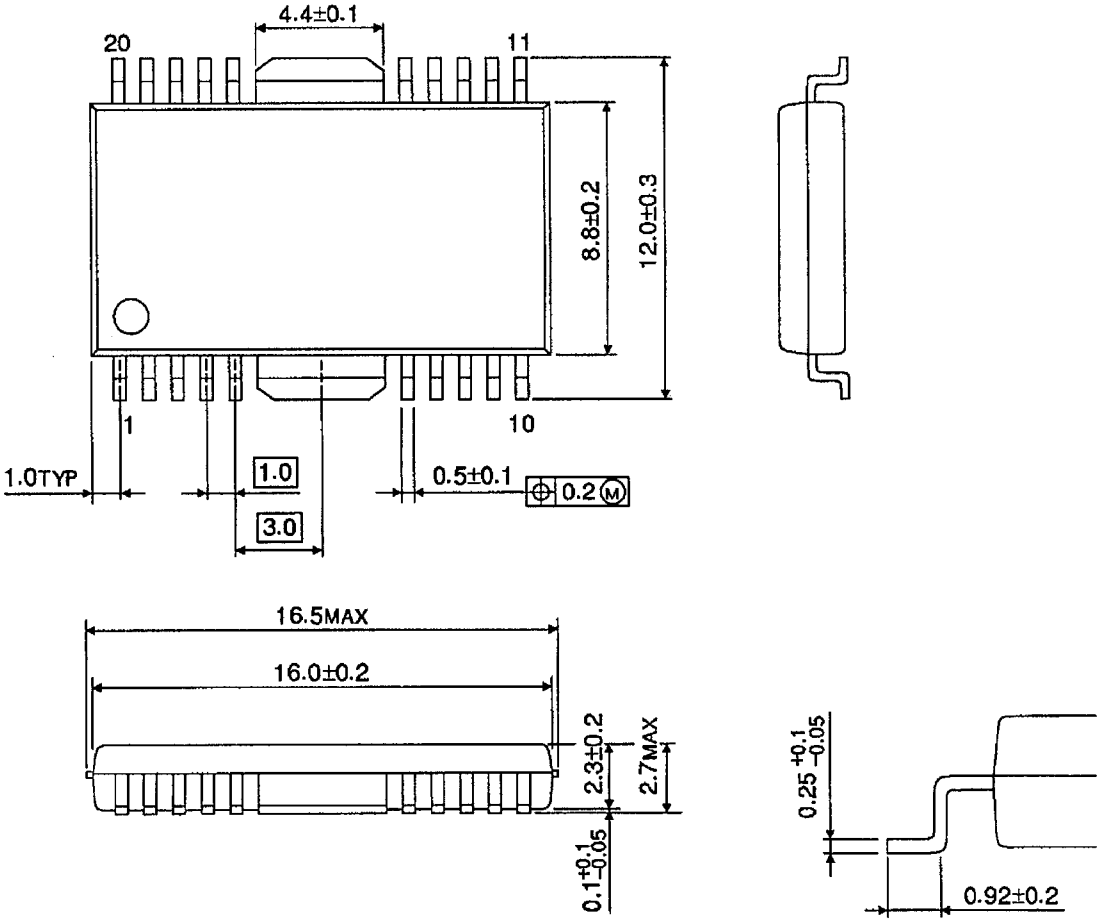
Unit: mm



Weight: 3.00 g (Typ.)

HSOP20-P-450-1.00

Unit: mm



Weight: 0.79 g (Typ.)

## Notes on Contents

### 1. Block Diagrams

Some of the functional blocks, circuits, or constants in the block diagram may be omitted or simplified for explanatory purposes.

### 2. Equivalent Circuits

The equivalent circuit diagrams may be simplified or some parts of them may be omitted for explanatory purposes.

### 3. Timing Charts

Timing charts may be simplified for explanatory purposes.

### 4. Application Circuits

The application circuits shown in this document are provided for reference purposes only. Thorough evaluation is required, especially at the mass production design stage.

Toshiba does not grant any license to any industrial property rights by providing these examples of application circuits.

### 5. Test Circuits

Components in the test circuits are used only to obtain and confirm the device characteristics. These components and circuits are not guaranteed to prevent malfunction or failure from occurring in the application equipment.

## IC Usage Considerations

### Notes on handling of ICs

- [1] The absolute maximum ratings of a semiconductor device are a set of ratings that must not be exceeded, even for a moment. Do not exceed any of these ratings.  
Exceeding the rating(s) may cause device breakdown, damage or deterioration, and may result in injury by explosion or combustion.
- [2] Use an appropriate power supply fuse to ensure that a large current does not continuously flow in case of over-current and/or IC failure. The IC will break down completely when used under conditions that exceed its absolute maximum ratings, when the wiring is routed improperly or when an abnormal pulse noise occurs from the wiring or load, causing a large current to continuously flow and the breakdown lead to smoke or ignition. To minimize the effects of the flow of a large current in case of breakdown, appropriate settings, such as fuse capacity, fusing time and insertion circuit location, are required.
- [3] If your design includes an inductive load such as a motor coil, incorporate a protection circuit into the design to prevent device malfunction or breakdown caused by the current resulting from the inrush current at power ON or the negative current resulting from the back electromotive force at power OFF. IC breakdown may cause injury, smoke or ignition.  
Use a stable power supply with ICs with built-in protection functions. If the power supply is unstable, the protection function may not operate, causing IC breakdown. IC breakdown may cause injury, smoke or ignition.
- [4] Do not insert devices in the wrong orientation or incorrectly.  
Make sure that the positive and negative terminals of power supplies are connected properly.  
Otherwise, the current or power consumption may exceed the absolute maximum rating, and exceeding the rating(s) may cause device breakdown, damage or deterioration, and may result in injury by explosion or combustion.  
In addition, do not apply current to any device that is incorrectly inserted or oriented, even for an instant.



**Points to remember on handling of ICs****(1) Heat Radiation Design**

In using an IC with large current flow such as a power amp, regulator or driver, please design the device so that heat is appropriately radiated, so as not to exceed the specified junction temperature ( $T_j$ ) at any time and condition. These ICs generate heat even during normal use. An inadequate IC heat radiation design can lead to a decrease in IC life, deterioration of IC characteristics or IC breakdown. In addition, please design the device taking into consideration the effect of IC heat radiation on peripheral components.

**(2) Back-EMF**

When a motor rotates in the reverse direction, stops or slows down abruptly, a current flows back to the motor's power supply due to the effect of back-EMF. If the current sink capability of the power supply is small, the device's motor power supply and output pins might be exposed to conditions beyond maximum ratings. To avoid this problem, take the effect of back-EMF into consideration in system design.

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