TOSHIBA BIPOLAR LINEAR INTEGRATED CIRCUIT SILICON MONOLITHIC

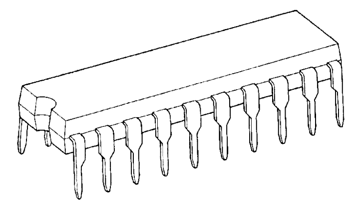
TA7712P/PG,TA7712F/FG

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

FEATURES

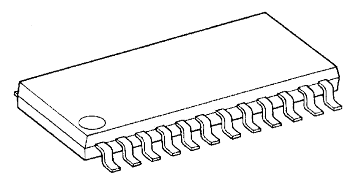
- No frequency generator (FG) required
  (The rotation signal is derived from the position sensor signal.)
- Start, Stop, clockwise (CW), counterclockwise (CCW) and Brake
- High-gain position sensor with input hysteresis
- Rotation signal output (with a frequency six times that of the position sensor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

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.)

The TA7712PG/FG:
The TA7712PG/FG is a Pb-free product.

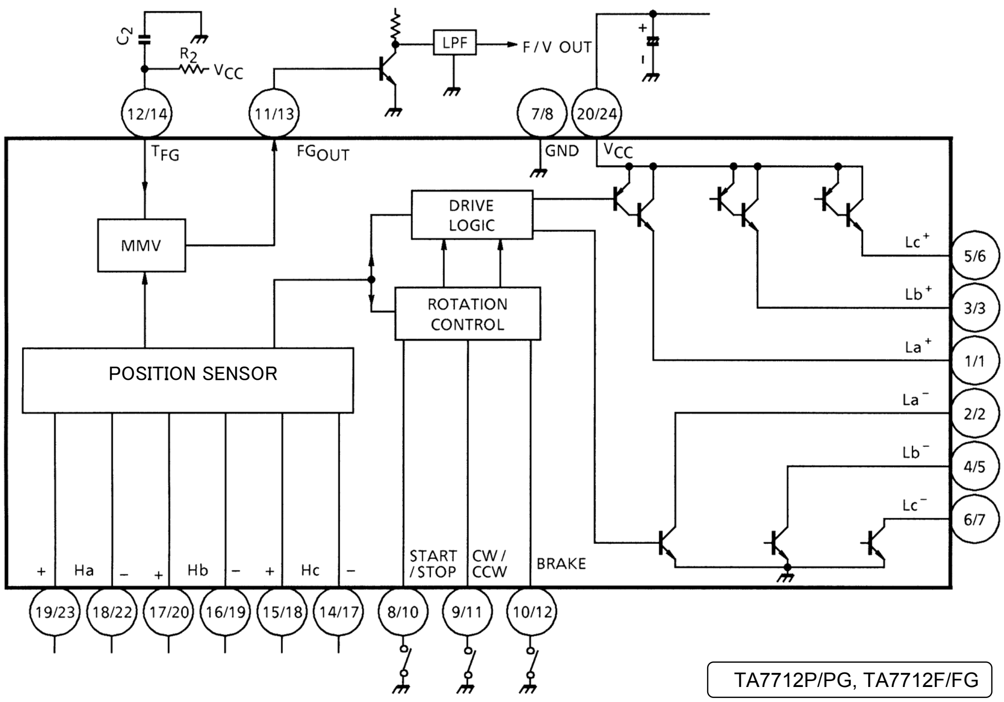
About solderability, following conditions were confirmed

- 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

BLOCK DIAGRAM



PIN DESCRIPTION

PIN No.		SYMBOL	DESCRIPTION
P/PG	F/FG		
1	1	La^{+}	High-side drive output for phase a
2	2	La^{-}	Low-side drive output for phase a
3	3	Lb^{+}	High-side drive output for phase b
4	5	Lb^{-}	Low-side drive output for phase b
5	6	Lc^{+}	High-side drive output for phase c
6	7	Lc^{-}	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_{OUT}	FG output
12	14	T_{FG}	Connection pin for a capacitor and an resistor
13	—	N. C.	No connect
14	17	Hc^{-}	c−phase negative Hall-amplifier input
15	18	Hc^{+}	c−phase positive Hall-amplifierinput
16	19	Hb^{-}	b−phase negative Hall-amplifier input
17	20	Hb^{+}	b−phase positive Hall-amplifier input
18	22	Ha^{-}	a−phase negative Hall-amplifier input
19	23	Ha^{+}	a−phase positive Hall-amplifier input
20	24	V_{CC}	Power supply input

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

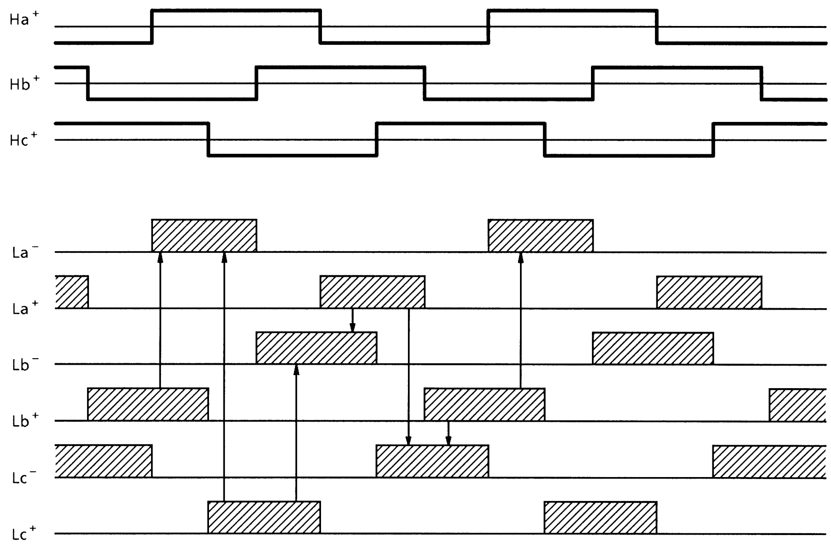
TIMING CHART

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

START / STOP = High

CW / CCW = low

BRAKE = High

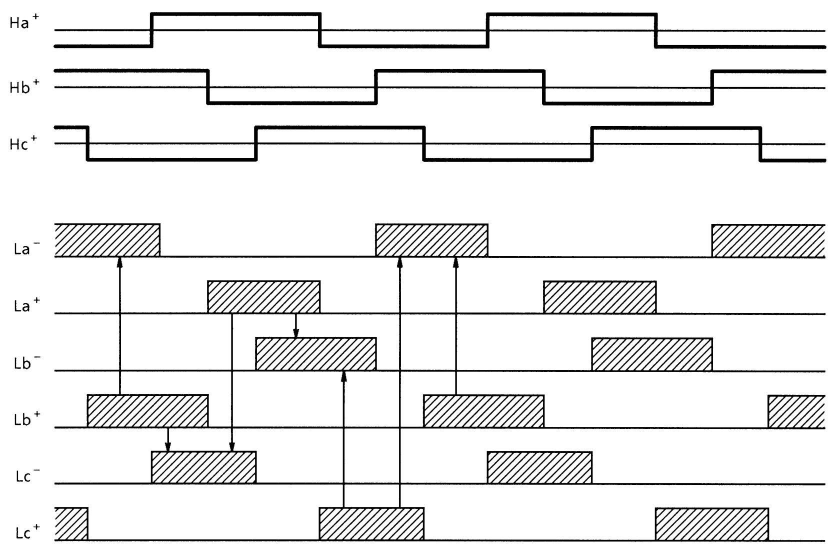


Counterclockwise rotation (The position sensor signals are switched in the following sequence: Ha → Hc → Hb.)

START / STOP = High

CW / CCW = High

BRAKE = High



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 FG_{OUT} pin (pin 11/13).
That is, since the FG_{OUT} 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) convertor 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 FG_{OUT} (pin 11/13) and T_{FG} (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_2 and C_2, which are connected to T_{FG} (pin 12/14).The square wave having the pulse width that is determined by C_2 and R_2 is generated from FG_{OUT} (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 FG_{OUT} output to a low-pass fileter and integrating the output signal.

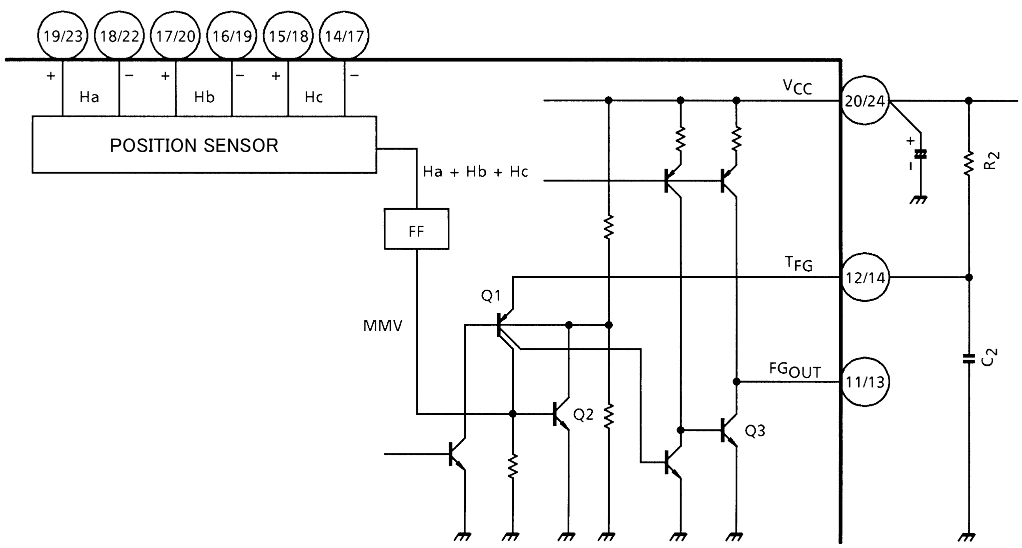


Figure 1

(2) Each Control Input

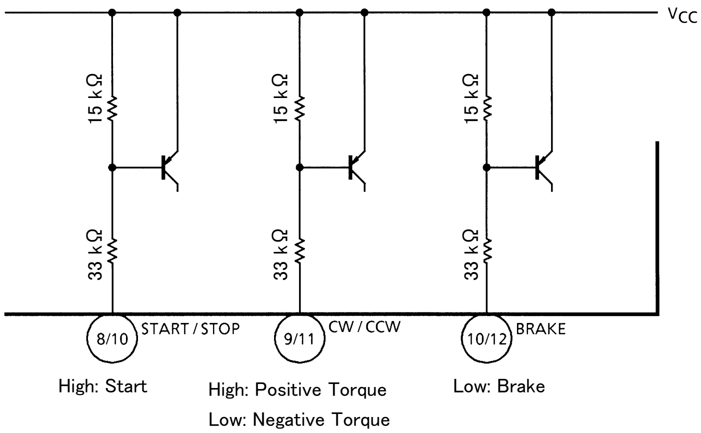


Figure 2

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

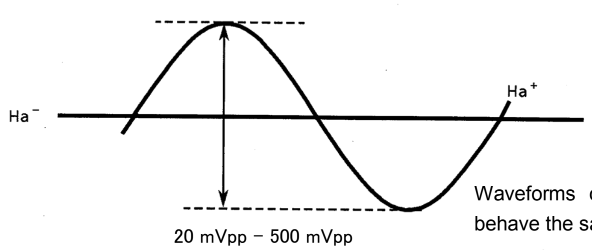
Note: In Stop mode, all outputs of La^+ through Lc^+ and La^- through Lc^- are disabled.
In Break mode, outputs of La^+ through Lc^+ are enabled. (Source mode)

(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 Iinputs

The input voltage swing should be between 20 mV_{PP} and 500 mV_{PP}.



Waveforms of the Hb and Hc input signals behave the same.

ABSOLUTE MAXIMUM RATINGS (Ta = 25°C)

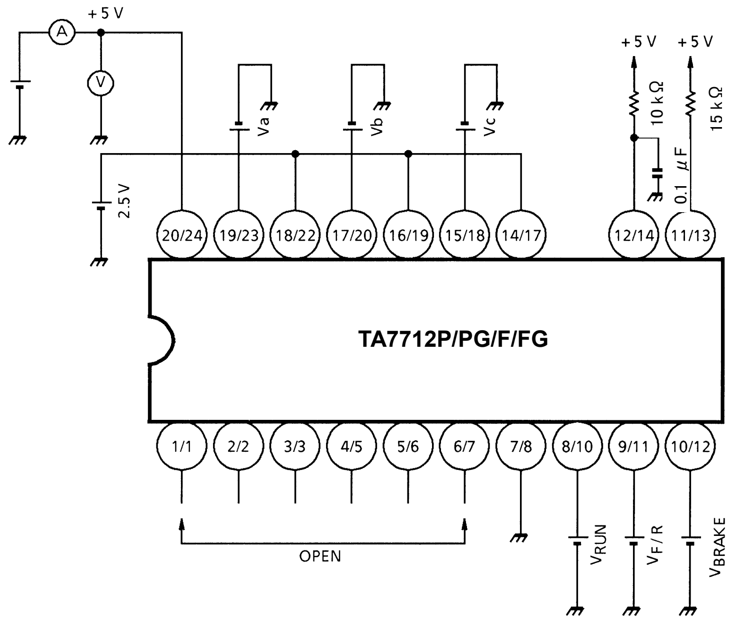
CHARACTERISTICS		SYMBOL	RATING	UNIT
Power Supply Voltage		V_{CC}	8	V
Output Current		I_O	±25	mA
Position Sensor Input Voltage (T_j = 25°C)		V_H	500	mV_{p-p}
Power Dissipation	TA8412P/PG	P_D (Note)	1.2	W
	TA8412F/FG		0.5	
Operating Temperature		T_{opr}	−30 to 75	°C
Storage Temperature		T_{stg}	−55 to 150	°C

Note: Measured for the IC only

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, V_{CC} = 5 V, Ta = 25°C)

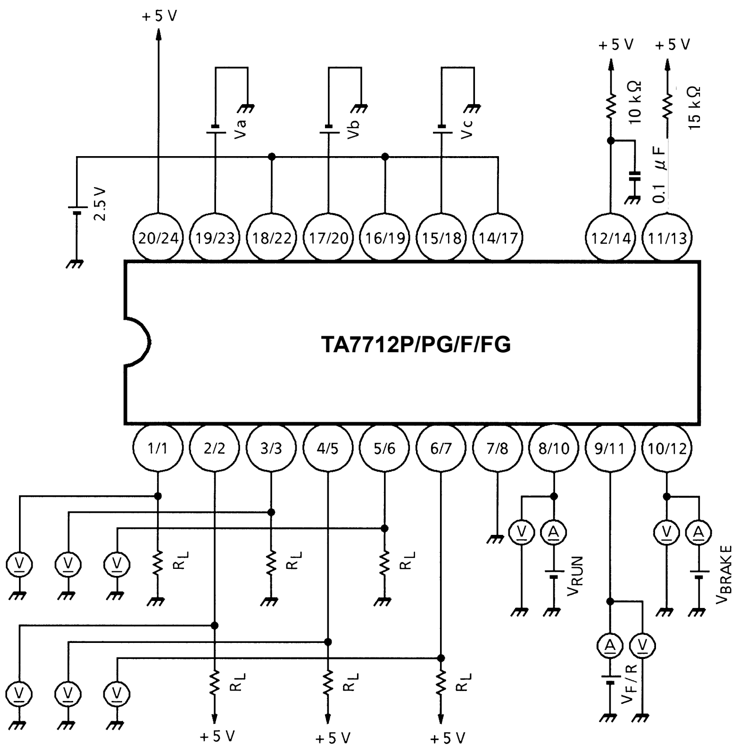
CHARACTERISTICS			SYMBOL	TEST CIR−CUIT	TEST CONDITIONS	MIN	TYP.	MAX	UNIT
Operating Supply Voltage			$V_{CC (opr)}$	—		4.75	5.00	5.25	V
Power Supply Current			I_{CC1}	1	In Stop mode	—	3.4	6.0	mA
			I_{CC2}		Output: open	—	17.0	26.0	
Saturation Voltage	High Side		$V_{SAT (U-1)}$	2	R_L = 200 Ω	—	1.3	2.0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

TEST CIRCUIT 1



	V_{RUN}	$V_{F/R}$	V_{BRAKE}	Va	Vb	Vc	REMARKS
I_{CC1}	1.0 V	1.0 V	1.0 V	2.48 V	2.48 V	2.52 V	
I_{CC2}	4.0 V	4.0 V	4.0 V	2.52 V	2.48 V	2.52 V	

TEST CIRCUIT 2



Hall Amplifier Input

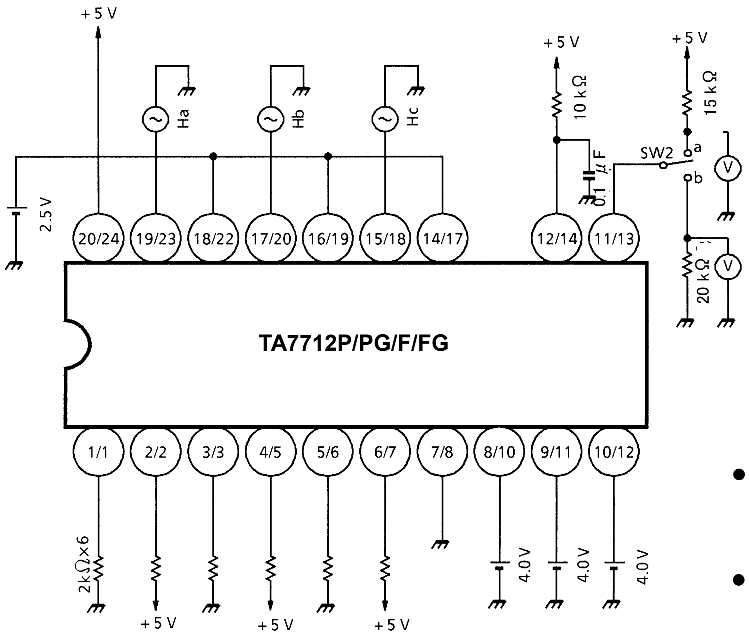
To check the input sensitivity and input hysteresis, set Va, Vb and Vc to 2.5 V ± 20 mV as shown below, and measure the leakage current and saturation voltage individually.

INPUT CONDITION						MEASUREMENT ITEM					
Va	Vb	Vc	RUN	F / R	BRAKE	La+	La−	Lb+	Lb−	Lc+	Lc−
2.52 V	2.48 V	2.48 V	$V_{IN\,R\,(H)}$	$V_{IN\,C\,(H)}$	$V_{IN\,B\,(H)}$	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

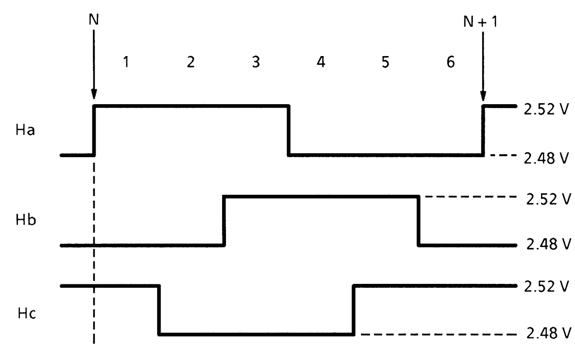
To verify the characteristics of the $V_{IN\,R\,(L)}$, $V_{IN\,C\,(L)}$ and $V_{IN\,B\,(L)}$ voltages, the output voltage should be checked while each respective terminal is set at 1.0 (V).

TEST CIRCUIT 3



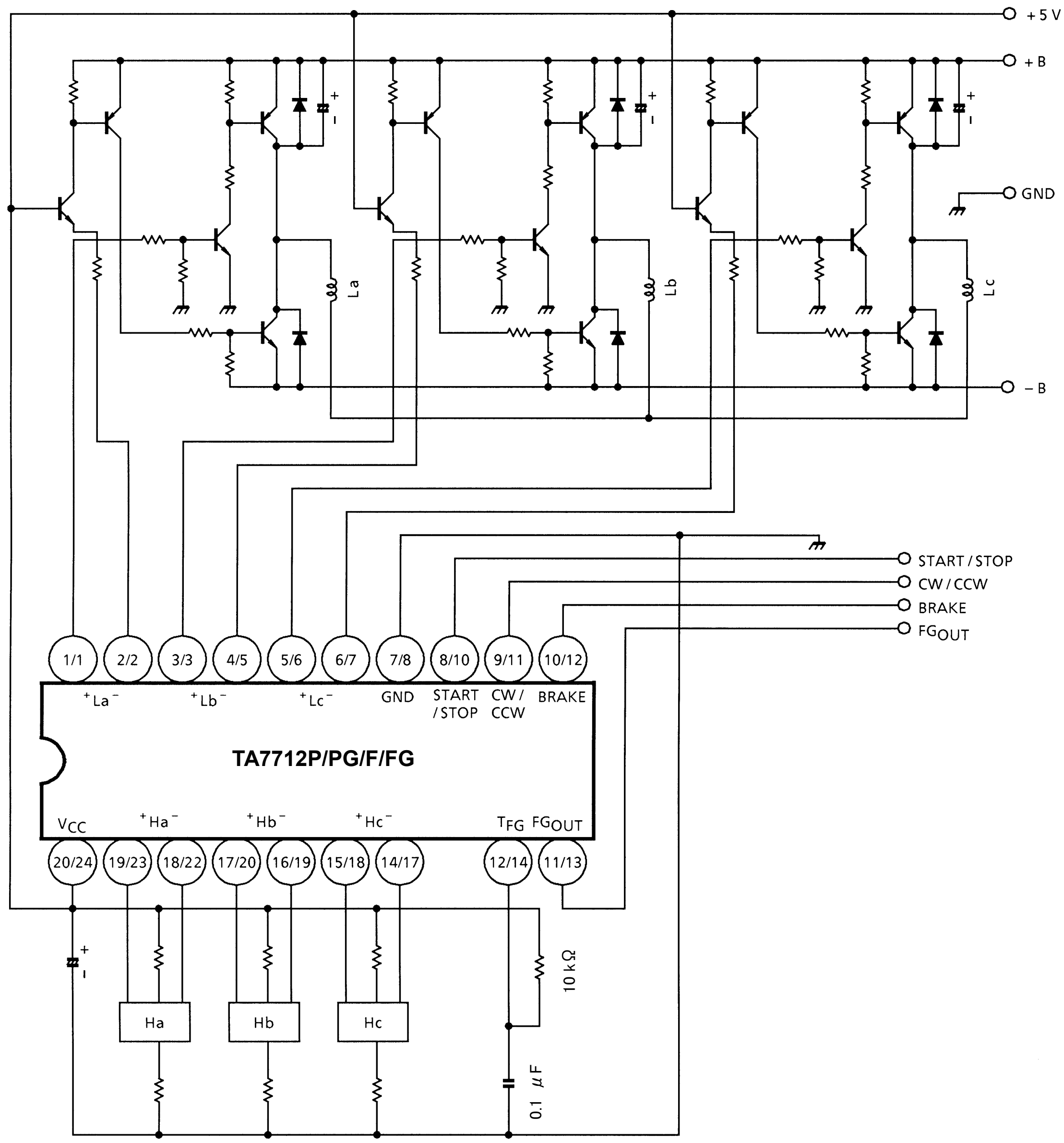
- Calculate the I_{FGH} current from the output voltage obtained when SW2 is connected to b.
- Measure V_{FGL} and τ_{FG} when SW2 is connected to a.

TIMING CHART FOR CLOCKWISE ROTATION

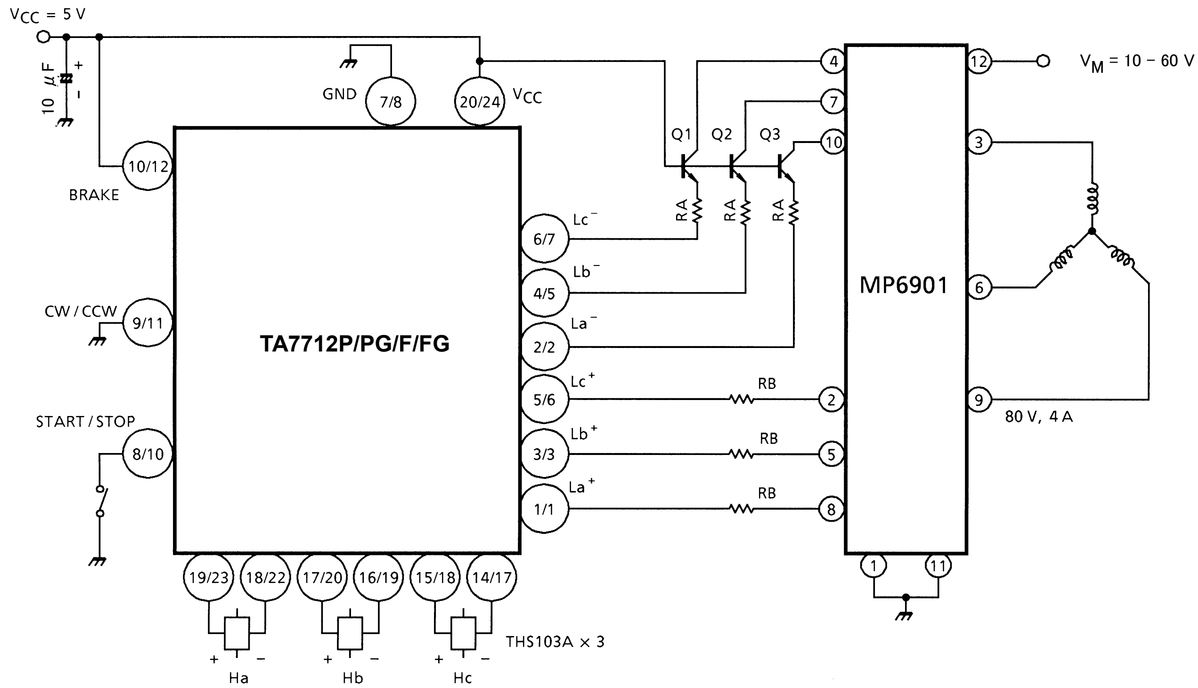


CLOCK: 360 Hz

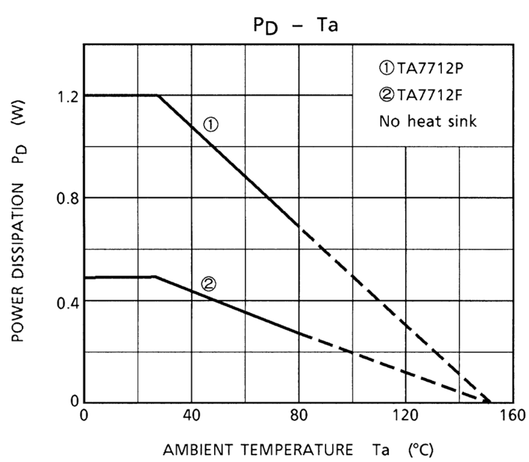
BASIC APPLICATION CIRCUIT



APPLICATION CIRCUIT

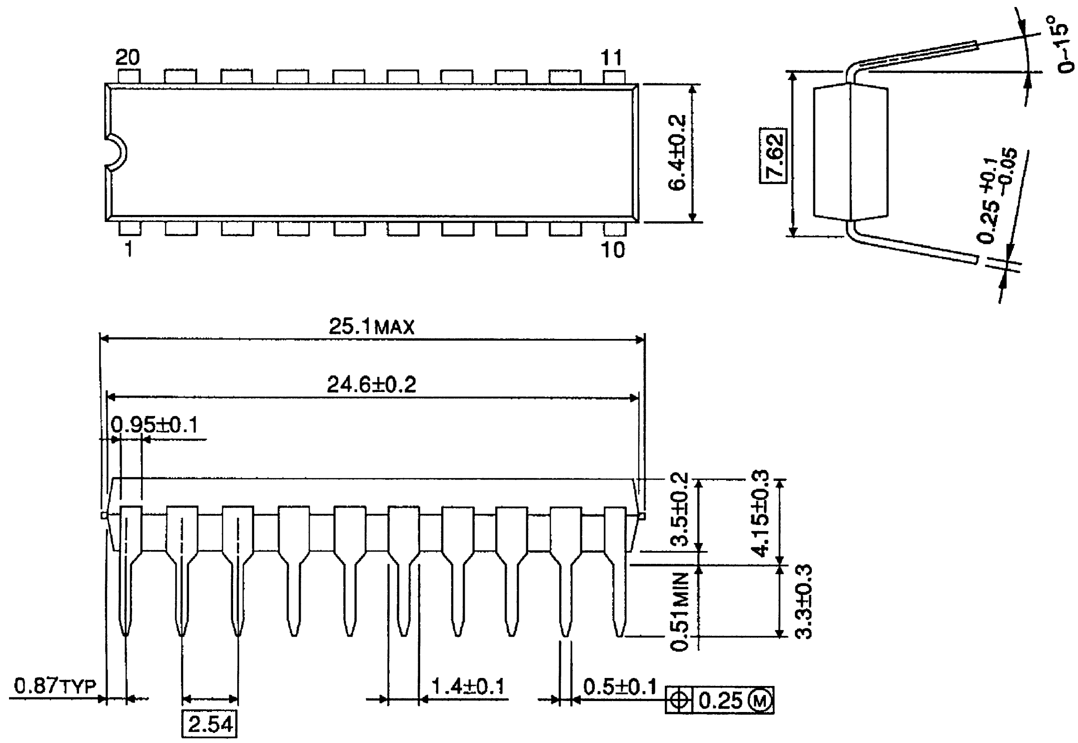


Note: The IC may be destroyed in case of a short-circuit across outputs, a short-circuit to power supply, a short-circuit to ground, or a short-circuit between neighboring pins. This possibility should be fully considered in the design of the output, V_{CC}, V_M and ground lines.



PACKAGE DIMENSIONS

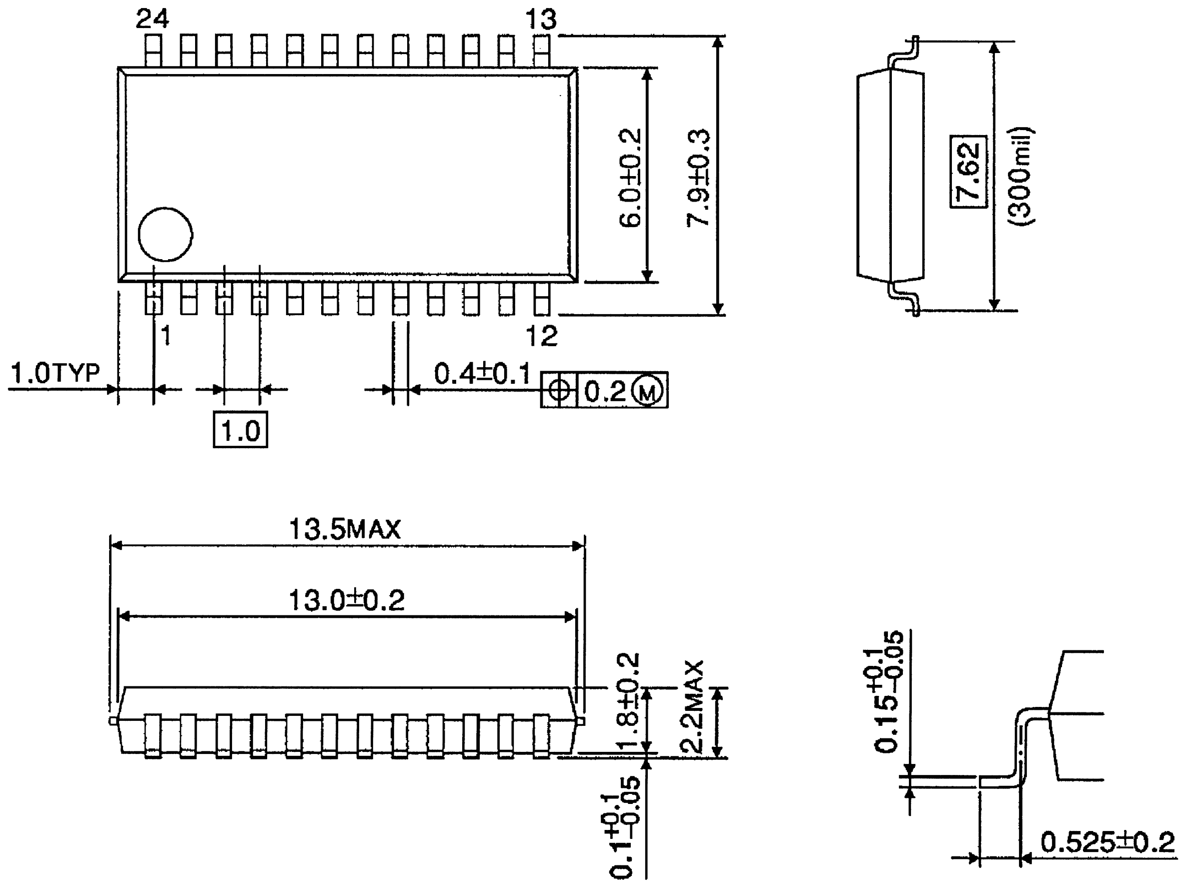
DIP20−P−300−2.54A Unit: mm



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.

RESTRICTIONS ON PRODUCT USE

20070701-EN

- The information contained herein is subject to change without notice.
- 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.
- The TOSHIBA products listed in this document are intended for usage in general electronics applications (computer, personal equipment, office equipment, measuring equipment, industrial robotics, domestic appliances, etc.).These TOSHIBA products are neither intended nor warranted for usage in equipment that requires extraordinarily high quality and/or reliability or a malfunction or failure of which may cause loss of human life or bodily injury ("Unintended Usage"). Unintended Usage include atomic energy control instruments, airplane or spaceship instruments, transportation instruments, traffic signal instruments, combustion control instruments, medical instruments, all types of safety devices, etc.. Unintended Usage of TOSHIBA products listed in his document shall be made at the customer's own risk.
- The products described in this document shall not be used or embedded to any downstream products of which manufacture, use and/or sale are prohibited under any applicable laws and regulations.
- The information contained herein is presented only as a guide for the applications of our products. No responsibility is assumed by TOSHIBA for any infringements of patents or other rights of the third parties which may result from its use. No license is granted by implication or otherwise under any patents or other rights of TOSHIBA or the third parties.
- Please contact your sales representative for product-by-product details in this document regarding RoHS compatibility. Please use these products in this document in compliance with all applicable laws and regulations that regulate the inclusion or use of controlled substances. Toshiba assumes no liability for damage or losses occurring as a result of noncompliance with applicable laws and regulations.
- The products described in this document are subject to foreign exchange and foreign trade control laws.