

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

# TA7289P, TA7289F/FG

## PWM STEPPING MOTOR DRIVER

The TA7289P, TA7289F/FG are PWM solenoid driver designed especially for use high efficiency stepping motor control. It consist of 1.5A peak current drive capable output full bridge driver, oscillation circuit for PWM switching, 4bit D-A for output current control and TTL compatible input circuit.

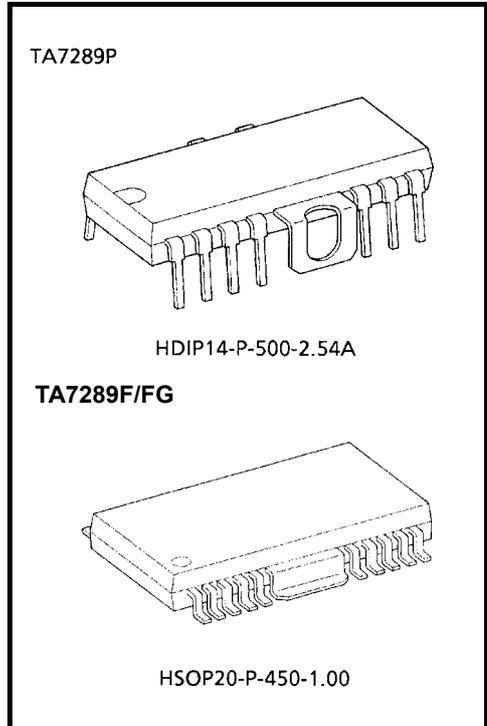
### FEATURES

- Wide Range of Operating Voltage  
: VCC (opr.) Min. = 6~27 V
- High Current Capability: I<sub>O</sub> Max = 1.5 A (PEAK)
- LS-TTL Compatible Control Inputs (IN A, IN B)
- Few External Components Required.
- Build-in 4bit DAC.

The TA7289FG is a Pb-free product.  
The TA7289P is Sn plated product including Pb.  
The following conditions apply to solderability:

\*Solderability

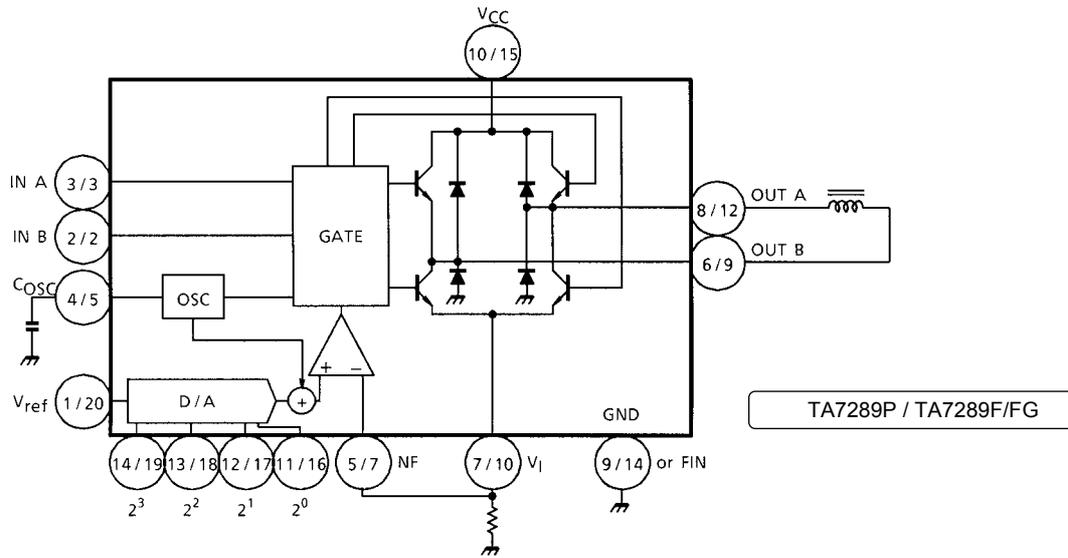
1. Use of Sn-37Pb solder bath  
\*solder bath temperature = 230°C  
\*dipping time = 5 seconds  
\*number of times = once  
\*use of R-type flux
2. Use of Sn-3.0Ag-0.5Cu solder bath  
\*solder bath temperature = 245°C  
\*dipping time = 5 seconds  
\*the number of times = once  
\*use of R-type flux



Weight

HDIP14-P-500-2.54A : 3.00g (Typ.)  
HSOP20-P-450-1.00 : 0.79g (Typ.)

**BLOCK DIAGRAM**



Note: Pin (1), (4), (6), (8), (11), (13) of TA7289F/FG are all NC (Non-connection)

## PIN FUNCTION

PIN No.		PIN SYMBOL	FUNCTIONAL DESCRIPTION	
P	F/FG			
1	20	V <sub>ref</sub>	NF voltage supply input terminal	
2	2	IN B	Signal input terminal	Function
3	3	IN A	Signal input terminal	
4	5	C <sub>OSC</sub>	Internal oscillation frequency input terminal	
5	7	NF	Output current detection terminal	
6	9	OUT B	Output B terminal	
7	10	V <sub>I</sub>	Comparator input terminal	
8	12	OUT A	Output A terminal	
9	14	GND	GND terminal	
10	15	V <sub>CC</sub>	Power voltage supply terminal	
11	16	2 <sup>0</sup>	D / A input terminal	
12	17	2 <sup>1</sup>	D / A input terminal	
13	18	2 <sup>2</sup>	D / A input terminal	
14	19	2 <sup>3</sup>	D / A input terminal	
FIN	FIN	GND	GND terminal	

Note: Pin (1), (4), (6), (8), (11), (13) of TA7289F/FG are all NC (Non-connection)

## FUNCTION

IN A	IN B	OUT A	OUT B	MODE
L	L	OFF	OFF	STOP
H	L	H	L	CW / CCW
L	H	L	H	CCW / CW
H	H	OFF	OFF	STOP

## INPUT CIRCUIT (IN A, IN B)

Input circuit is shown in Fig.1 IN A and IN B are TTL compatible "Low Active" type and have a hysteresis of 0.8 V Typ at T<sub>j</sub> = 25°C.

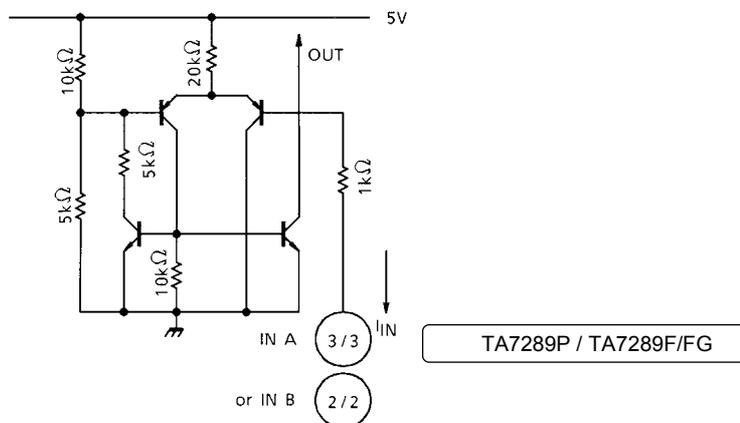
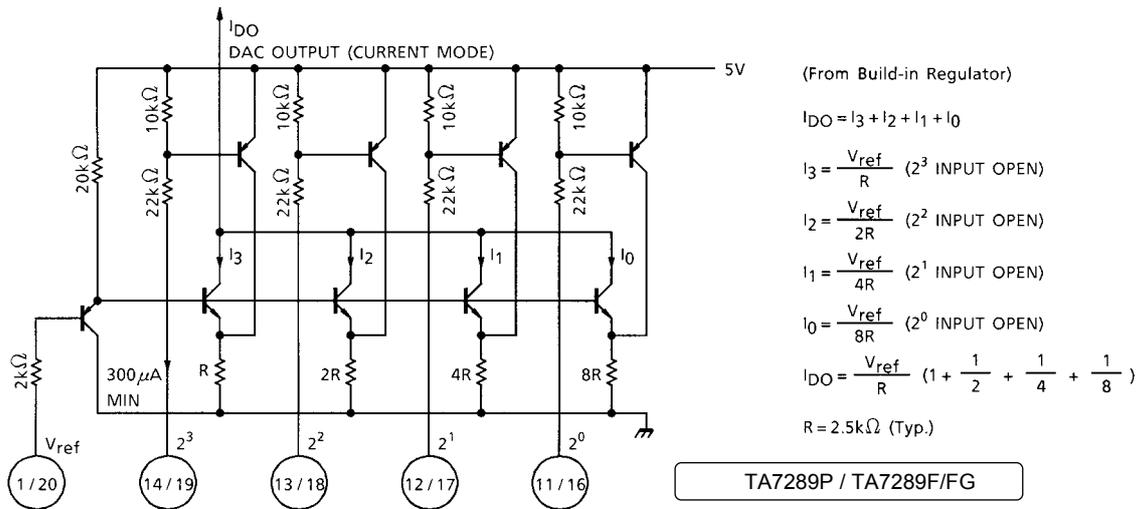


Fig. 1

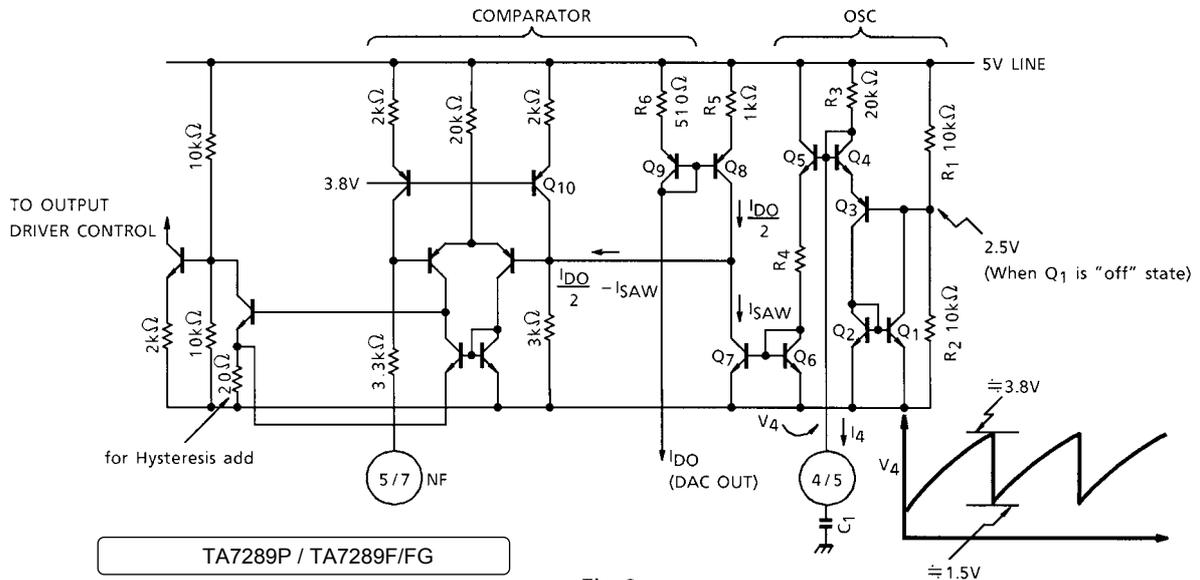
**D / A AND Vref CIRCUIT**



**Fig. 2**

$I_{DO}$  of current mode DAC output is proportional to multiplied voltage of  $V_{ref}$  (PIN (1) (or (20))) and DAC inputs. DAC inputs are all "low active" type and required input current of 300  $\mu$ A MIN for each input terminal.

**OSC AND COMPARATOR**



**Fig. 3**

Sawtooth OSC circuit consists of Q<sub>1</sub> through Q<sub>4</sub> and R<sub>1</sub> through R<sub>3</sub>.

R<sub>1</sub> and R<sub>2</sub> are voltage divider of 5 V build-in regulator.

Q<sub>1</sub> is turned "off" when V<sub>4</sub> is less than the voltage of 2.5 V + V<sub>BE</sub> Q<sub>4</sub> + V<sub>BE</sub> Q<sub>3</sub> approximately equal to 3.8 V. V<sub>4</sub> is increased by C<sub>1</sub> charging of I<sub>4</sub>. Q<sub>1</sub> and Q<sub>2</sub> are turned "ON" when V<sub>4</sub> becomes V<sub>4</sub> - H level.

Lower level of V<sub>4</sub> (V<sub>4</sub> - L) is equal to V<sub>BE</sub> Q<sub>4</sub> + V<sub>BE</sub> Q<sub>3</sub> + V<sub>SAT</sub> Q<sub>1</sub> approximately equal to 1.5 V.

V<sub>4</sub> is calculated by following equation.

$$V_4 = 5 \cdot (1 - e^{-\frac{1}{C_1 R_3} t}) \dots \dots \dots (1)$$

Assuming that V<sub>4</sub> = 1.5 V (t = t<sub>1</sub>) and = 3.8 V (t = t<sub>2</sub>).

C<sub>1</sub> is external capacitance connected to Pin (4) (or (5)) and R<sub>3</sub> is on-chip 20 kΩ resistor.

Therefore, OSC frequency is calculated as follows.

$$t_1 = -C_1 \cdot R_3 \cdot \ln \left(1 - \frac{1.5}{5}\right) \dots \dots \dots (2)$$

$$t_2 = -C_1 \cdot R_3 \cdot \ln \left(1 - \frac{3.8}{5}\right) \dots \dots \dots (3)$$

$$f_{OSC} = \frac{1}{t_1 - t_2} = \frac{1}{C_1 \cdot (R_3 \cdot \ln \left(1 - \frac{1.5}{5}\right) - R_3 \cdot \ln \left(1 - \frac{3.8}{5}\right))}$$

$$= \frac{1}{21.4 C_1} (\text{kHz}) \text{ (Unit of } C_1 \text{ is } \mu\text{F)}$$

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

CHARACTERISTIC		SYMBOL	RATING	UNIT
Supply Voltage		V <sub>CC</sub>	30	V
		V <sub>ref</sub>	30	
Reference Voltage		V <sub>IN</sub>	7	
		V <sub>I</sub>	2	
Output Current	TA7289P	I <sub>O</sub> (MAX.)	1.5	A
	TA7289F/FG		0.8	
	TA7289P	I <sub>O</sub> (AVE.)	0.7	
	TA7289F/FG		0.3	
Power Dissipation	TA7289P	PD (Note)	2.3	W
	TA7289F/FG		1.0	
Operating Temperature		T <sub>opr</sub>	-30~85	°C
Storage Temperature		T <sub>stg</sub>	-55~150	°C

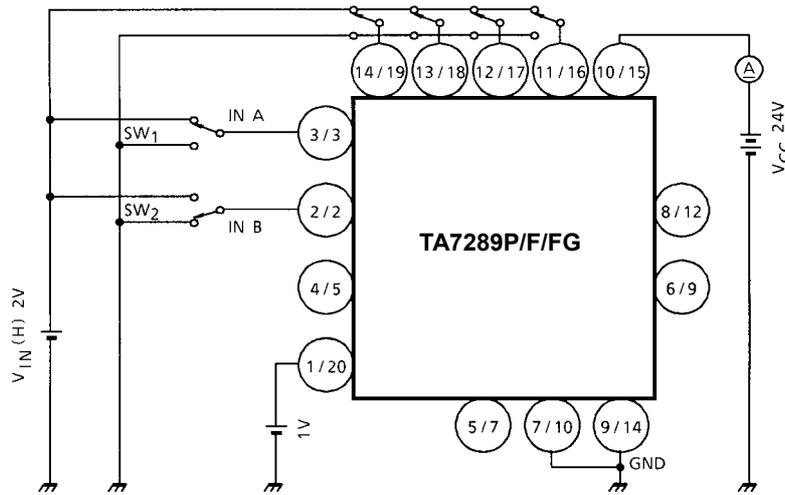
Note: NO HEAT SINK

## ELECTRICAL CHARACTERISTICS (Unless otherwise specified, $V_{CC} = 24\text{ V}$ , $T_a = 25^\circ\text{C}$ )

CHARACTERISTIC	SYMBOL	TEST CIR-CUIT	TEST CONDITION	MIN	TYP.	MAX	UNIT	
Quiescent Current	$I_{CC1}$	1	CW / CCW	Output : Open	12	20	30	mA
	$I_{CC2}$		STOP		12	20	30	
	$I_{CC3}$		CW / CCW mode, $2^0 \sim 2^3$ : H		12	20	30	
	$I_{CC4}$		CW / CCW mode, $2^0 \sim 2^3$ : L		13	23	32	
Output Voltage	$V_{IN(H)}$	2	IN A IN B, Source type.	2.0	—	7.0	V	
	$V_{IN(L)}$			-0.4	—	0.8		
Input Hysteresis Width	$\Delta V_{IN}$	2	—	—	0.8	—	V	
Input Current	$I_{IN1}$	2	IN A, IN B $V_{IN} = 0\text{ V}$ Source type	—	25	35	$\mu\text{A}$	
	$I_{IN2}$		$2^0, 2^1, 2^2, 2^3$ $V_{IN} = 0\text{ V}$ Source type	90	160	200		
Output Saturation Voltage	$V_{SAT\ U-1}$	3	$I_{OUT} = 0.2\text{ A}$	—	1.1	1.5	V	
	$V_{SAT\ L-1}$			—	0.8	1.1		
	$V_{SAT\ U-2}$		$I_{OUT} = 0.7\text{ A}$	—	1.2	1.7		
	$V_{SAT\ L-2}$			—	0.9	1.3		
	$V_{SAT\ U-3}$		$I_{OUT} = 1.5\text{ A}$	—	1.8	2.6		
	$V_{SAT\ L-3}$			—	1.2	1.9		
Control Supply Voltage	$V_{ref}$	—	—	GND	—	2.0	V	
Control Supply Current	$I_{ref}$	2	$V_{ref} = 0 \sim 2.0\text{ V}$	—	25	35	$\mu\text{A}$	
Diode Forward Voltage	$V_{FU}$	4	$I_F = 1.5\text{ A}$	—	2.6	3.3	V	
	$V_{FL}$			—	0.8	1.1		
Output Leakage Current	$I_{L-U}$	5	$V_L = 30\text{ V}$	—	—	50	$\mu\text{A}$	
	$I_{L-L}$		$V_L = 30\text{ V}$	—	—	50		
NF Terminal Current	$I_{NF}$	6	Source type $V_{NF} = 0 \sim 2.0\text{ V}$ $T_j = 0 \sim 125^\circ\text{C}$	180	300	490	$\mu\text{A}$	
Internal Supply Output Voltage	$V_{CC2}$	6	—	—	5	—	V	
Resistor for Oscillation (R3)	$R_{OSC}$	6	$T_j = 0 \sim 125^\circ\text{C}$	13	20	32	$\text{k}\Omega$	

## TEST CIRCUIT 1

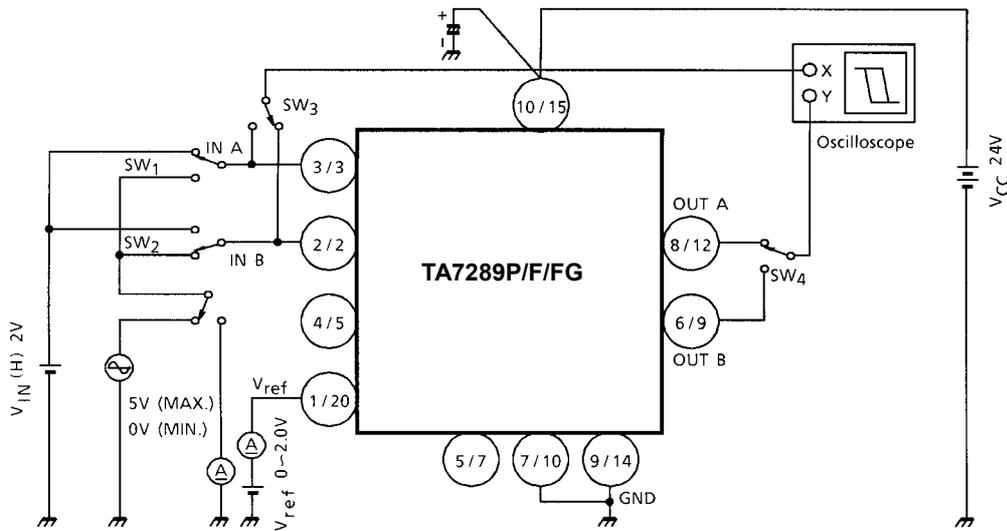
$I_{CC1, 2, 3, 4}$



TA7289P / TA7289F/FG

## TEST CIRCUIT 2

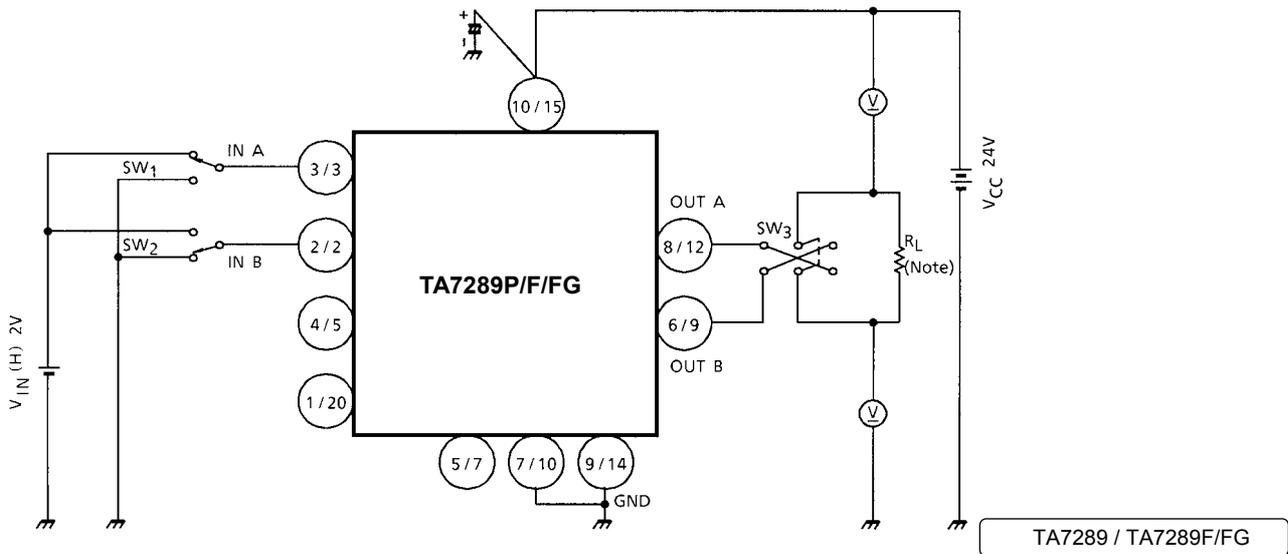
$V_{IN(H)}, (L), I_{IN1, 2}, \Delta V_{IN}, I_{ref}$



TA7289P / TA7289F/FG

## TEST CIRCUIT 3

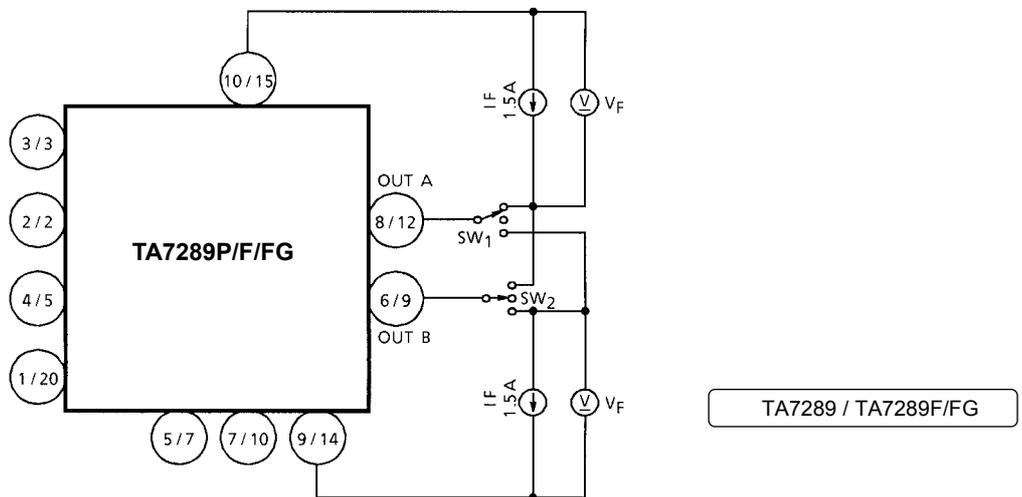
$V_{SAT}$  U1, L1, U2, L2, U3, L3



Note: Calibrate  $I_{OUT}$  to 0.2A / 0.7A / 1.5A by  $R_L$

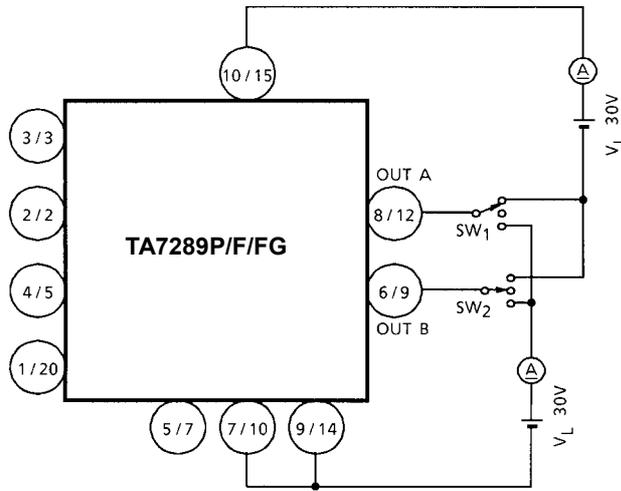
## TEST CIRCUIT 4

$V_{FU}$ ,  $V_{FL}$



## TEST CIRCUIT 5

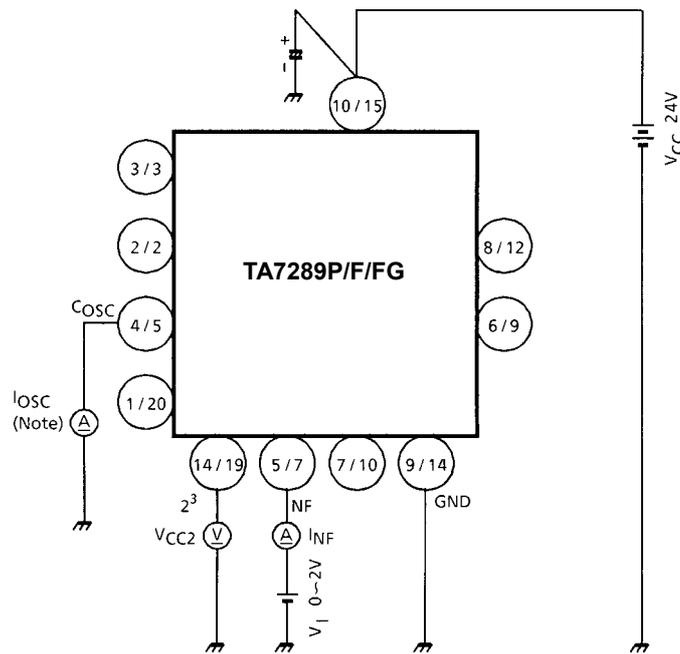
$I_{L-U}$ ,  $I_{L-L}$



TA7289P / TA7289F/FG

## TEST CIRCUIT 6

$I_{NF}$ ,  $V_{CC2}$ ,  $R_{OSC}$

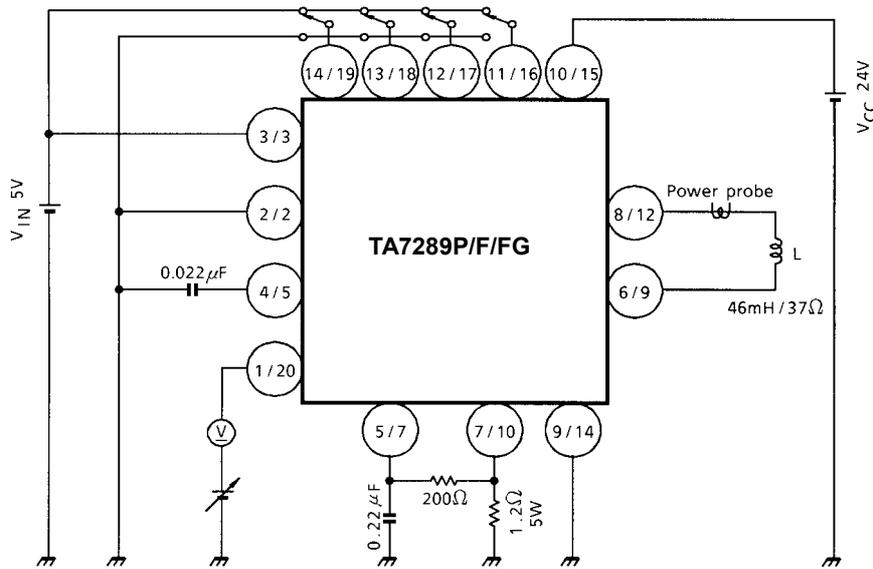


TA7289P / TA7289F/FG

Note:  $R_{OSC} = \frac{V_{CC2} (V)}{I_{OSC} (A)} (\Omega)$

**TEST CIRCUIT 7**

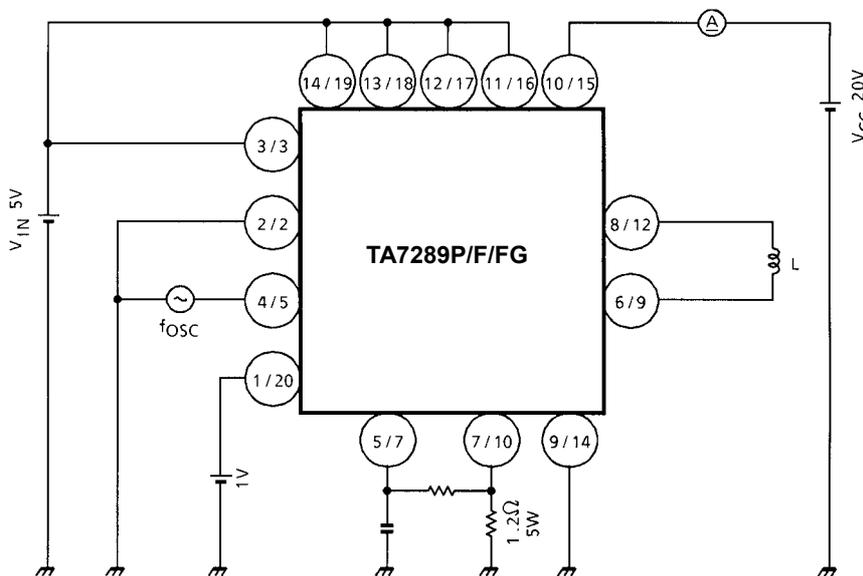
$I_{OUT} - V_{ref}$  CHARACTERISTIC,  $I_{OUT} - D / A$  CHARACTERISTIC



TA7289P / TA7289F/FG

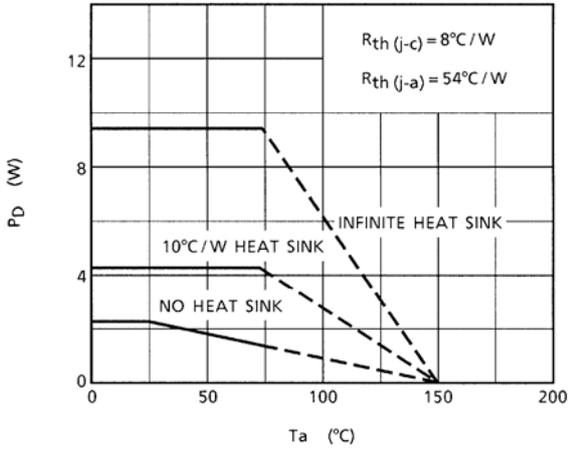
**TEST CIRCUIT 8**

$I_{CC} -$  FREQUENCY CHARACTERISTIC

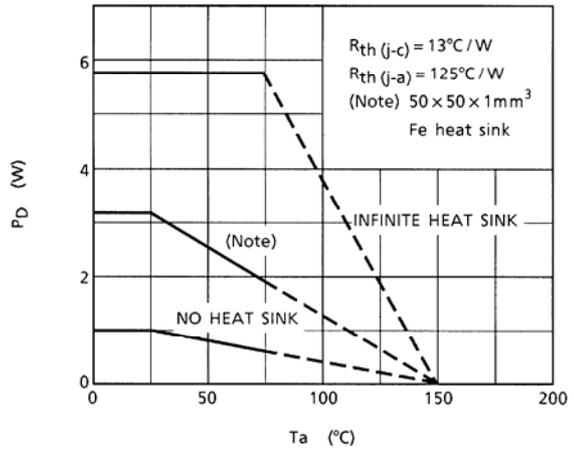


TA7289P / TA7289F/FG

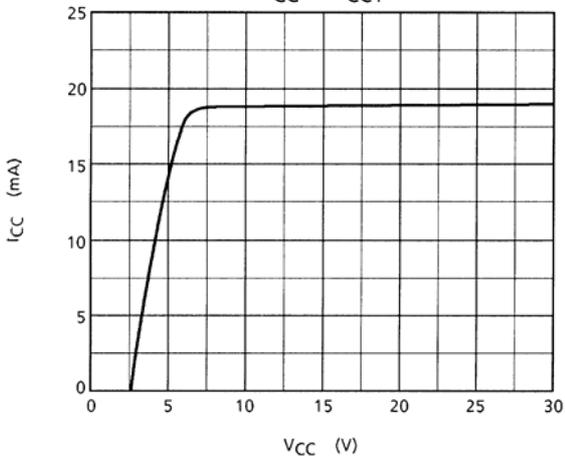
TA7289P PD - Ta



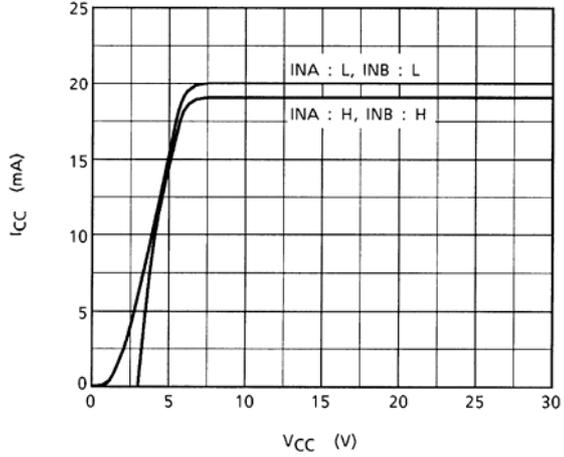
TA7289F/FG PD - Ta



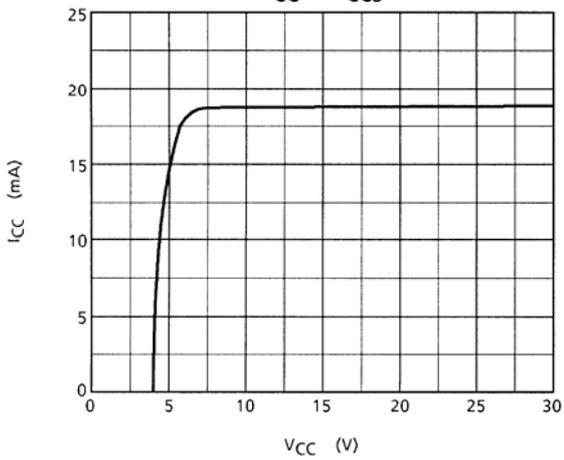
VCC - ICC1



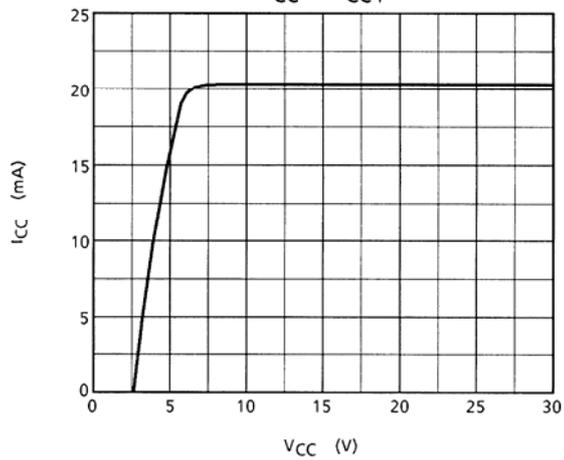
VCC - ICC2

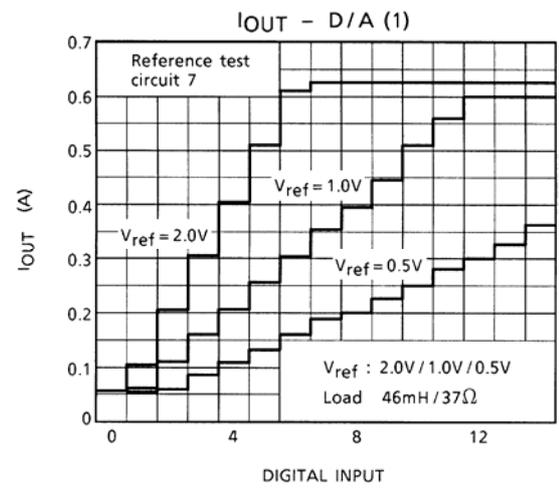
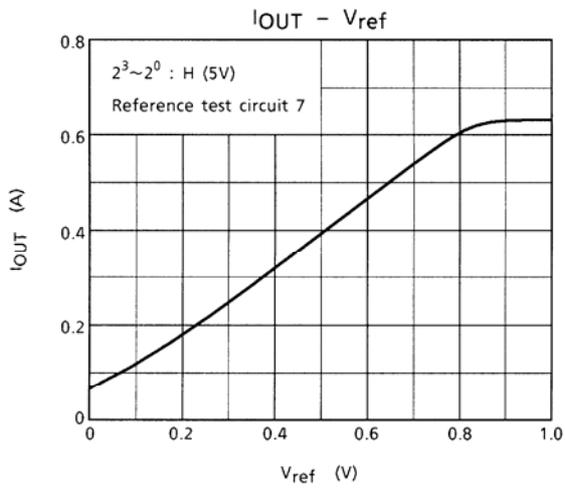
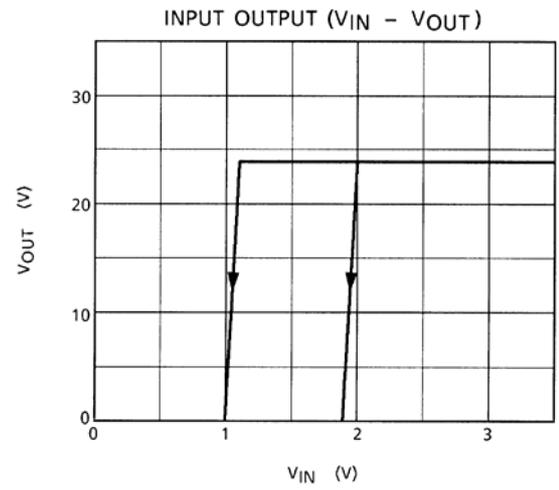
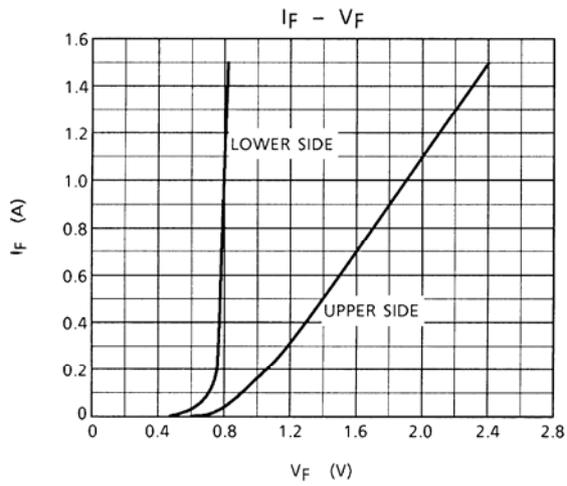
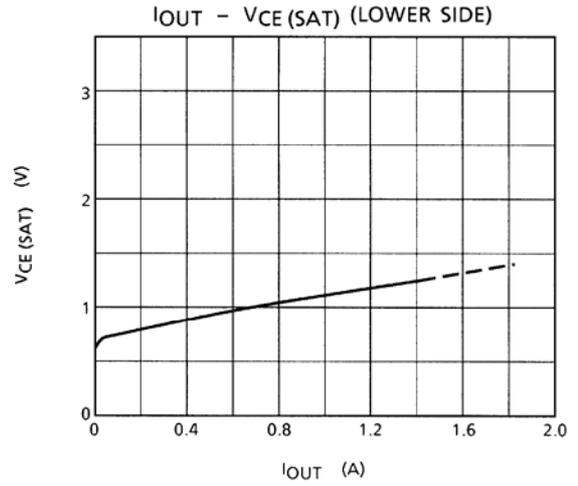
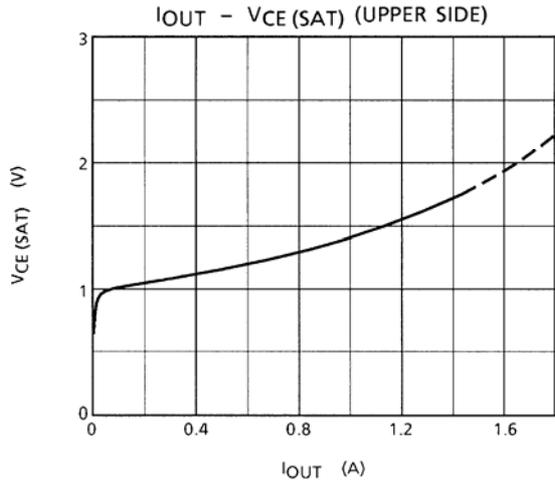


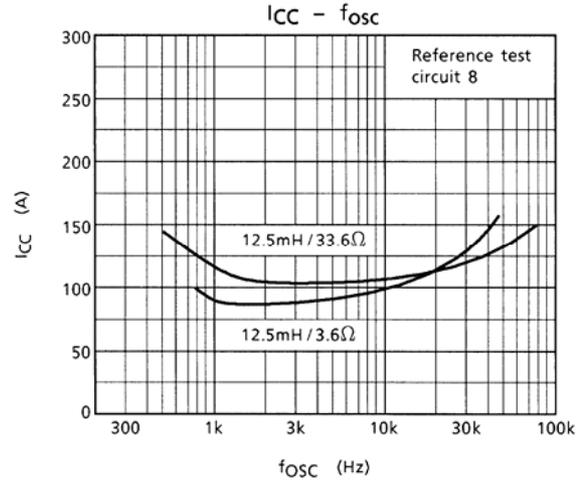
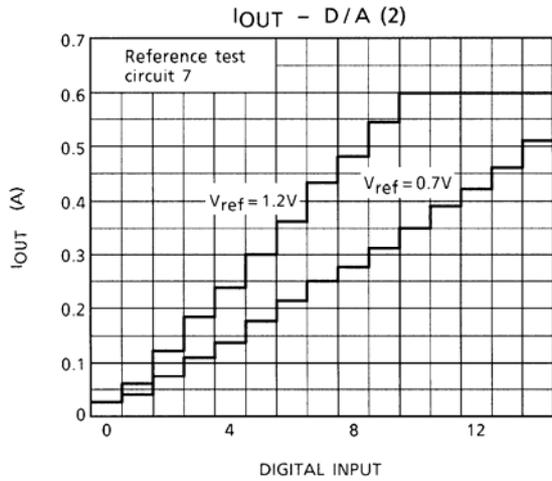
VCC - ICC3



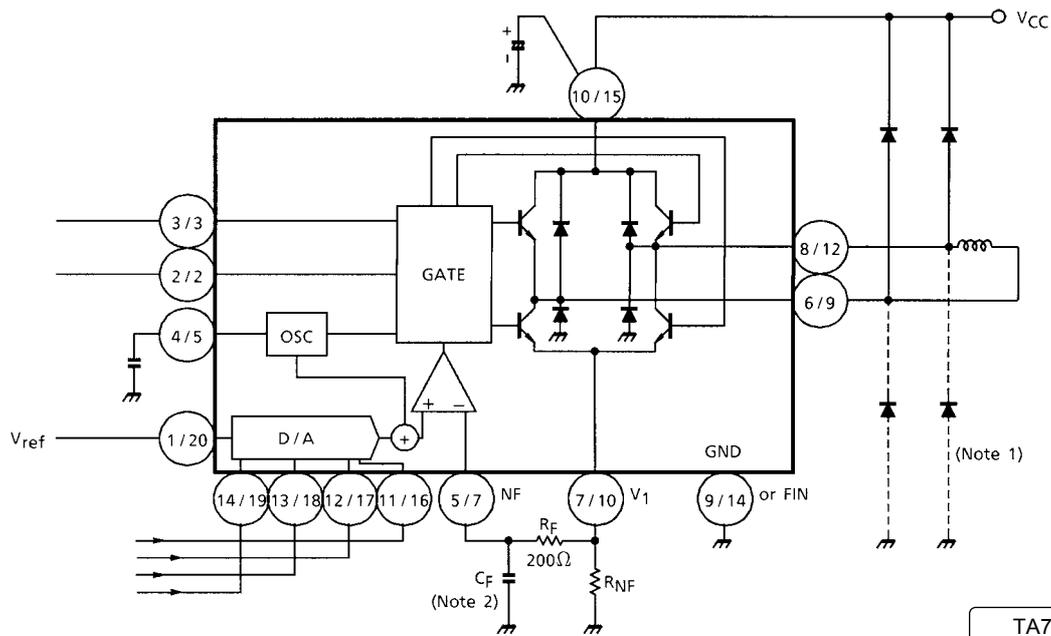
VCC - ICC4







**APPLICATION CIRCUIT 1**



TA7289P / TA7289F/FG

Note 1: Connect if required.

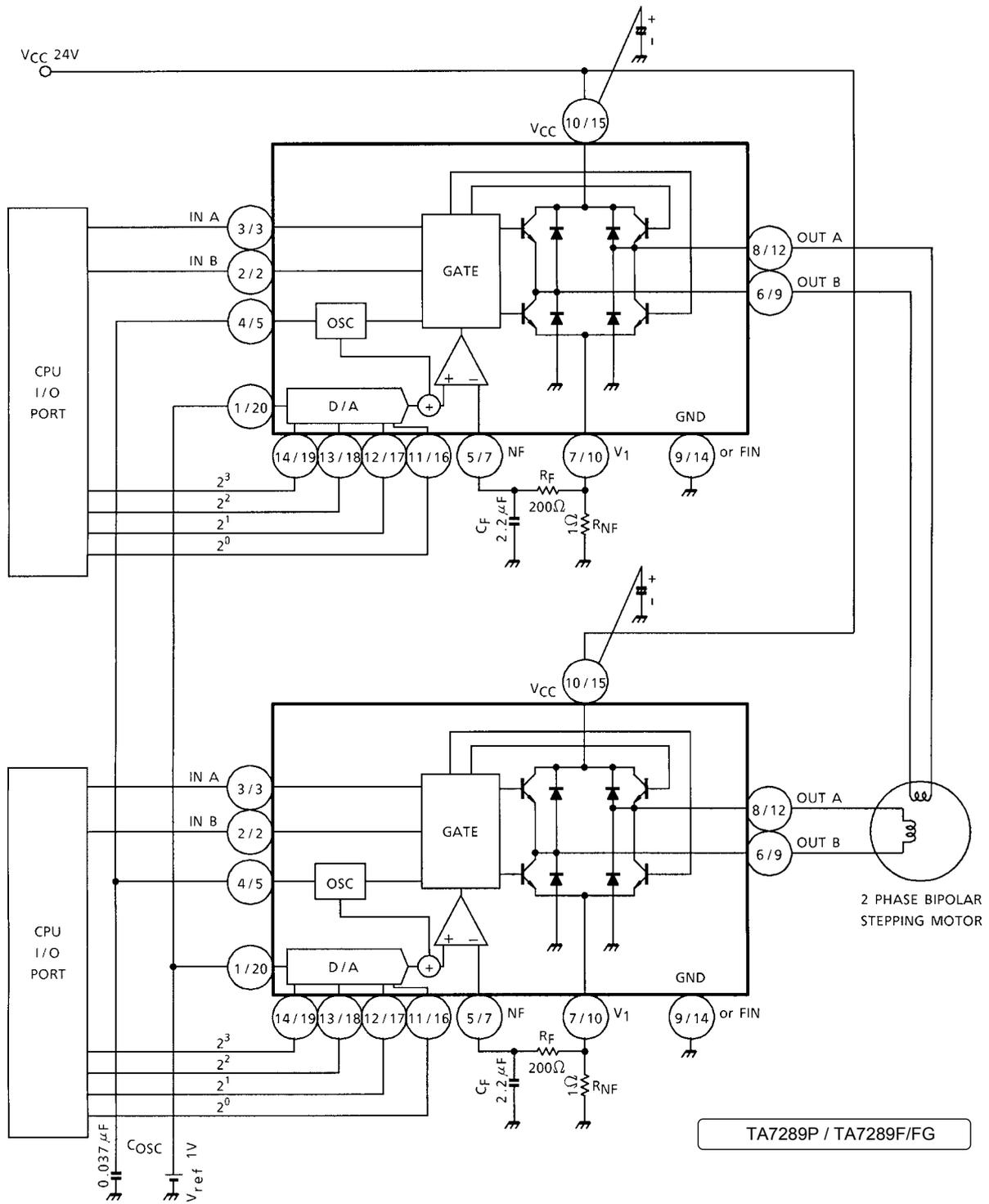
Note 2: Recommended  $R_F$  value is approximately  $200\ \Omega$ .

And  $C_F$  value is concerned with the OSC frequency.

We recommend to select optimum value of  $C_F$  under the experimental consideration of noise cutting and time delay characteristics.

Note 3: 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.

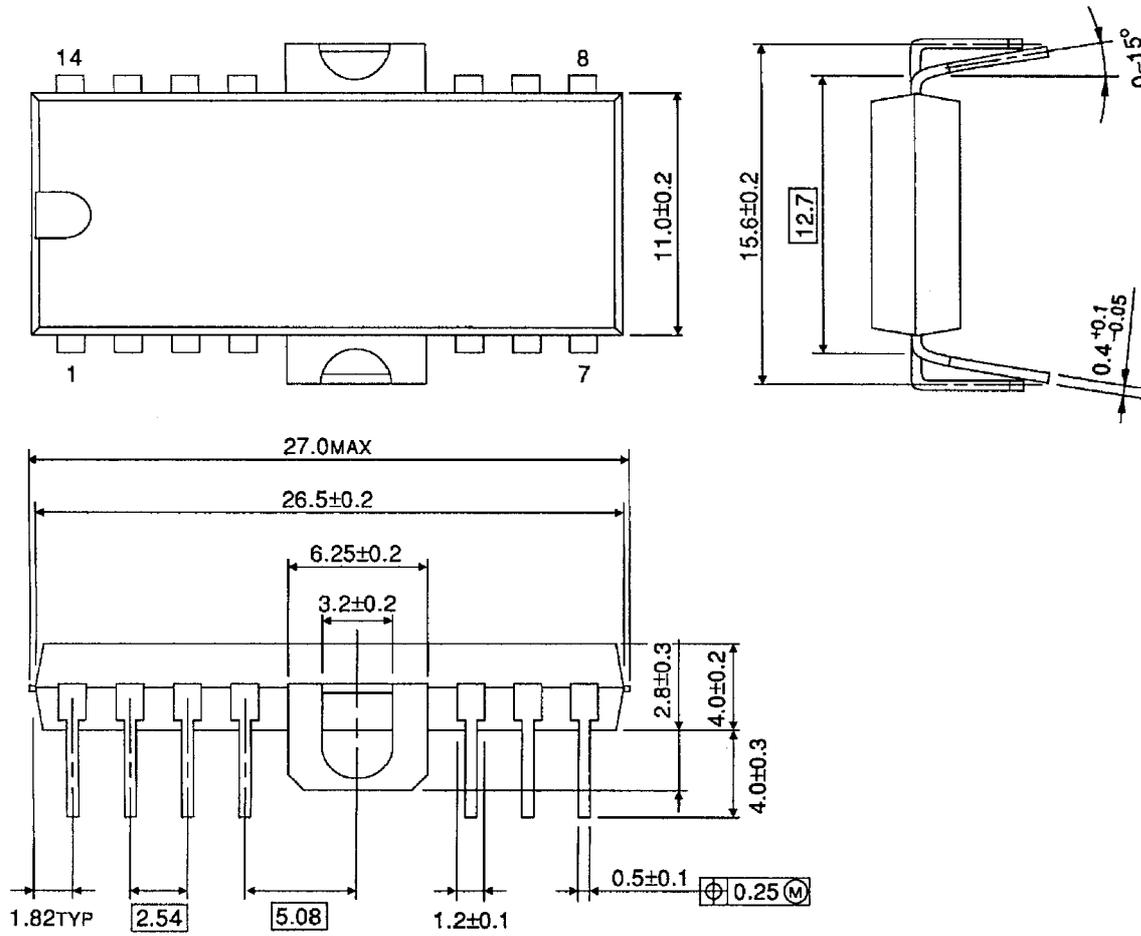
## APPLICATION CIRCUIT 2 (PWM chopper stepping motor driver)



## PACKAGE DIMENSIONS

HDIP14-P-500-2.54A

Unit: mm

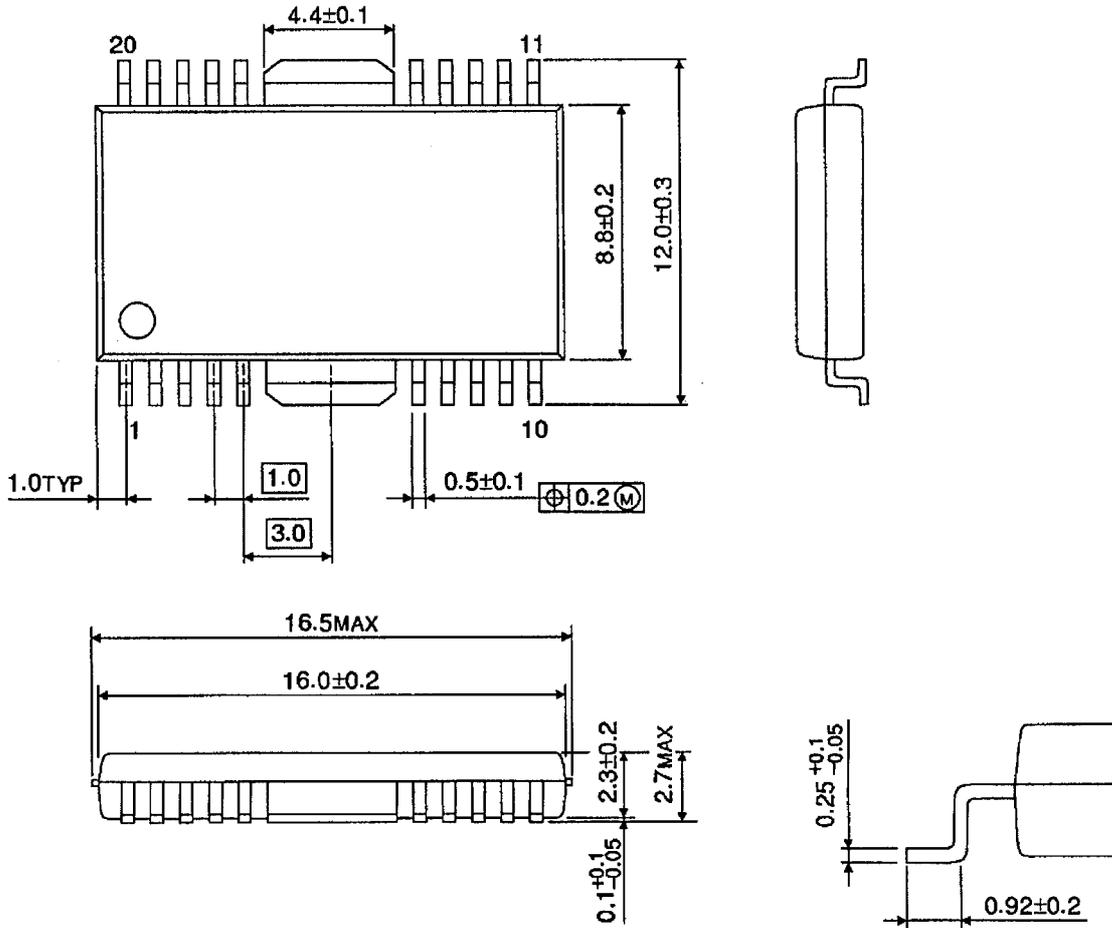


Weight: 3.00 g (Typ.)

## PACKAGE DIMENSIONS

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 the device breakdown, damage or deterioration, and may result 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 fully break down 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 can lead 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 the device breakdown, damage or deterioration, and may result injury by explosion or combustion.  
In addition, do not use any device that is applied the current with inserting in the wrong orientation or incorrectly even just one time.

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

In using an IC with large current flow such as power amp, regulator or driver, please design the device so that heat is appropriately radiated, 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 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 with 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.

**RESTRICTIONS ON PRODUCT USE**

060116EBA

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