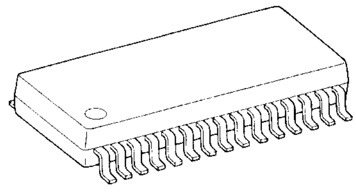
Toshiba Bipolar Linear Integrated Circuit Multi-Chip

TA8493F/FG, TA8493AF/AFG, TA8493BF/BFG

3-Phase Full Wave Brushless DC Motor Driver IC for CD-ROM Drives



Weight: 0.63 g (typ.)

These 3-phase, full-wave, brushless DC motor driver ICs have been developed for use in CD-ROM drive spindle motors. The TA8493F/FG/ AF/AFG/ BF/BFG contain in its upper stage a discrete power transistor (P-ch-MOS) and uses direct PWM control system, which enables the IC to provide superior thermal efficiency.

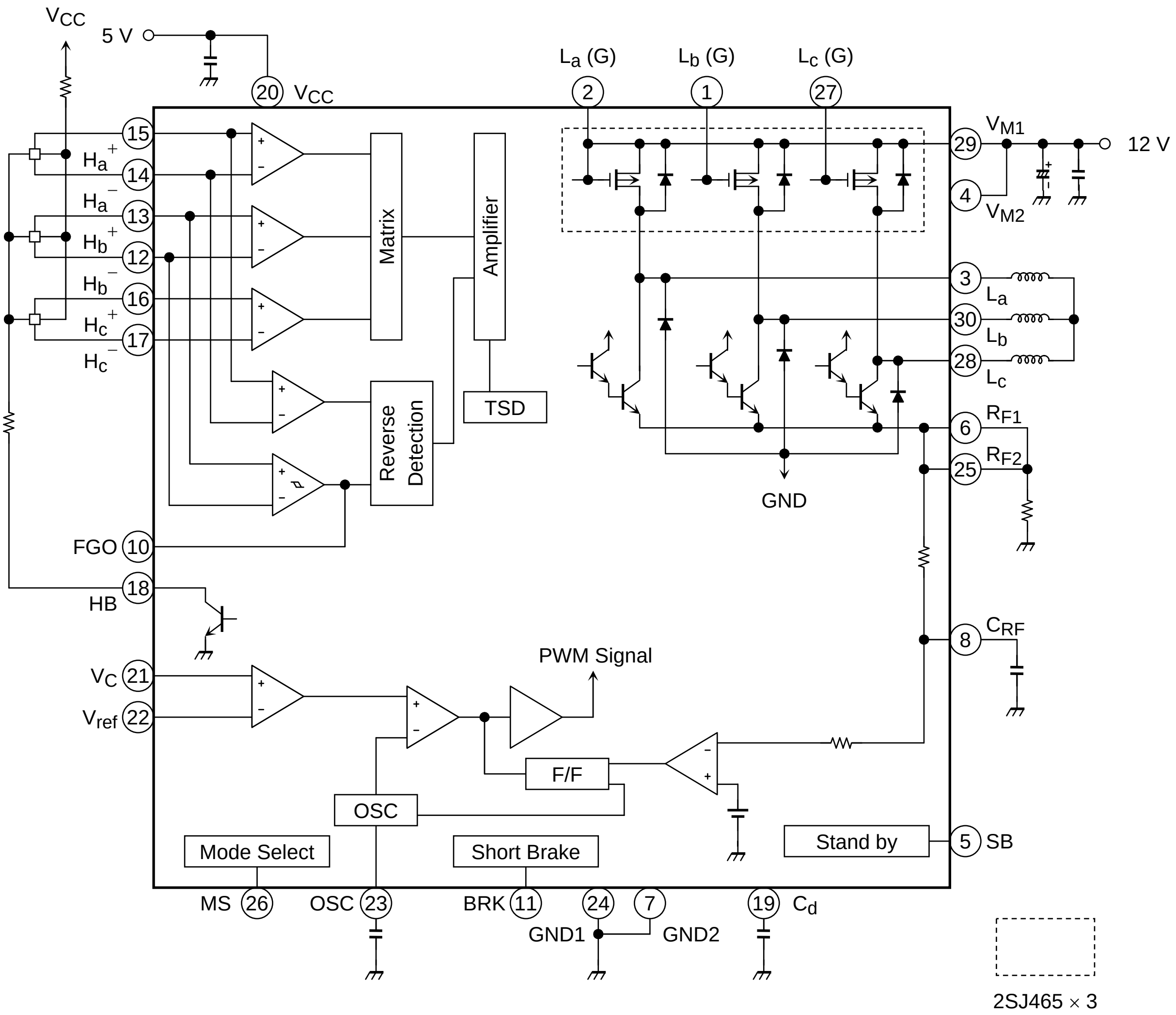
Furthermore, the multi-chip structure of this device facilitates dispersion of the heat generated inside the package, making it possible to suppress heat concentration.

Features

- Multi-chip structure (3 × 2SJ465 chips built-in)
- Direct PWM control system
- Drive system: 120 ° drive system (TA8493F/FG/BF/BFG)
  : 180 ° drive system (TA8493AF/AFG)
- Built-in current limiter: I_{LIM} = 0.7 A (typ.) (at R_F = 0.33 Ω)
- Built-in reversing brake/short brake functions
- FG signal output (using hall element output signal)
- Built-in hall bias
- Built-in thermal shutdown circuit
- Package: MFP-30

TA8493FG/AFG/BFG:
The TA8493FG/AFG/BFG is a Pb-free product.
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



9 pin: N.C.

PIN Assignment

Terminal No.	Terminal Symbol	Function	Remarks
1	L_b (G)	b-phase upper side power transistor (base) output terminal	Keep open.
2	L_a (G)	a-phase upper side power transistor (base) output terminal	Keep open.
3	L_a	a-phase output terminal	Connect to the coil.
4	V_{M2}	Supply voltage terminal for motor drive	Connect to V_{M1} externally.
5	SB	RUN/STOP control terminal	H: RUN, L: STOP
6	R_{F1}	Output current detection terminal	Sets limiter current value. Connect to R_{F2} externally and between this terminal and GND.
7	GND2	GND	—
8	C_{RF}	Output current filter terminal	Connect a capacitor between this terminal and GND.
9	N.C.		
10	FGO	FG amplifier output terminal	Outputs a signal whose frequency is determined by the CD rotation frequency.
11	BRK	Brake mode select terminal	Output mode when $V_C > V_{ref}$
12	H_b^-	b-phase negative hall signal input terminal	Connect to hall element output terminal.
13	H_b^+	b-phase positive hall signal input terminal	Connect to hall element output terminal.
14	H_a^-	a-phase negative hall signal input terminal	Connect to hall element output terminal.
15	H_a^+	a-phase positive hall signal input terminal	Connect to hall element output terminal.
16	H_c^+	c-phase positive hall signal input terminal	Connect to hall element output terminal.
17	H_c^-	a-phase negative hall signal input terminal	Connect to hall element output terminal.
18	HB	Hall element bias terminal	Open collector output. Connect to the negative side of hall element bias line.
19	C_d	Forward/reverse changeover gain adjustment terminal	Adjust a rotation direction changeover gain
20	V_{CC}	Supply voltage terminal for control circuits	$V_{CC\ (opr)}$ = 4.5 to 5.5 V
21	V_C	Control amplifier input terminal	Use the control signal as input.
22	V_{ref}	Control amplifier reference voltage input terminal	Use the reference voltage for the control amplifier as input.
23	OSC	Triangular wave oscillation terminal	Connect a capacitor between this terminal and GND.
24	GND1	GND	—
25	R_{F2}	Output current detection terminal	Sets limiter current value. Connect to R_{F1} externally and between this terminal and GND.
26	MS	Mode select terminal	Determines output mode.
27	L_c (G)	c-phase upper side power transistor (base) output terminal	Keep open.
28	L_c	c-phase output terminal	Connect to the coil.
29	V_{M1}	Supply voltage terminal for motor drive	Connect to V_{M2} externally.
30	L_b	b-phase output terminal	Connect to the coil.

Absolute Maximum Ratings (Ta = 25°C)

Characteristics	Symbol	Rating	Unit
Power Supply Voltage	V_{CC}	7	V
	V_M	16	
Output Current	I_O	1.5	A
Power Dissipation	P_D (Note1)	1.0	W
Junction Temperature	T_j	150	°C
Operating Temperature	T_{opr}	−20 to 75	°C
Storage Temperature	T_{stg}	−55 to 150	°C

Note1: unmounted

Operating Voltage Range

Characteristics	Symbol	Operating Range	Unit
Power Supply Voltage	V_{CC}	4.5 to 5.5	V
	V_M	10 to 14	

Electrical Characteristics (V_{CC} = 5 V, V_M = 12 V, Ta = 25°C)

Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Supply Voltage		I_{CC1}	1	Stop mode	—	0.3	0.8	mA
		I_{CC2}		Run mode, output open	—	7	15	
Hall Amp.	Input Current	I_{INH}	2	V_{CMRH} = 2.5 V, (sink current)	—	—	2	μA
	Common Mode Input Voltage Range	V_{CMRH}		—	1.5	—	4.0	V
	Input Amplitude	V_H		—	100	—	—	mV_{p-p}
Hall Element Bias Saturation Voltage		V_{HB}	2	I_{HB} = 10 mA	—	1.3	2.0	V
Control Amp.	Common Mode Input Voltage Range	V_{CMRC}	2	—	0.5	—	4.0	V
	Input Current	I_{INC}		$V_C = V_{ref}$ = 1.65 V, (source current)	—	—	5.0	μA
	Dead Zone Voltage Width	V_{DZ}	—	V_{ref} = 1.65 V, R_F = 0.33 Ω (Note2)	—	100	—	mV
	Input Offset Voltage	$\Delta V_{OFF (F)}$	2	CW mode, V_{ref} = 1.65 V, R_F = 0.33 Ω	20	50	150	
		$\Delta V_{OFF (R)}$		CCW mode, V_{ref} = 1.65 V, R_F = 0.33 Ω	20	50	150	
Current Limit Amp.	Limit Current	I_{LIM}	—	R_F = 0.33 Ω (Note2)	—	700	—	mA
		V_{LIM}	3	—	0.25	0.3	0.35	V
RUN/STOP Control Circuit	Input Voltage (H)	$V_{INS (H)}$	1	(RUN)	3.0	—	V_{CC}	V
	Input Voltage (L)	$V_{INS (L)}$		(STOP)	GND	—	1.0	
	Input Current	$I_{INS (L)}$		V_{INS} = GND, (source current)	—	—	1	μA

Note2: this is not tested.

Characteristics		Symbol	Test Circuit	Test Condition	Min	Typ.	Max	Unit
Output Circuit	Output Resistance (upper side)	$R_{ON (U)}$	4	I_O = 0.6 A	—	0.5	1.0	Ω
	Saturation Voltage (lower side)	$V_{SAT (L)}$		I_O = 0.6 A	—	0.4	0.8	V
	Cut-off Current (upper side)	$I_{L (U)}$	5	V_L = 16 V	—	—	10	μA
	Cut-off Current (lower side)	$I_{L (L)}$		V_L = 16 V	—	—	10	
Mode Select Circuit	Input Voltage (H)	$V_{MS (H)}$	6	CCW mode $V_C > V_{ref}$, BRK: L	3.0	—	V_{CC}	V
	Input Voltage (L)	$V_{MS (L)}$		Reversing brake mode $V_C > V_{ref}$, BRK: L	—	—	0.5	
	Input Current	I_{INMS}		V_{MS} = GND, (source current)	—	—	1	μA
FG Amp.	Hysteresis Voltage	V_{HYS}	8	—	5	20	45	mV_{p-p}
	Output Voltage (H)	$V_{OFG (H)}$	7	Source current: 10 μA	V_{CC} − 0.5	—	—	V
	Output Voltage (L)	$V_{OFG (L)}$		Sink current: 10 μA	—	—	0.5	
Short Brake Circuit	Input Voltage (H)	$V_{BRK (H)}$	6	—	3.0	—	V_{CC}	V
	Input Voltage (L)	$V_{BRK (L)}$		—	—	—	0.5	
	Input Current	I_{INBRK}		V_{BRK} = GND, (source current)	—	—	1	μA
Triangular Oscillation Circuit	Oscillation Frequency	f_{OSC}	—	C = 560 pF (Note2)	—	39	—	kHz
Thermal Shut-down Operating Temperature		TSD	—	Junction temperature (according to design specification) (Note2)	—	175	—	°C

Note2: this is not tested.

Function Table

			Forward			Reverse		
H_a	H_b	H_c	L_a	L_b	L_c	L_a	L_b	L_c
H	L	L	H	L	M	L	H	M
H	H	L	H	M	L	L	M	H
L	H	L	M	H	L	M	L	H
L	H	H	L	H	M	H	L	M
L	L	H	L	M	H	H	M	L
H	L	H	M	L	H	M	H	L

<Forward>

$L_a = -(H_c - H_a)$
$L_b = -(H_a - H_b)$
$L_c = -(H_b - H_c)$

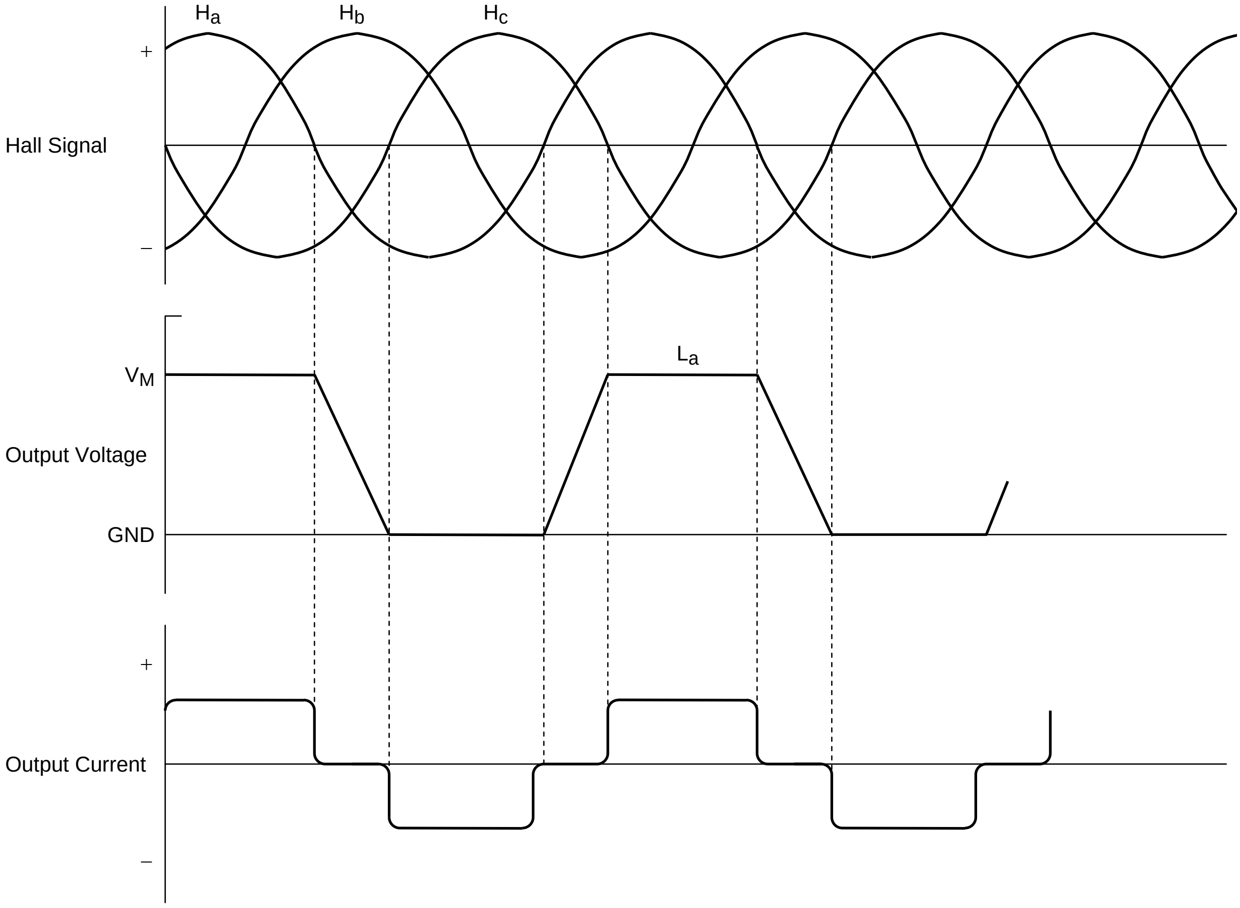
<Reverse>

$L_a = (H_c - H_a)$
$L_b = (H_a - H_b)$
$L_c = (H_b - H_c)$

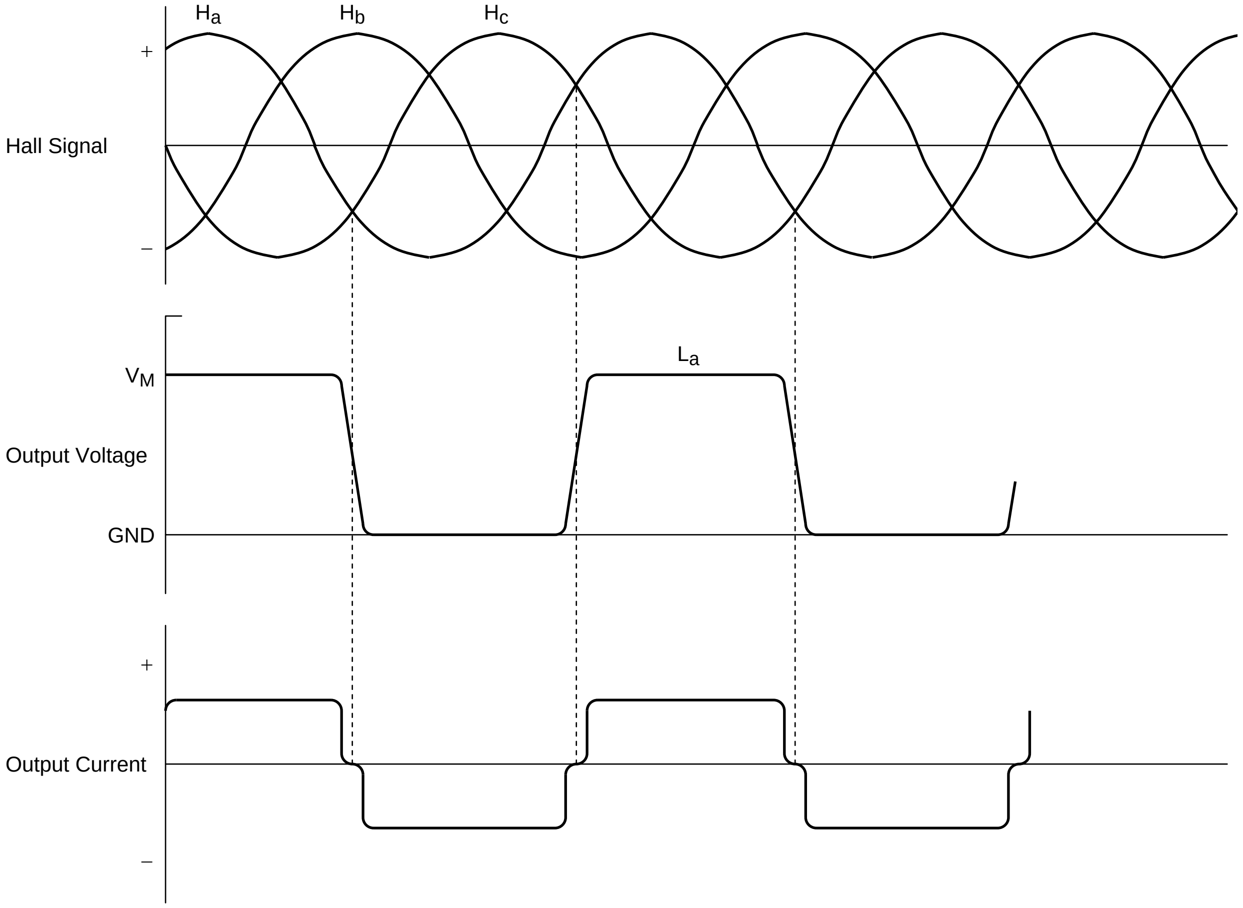
Timing Diagram

<Forward>

(TA8493F/FG/BF/BFG)



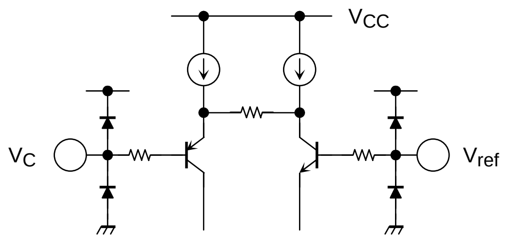
(TA8493AF/AFG)



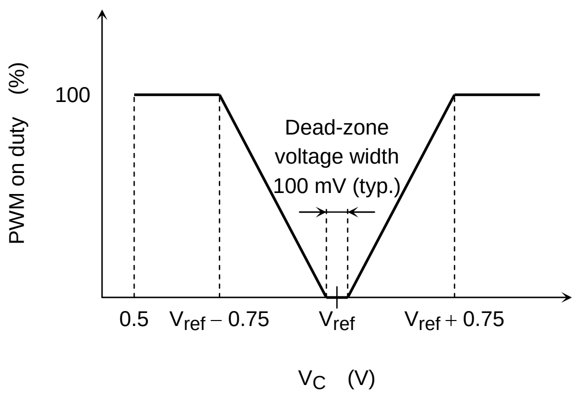
Functional Description

This IC is a 3-phase, full wave brushless DC motor driver of the direct PWM control type.

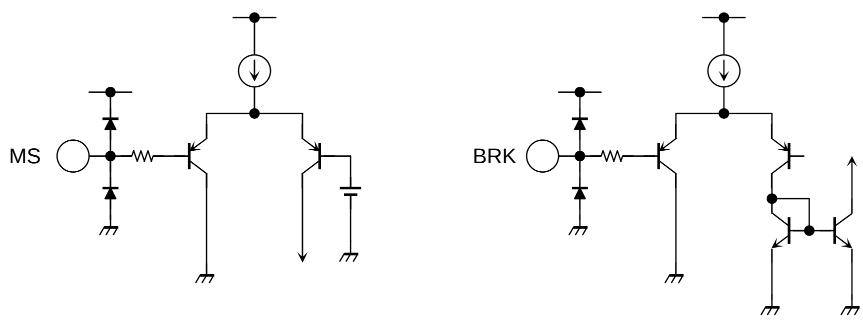
- Control amp input circuit



The common mode input voltage ranges for both V_C and V_{ref} are 0.5 to 4.0 V.
Relation between control input and PWM ON duty is shown below, PWM ON duty is 100% when $|V_{ref} - V_C| = 0.75$ V (typ.)
The input is provided with a dead-zone area whose voltage width is 100 mV (typ.)



- Mode select/short brake circuit



When $V_C > V_{ref}$, one of three modes (reverse rotation, reversing brake or short brake mode) can be selected by setting the MS and BRK pins appropriately.

<Function>

$V_C < V_{ref}$

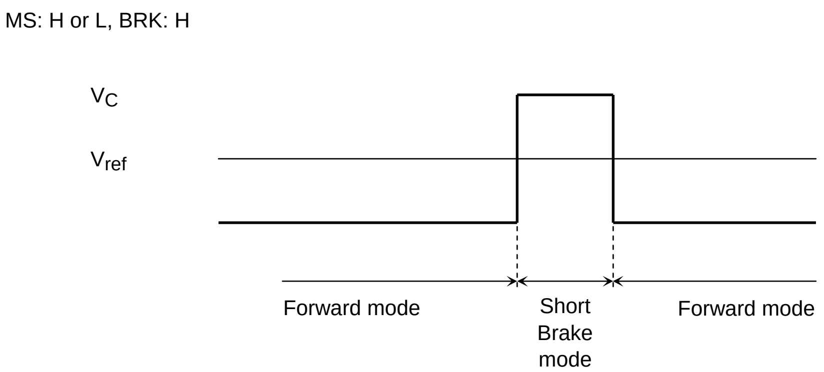
		BRK	
		H	L
MS	H	Forward	Forward
	L	Forward	Forward

$V_C > V_{ref}$

		BRK	
		H	L
MS	H	Short brake	Reverse
	L	Short brake	Reversing brake

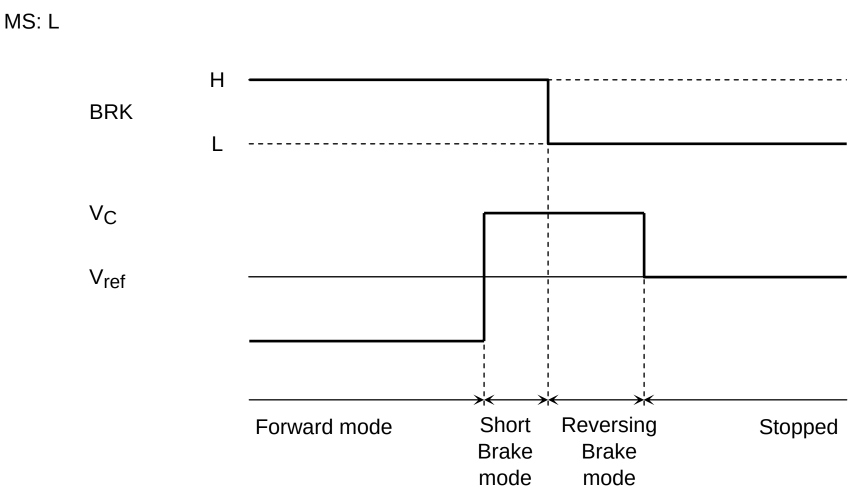
In Short Brake mode, the upper-stage power transistor is turned on and the lower-stage power transistor is turned off.

(short brake)

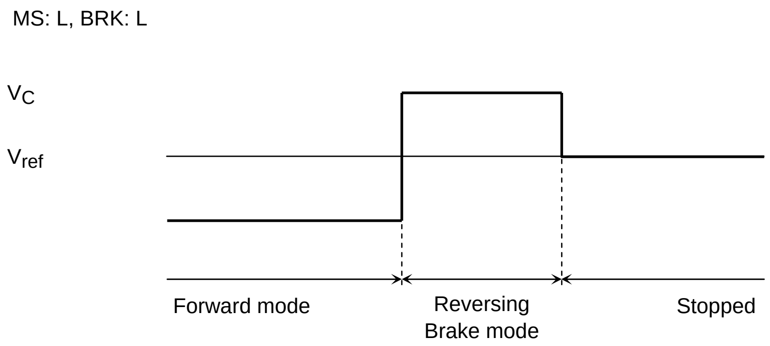


(reversing brake)

(1) When stopping the motor by applying a reversing brake after a short brake



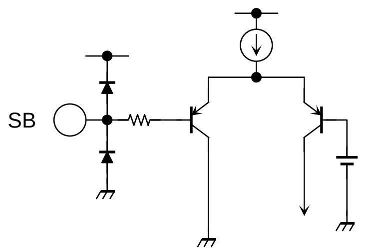
(2) When stopping the motor using reversing brake mode



Note3: For an explanation of the Reversing Brake mode stopping sequence, refer to the explanation of the reverse rotation detection circuit.

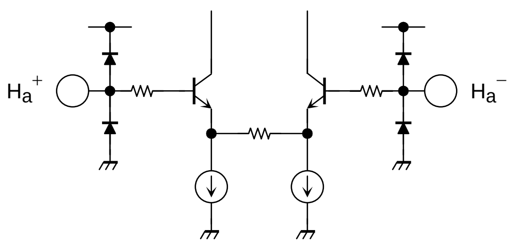
The short brake generates less heat than the reversing brake. Therefore Toshiba recommends a combined use of the short and reversing brakes when stopping the motor.

- Run/stop control circuit



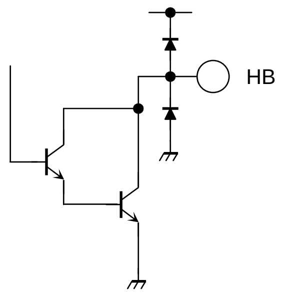
When the driver IC is standing by, all of its circuits except the FG amp and the hall amp are turned off.
H: start
L: standby

- Hall amp circuit



The common mode input voltage range for V_{CMRH} is 1.5 to 4.0 V.

- Hall element bias circuit

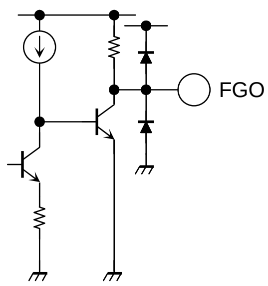


The hall element bias current is turned off when the driver IC is in standby state.
Make sure that the negative hall bias line is connected to the HB pin.
The remaining voltage is as follows:

V_{HB} = 1.2 V (typ.)   at I_{HB} = 10 mA

Furthermore, this circuit cannot be used if FG output is necessary in standby state.
When the HB terminal is not used, the negative hall bias line must be connected to GND with a resistor in between.

- FG amp circuit



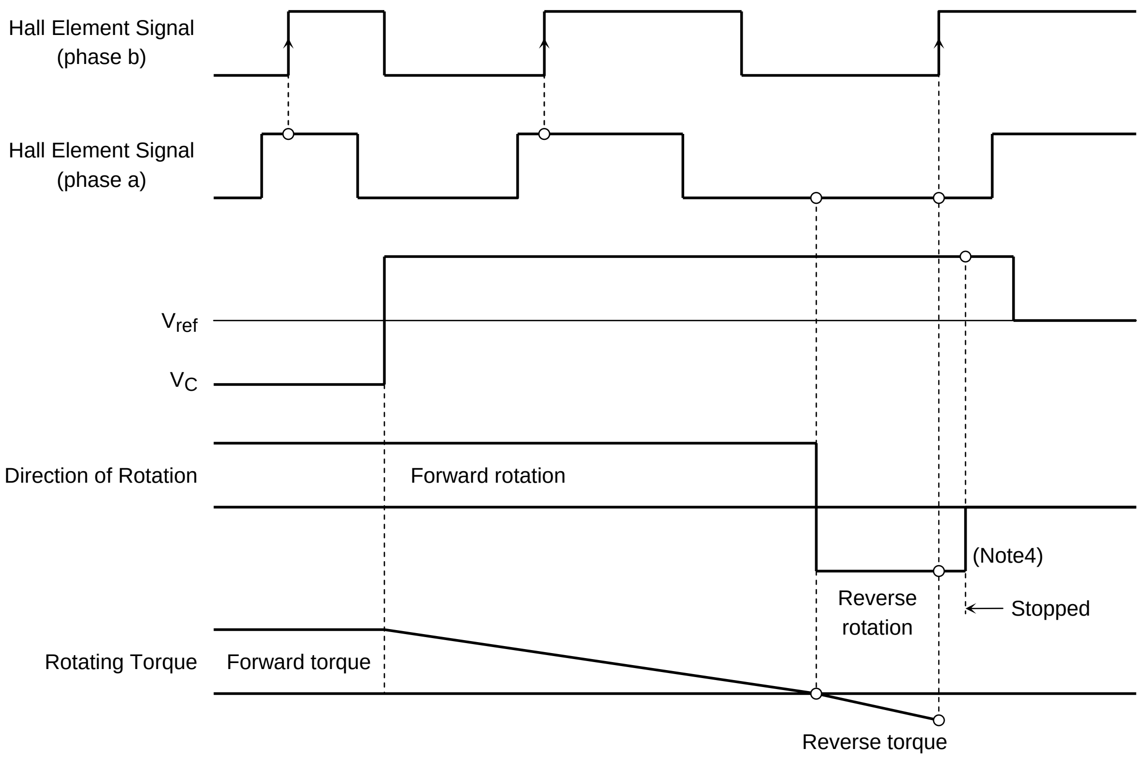
This circuit uses a hall element signal which is output to FGO after a Schmitt stage.
The FG amp has a hysteresis of 20 mV_{p-p} (typ.) and its output voltages are

High level: V_{CC} − 0.5 to V_{CC} [V]
Low level: GND to 0.5 V   at I_{OFG} = 10 μA

The FG amp is active when it is in standby state. When the hall element signal is input, the FG signal is output.

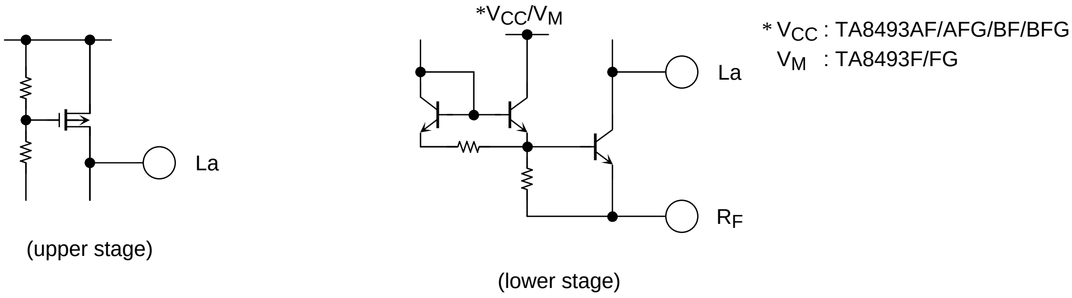
• Reverse rotation detection circuit

By comparing the two phases of the Hall element signal, this circuit detects a state where the phases are inverted, at which time the torque is reduced to 0. The detection accuracy is determined by the number of pulses per rotation of Hall element output.



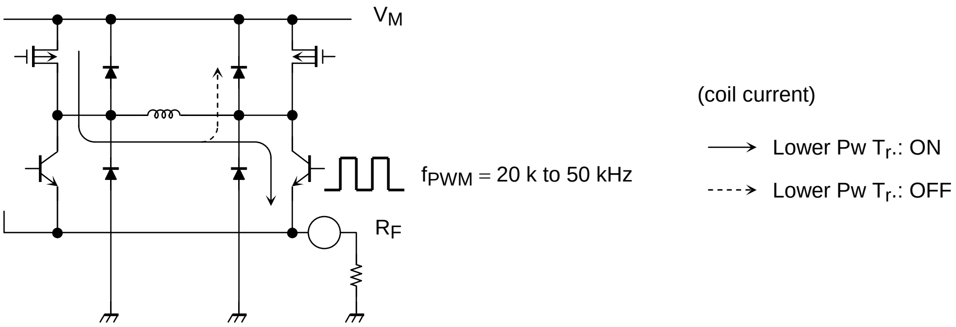
Note4: Due to its inertial force, the motor does not stop immediately after the torque is reduced to 0.

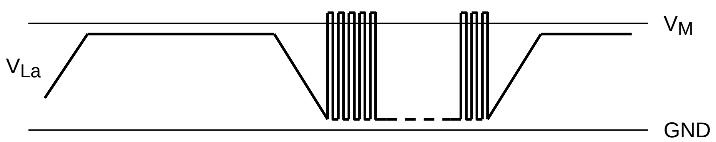
• Output circuit



This circuit uses the system to chop the lower power transistors and resurrect coil current through upper stage diodes.

The upper-stage power transistors consist of Pch-MOS transistors (2SJ465), which give high torque efficiency.





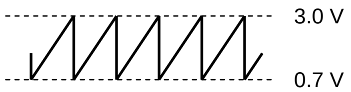
Note: Lower-stage predrivers of TA8493AF/AFG/BF/BFG are supplied by V_{CC} to reduce the power dissipation.

• Triangular wave oscillator circuit

Triangular waves are generated by connecting a capacitor between the OSC pin and GND.

This circuit is current output type, which makes PWM signal by comparing its output current with control amp output current.

$$f_{OSC}\ [Hz] = \frac{50 \times 10^{-6}\ [A]}{(3.0 - 0.7)\ [V] \times C\ [F]}$$



Taking into account efficiency considerations and the effects of noise, Toshiba recommends using the IC with an oscillation frequency of 20 kHz to 50 kHz.

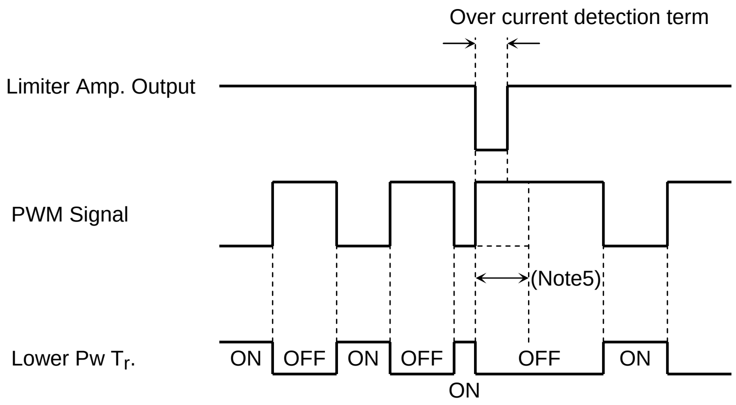
- Current limiter circuit

  The current limit value is determined by the equation below.

  $$I_{LIM} \simeq \frac{0.3}{R_F + 0.1} \text{ [A] (typ.)}$$

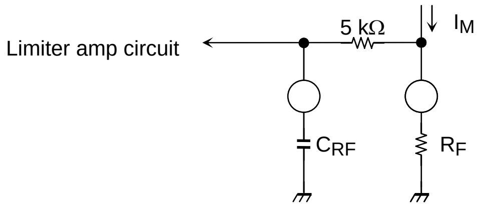
  This circuit cut off lower power transistors compulsorily when filtered V_{RF} is more than reference voltage. (0.3 V)

  PWM signal cut off compulsorily is released from OFF state by next ON signal.



Note5: Keep "H" level in this term

Consider inside resistance (5 kΩ) when setting the capacitance value (C_{RF}).



- Thermal shut down circuit

  The circuit turns off output when T_j = 175°C (typ.) (according to design specification)

External Parts

Terminal No.	Function	Recommended Value	Remarks
C_1	Power supply line oscillation prevention	0.22 μF	—
C_2	Power supply line noise prevention	100 pF to 1000 pF	(Note6)
C_3	Power supply line noise prevention	10 μF to 33 μF	(Note6)
C_4	Filter	470 pF	—
C_5	Forward/reverse changeover gain adjustment	0.01 μF	(Note7)
C_6	Triangular wave oscillation	470 pF to 1000 pF	—
R_1	Hall element bias	—	(Note8)
R_2	Control amp reference voltage	—	(Note9)
R_3	Output current detection	0.25 Ω to 0.5 Ω	—

Note6: Absorb switching noise by C_2 and C_3.

Note7: This is used to adjust the rotation direction changeover gain.

This capacitance valve and the gain are in inverse.

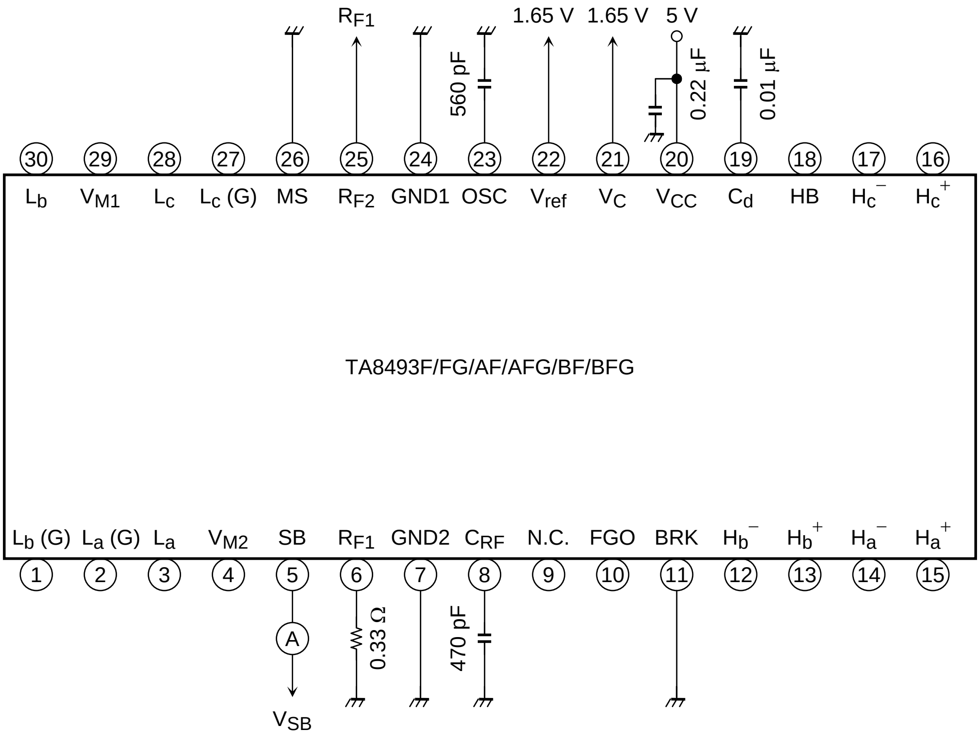
This capacitance is to prevent from output through current.

Note8: Be sure to set this bias so that the hall element output amplitude and common mode input voltage fall within the ranges specified in the table of electrical characteristic.

Note9: The voltage must be set to fall within the common mode input voltage range of the control amp.

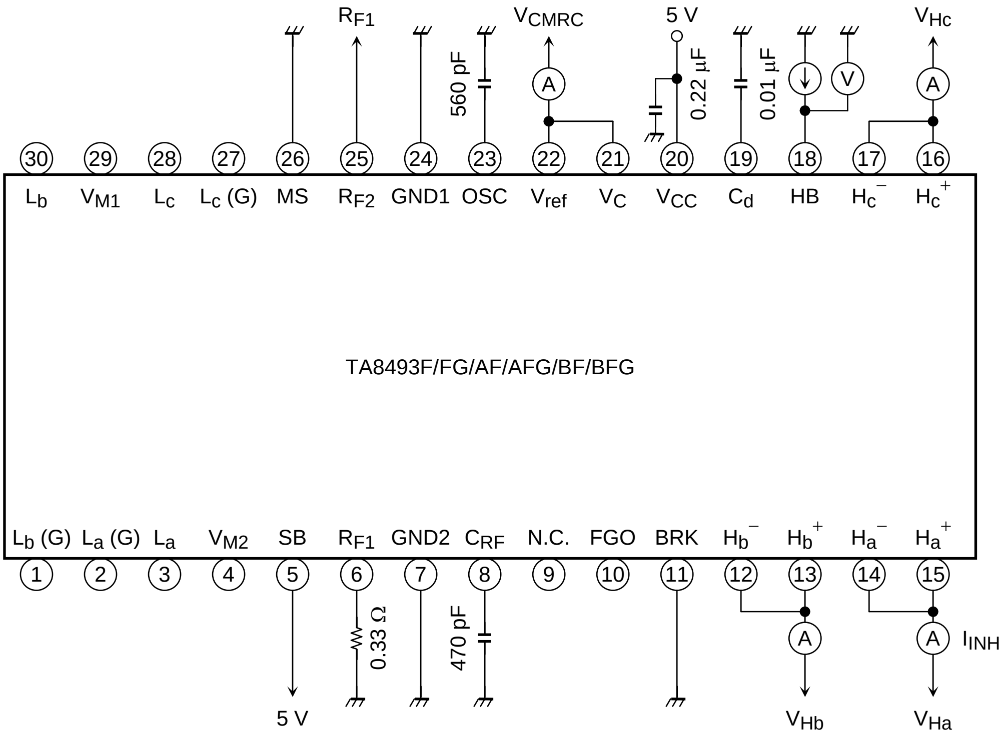
Test Circuit

1. I_{CC1}, I_{CC2}, $V_{INS (H)}$, $V_{INS (L)}$, I_{INS}



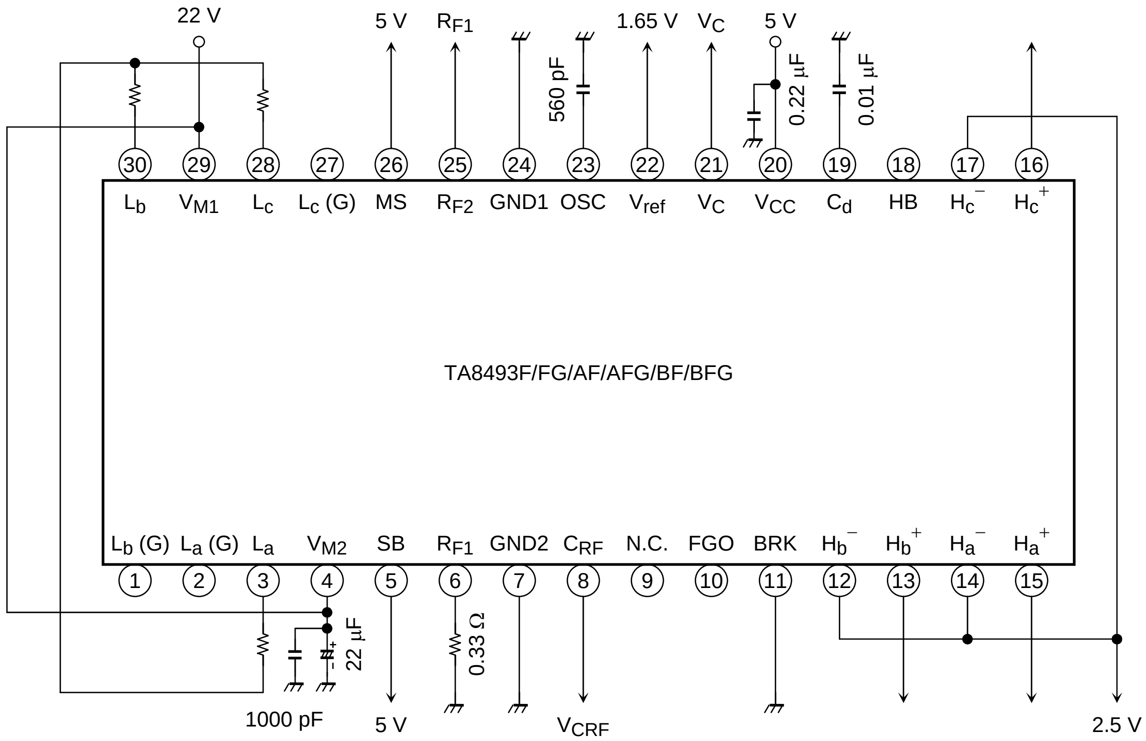
- I_{CC1}: V_{SB} = 0.5 V
- I_{CC2}: V_{SB} = 3.0 V
- $V_{INS (H)}$, $V_{INS (L)}$: Judged by the gap between I_{CC1} and I_{CC2}
- I_{INS}: V_{INS} = 0 V

2. I_{INH}, I_{CMRH}, V_{HB}, I_{INC}, V_{CMRC}



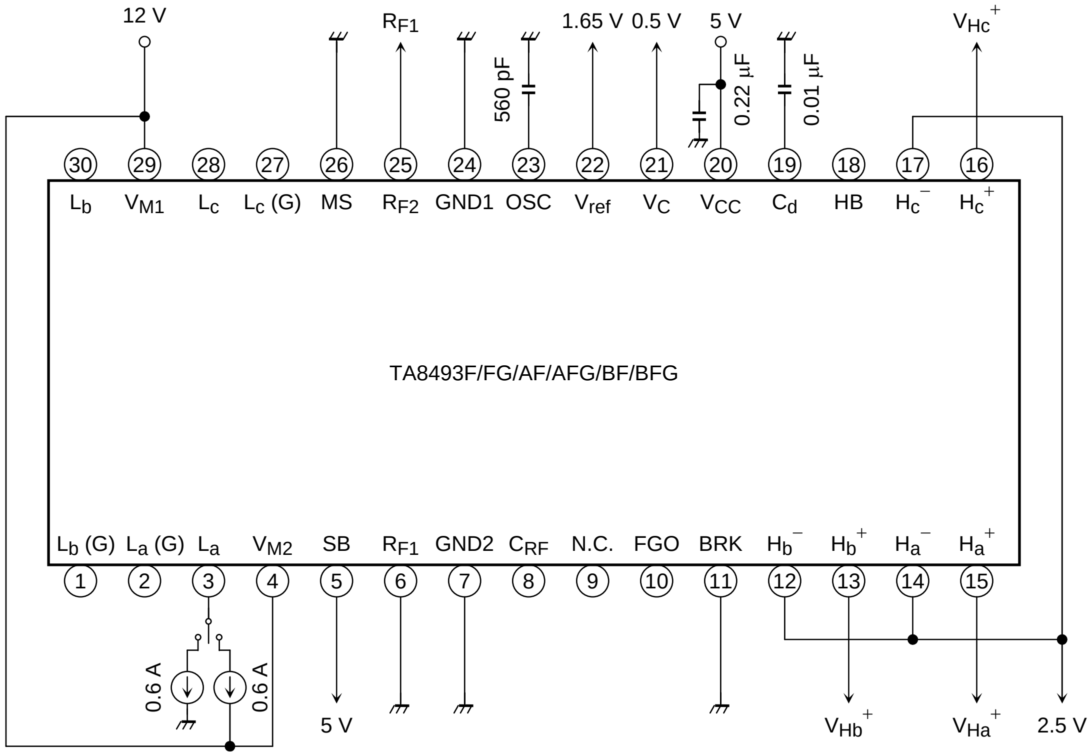
- I_{INH}: Total of a phase negative and positive input current.
  $V_{Ha} = V_{Hb} = V_{Hc} = 2.5$ V
- V_{CMRH}: Measure the I_{INH} gap between $V_{Ha} = 1.5$ V and $V_{Ha} = 4.0$ V.
  b and c phase are measured the same method.
- V_{HB}: $I_{HB} = 10$ mA
- V_{INC}: Total of V_C and V_{ref} input current. At $V_{CMRC} = 1.65$ V.
- V_{CMRC}: Measure the I_{INC} gap between $V_{CMRC} = 0.5$ V and $V_{CMRC} = 4.0$ V.

3. $\Delta V_{OFF\ (F)}$, $\Delta V_{OFF\ (R)}$, V_{LIM}



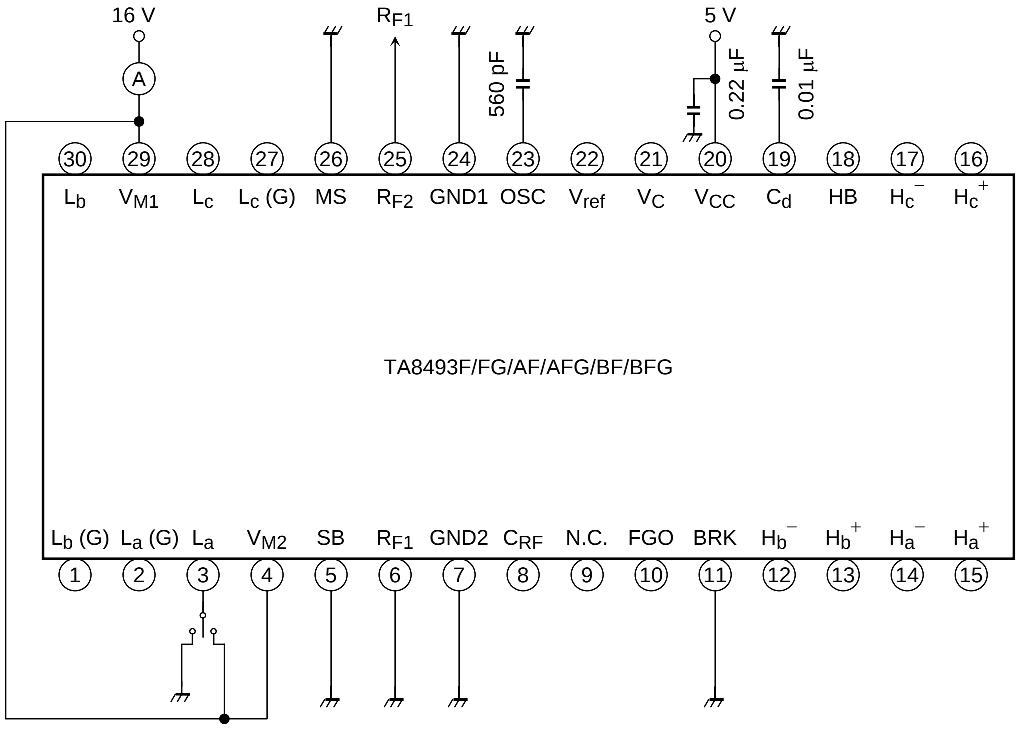
- $\Delta V_{OFF\ (F)}$: Measure V_{RF} at V_C = 1.63 V/1.5 V.
- $\Delta V_{OFF\ (R)}$: Measure V_{RF} at V_C = 1.67 V/1.8 V.
- V_{LIM}: Switch the V_{CRF} from 0 V to 0.4 V.
  Measure the V_{CRF} at the point when output voltage level changes from low (L) to high (H)

4. $R_{ON\ (U)}$, $V_{SAT\ (L)}$



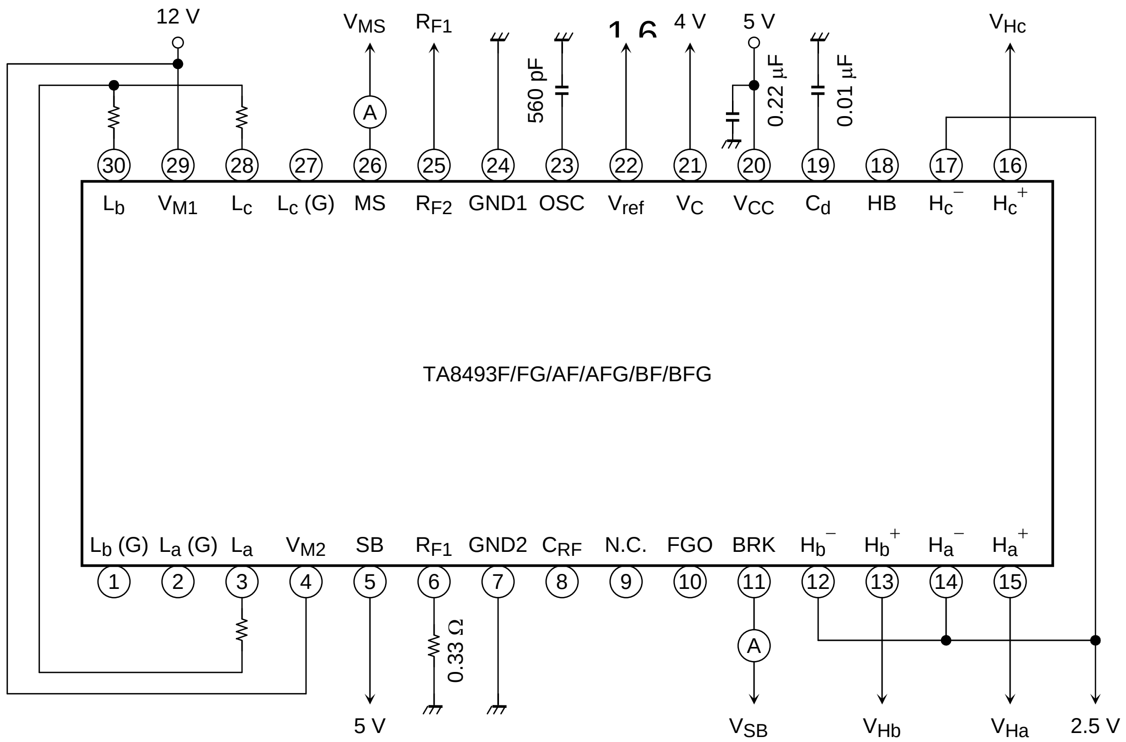
- $R_{ON\ (U)}$: Determined output function by V_{Ha}^{+}, V_{Hb}^{+}, V_{Hc}^{+} (2.45 V/2.55 V).
  Measure voltage value between V_M and L_a, and change to resistance valve. b phase and c phase are measured the same method.
- $V_{SAT\ (L)}$: Determined output function by V_{Ha}^{+}, V_{Hb}^{+}, V_{Hc}^{+} (2.45 V/2.55 V).
  Measure voltage value between L_a and GND. b phase and c phase are measured the same method.

5. $I_{L\,(U)}$, $I_{L\,(L)}$



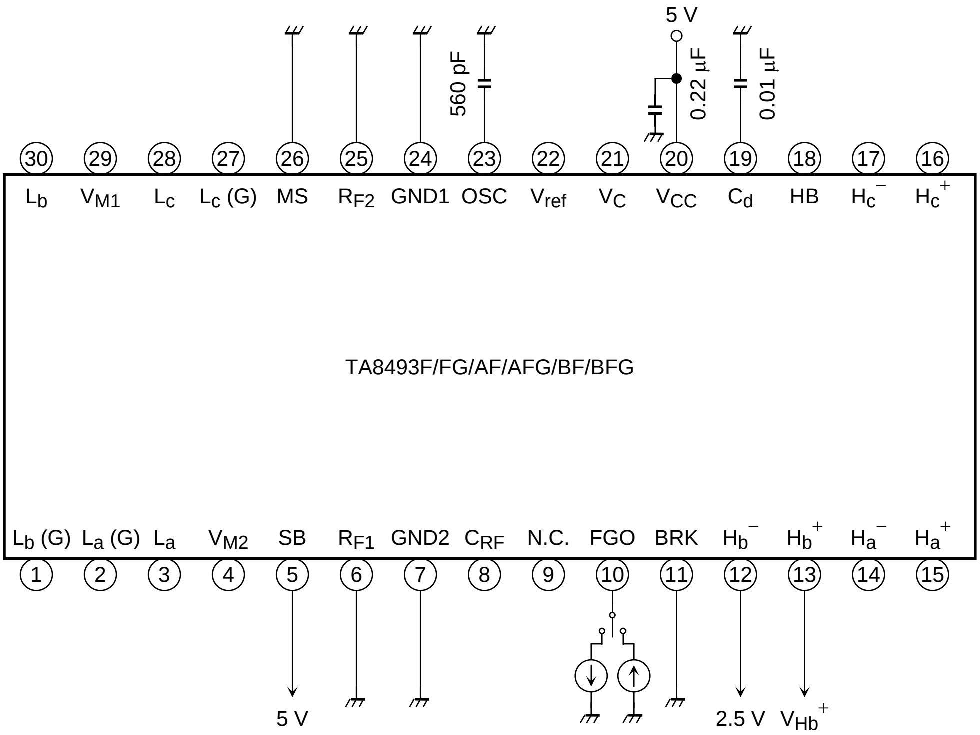
- $I_{L\,(U)}$: Measure I_M when L_a and GND are shorted. b phase and c phase are measured the same method.
- $I_{L\,(L)}$: Measure I_M when V_M and L_a are shorted. b phase and c phase are measured the same method.

6. $V_{MS\ (H)}$, $V_{MS\ (L)}$, I_{INS}, $V_{BRK\ (H)}$, $V_{BRK\ (L)}$, I_{INBRK}



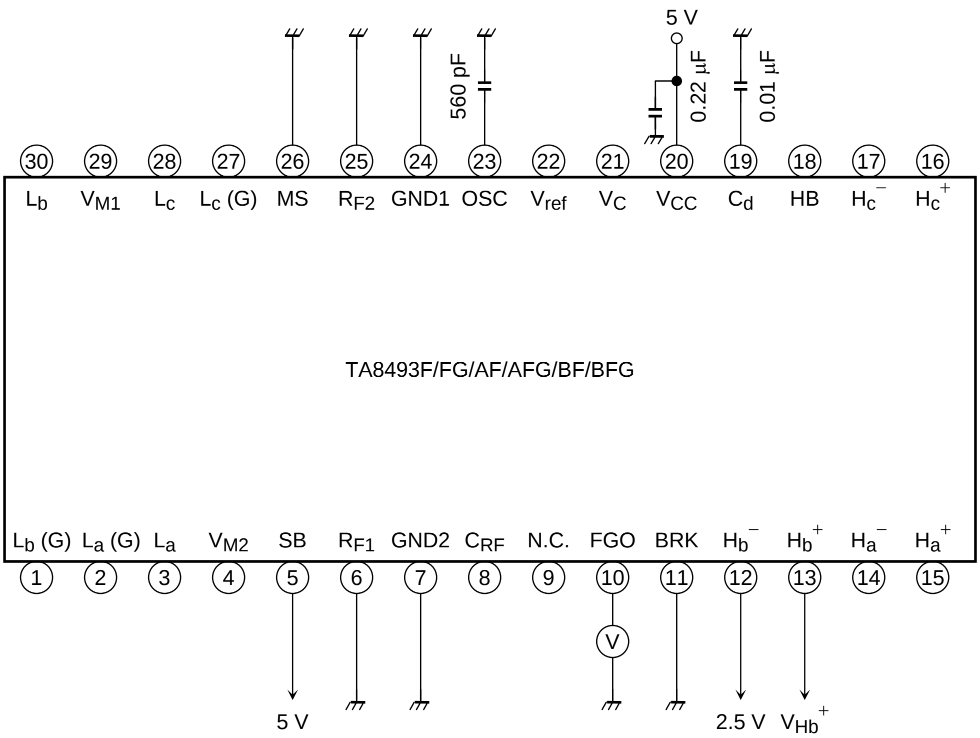
- $V_{MS\ (H)}$: V_{MS} = 3.0 V, V_{BRK} = 0 V, verify that output function is reverse mode.
- $V_{MS\ (L)}$: V_{MS} = 0.5 V, V_{BRK} = 0 V, switch from foward mode to reverse mode by V_{Ha}, V_{Hb} V_{Hc}. Verify that V_{RF} changes to zero.
- $I_{MS\ (L)}$: V_{MS} = 0 V, V_{BRK} = 0 V
- $V_{BRK\ (H)}$: V_{MS} = 5 V, V_{BRK} = 3.0 V, verify that $L_a = L_b = L_c$: H
- $V_{BRK\ (L)}$: V_{MS} = 5 V, V_{BRK} = 0.5 V, verify that output function is reverse mode.

7. $V_{OFG\ (H)}$, $V_{OFG\ (L)}$



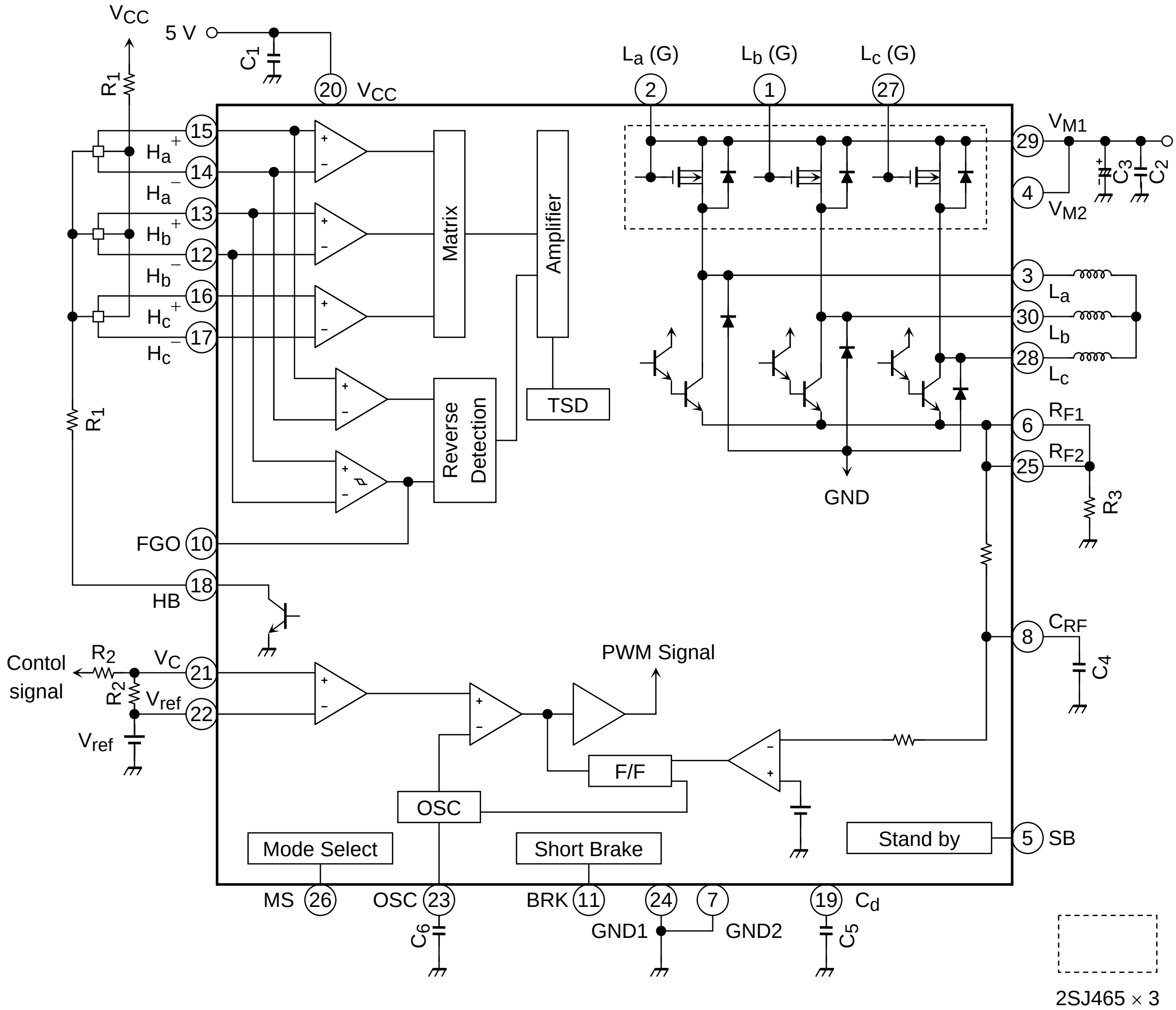
- $V_{OFG\ (H)}$: V_{Hb}^{+} = 2.53 V, I_{FGO} = 10 μA (source)
- $V_{OFG\ (L)}$: V_{Hb}^{+} = 2.47 V, I_{FGO} = 10 μA (sink)

8. V_{HYS}



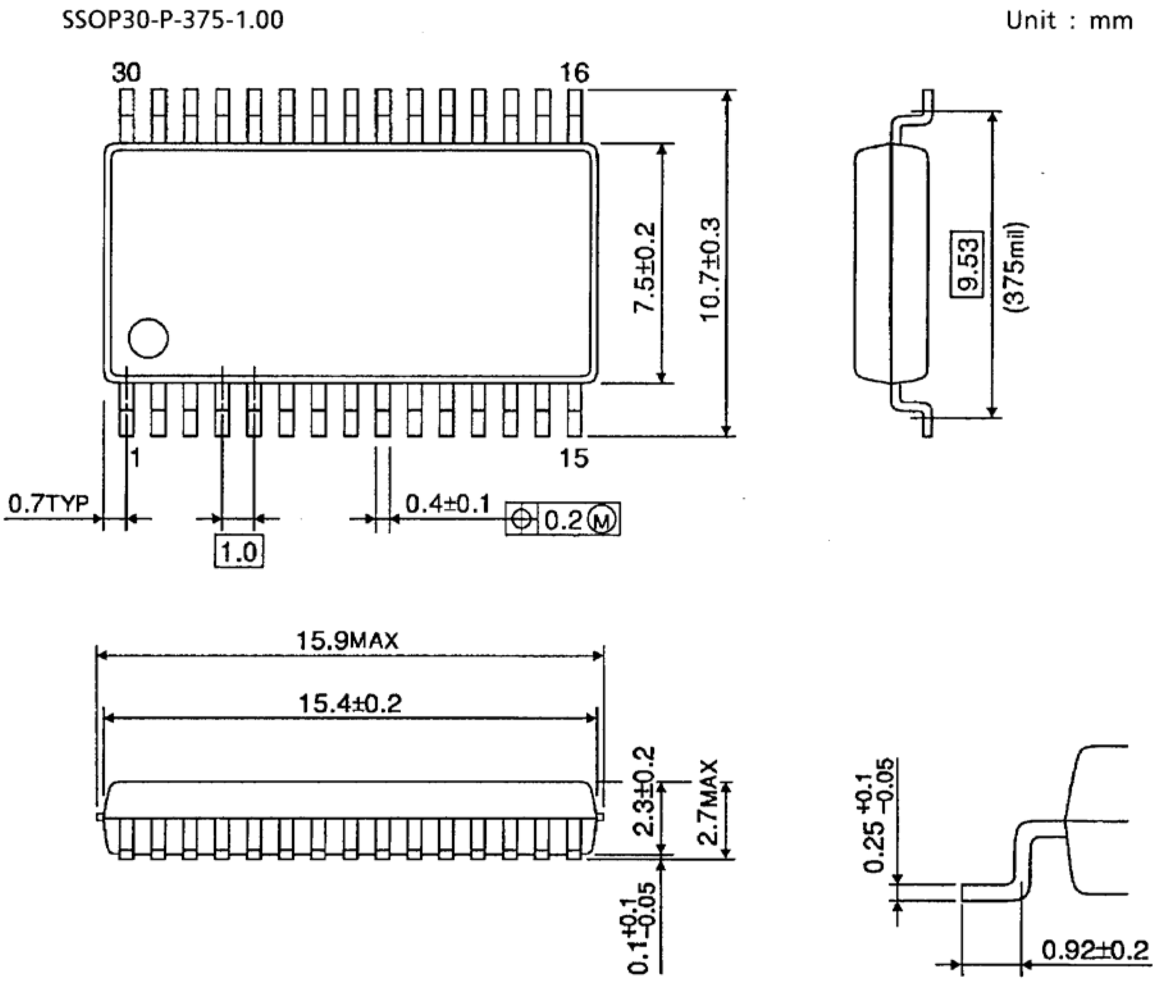
- V_{HYS}: Switch the V_{Hb}^{+} from high (H) to low (L) and from (L) to (H).
  Measure the V_{Hb}^{+} at the point when FGO function changes.

Application Circuit



Note10: 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.

Package Dimensions



Weight: 0.63 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) Over current Protection Circuit

Over current protection circuits (referred to as current limiter circuits) do not necessarily protect ICs under all circumstances. If the Over current protection circuits operate against the over current, clear the over current status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the over current protection circuit to not operate properly or IC breakdown before operation. In addition, depending on the method of use and usage conditions, if over current continues to flow for a long time after operation, the IC may generate heat resulting in breakdown.

(2) Thermal Shutdown Circuit

Thermal shutdown circuits do not necessarily protect ICs under all circumstances. If the thermal shutdown circuits operate against the over temperature, clear the heat generation status immediately.

Depending on the method of use and usage conditions, such as exceeding absolute maximum ratings can cause the thermal shutdown circuit to not operate properly or IC breakdown before operation.

(3) 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.

(4) 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

060116EBA

- The information contained herein is subject to change without notice. 021023_D
- 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
- 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 this document shall be made at the customer's own risk. 021023_B
- 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. 060106_Q
- 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 patent or patent rights of TOSHIBA or others. 021023_C
- The products described in this document are subject to the foreign exchange and foreign trade laws. 021023_E