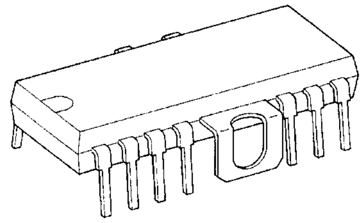
TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

TA7289P,TA7289F/FG

PWM STEPPING MOTOR DRIVER

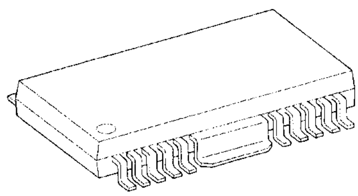
The TA7289P, TA7289F/FG are PWM solenoid driver designed especially for use high efficiency stepping motor control.
It consist of 1.5A peak current drive capable output full bridge driver, oscillation circuit for PWM switching, 4bit D−A for output current control and TTL compatible input circuit.

TA7289P



HDIP14-P-500-2.54A

TA7289F/FG



HSOP20-P-450-1.00

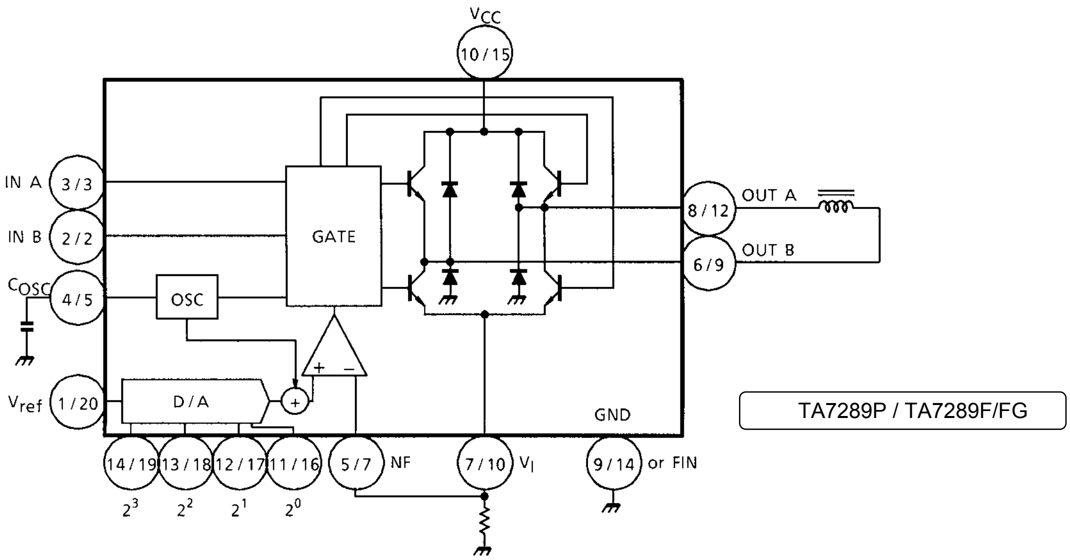
Weight
HDIP14−P−500−2.54A : 3.00g (Typ.)
HSOP20−P−450−1.00 : 0.79g (Typ.)

FEATURES

- Wide Range of Operating Voltage
  : $V_{CC\ (opr.)}$ Min. = 6~27 V
- High Current Capability: I_O 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

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_{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), (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 $T_j = 25°C$.

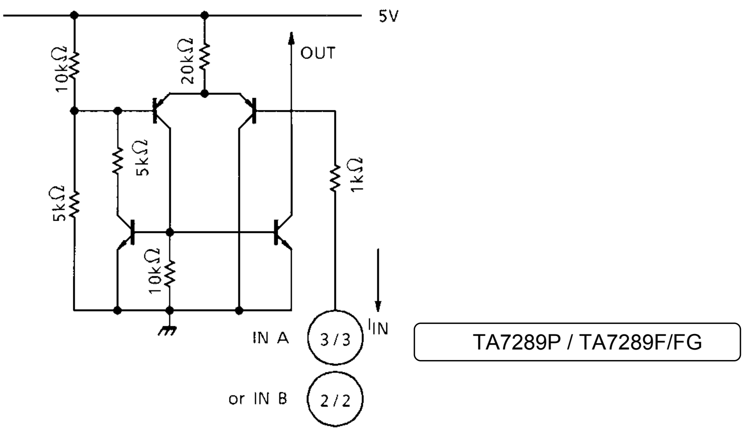


Fig. 1

D / A AND Vref CIRCUIT

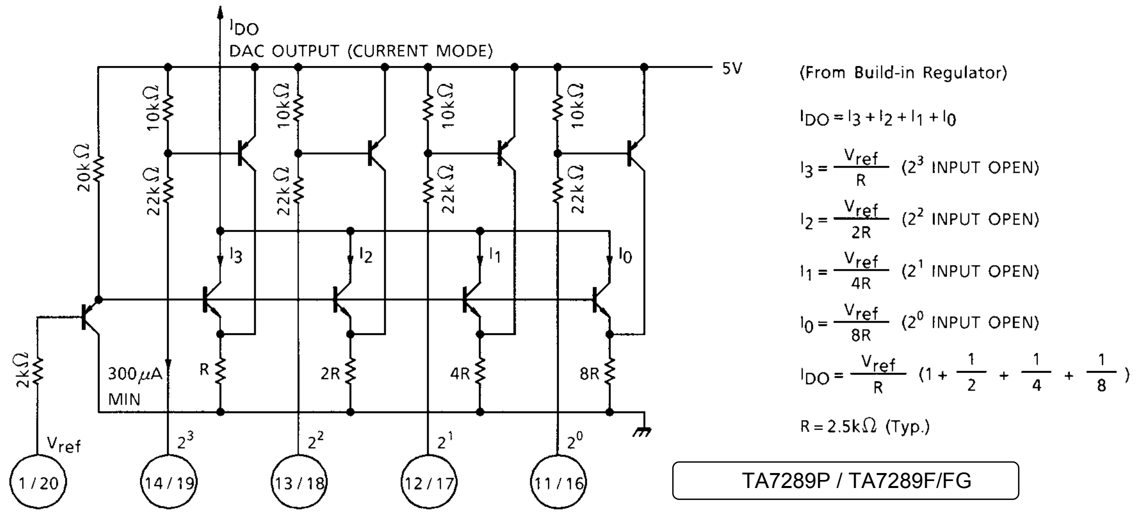


Fig. 2

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 300 μA MIN for each input terminal.

OSC AND COMPARATOR

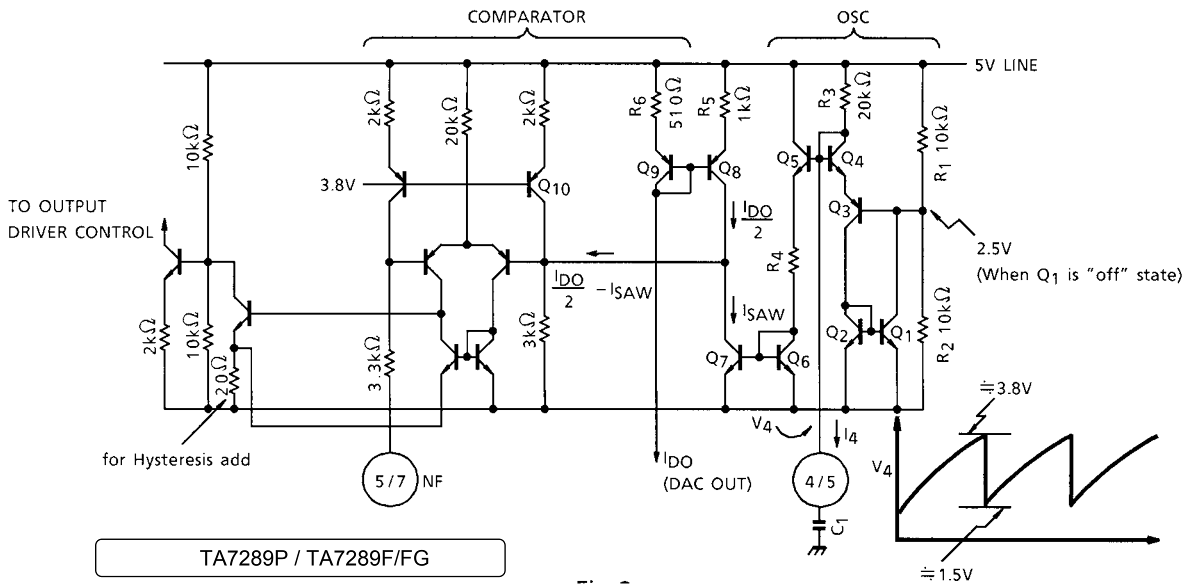


Fig. 3

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 5 V build−in regulator.
Q_1 is turned "off" when V_4 is less than the voltage of 2.5 V + V_{BE} Q_4 + V_{BE} Q_3 approximately equal to 3.8 V. 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 1.5 V.
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 = 1.5 V (t = t_1) and=3.8 V (t = t_2).
C_1 is external capacitance connected to Pin (4) (or (5)) and R_3 is on−chip 20 kΩ resistor.
Therefore, OSC frequency is calculated as follows.

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

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

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

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

ABSOLUTE 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/FG		0.8	
	TA7289P	$I_{O\ (AVE.)}$	0.7	
	TA7289F/FG		0.3	
Power Dissipation	TA7289P	PD (Note)	2.3	W
	TA7289F/FG		1.0	
Operating Temperature		T_{opr}	−30~85	°C
Storage Temperature		T_{stg}	−55~150	°C

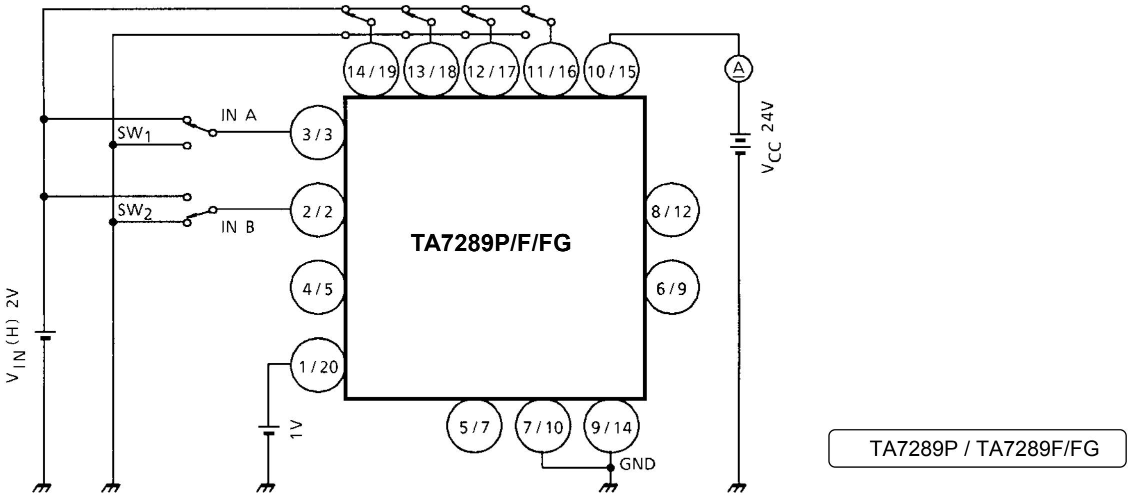
Note: NO HEAT SINK

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC} = 24 V, 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, 2^0~2^3: H		12	20	30	
	I_{CC4}		CW / CCW mode, 2^0~2^3: 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	ΔV_{IN}	2	—		—	0.8	—	V
Input Current	I_{IN1}	2	IN A, IN B V_{IN} = 0 V Source type		—	25	35	μA
	I_{IN2}		2^0, 2^1, 2^2, 2^3 V_{IN} = 0 V Source type		90	160	200	
Output Saturation Voltage	$V_{SAT\ U-1}$	3	I_{OUT} = 0.2 A		—	1.1	1.5	V
	$V_{SAT\ L-1}$				—	0.8	1.1	
	$V_{SAT\ U-2}$		I_{OUT} = 0.7 A		—	1.2	1.7	
	$V_{SAT\ L-2}$				—	0.9	1.3	
	$V_{SAT\ U-3}$		I_{OUT} = 1.5 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} = 0~2.0 V		—	25	35	μA
Diode Forward Voltage	V_{FU}	4	I_F = 1.5 A		—	2.6	3.3	V
	V_{FL}				—	0.8	1.1	
Output Leakage Current	I_{L-U}	5	V_L = 30 V		—	—	50	μA
	I_{L-L}		V_L = 30 V		—	—	50	
NF Terminal Current	I_{NF}	6	Source type V_{NF} = 0~2.0 V T_j = 0~125°C		180	300	490	μA
Internal Supply Output Voltage	V_{CC2}	6	—		—	5	—	V
Resistor for Oscillation (R3)	R_{OSC}	6	T_j = 0~125°C		13	20	32	kΩ

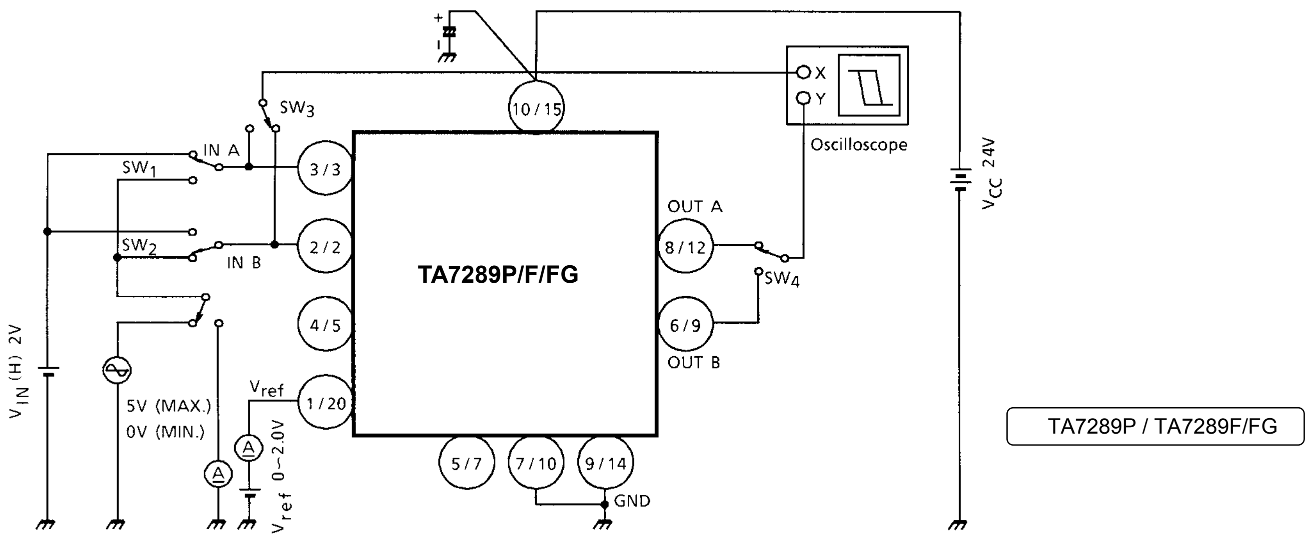
TEST CIRCUIT 1

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



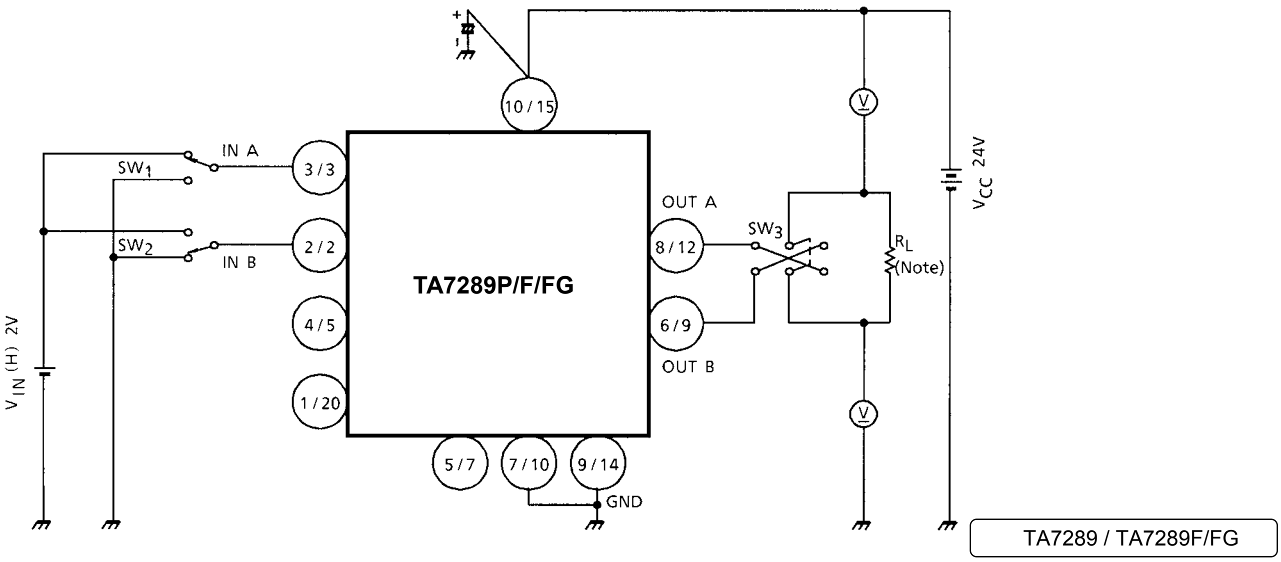
TEST CIRCUIT 2

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



TEST CIRCUIT 3

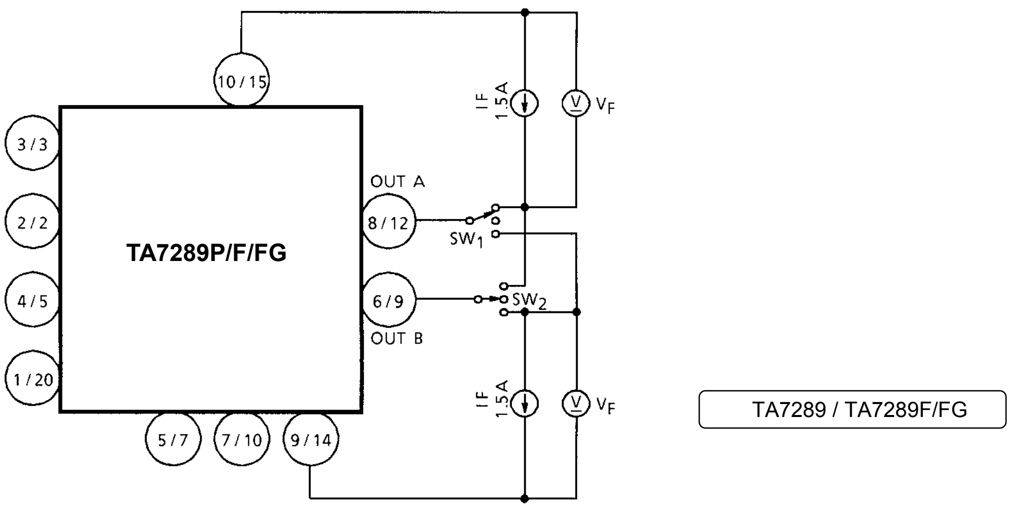
V_{SAT} U1, L1, U2, L2, U3, L3



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

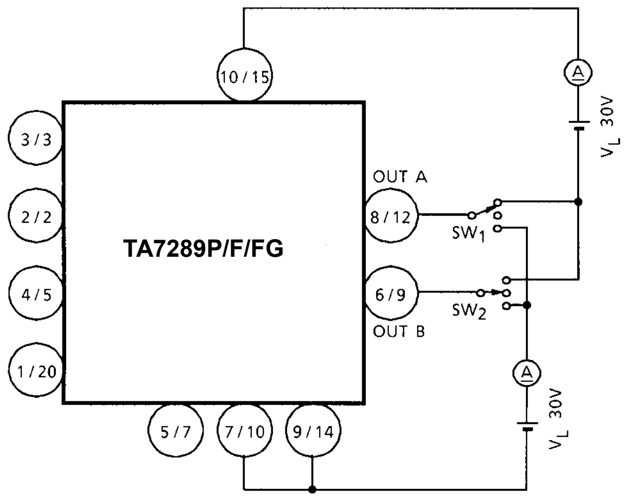
TEST CIRCUIT 4

V_{FU}, V_{FL}



TEST CIRCUIT 5

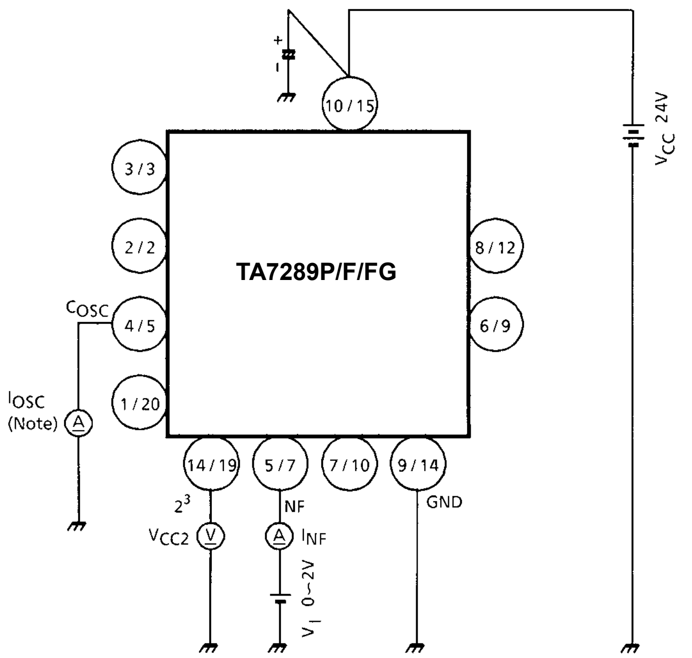
I_{L-U}, I_{L-L}



TA7289P / TA7289F/FG

TEST CIRCUIT 6

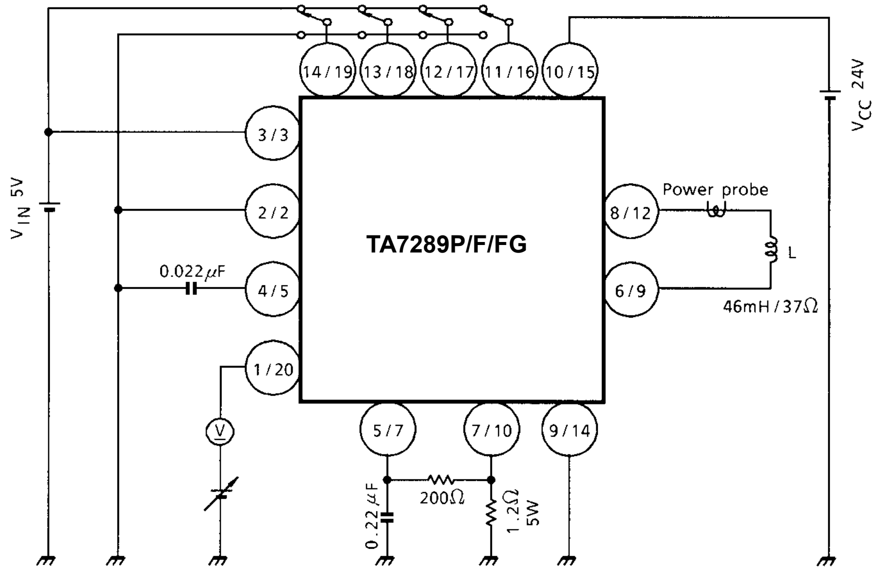
I_{NF}, V_{CC2}, R_{OSC}



TA7289P / TA7289F/FG

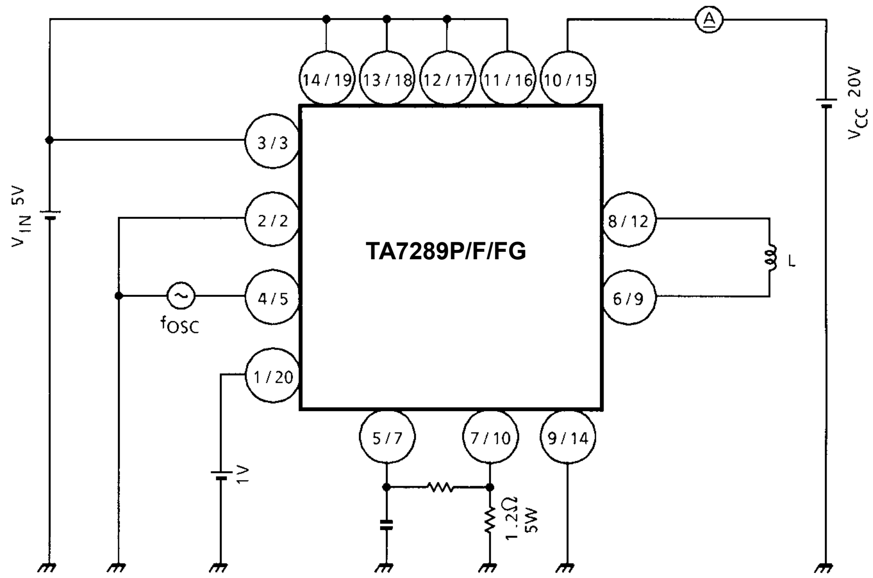
Note: $R_{OSC} = \dfrac{V_{CC2}\,(V)}{I_{OSC}\,(A)}\,(\Omega)$

TEST CIRCUIT 7
I_{OUT} – V_{ref} CHARACTERISTIC, I_{OUT} – D / A CHARACTERISTIC

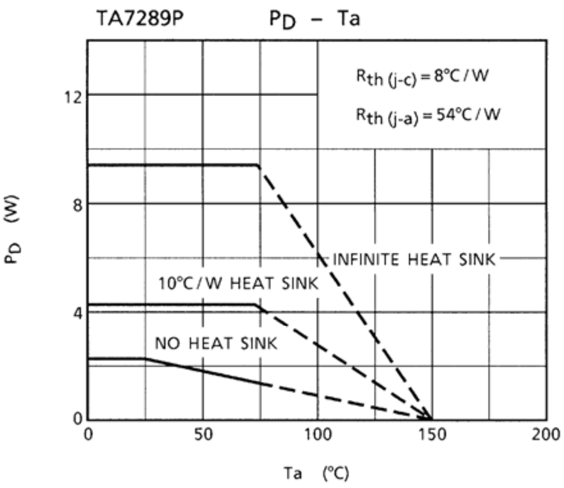


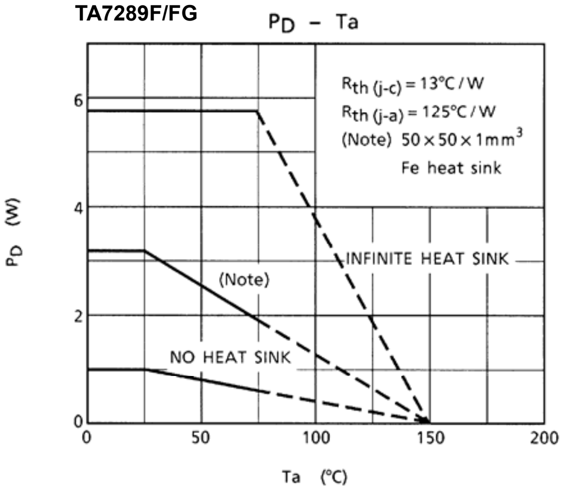
TA7289P / TA7289F/FG

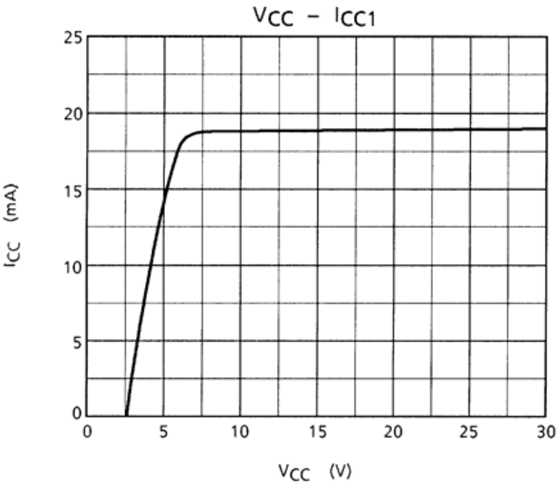
TEST CIRCUIT 8
I_{CC} – FREQUENCY CHARACTERISTIC

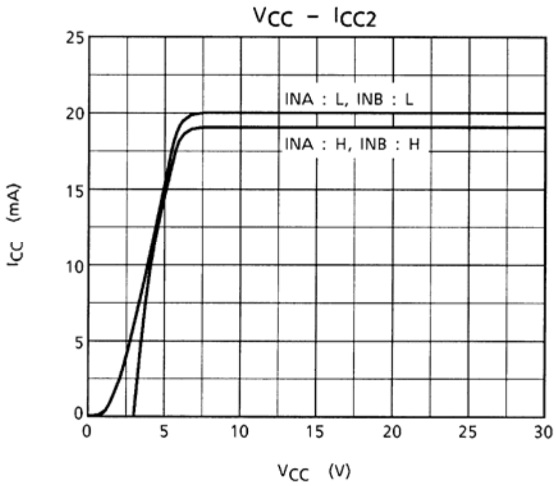


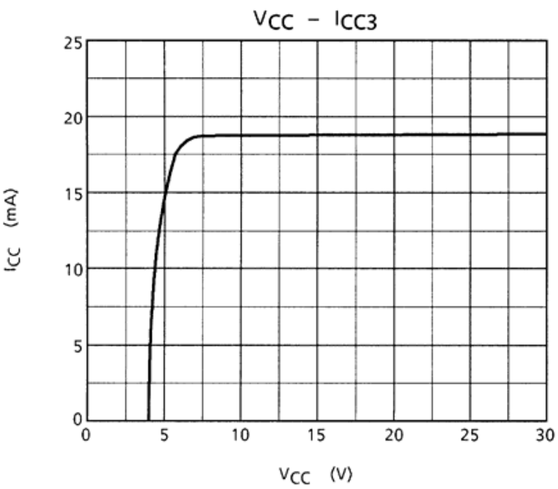
TA7289P / TA7289F/FG

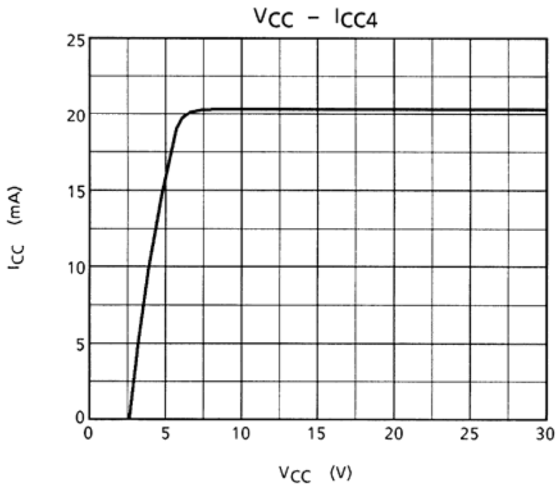

TA7289P
PD – Ta
Rth (j-c) = 8°C / W
Rth (j-a) = 54°C / W
INFINITE HEAT SINK
10°C / W HEAT SINK
NO HEAT SINK
PD (W)
Ta (°C)
0
4
8
12
50
100
150
200

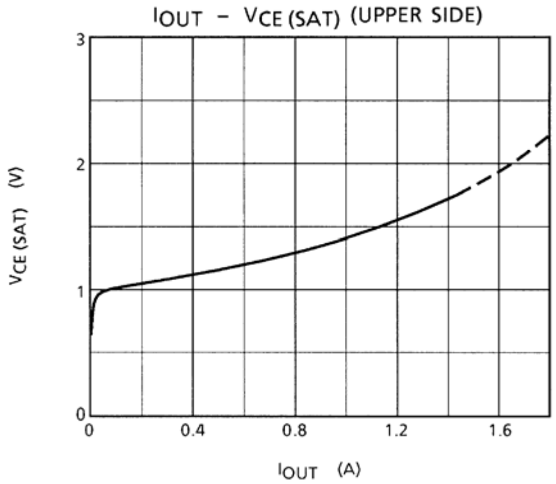

TA7289F/FG
PD – Ta
Rth (j-c) = 13°C / W
Rth (j-a) = 125°C / W
(Note) 50 × 50 × 1mm3
Fe heat sink
INFINITE HEAT SINK
(Note)
NO HEAT SINK
PD (W)
Ta (°C)
0
2
4
6
50
100
150
200

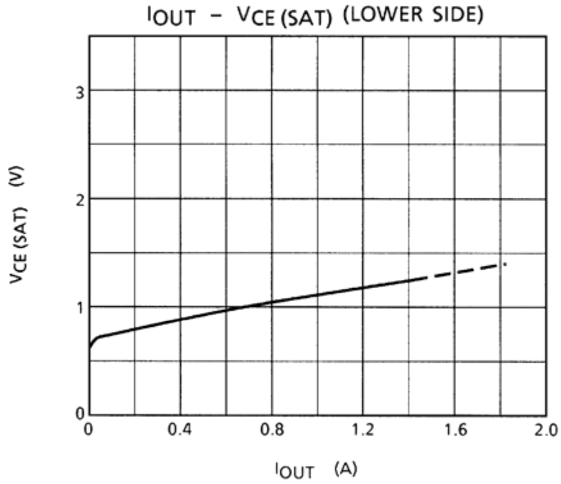

VCC – ICC1
ICC (mA)
VCC (V)
0
5
10
15
20
25
30

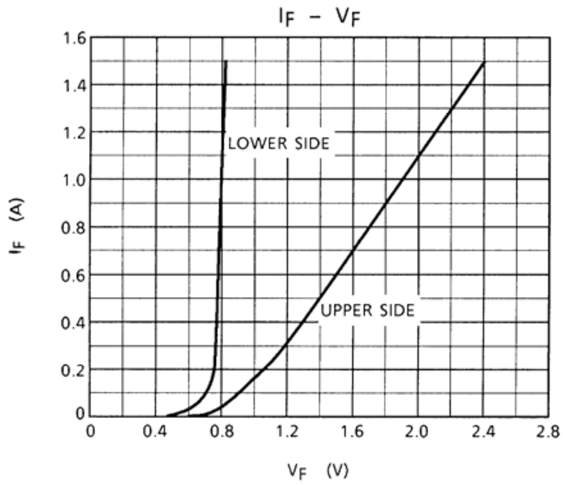

VCC – ICC2
INA : L, INB : L
INA : H, INB : H
ICC (mA)
VCC (V)
0
5
10
15
20
25
30

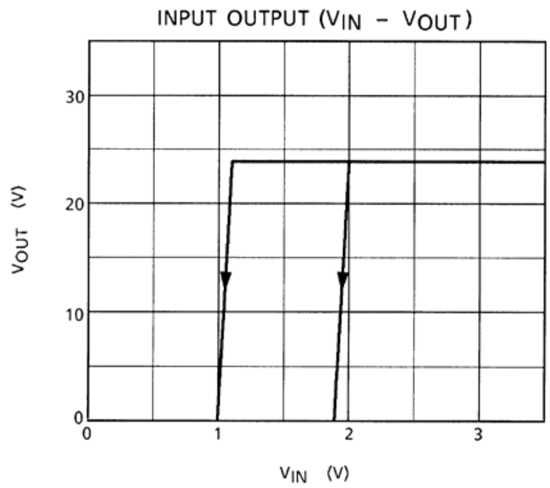

VCC – ICC3
ICC (mA)
VCC (V)
0
5
10
15
20
25
30

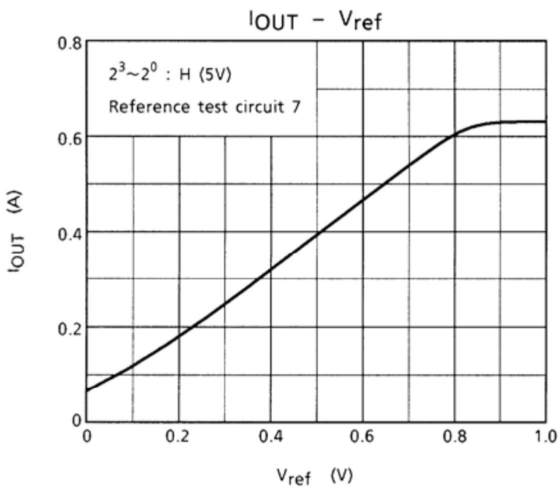

VCC – ICC4
ICC (mA)
VCC (V)
0
5
10
15
20
25
30

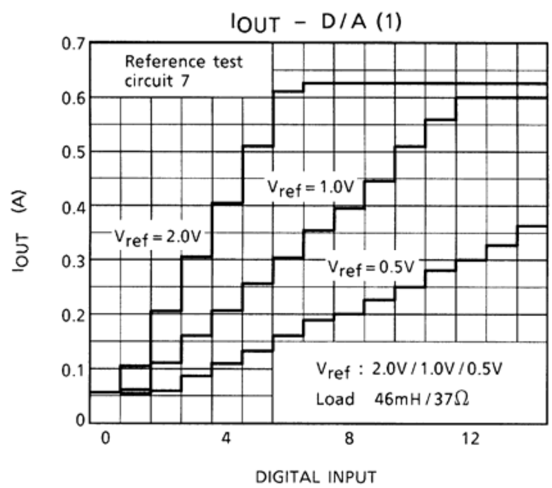

IOUT – VCE (SAT) (UPPER SIDE)
VCE (SAT) (V)
0
1
2
3
0
0.4
0.8
1.2
1.6
IOUT (A)

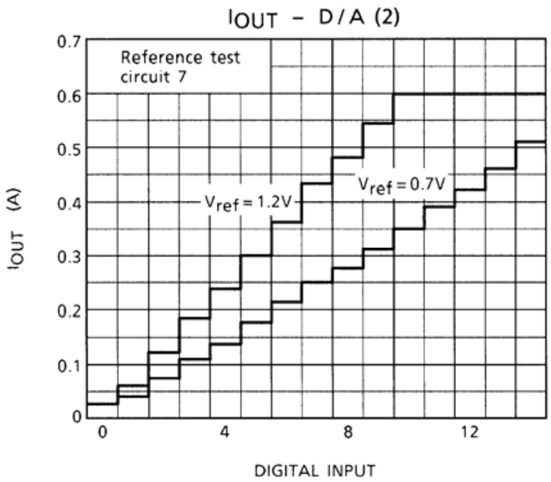

IOUT – VCE (SAT) (LOWER SIDE)
VCE (SAT) (V)
0
1
2
3
0
0.4
0.8
1.2
1.6
2.0
IOUT (A)

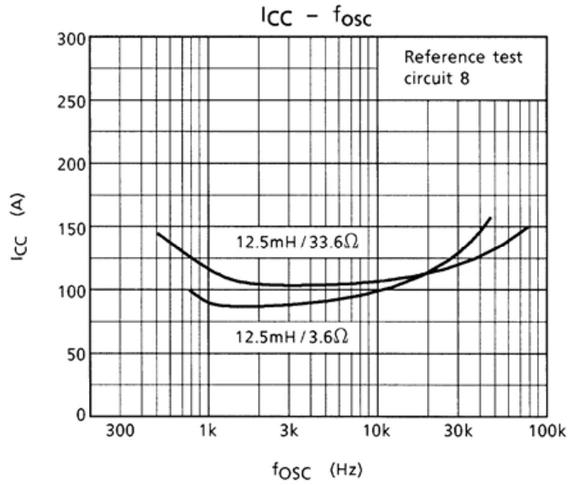

IF – VF
IF (A)
0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
LOWER SIDE
UPPER SIDE
0
0.4
0.8
1.2
1.6
2.0
2.4
2.8
VF (V)


INPUT OUTPUT (VIN – VOUT)
VOUT (V)
0
10
20
30
0
1
2
3
VIN (V)

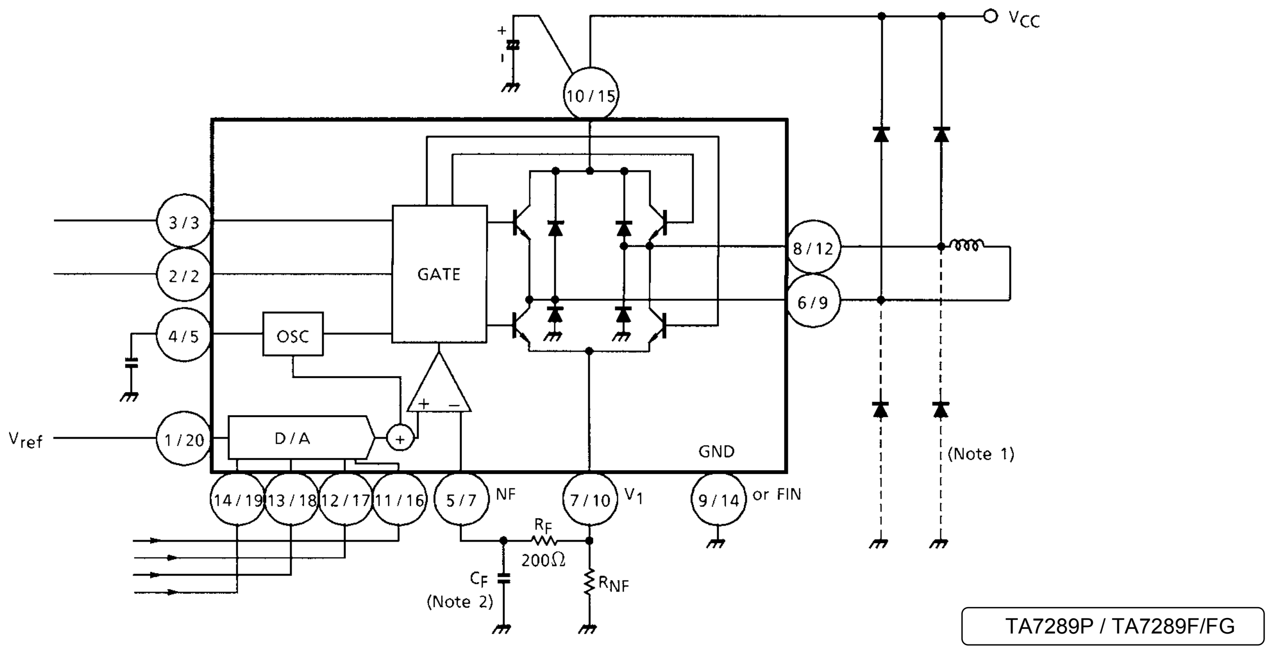

IOUT – Vref
IOUT (A)
0
0.2
0.4
0.6
0.8
2^3~2^0 : H (5V)
Reference test circuit 7
0
0.2
0.4
0.6
0.8
1.0
Vref (V)


IOUT – D/A (1)
IOUT (A)
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
Reference test circuit 7
Vref = 1.0V
Vref = 2.0V
Vref = 0.5V
Vref : 2.0V / 1.0V / 0.5V
Load 46mH / 37Ω
0
4
8
12
DIGITAL INPUT





APPLICATION CIRCUIT 1

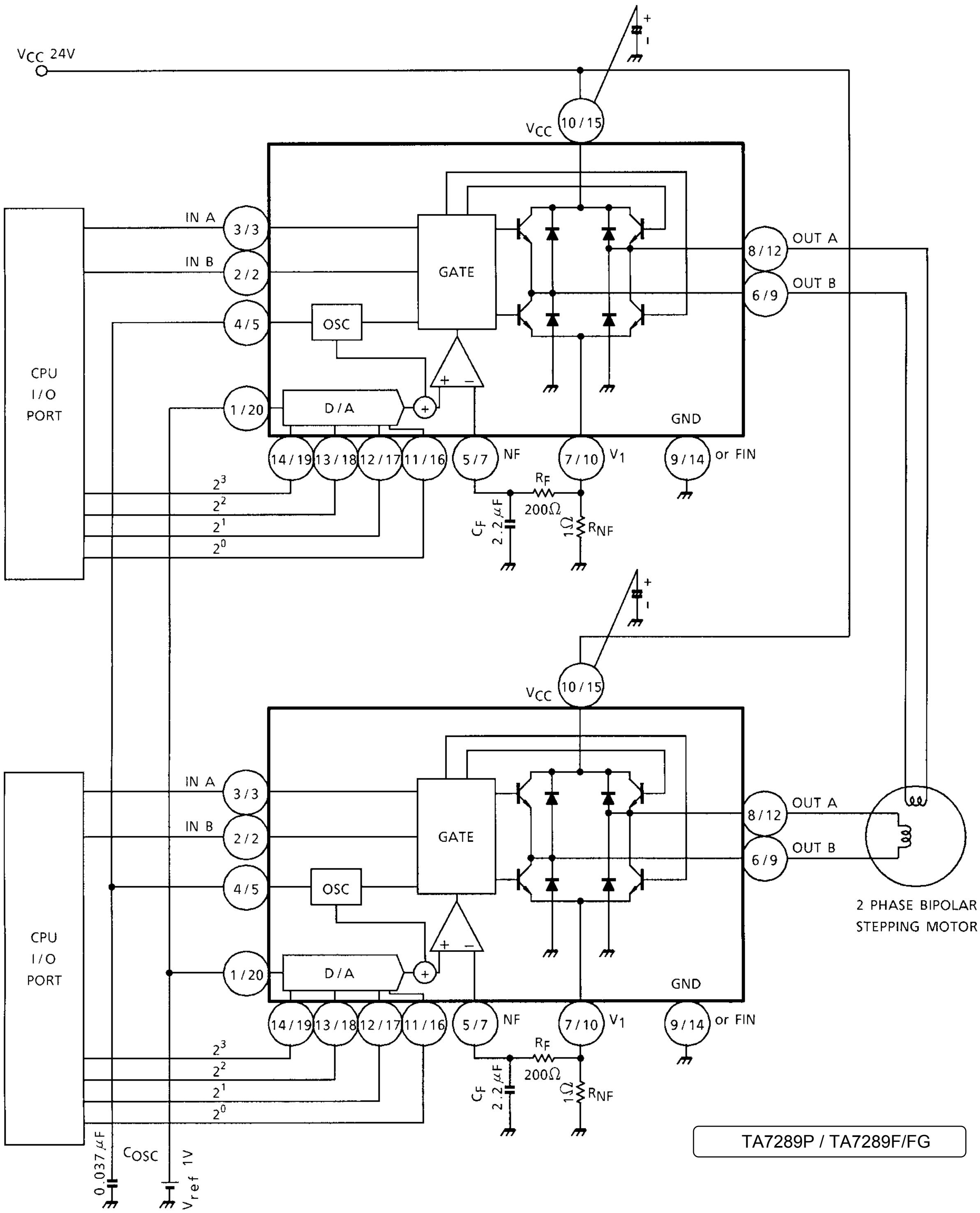


Note 1: Connect if required.

Note 2: Recommended R_F value is approximately 200 Ω.
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.

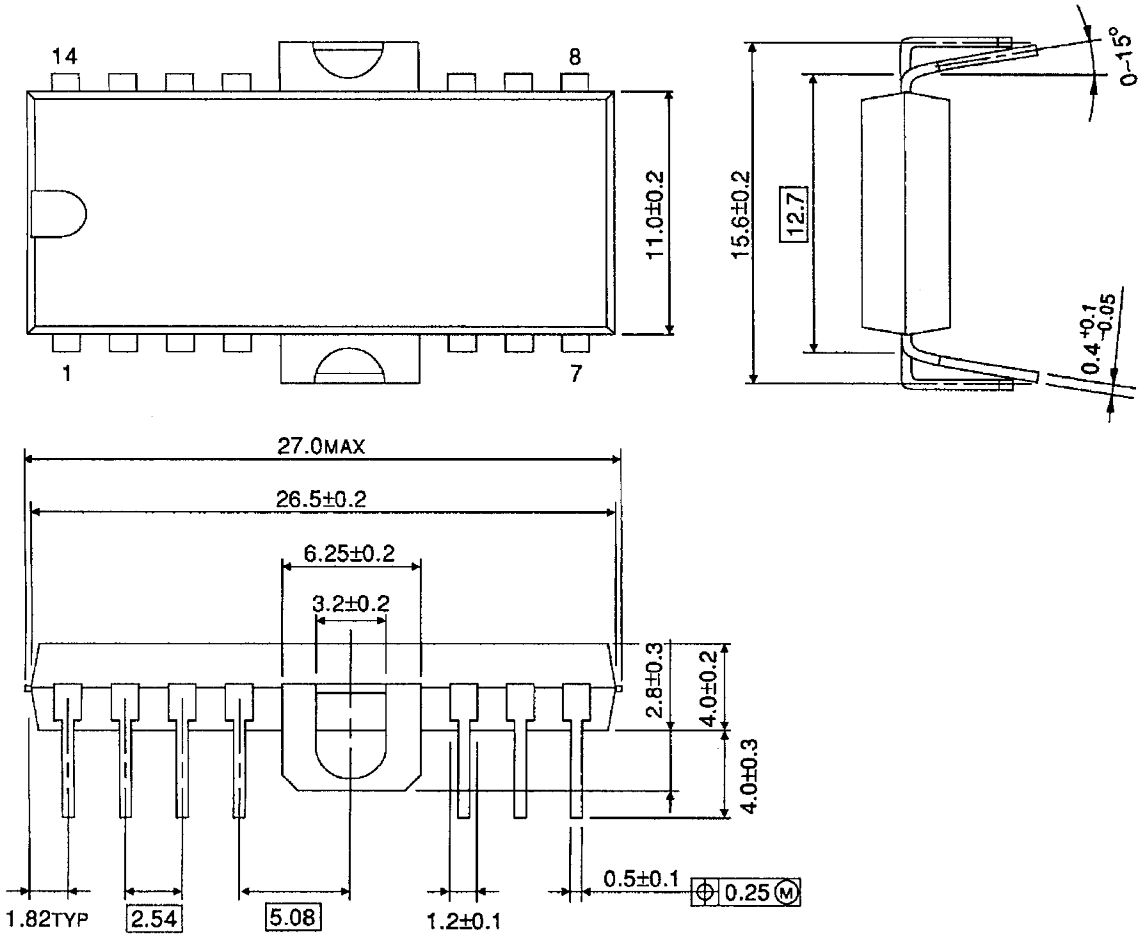
Note 3: Utmost care is necessary in the design of the output, V_{CC}, V_M, and GND lines since the IC may be destroyed by short-circuiting between outputs, air contamination faults, or faults due to improper grounding, or by short-circuiting between contiguous pins.

APPLICATION CIRCUIT 2 (PWM chopper stepping motor driver)



PACKAGE DIMENSIONS

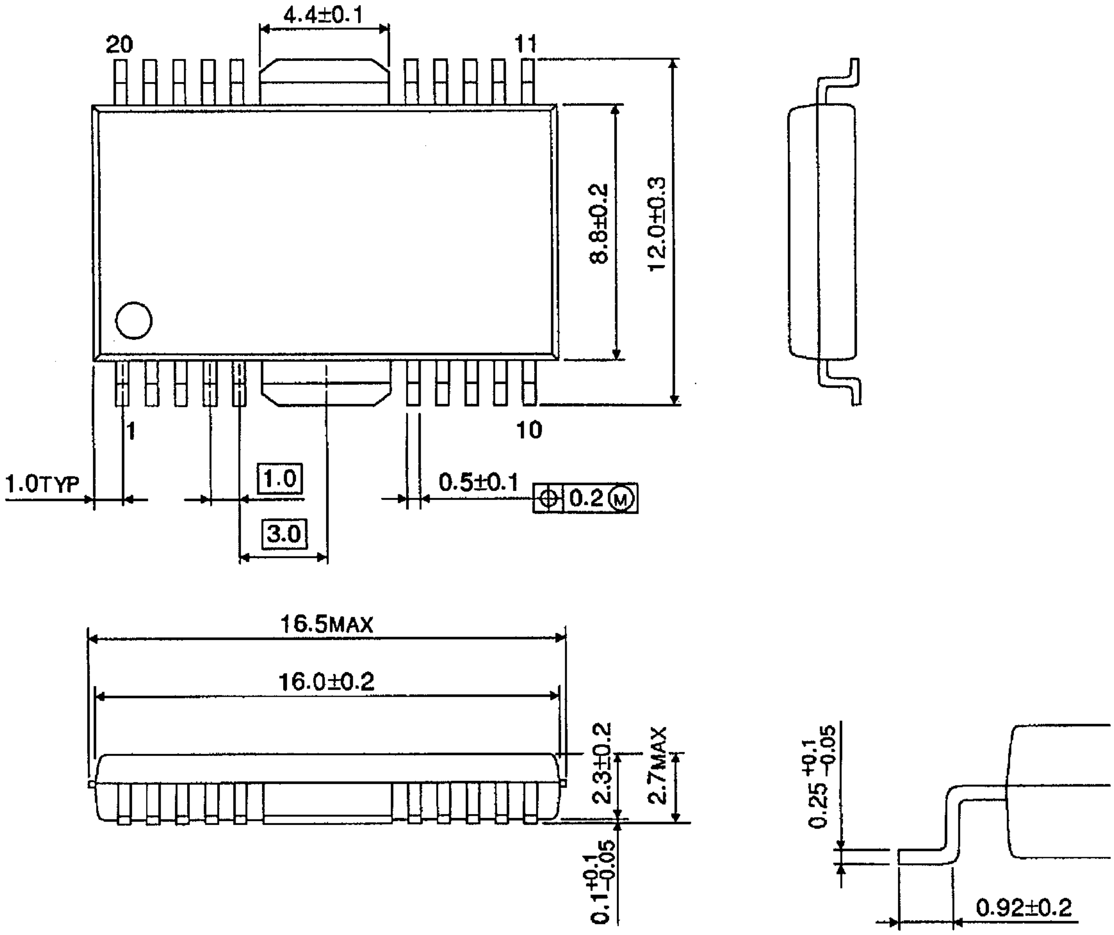
HDIP14−P−500−2.54A Unit: mm



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 considerate 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 flow 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

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- TOSHIBA is continually working to improve the quality and reliability of its products. Nevertheless, semiconductor devices in general can malfunction or fail due to their inherent electrical sensitivity and vulnerability to physical stress. It is the responsibility of the buyer, when utilizing TOSHIBA products, to comply with the standards of safety in making a safe design for the entire system, and to avoid situations in which a malfunction or failure of such TOSHIBA products could cause loss of human life, bodily injury or damage to property.
  In developing your designs, please ensure that TOSHIBA products are used within specified operating ranges as set forth in the most recent TOSHIBA products specifications. Also, please keep in mind the precautions and conditions set forth in the “Handling Guide for Semiconductor Devices,” or “TOSHIBA Semiconductor Reliability Handbook” etc. 021023_A
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