

TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

# TA7712P/PG, TA7712F/FG

3-Phase, Full-Wave Brushless DC Motor Controller IC

## FEATURES

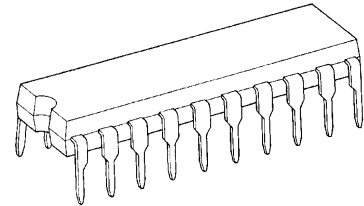
- No frequency generator (FG) required  
(The rotation signal is derived from the position sensor signal.)
- Start, Stop, clockwise (CW), counterclockwise (CCW) and Brake
- High-gain position sensor with input hysteresis
- Rotation signal output (with a frequency six times that of the position sensor output (Hall effect output))
- External transistors are required.

The TA7712PG/FG:

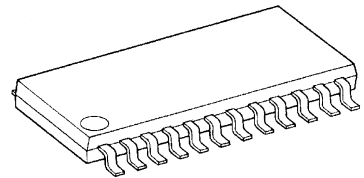
The TA7712PG/FG is a Pb-free product.

About solderability, following conditions were confirmed

- Solderability
  - (1) Use of Sn-37Pb solder Bath
    - solder bath temperature = 230°C
    - dipping time = 5 seconds
    - the 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

**TA7712P/PG**

DIP20-P-300-2.54A

**TA7712F/FG**

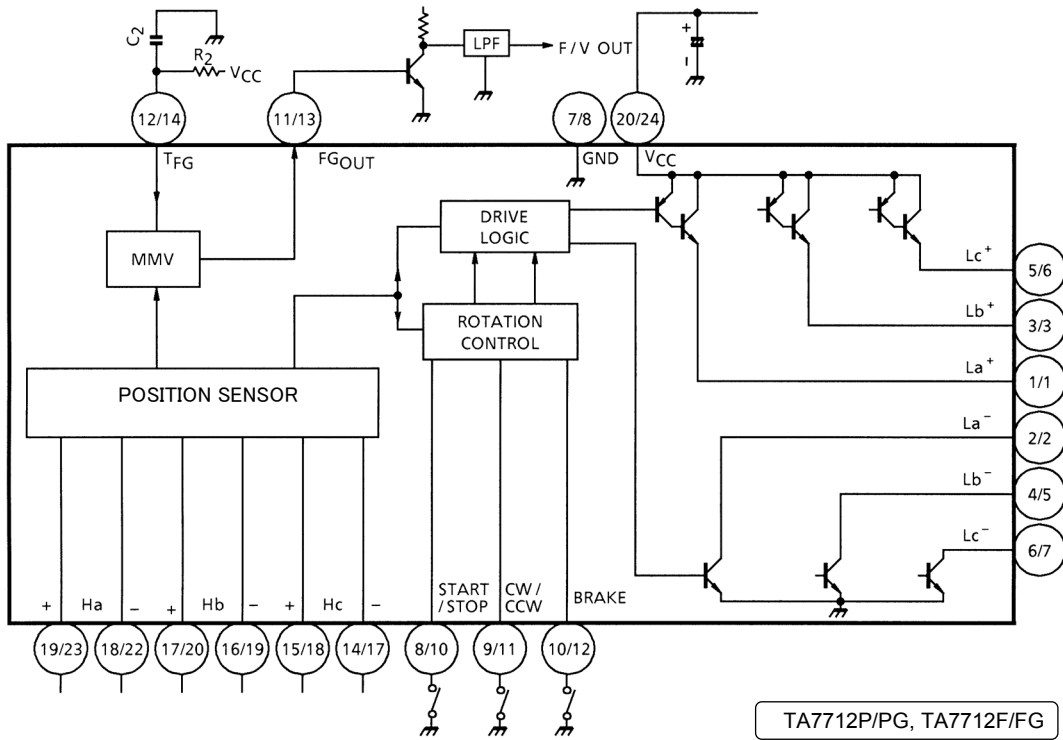
SSOP24-P-300-1.00

Weight

DIP20-P-300-2.54A : 2.25 g (Typ.)

SSOP24-P-300-1.00 : 0.32 g (Typ.)

**BLOCK DIAGRAM**



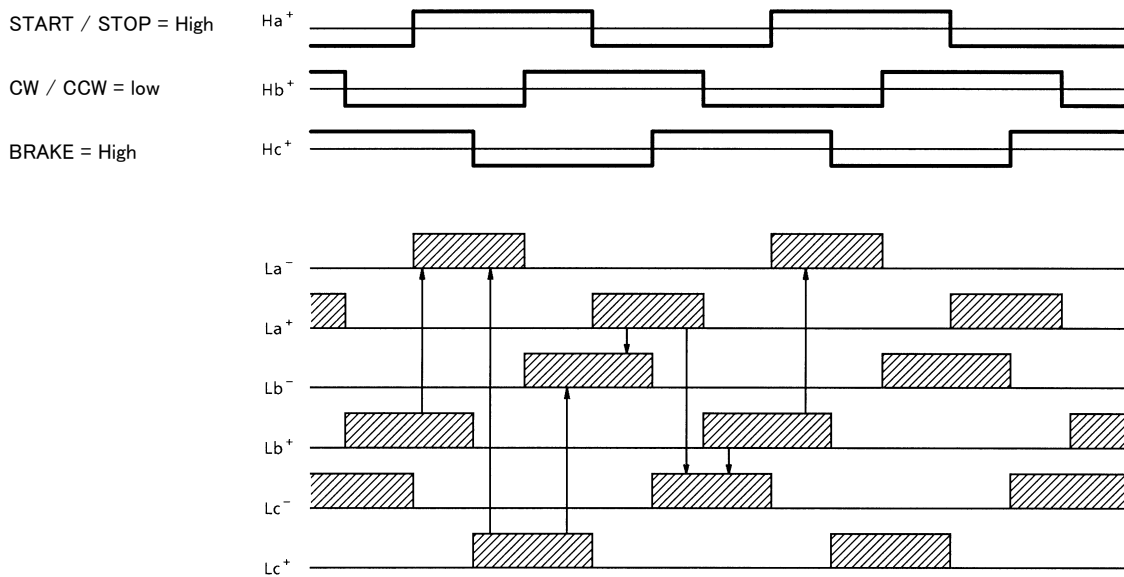
**PIN DESCRIPTION**

PIN No.		SYMBOL	DESCRIPTION
P/PG	F/FG		
1	1	La <sup>+</sup>	High-side drive output for phase a
2	2	La <sup>-</sup>	Low-side drive output for phase a
3	3	Lb <sup>+</sup>	High-side drive output for phase b
4	5	Lb <sup>-</sup>	Low-side drive output for phase b
5	6	Lc <sup>+</sup>	High-side drive output for phase c
6	7	Lc <sup>-</sup>	Low-side drive output for phase c
7	8	GND	Ground
8	10	START/STOP	Start/Stop select input
9	11	CW/CCW	Rotation direction select input
10	12	BRAKE	Brake input
11	13	FG <sub>OUT</sub>	FG output
12	14	T <sub>FG</sub>	Connection pin for a capacitor and an resistor
13	—	N. C.	No connect
14	17	Hc <sup>-</sup>	c-phase negative Hall-amplifier input
15	18	Hc <sup>+</sup>	c-phase positive Hall-amplifier input
16	19	Hb <sup>-</sup>	b-phase negative Hall-amplifier input
17	20	Hb <sup>+</sup>	b-phase positive Hall-amplifier input
18	22	Ha <sup>-</sup>	a-phase negative Hall-amplifier input
19	23	Ha <sup>+</sup>	a-phase positive Hall-amplifier input
20	24	V <sub>CC</sub>	Power supply input

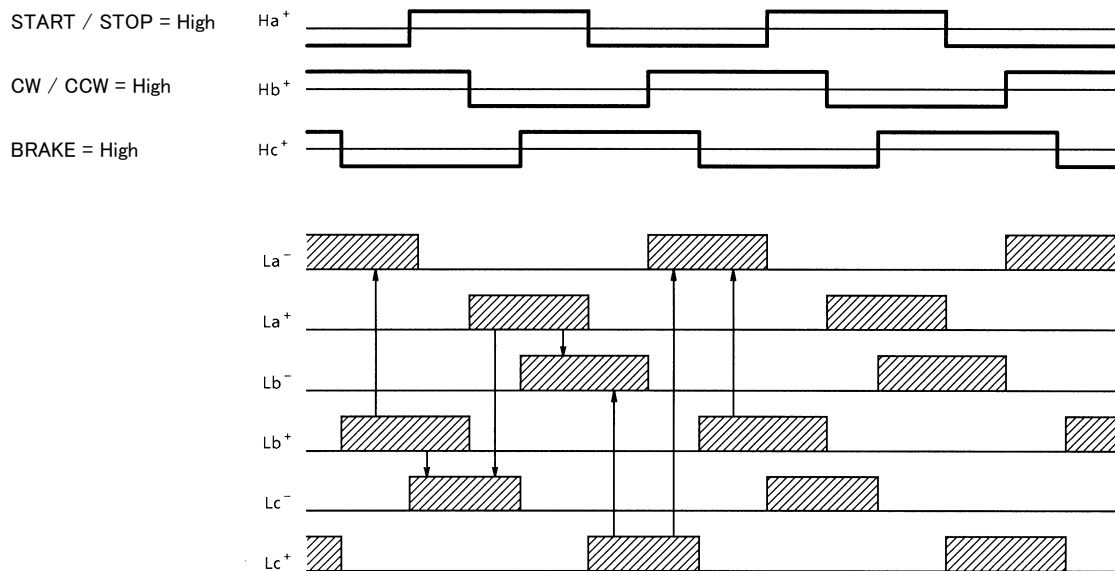
F/FG: Pins 4, 9, 15, 16 and 21: No connect

## TIMING CHART

**Clockwise rotation (The position sensor signals are switched in the following sequence: Ha → Hb → Hc.)**



**Counterclockwise rotation (The position sensor signals are switched in the following sequence: Ha → Hc → Hb.)**



**APPLICATIONS OF THE TA7712P/PG, TA7712F/FG**

The TA7712P/PG and TA7712F/FG are provided with a stop function, which enables them to stop the motor having a large inertia like a video disk player in a short time, so that disks can be changed quickly.

To eliminate the need of the frequency generator (FG), which was conventionally required for generating the rotation signal, signals from the position sensor input are ORed and its synthesized signal is sent out from the FGOUT pin (pin 11/13).

That is, since the FGOUT signal is a mixture of three position sensor outputs (Ha, Hb and Hc), its frequency is six times that of each position sensor signal. This enables the TA7712P/PG and TA7712F/FG to achieve sufficient control characteristics even with the F-V (frequency to voltage) converter using a monostable multivibrator (MMV). The difference between them and the TA7713P/PG is that the stop function is automated in the TA7713P/PG, while it is operated by the external signal in the TA7712P/PG.

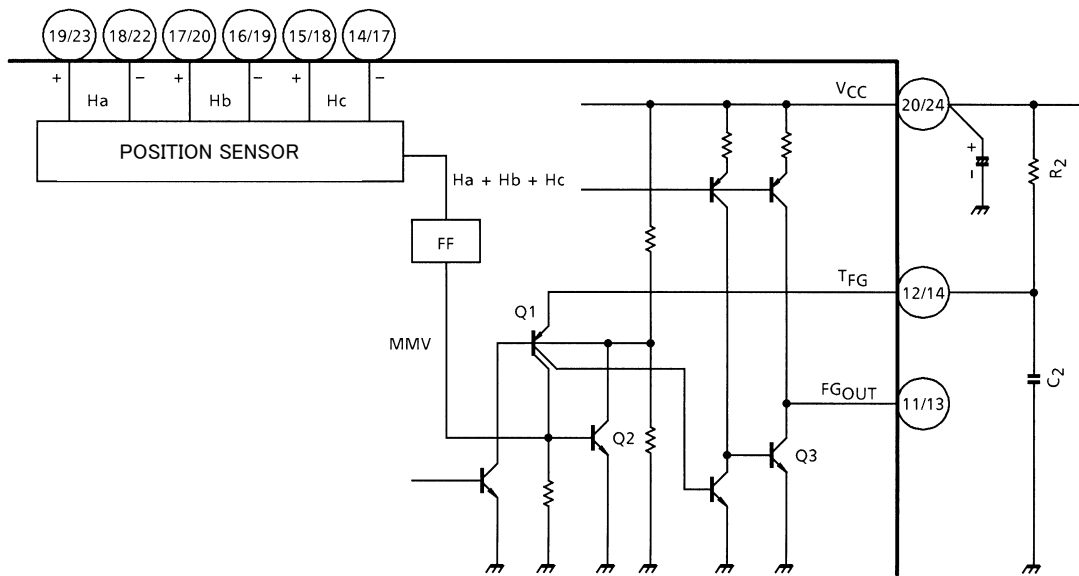
The following sections describe the applications of the TA7713P/PG.

(1) Functional Description on the FGOUT (pin 11/13) and T<sub>FG</sub> (pin 12/14) pins

Q1 and Q2 in Figure 1 comprise a monostable multivibrator. The position sensor input signals, Ha, Hb and Hc, are combined together and applied to the base of Q2 after squaring waveform with a flip-flop, FF.

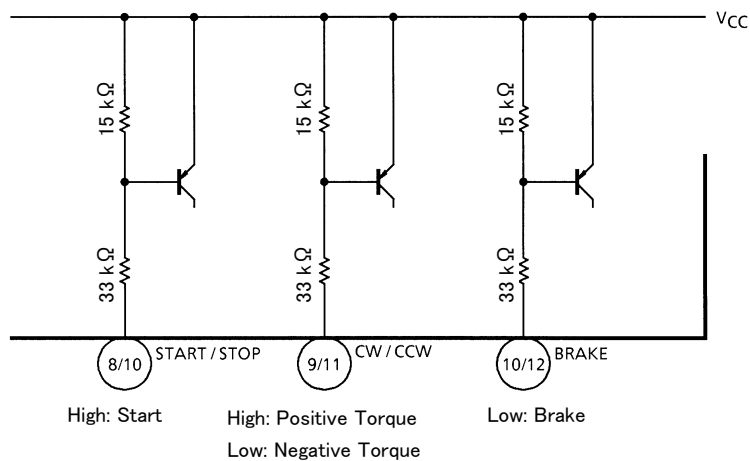
The output pulse width of the MMV consisting of Q1 and Q2 is determined by R<sub>2</sub> and C<sub>2</sub>, which are connected to T<sub>FG</sub> (pin 12/14). The square wave having the pulse width that is determined by C<sub>2</sub> and R<sub>2</sub> is generated from FGOUT (pin 11/13). The frequency of this square wave, which is proportional to that of the rotation signal, is six times the frequency of each position sensor signal. (Six pulses per electrical revolution)

The F-V conversion is performed by connecting the FGOUT output to a low-pass filter and integrating the output signal.



**Figure 1**

(2) Each Control Input



**Figure 2**

START / STOP	CW / CCW	BRAKE	OUTPUT
H	H	H	Positive Torque mode
H	L	H	Negative Torque mode
H or L	H or L	L	Break mode
L	H or L	H	Stop mode

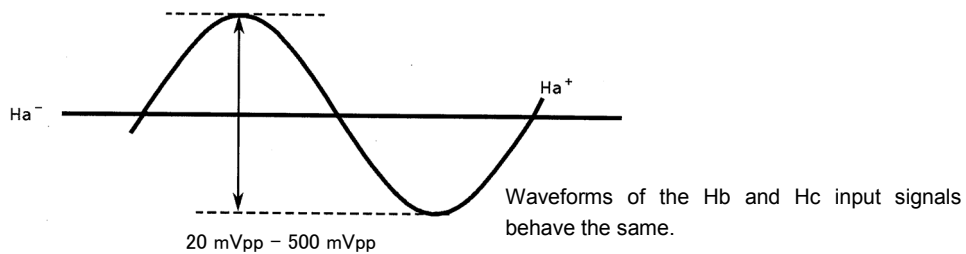
Note: In Stop mode, all outputs of  $La^+$  through  $Lc^+$  and  $La^-$  through  $Lc^-$  are disabled.  
 In Break mode, outputs of  $La^+$  through  $Lc^+$  are enabled. (Source mode)

(3) Output Circuitry

As shown in the block diagram, the high-side outputs come from the emitters of Darlington-connected PNP and NPN transistors, and the low-side outputs are open-collectors of NPN transistors. Connect external transistors in the same manner as shown in the application circuit.

(4) Position Sensor inputs

The input voltage swing should be between 20 mV<sub>PP</sub> and 500 mV<sub>PP</sub>.



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

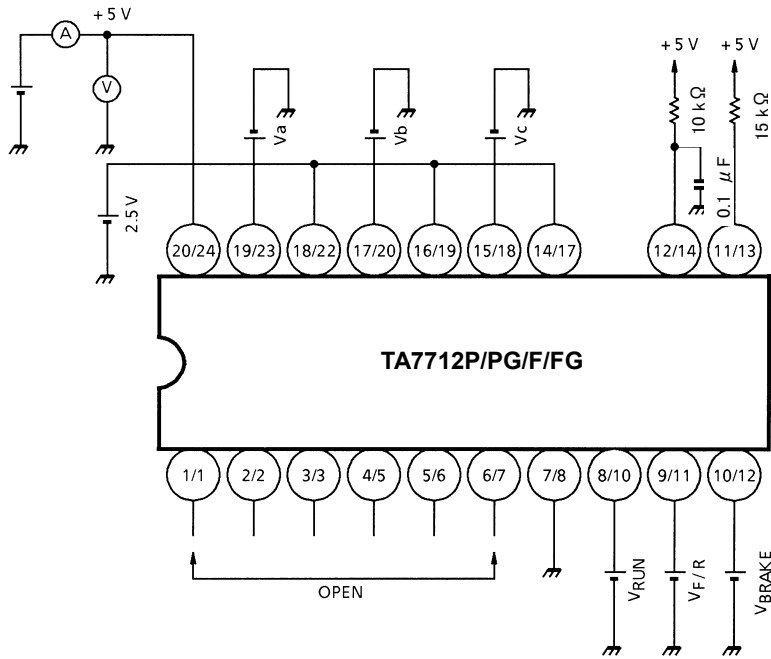
CHARACTERISTICS		SYMBOL	RATING	UNIT
Power Supply Voltage		V <sub>CC</sub>	8	V
Output Current		I <sub>O</sub>	±25	mA
Position Sensor Input Voltage (T <sub>j</sub> = 25°C)		V <sub>H</sub>	500	mV <sub>p-p</sub>
Power Dissipation	TA8412P/PG	P <sub>D</sub> (Note)	1.2	W
	TA8412F/FG		0.5	
Operating Temperature		T <sub>opr</sub>	-30 to 75	°C
Storage Temperature		T <sub>stg</sub>	-55 to 150	°C

Note: Measured for the IC only

## ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V<sub>CC</sub> = 5 V, Ta = 25°C)

CHARACTERISTICS		SYMBOL	TEST CIR-CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT	
Operating Supply Voltage		V <sub>CC (opr)</sub>	—		4.75	5.00	5.25	V	
Power Supply Current		I <sub>CC1</sub>	1	In Stop mode	—	3.4	6.0	mA	
		I <sub>CC2</sub>		Output: open	—	17.0	26.0		
Saturation Voltage	High Side	V <sub>SAT (U-1)</sub>	2	R <sub>L</sub> = 200 Ω	—	1.3	2.0	V	
		V <sub>SAT (U-2)</sub>		R <sub>L</sub> = 2 kΩ	—	1.0	1.3		
	Low Side	V <sub>SAT (L-1)</sub>		R <sub>L</sub> = 200 Ω	—	0.8	1.2		
		V <sub>SAT (L-2)</sub>		R <sub>L</sub> = 2 kΩ	—	0.18	0.4		
Leakage Current	High Side	I <sub>L (U)</sub>	2		—	—	100	μA	
	Low Side	I <sub>L (L)</sub>			—	—	100		
Position Sensor Input	In-phase Input Voltage Range		—		2.0	—	4.5	V	
	Input Sensitivity				20	—	—	mV <sub>p-p</sub>	
	Input Hysteresis				2	7	15	mV	
START Input (RUN)	Operating Input Voltage	H	V <sub>INR (H)</sub>	2	4.0	—	—	V	
		L	V <sub>INR (L)</sub>	2	—	—	1.0		
	Input Current	L	I <sub>INR</sub>	2	V <sub>INR</sub> = 1.0 V	—	—	200	μA
CW / CCW Input (FWD / REV)	Operating Input Voltage	H	V <sub>INC (H)</sub>	2		4.0	—	V	
		L	V <sub>INC (L)</sub>			—	—		1.0
	Input Current	L	I <sub>INC</sub>			V <sub>INC</sub> = 1.0 V	—	—	200
BRAKE Input (BRAKE)	Operating Input Voltage	H	V <sub>INB (H)</sub>	2		4.0	—	V	
		L	V <sub>INB (L)</sub>			—	—		1.0
	Input Current	H	I <sub>INB</sub>			V <sub>INB</sub> = 1.0 V	—	—	200
FG Output	Output Current	H	I <sub>FGH</sub>	3		80	—	μA	
	Output Voltage	L	V <sub>FGL</sub>	3	I <sub>FG</sub> = 0.3 mA	—	—	0.4	V
	Pulse Width		τ <sub>FG</sub>	3	C = 0.1 μF, R = 10 kΩ	0.9	1.0	1.1	ms

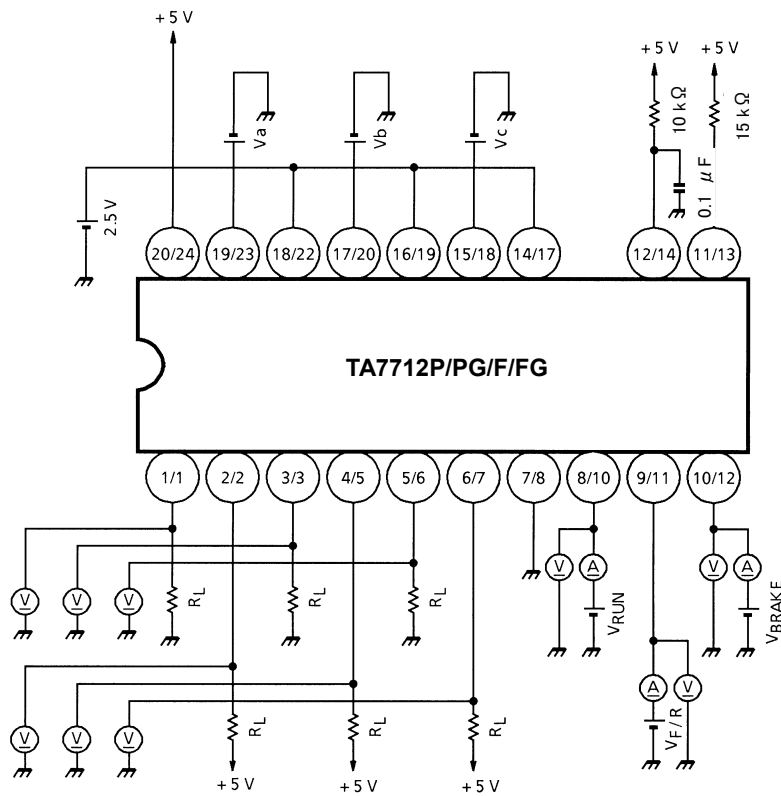
**TEST CIRCUIT 1**



	V <sub>RUN</sub>	V <sub>F/R</sub>	V <sub>BRAKE</sub>	V <sub>a</sub>	V <sub>b</sub>	V <sub>c</sub>	REMARKS
I <sub>CC1</sub>	1.0 V	1.0 V	1.0 V	2.48 V	2.48 V	2.52 V	
I <sub>CC2</sub>	4.0 V	4.0 V	4.0 V	2.52 V	2.48 V	2.52 V	



## TEST CIRCUIT 2



### Hall Amplifier Input

To check the input sensitivity and input hysteresis, set  $V_a$ ,  $V_b$  and  $V_c$  to  $2.5\text{ V} \pm 20\text{ mV}$  as shown below, and measure the leakage current and saturation voltage individually.

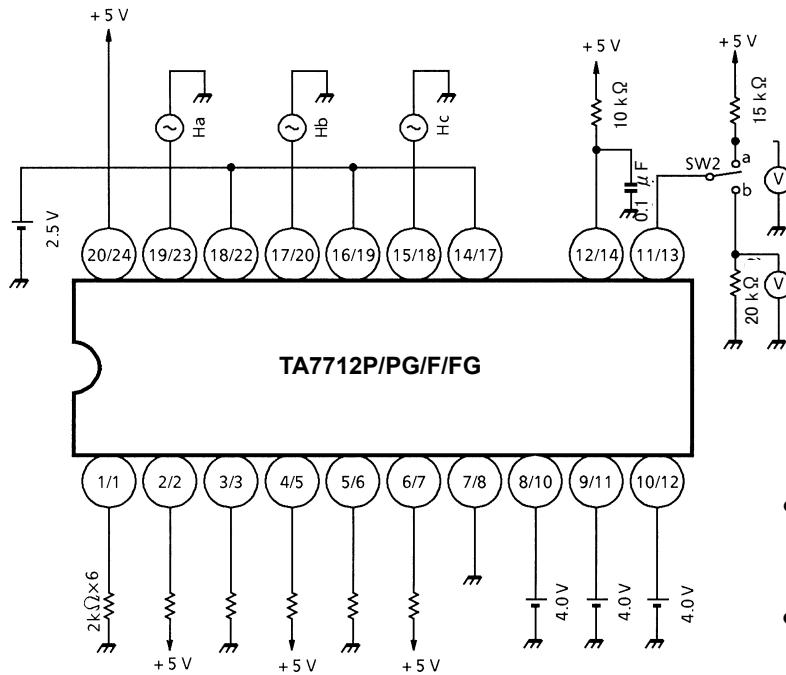
INPUT CONDITION						MEASUREMENT ITEM					
$V_a$	$V_b$	$V_c$	RUN	F / R	BRAKE	$La^+$	$La^-$	$Lb^+$	$Lb^-$	$Lc^+$	$Lc^-$
2.52 V	2.48 V	2.48 V	$V_{INR} (H)$	$V_{INC} (H)$	$V_{INB} (H)$	LEAK	SAT	LEAK	LEAK	SAT	LEAK
2.48 V	2.52 V	2.48 V	—	—	—	SAT	LEAK	—	SAT	LEAK	—
2.48 V	2.48 V	2.52 V	—	—	—	—	—	SAT	—	—	SAT

LEAK: Measurement of a leakage current

SAT: Measurement of a saturation voltage

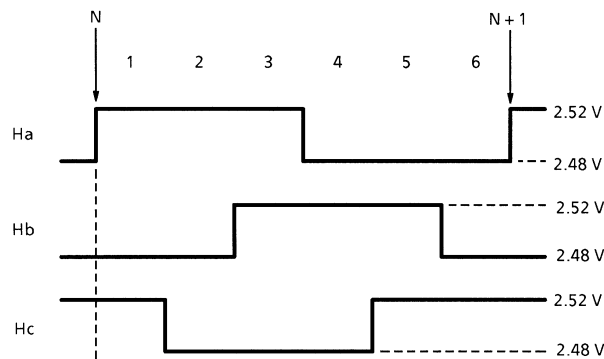
To verify the characteristics of the  $V_{INR} (L)$ ,  $V_{INC} (L)$  and  $V_{INB} (L)$  voltages, the output voltage should be checked while each respective terminal is set at 1.0 (V).

**TEST CIRCUIT 3**



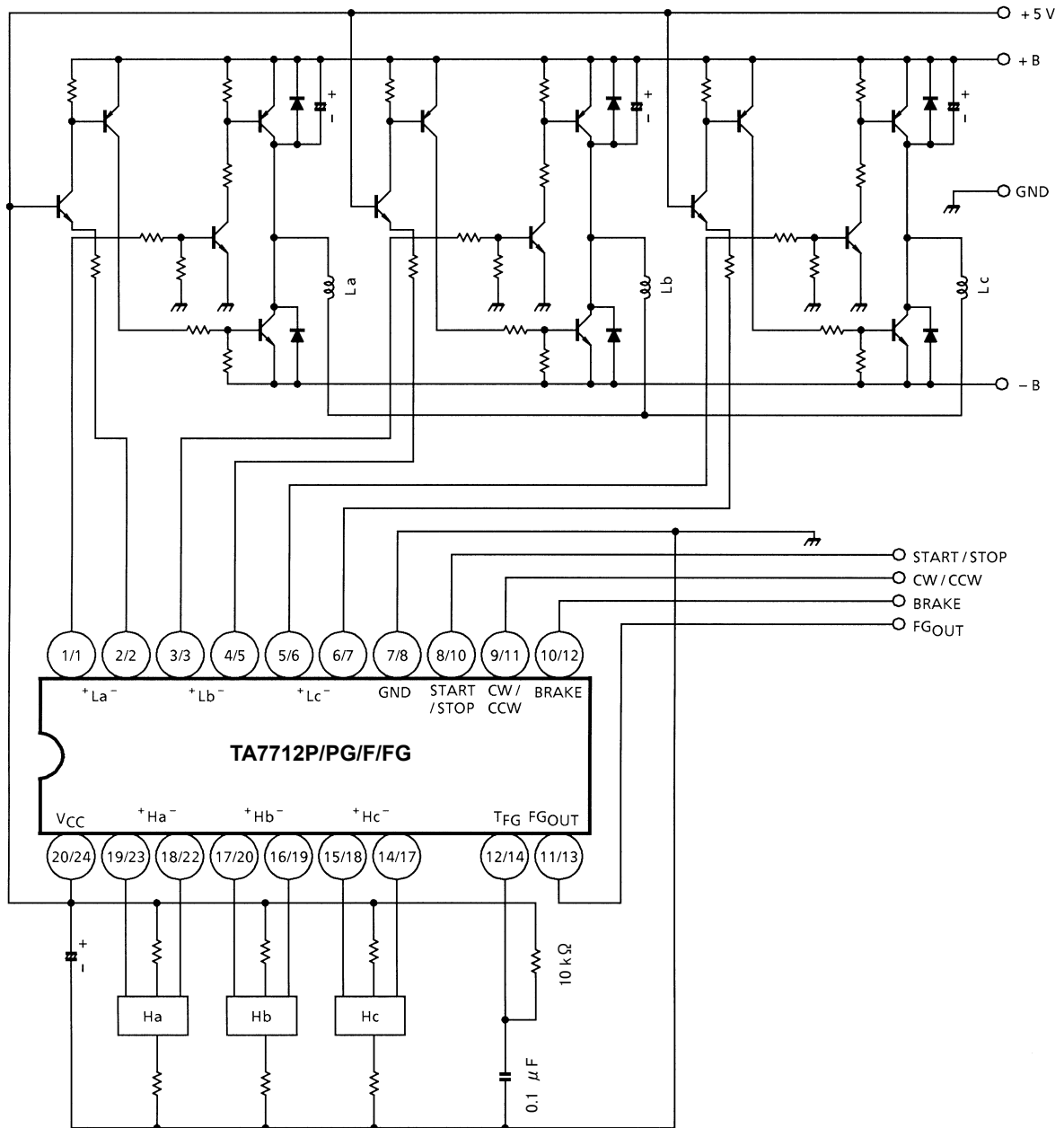
- Calculate the  $I_{FGH}$  current from the output voltage obtained when SW2 is connected to b.
- Measure  $V_{FGL}$  and  $\tau_{FG}$  when SW2 is connected to a.

**TIMING CHART FOR CLOCKWISE ROTATION**

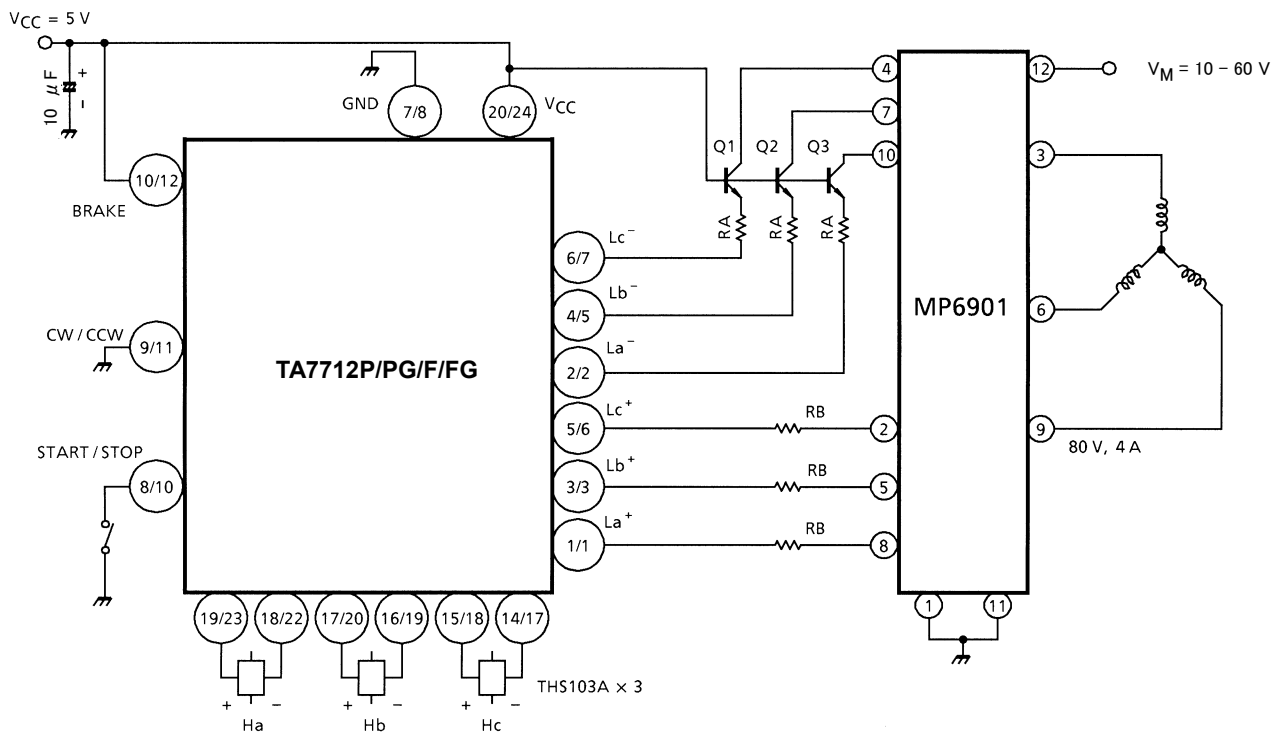


**CLOCK: 360 Hz**

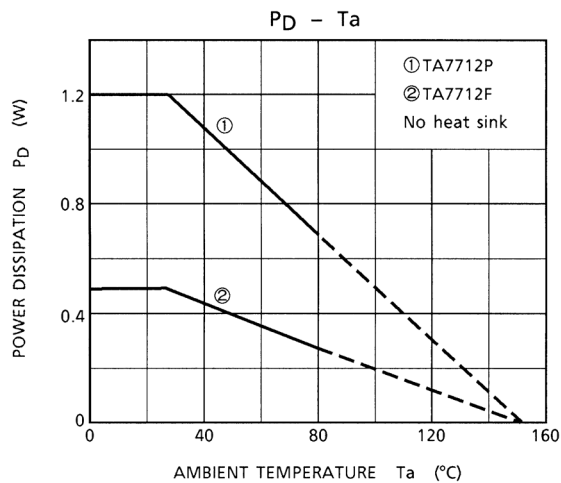
**BASIC APPLICATION CIRCUIT**



## APPLICATION CIRCUIT



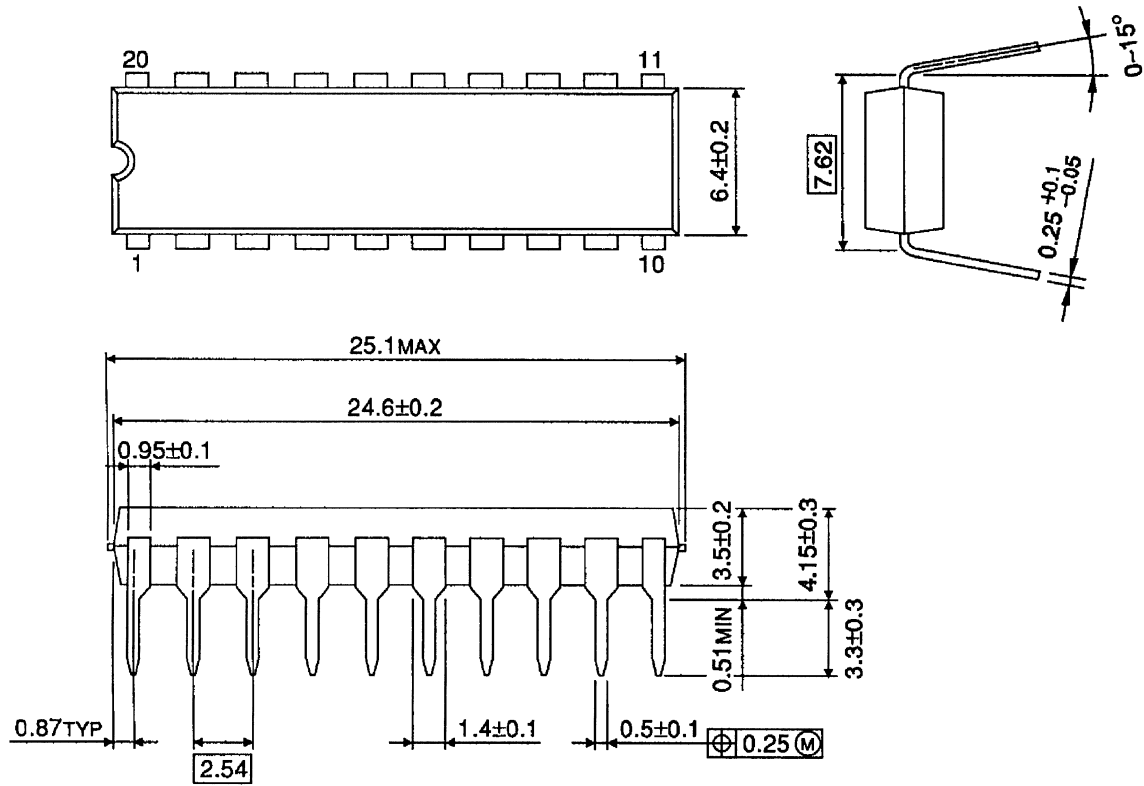
Note: The IC may be destroyed in case of a short-circuit across outputs, a short-circuit to power supply, a short-circuit to ground, or a short-circuit between neighboring pins. This possibility should be fully considered in the design of the output,  $V_{CC}$ ,  $V_M$  and ground lines.



## PACKAGE DIMENSIONS

DIP20-P-300-2.54A

Unit: mm

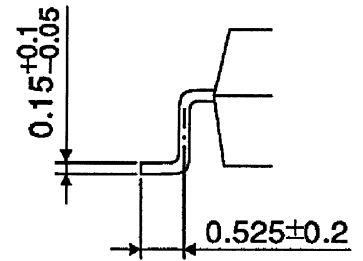
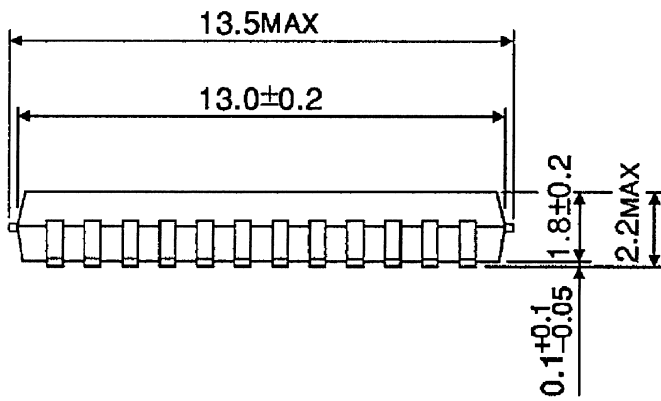
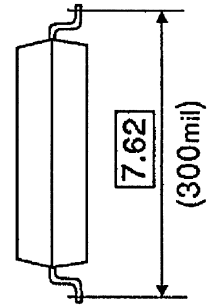
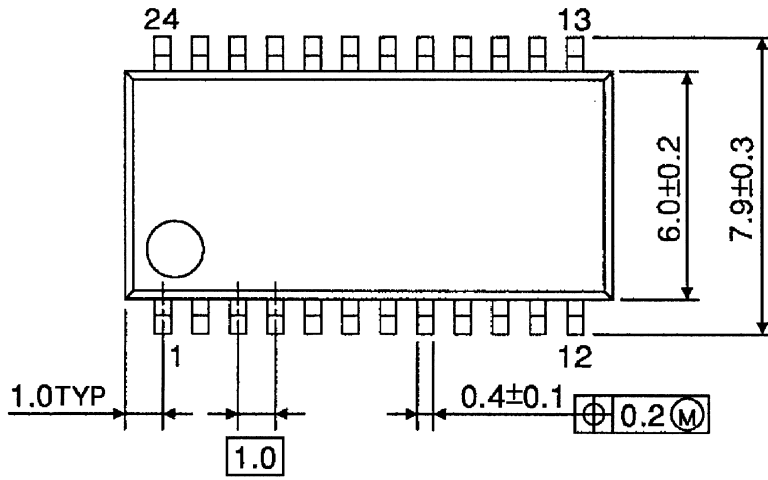


Weight: 2.25 g (Typ.)

**PACKAGE DIMENSIONS**

SSOP24-P-300-1.00

Unit: mm



Weight: 0.32 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] 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****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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20070701-EN

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