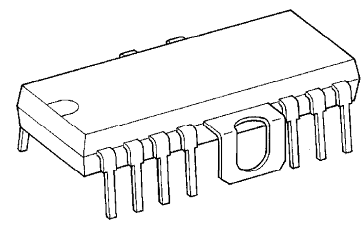
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

# TA7289P, TA7289F

## PWM STEPPING MOTOR DRIVER

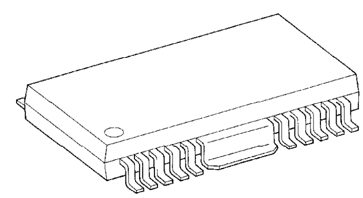
The TA7289P, TA7289F are PWM solenoid driver designed especially for use high efficiency stepping motor control. It consist of 1.5A peak current drive capable output full bridge driver, oscillation circuit for PWM switching, 4bit D-A for output current control and TTL compatible input circuit.

TA7289P



HDIP14-P-500-2.54A

TA7289F



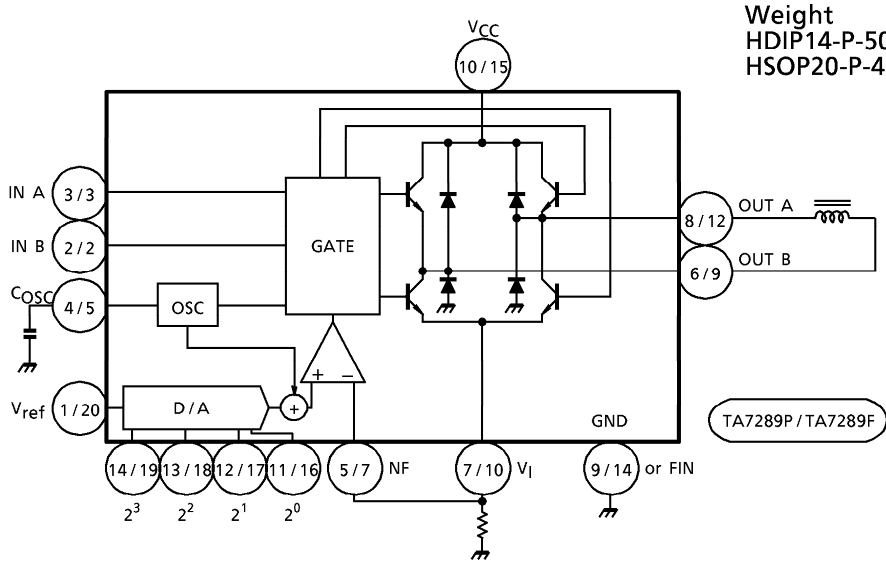
HSOP20-P-450-1.00

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

### FEATURES

- Wide Range of Operating Voltage
  : $V_{CC\,(opr.)}$ Min. = 6~27V
- High Current Capability : $I_O$ Max = 1.5A (PEAK)
- LS-TTL Compatible Control Inputs (IN A, IN B)
- Few External Components Required.
- Build-in 4bit DAC.

### BLOCK DIAGRAM




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

961001EBA2

## PIN FUNCTION

| PIN No. P | PIN No. F | PIN SYMBOL | FUNCTIONAL DESCRIPTION | |
|---|---|---|---|---|
| 1 | 20 | $V_{ref}$ | NF voltage supply input terminal | |
| 2 | 2 | IN B | Signal input terminal | Function |
| 3 | 3 | IN A | Signal input terminal | |
| 4 | 5 | $C_{OSC}$ | Internal oscillation frequency input terminal | |
| 5 | 7 | NF | Output current detection terminal | |
| 6 | 9 | OUT B | Output B terminal | |
| 7 | 10 | $V_I$ | Comparator input terminal | |
| 8 | 12 | OUT A | Output A terminal | |
| 9 | 14 | GND | GND terminal | |
| 10 | 15 | $V_{CC}$ | Power voltage supply terminal | |
| 11 | 16 | $2^0$ | D / A input terminal | |
| 12 | 17 | $2^1$ | D / A input terminal | |
| 13 | 18 | $2^2$ | D / A input terminal | |
| 14 | 19 | $2^3$ | D / A input terminal | |
| FIN | FIN | GND | GND terminal | |

(Note) Pin ①, ④, ⑥, ⑧, ⑪ of TA7289F 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 0.8V Typ at $T_j = 25°C$.

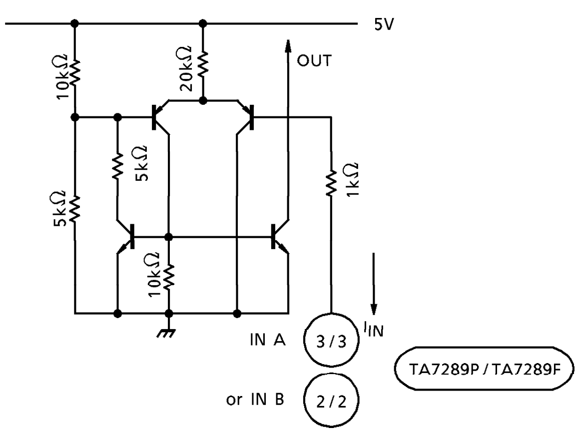
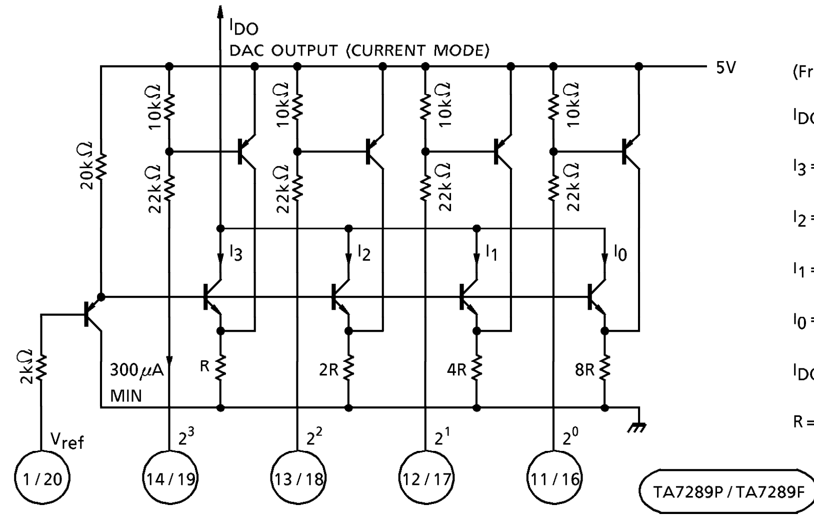



Fig.1

961001EBA2'

### D / A AND $V_{ref}$ CIRCUIT




(From Build-in Regulator)

$I_{DO} = I_3 + I_2 + I_1 + I_0$

$I_3 = \frac{V_{ref}}{R}$ ($2^3$ INPUT OPEN)

$I_2 = \frac{V_{ref}}{2R}$ ($2^2$ INPUT OPEN)

$I_1 = \frac{V_{ref}}{4R}$ ($2^1$ INPUT OPEN)

$I_0 = \frac{V_{ref}}{8R}$ ($2^0$ INPUT OPEN)

$I_{DO} = \frac{V_{ref}}{R} \left(1 + \frac{1}{2} + \frac{1}{4} + \frac{1}{8}\right)$

$R = 2.5k\Omega$ (Typ.)

Fig.2

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

### OSC AND COMPARATOR

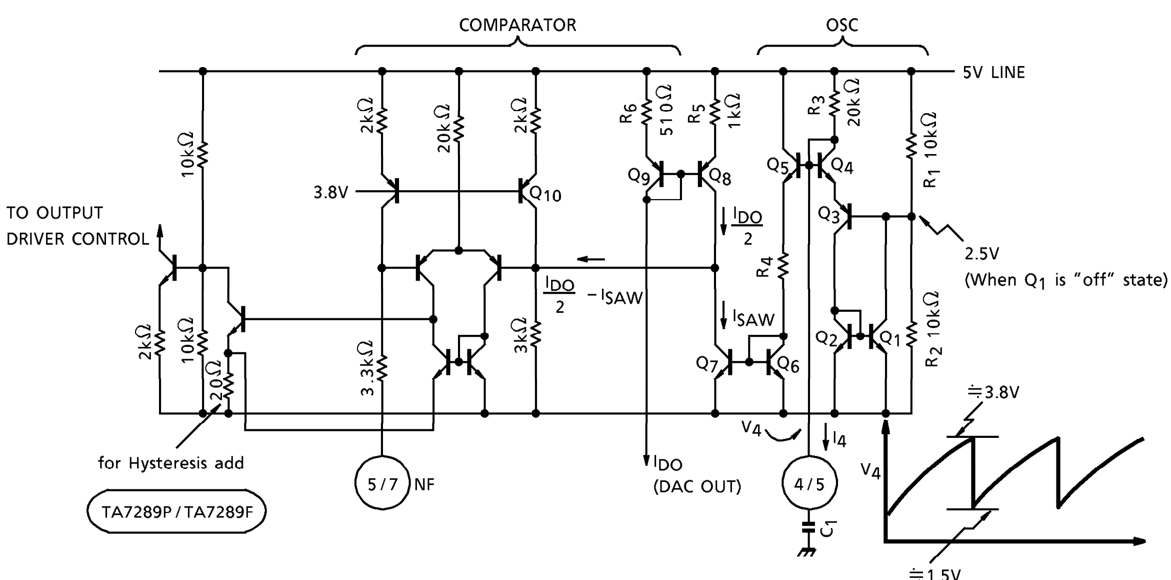



Fig.3

Sawtooth OSC circuit consists of $Q_1$ through $Q_4$ and $R_1$ through $R_3$.
$R_1$ and $R_2$ are voltage divider of 5V build-in regulator.
$Q_1$ is turned "off" when $V_4$ is less than the voltage of $2.5V + V_{BE}\ Q_4 + V_{BE}\ Q_3$ approximately equal to 3.8V. $V_4$ is increased by $C_1$ charging of $I_4$. $Q_1$ and $Q_2$ are turned "ON" when $V_4$ becomes $V_4$ – H level.
Lower level of $V_4$ ($V_4$ – L) is equal to $V_{BE}\ Q_4 + V_{BE}\ Q_3 + V_{SAT}\ Q_1$ approximately equal to 1.5V.
$V_4$ is calculated by following equation.

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

Assuming that $V_4 = 1.5V$ $(t = t_1)$ and $= 3.8V$ $(t = t_2)$.
$C_1$ is external capacitance connected to Pin ④ (or ⑤) and $R_3$ is on-chip 20kΩ resistor.
Therefore, OSC frequency is calculated as follows.

$$t_1 = -C_1 \cdot R_3 \cdot 1n\ (1 - \frac{1.5}{5}) \quad \text{②}$$

$$t_2 = -C_1 \cdot R_3 \cdot 1n\ (1 - \frac{3.8}{5}) \quad \text{③}$$

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

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

**MAXIMUM RATINGS** (Ta = 25°C)

| CHARACTERISTIC | | SYMBOL | RATING | UNIT |
|---|---|---|---|---|
| Supply Voltage | | $V_{CC}$ | 30 | V |
| | | $V_{ref}$ | 30 | |
| Reference Voltage | | $V_{IN}$ | 7 | |
| | | $V_I$ | 2 | |
| Output Current | TA7289P | $I_O$ (MAX.) | 1.5 | A |
| | TA7289F | | 0.8 | |
| | TA7289P | $I_O$ (AVE.) | 0.7 | |
| | TA7289F | | 0.3 | |
| Power Dissipation | TA7289P | $P_D$ (Note) | 2.3 | W |
| | TA7289F | | 1.0 | |
| Operating Temperature | | $T_{opr}$ | −30~85 | °C |
| Storage Temperature | | $T_{stg}$ | −55~150 | °C |

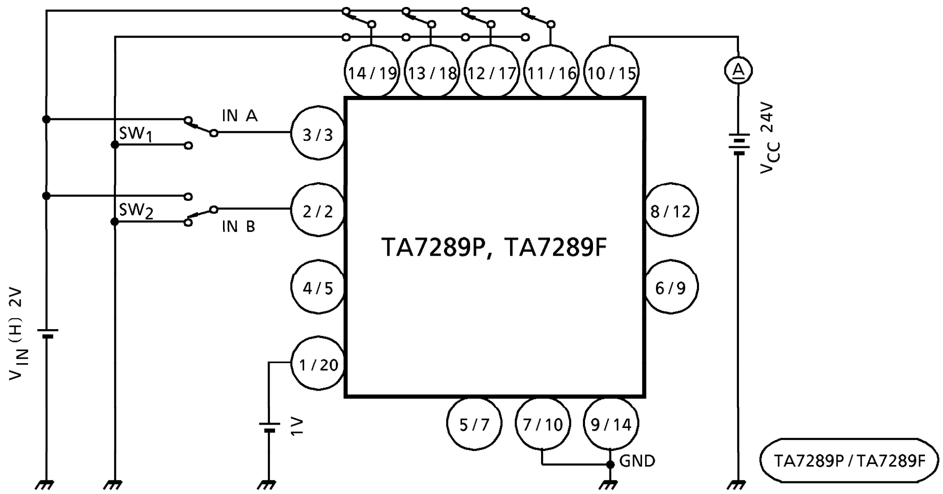
(Note) NO HEAT SINK

**ELECTRICAL CHARACTERISTICS** (Unless otherwise specified, $V_{CC} = 24V$, $Ta = 25°C$)

| 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 $V_{IN} = 0V$ Source type | | — | 25 | 35 | μA |
| | $I_{IN2}$ | | $2^0$, $2^1$, $2^2$, $2^3$ $V_{IN} = 0V$ Source type | | 90 | 160 | 200 | |
| Output Saturation Voltage | $V_{SAT\ U1}$ | 3 | $I_{OUT} = 0.2A$ | | — | 1.1 | 1.5 | V |
| | $V_{SAT\ L1}$ | | | | — | 0.8 | 1.1 | |
| | $V_{SAT\ U2}$ | | $I_{OUT} = 0.7A$ | | — | 1.2 | 1.7 | |
| | $V_{SAT\ L2}$ | | | | — | 0.9 | 1.3 | |
| | $V_{SAT\ U3}$ | | $I_{OUT} = 1.5A$ | | — | 1.8 | 2.6 | |
| | $V_{SAT\ L3}$ | | | | — | 1.2 | 1.9 | |
| Control Supply Voltage | $V_{ref}$ | — | — | | GND | — | 2.0 | V |
| Control Supply Current | $I_{ref}$ | 2 | $V_{ref} = 0 \sim 2.0V$ | | — | 25 | 35 | μA |
| Diode Forward Voltage | $V_{FU}$ | 4 | $I_F = 1.5A$ | | — | 2.6 | 3.3 | V |
| | $V_{FL}$ | | | | — | 0.8 | 1.1 | |
| Output Leakage Current | $I_{L\text{-}U}$ | 5 | $V_L = 30V$ | | — | — | 50 | μA |
| | $I_{L\text{-}L}$ | | $V_L = 30V$ | | — | — | 50 | |
| NF Terminal Current | $I_{NF}$ | 6 | Source type $V_{NF} = 0 \sim 2.0V$ $T_j = 0 \sim 125°C$ | | 180 | 300 | 490 | μA |
| Internal Supply Output Voltage | $V_{CC2}$ | 6 | — | | — | 5 | — | V |
| Resistor for Oscillation (R3) | $R_{OSC}$ | 6 | $T_j = 0 \sim 125°C$ | | 13 | 20 | 32 | kΩ |

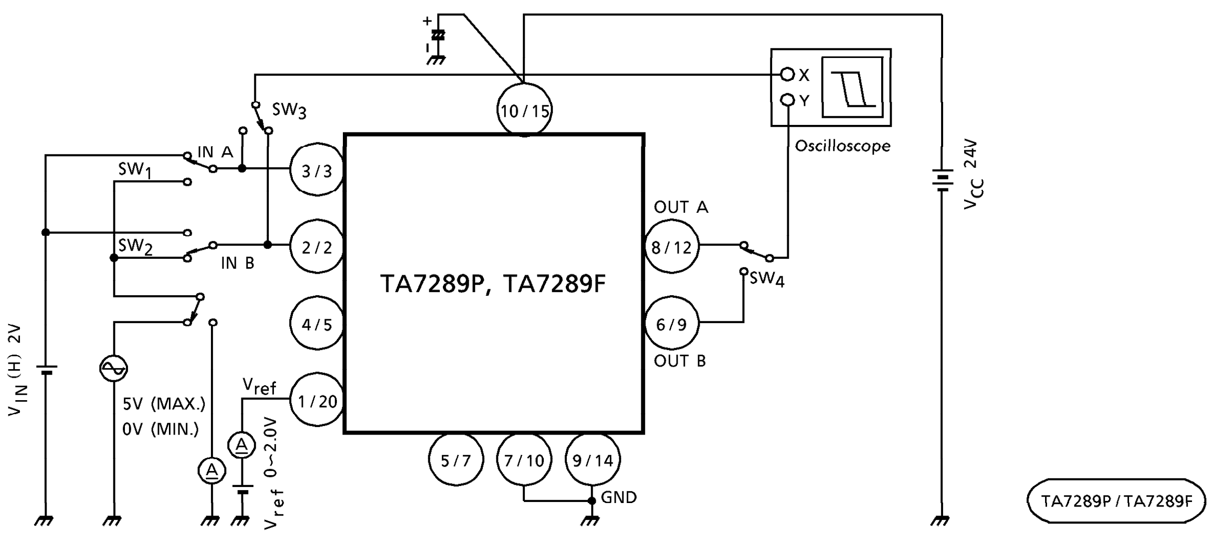
**TEST CIRCUIT 1**

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



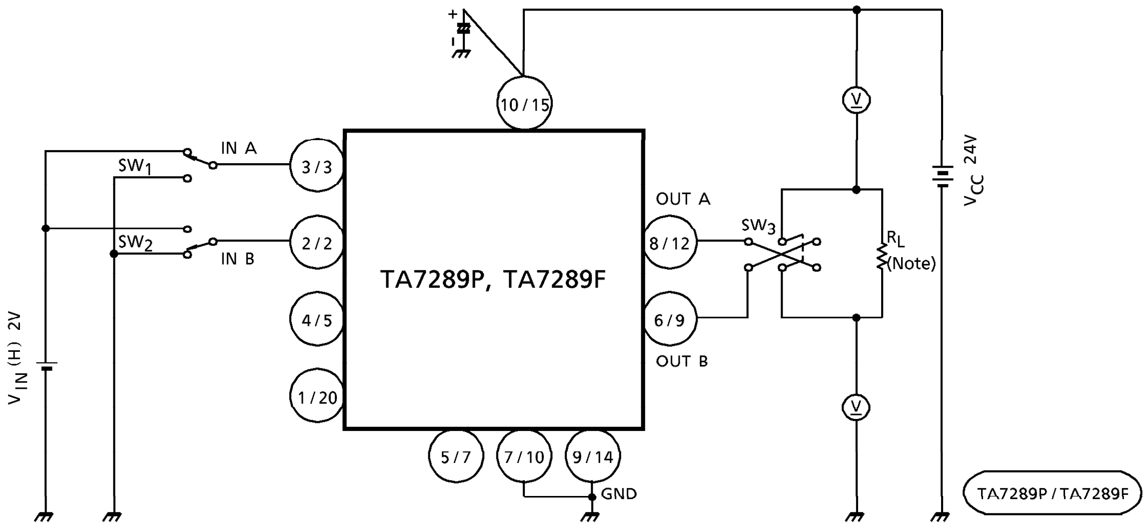

**TEST CIRCUIT 2**

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



**TEST CIRCUIT 3**

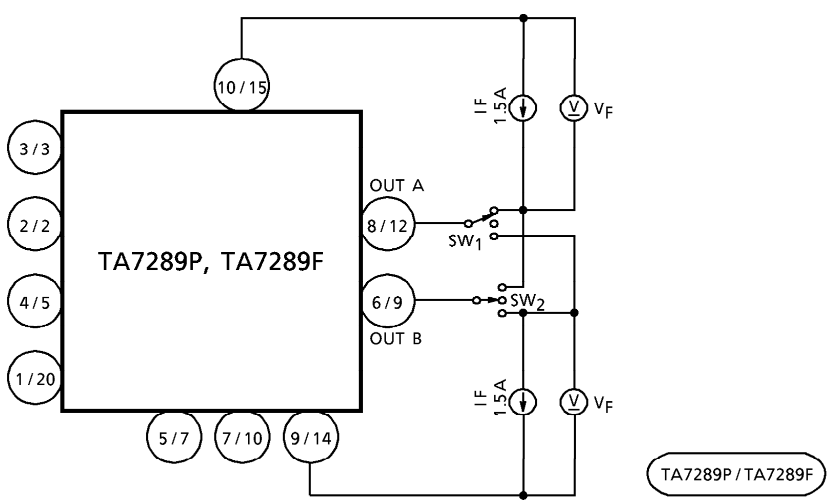
$V_{SAT}$ U1, L1, U2, L2, U3, L3




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

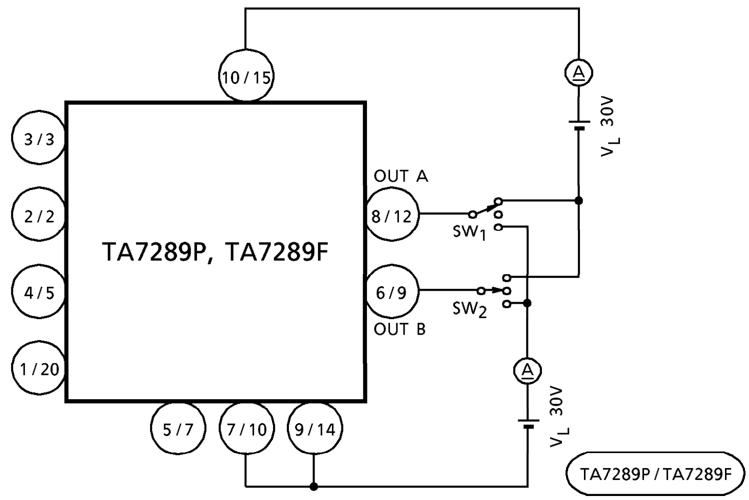
**TEST CIRCUIT 4**

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



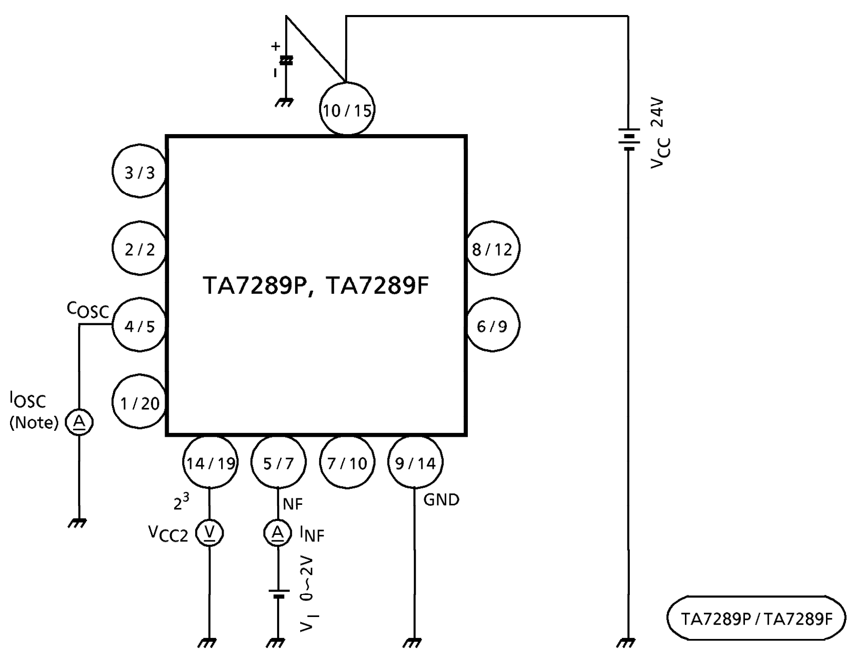
**TEST CIRCUIT 5**

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




**TEST CIRCUIT 6**

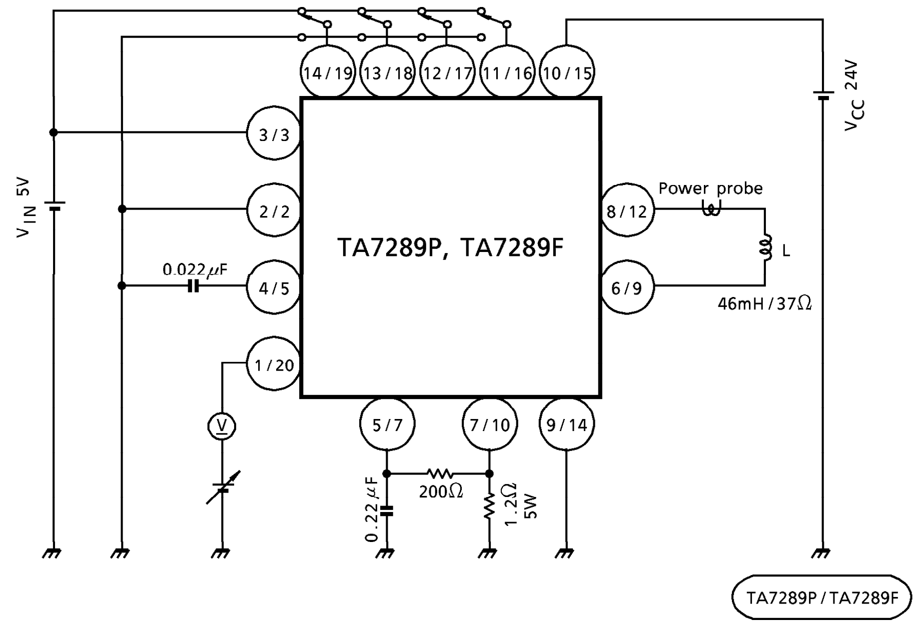
$I_{NF}$, $V_{CC2}$, $R_{OSC}$




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

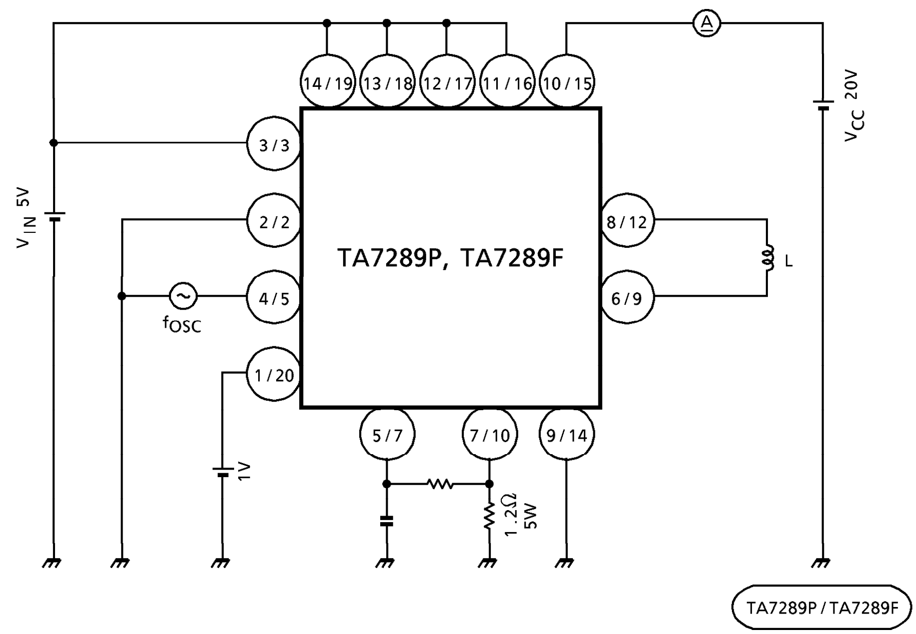
**TEST CIRCUIT 7**

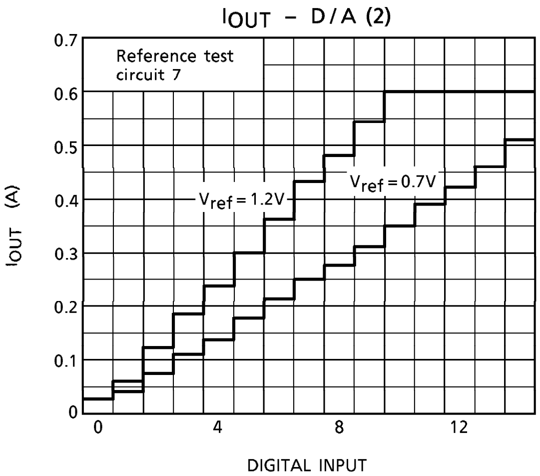
$I_{OUT}$-$V_{ref}$ CHARACTERISTIC, $I_{OUT}$-D / A CHARACTERISTIC

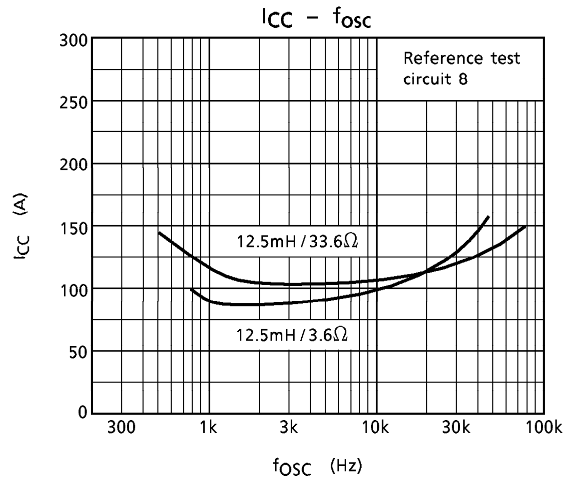



**TEST CIRCUIT 8**

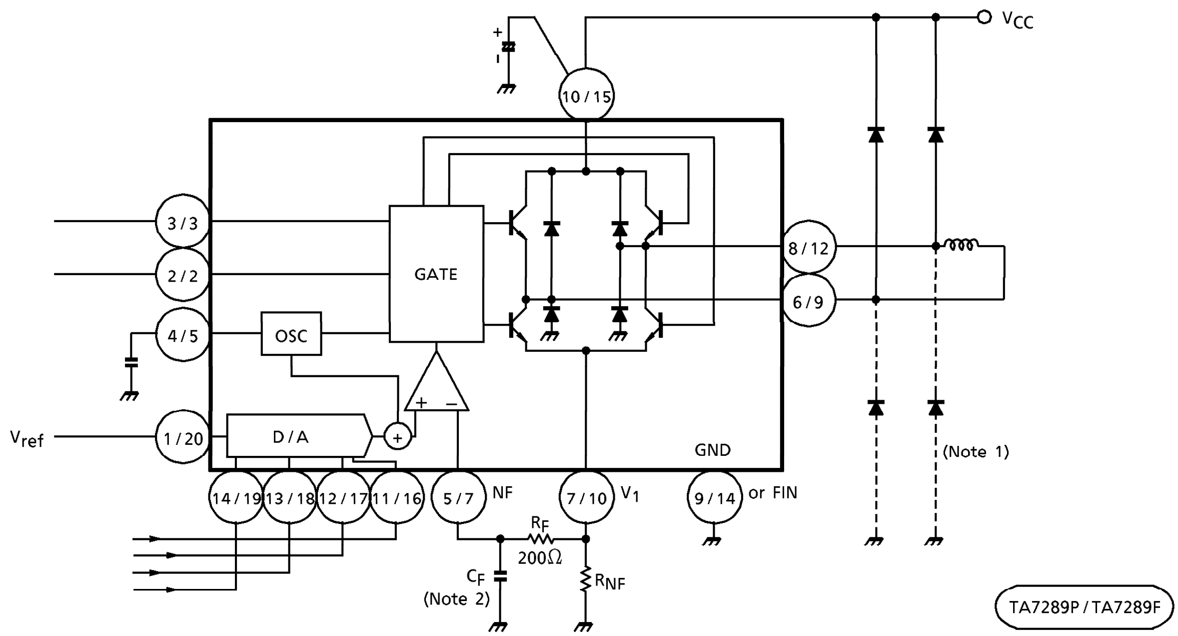
$I_{CC}$- FREQUENCY CHARACTERISTIC






## APPLICATION CIRCUIT 1

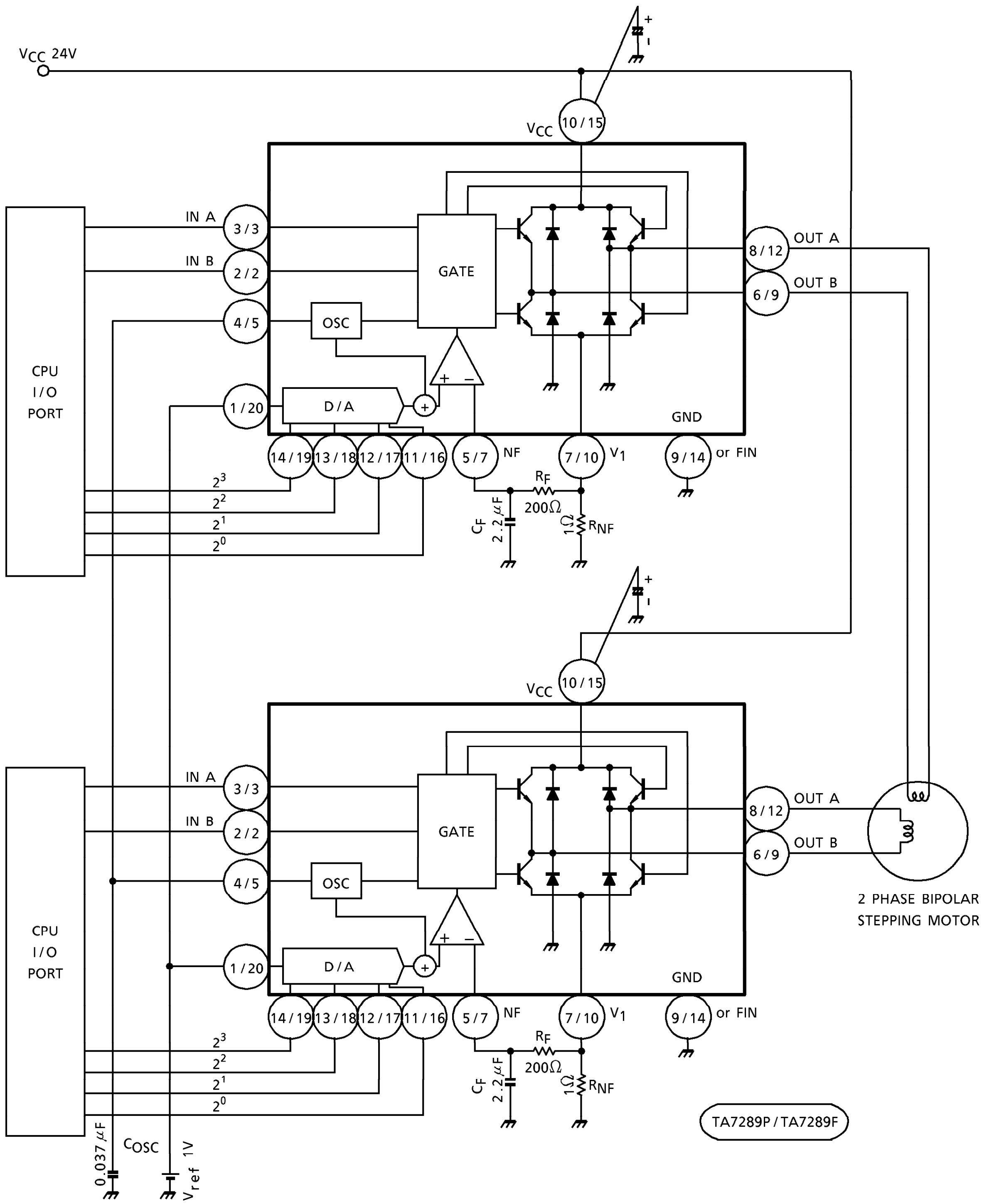



(Note 1) Connect if required.

(Note 2) Recommended $R_F$ value is approximately 200Ω.
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.

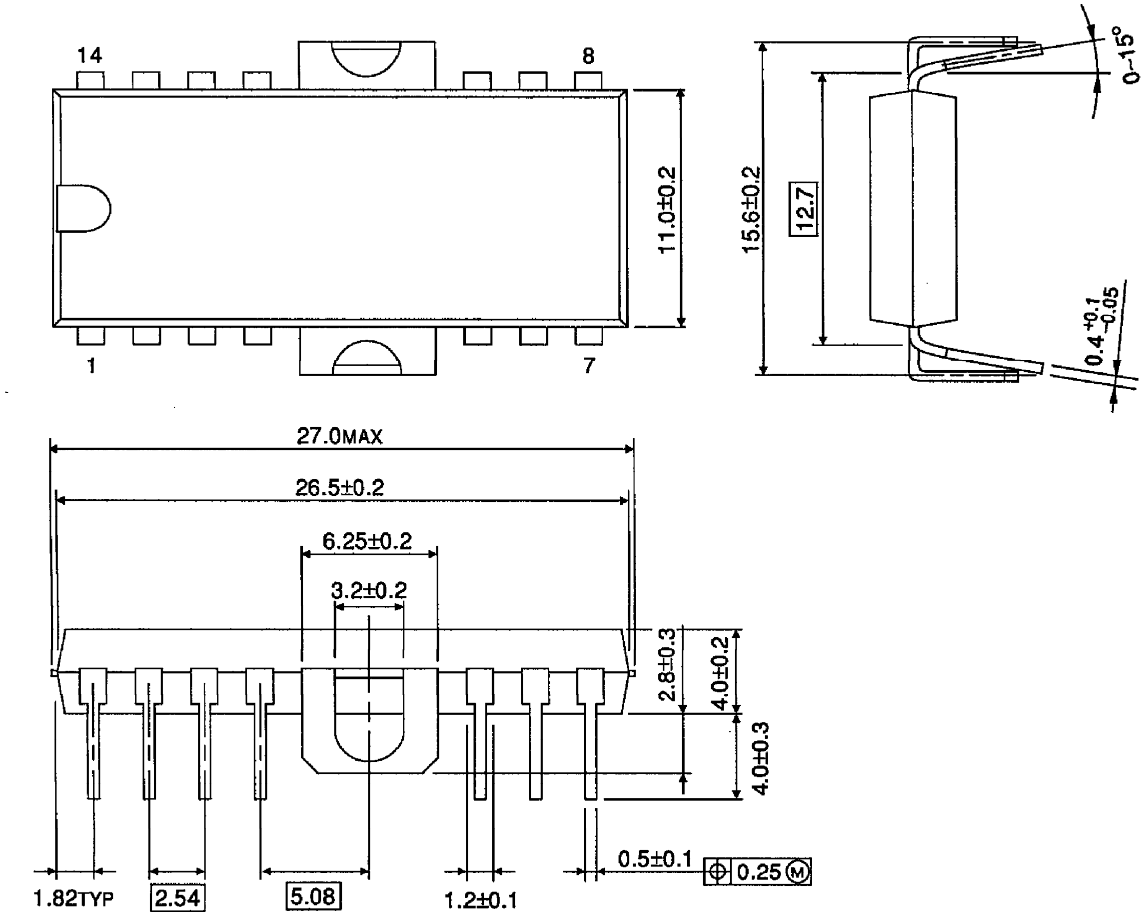
(Note 3) Utmost care is necessary in the design of the output line, $V_{CC}$ and GND line since IC may be destroyed due to short-circuit between outputs, air contamination fault, or fault by improper grounding.

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



**OUTLINE DRAWING**
HDIP14-P-500-2.54A

Unit : mm

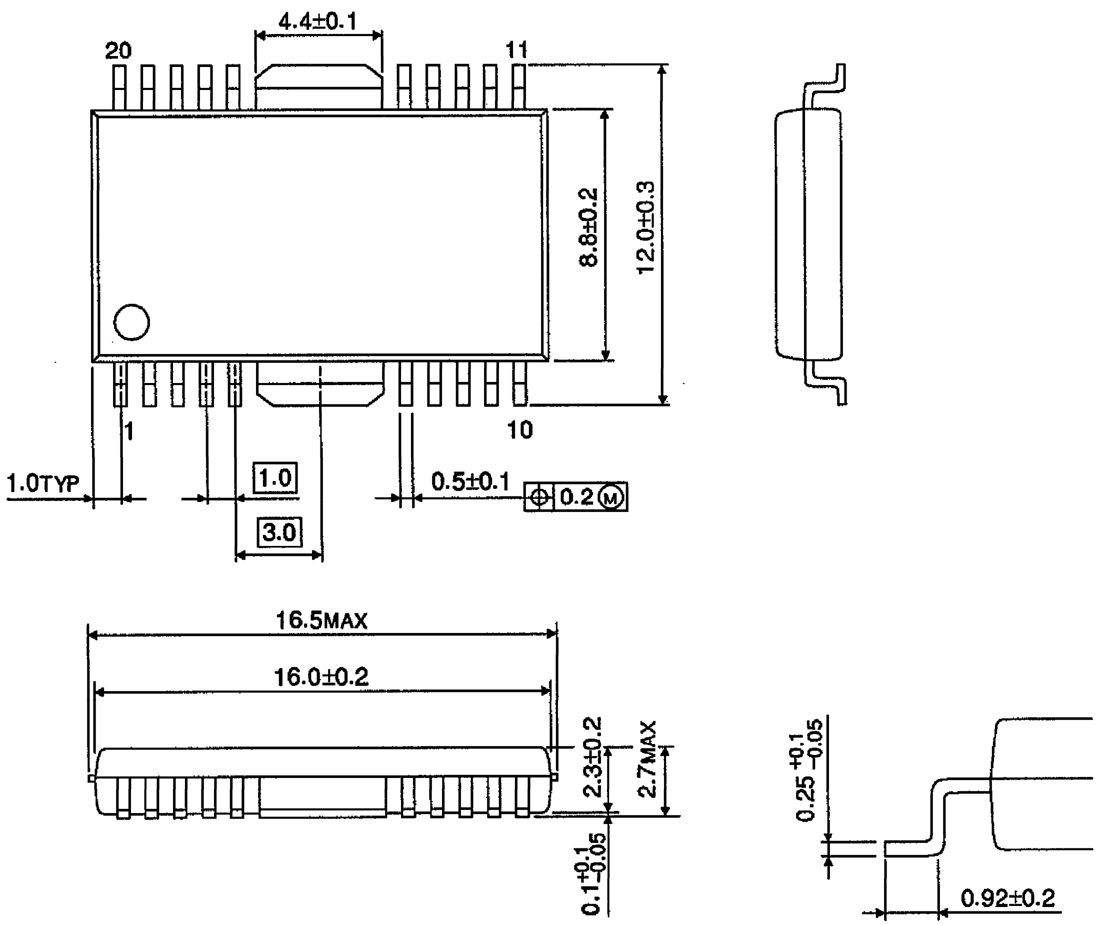



Weight : 3.00g (Typ.)

**OUTLINE DRAWING**

HSOP20-P-450-1.00

Unit : mm




Weight : 0.79g (Typ.)